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Description of two new species of the microhylid frog genus *Oreophryne* (Amphibia: Anura: Microhylidae) from southern Papua New Guinea

Rainer Günther [1] & Stephen Richards [2]

[1] Museum für Naturkunde, Invalidenstr. 43, 10115 Berlin, Germany; rainer.guenther(at)mfn-berlin.de — [2] Herpetology Department, South Australian Museum, North Terrace, Adelaide, South Australia 5000, Australia; steve.richards(at)samuseum.sa.gov.au

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Abstract

Two new species of the microhylid genus *Oreophryne* are described on the basis of material collected from the Kikori River Basin in southern Papua New Guinea. Both species belong to the group of *Oreophryne* that have a ligamentous connection between the procoracoid and scapula. One of the new species is small (snout-urostyle length in males 19.7 – 23.3 mm and in females 23.8 – 27.4 mm), and males can be distinguished from congeners in this group by having one or a few conspicuous yellow spots in the inguinal region and an advertisement call consisting of a loud rattle lasting 1.4 – 2.3 seconds. The second species is larger (males 25.9 – 31.4 mm and females 30.1 – 34.7 mm) and in life has a uniform brownish-grey dorsum with numerous tiny white dots. Its advertisement call is a series of 9 – 15 'whistling' or 'peeping' notes. Both species are predominantly arboreal, normally calling from perches more than 2 m above the ground.

Kurzfassung

Auf der Basis von Material, das in den Jahren 2001 – 2003 im Kikori River Basin im südlichen Papua Neuguinea gesammelt wurde, werden hier zwei neue Frösche aus der Microhyliden-Gattung *Oreophryne* beschrieben. Beide Arten zeichnen sich durch eine ligamentöse Verbindung zwischen Procoracoid und Scapula aus. Eine der neuen Arten ist klein (Kopf-Rumpf-Länge der Männchen 19,7 – 23,3 mm und der Weibchen 23,8 – 27,4 mm) und die meisten Männchen können von ihren Gattungsverwandten durch einen oder mehrere auffällige gelbe Flecken in der Inguinalregion sowie ihre knarrenden Paarungsrufe von 1,4 bis 2,3 s Dauer unterschieden werden. Die zweite Art ist größer (Männchen 25,9 – 31,4 mm und Weibchen 30,1 – 34,7 mm) und hat eine einförmig grau-braune Oberseite, die mit vielen weißen Fleckchen durchsetzt ist. Ihre Paarungsrufe bestehen aus einer Serie von 9 – 15 pfeifenden oder piependen Silben. Beide neuen Arten leben vorwiegend arboricol, wobei sich ihre Sitzwarten normalerweise mehr als 2 m über dem Grund befinden.

Key words

Frog, new species, Microhylidae, New Guinea, Kikori Basin.

Introduction

The Kikori River Basin in southern Papua New Guinea (PNG) encompasses a broad range of habitats, from low altitude coastal mangroves and rainforest to lush hill forest, montane moss forest and high-montane grassland. The frog fauna in this area is extremely diverse and, despite recent taxonomic studies of microhylid (Richards & Oliver 2010; Günther *et al.* 2012) and hylid (Richards & Oliver 2006; Richards 2007) species from the catchment nearly half of the frogs known from there remain undescribed (e.g. Richards 2002).

Frogs of the genus *Oreophryne* reach their greatest diversity on the island of New Guinea where numerous new species have been described in recent years (e.g. Günther & Richards 2011; Günther *et al.* 2009, 2012, 2014;

KRAUS 2011, 2013; KRAUS & ALLISON 2009), and they currently represent one of the most speciose group of microhylid frogs known from the region. During the course of three surveys in the Kikori Basin between 2001 and 2003 the junior author obtained material of two *Oreophryne* species that do not match the descriptions of any known taxon. They were illustrated as *Oreophryne* sp. nov. 2 and *Oreophryne* sp. nov. 3 by RICHARDS (2002) and we here provide formal descriptions of these two new species.

Material and methods

Male frogs were collected at night after they were located by their advertisement calls; females were detected when they were exposed on foliage. Representative specimens were photographed in life the next day, and all specimens were then anaesthetised in an aqueous chlorobutanol solution and subsequently fixed in 5 % formalin. Liver samples were taken from some specimens before fixation, and stored in 96 % ethanol to enable later DNA sequencing. All specimens were transferred to 75 % ethanol within two days of fixation. One specimen of the first new species was cleared and stained as an osteological preparation according to a method modified from DINGERKUS & UHLER (1977) and the pectoral region was dissected from a specimen of the second new species. 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 preserved specimens only:

SUL snout-urostyle length from tip of snout to distal 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 compare our SUL measurements with SVL's presented for members of the genus in some papers;
TL tibia length: external distance between knee and ankle;
TaL length of tarsus: external distance between tarsal and ankle joints held at right angles;
T4L length of 4th toe: from tip of toe to proximal end of inner metatarsal tubercle;
T4D transversal diameter of disc of 4th toe;
T1D transversal diameter of disc of first toe;
F3L length of 3rd finger;
F3D transversal diameter of disc of 3rd finger;
F1D transversal diameter of disc of first finger;
HL head length, from tip of snout to posterior margin of tympanum;
HW head width, taken in the region of the tympana;
SL snout length, from an imaginary line connecting the centres of the eyes to tip of the 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;
TyD horizontal diameter of tympanum.

Advertisement calls were recorded under natural conditions with a Sony Pro-Walkman or a Sony TCM 5000EV tape recorder and a Sennheiser ME66 Microphone with K6 power module, and analysed with Avisoft-SAS Lab Pro software.

Material studied for comparative purposes is listed by GÜNTHER (2015).

Abbreviations of collections

SAMA South Australian Museum, Adelaide, Australia
PNGNM Papua New Guinea National Museum and Art Gallery, PNG
ZMB Museum für Naturkunde Berlin (formerly Zoologisches Museum Berlin)

Oreophryne flavomaculata sp. nov.

Oreophryne sp. nov. 2, RICHARDS (2002)

Holotype. SAMA R69679 (Field number: FN SJR 2287), adult male, Summit of Iagifu Ridge, Agogo Range near Moro, Southern Highlands Province, Papua New Guinea (06°25.961S, 143°12.897E; 1,300 m above sea level (a.s.l.)), collected by S. RICHARDS on 19 October 2001.

Paratypes. SAMA R69682 (FN SJR 2442), adult male, Gobe Ridge Road, Southern Highlands Province, Papua New Guinea (06°48.869S, 143°46.459E; 900 m a.s.l.), collected by S. RICHARDS on 28 October 2001; SAMA R69678 (FN SJR 2284), SAMA R69680 (FN SJR 2289), ZMB 83556 (FN SJR 2288) same data as holotype. SAMA R69681 (SJR 2132), SAMA R69683 (FN SJR 2136) same data as holotype but collected on 28 May 2002; ZMB 83557, 83558, 83559 (FN SJR 2356–58) same data as holotype but collected 21 October 2001; PNGNM unregistered (FN SJR 2129), same data as holotype but collected on 27 May 2002. Geographical position of the collection sites see on Fig. 1.

ZMB 83557 (FN SJR 2356) is now an osteological preparation.

Diagnosis. A small species of the genus *Oreophryne* with a snout-urostyle length in males (n=9) from 19.7–23.3 mm and in females (n=2) from 23.8–27.4 mm. Connection between procoracoid and scapula ligamentous. No webs between fingers or toes; fifth toe somewhat longer than third; finger discs wider than toe discs (ratio T4D/F3D 0.80–1.00); tibiae moderately long (TL/SUL 0.43–0.50). Eyes large (ED/SUL 0.128–0.161), eye-naris distance about same as internarial distance (END/IND 0.85–1.20). Ground colour of dorsal and lateral body and limb surfaces in life pale yellow to dark yellow or reddish with diffuse or solid dark brown flecks, less prominent on body than on limbs. Ground colour in preservative off-white to brownish with grey or brown flecks or stripes mainly concentrated laterally. Most specimens

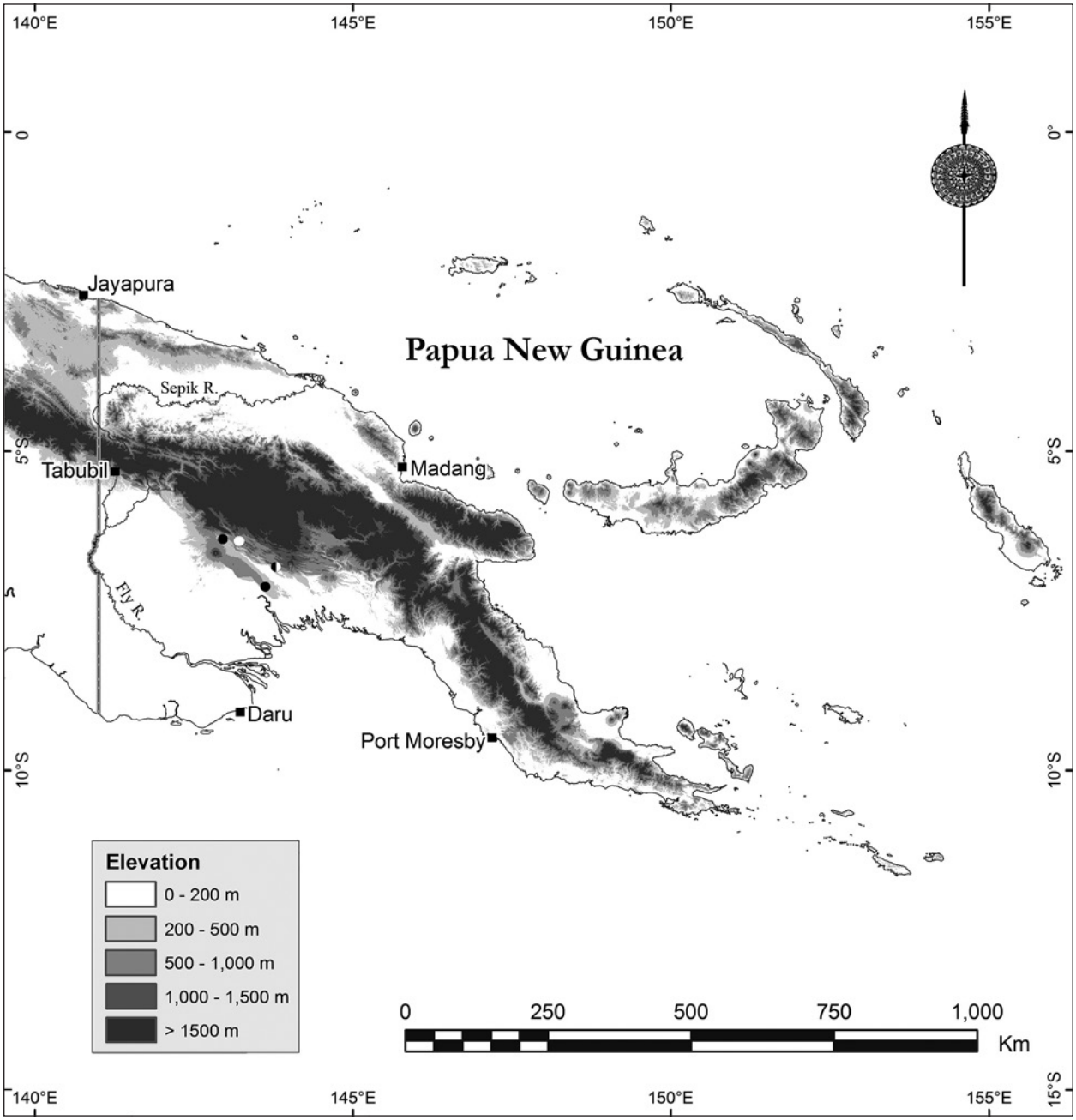

Fig. 1. Map of known locations for *O. flavomaculata* (white circles) and *O. pseudunicolor* (black circles). The half-black circle is the only known site where the two species occur in sympatry.

with a small, irregular shaped, pale lumbar spot and one or a few conspicuous yellow spots in the inguinal region. Advertisement call a loud rattle of 1.4–2.3 seconds (s); notes strongly pulsed, lasting on average 14 milliseconds (ms) with a repetition rate of 21.3–24.3 notes per second (s). Dominant frequency is at 3.00 kHz.

Description of the holotype (Figs. 2–6). Adult male with a SUL of 19.7 mm. Additional measurements and ratios are listed in Table 1. Head broader than long (HL/HW 0.86); tip of snout truncate in dorsal view and also in lateral view; nostrils near tip of snout, directed laterally and not visible from above, distance between nares slightly less than distance between eye and naris (END/IND 1.11); canthus rostralis in dorsal view curved inward; loreal region sloped and its upper margin (canthus rostralis) rounded; tongue narrow anteriorly, broadened posteriorly and without indentation; prepharyngeal ridge with eight poorly developed denticles; moderately long vocal slits on both sides of mouth floor; tympanum small (about one-third of eye diameter) and hardly visible; no prominent supratympanic fold. Legs moderately long (TL/SUL 0.48). Fingers unwebbed and with broad and grooved terminal discs, their relative lengths 3>4~2>1 (Fig. 4); disc of third finger twice width of penultimate phalanx, no prominent metacarpal or subarticular tubercles. All toes with wide and grooved terminal discs, discs of third toe same width as disc of fourth toe; no webs be-

Fig. 2. *Oreophryne flavomaculata* sp. nov. preserved holotype in dorsal view.

Fig. 3. *Oreophryne flavomaculata* sp. nov. preserved holotype in ventral view.

Fig. 4. *Oreophryne flavomaculata* sp. nov. preserved holotype, left hand in ventral view.

Fig. 5. *Oreophryne flavomaculata* sp. nov. preserved holotype, right foot in ventral view.

tween toes and no prominent metatarsal or subarticular tubercles; relative lengths of toes 4>5>3>2>1 (Fig. 5). A conspicuous tubercle between angle of jaw and insertion of upper arm; no other distinct tubercles on dorsal or ventral surfaces in preservative but in life some inconspicuous tubercles were evident on flanks and dorsal surfaces of limbs.

Colour in preservative: Ground colour of all dorsal surfaces off-white with diffuse brown stipples and flecks on fore and hind legs; head also irregularly pigmented with brown laterally; a conspicuous brown postocular fleck merges dorsolaterally with a large but less intensely pigmented blotch that reaches nearly as far as the inguinal region and that has a posterioventrally directed branch. An off-white mid-dorsal line divides a pair of small brown spots between scapular and occipital region and a brown area between the eyes. Ventral surfaces off-white with diffuse brown mottles mainly on chest, lower arms and thighs. Yellow inguinal spot(s) barely visible.

Colour in life: Ground colour of body yellowish laterally, yellowish-red dorsally, and of dorsal limbs reddish. Dorsally limbs covered by a dense pattern of diffuse brown pigmentation except on upper arm. A dark brown and posteriorly bifid (compare Fig. 2) blotch on upper flank; this blotch is connected by a broad band of less intense brown with a dark brown postocular fleck. Two pairs of dark brown spots between eyes and one pair between scapular region and occiput. Largest (lower) portion of tympanum yellowish; tubercle between corner of mouth and insertion of upper arm appears as a short but conspicuous whitish streak. Pupil horizontally oval with reddish inner margin, iris silvery with brown venation (Fig. 6).

Morphological variation in the type series. Measurement and body ratios of the type specimens are presented in Table 1. Six of the ten paratypes are coloured similarly to the holotype, with a broad pale mid-dorsal band and dark dorsolateral patches. A typical example of this colour pattern is exhibited by SAMA R69682, which is illustrated in Fig. 7. The remaining four specimens have pale dorsal and lateral surfaces while the largest female, ZMB 83556, exhibits a rather uniform brownish dorsum in preservative. All males have one or several more or less conspicuous yellow spots in the inguinal region (Fig. 8). Female ZMB 83556 does not show such spots and the

Table 1. Body measurements and body ratios of the type series of *Oreophryne flavomaculata* sp. nov. SAMA R69679 is the holotype; all types are adult males except ZMB 83556 and ZMB 83557 which are adult females.

Reg./No.	PNGNM unregistered	SAMA R69681	SAMA R69683	SAMA R69678	SAMA R69679	ZMB 83556	SAMA R69680	ZMB 83557	ZMB 83559	ZMB 83558	SAMA R69682	Mean ± SD
SUL	20.1	20.8	23.3	20.3	19.7	27.4	22.1	23.8	20.5	19.9	22.2	
TL	10.1	10.1	11.0	9.4	9.5	11.7	9.6	10.9	9.6	9.5	10.8	
TaL	6.9	7.0	7.4	6.5	6.6	8.5	6.9	7.1	6.5	6.7	7.1	
T4L	8.5	8.5	9.1	8.4	7.9	10.2	9.0	10.6	8.3	8.4	9.8	
T4D	1.0	1.0	1.3	1.0	1.1	1.3	1.4	1.5	1.1	1.2	1.3	
F3L	6.1	6.2	6.9	5.8	5.9	8.4	6.4	7.6	5.7	6.0	7.1	
F3D	1.1	1.2	1.6	1.2	1.1	1.4	1.5	1.8	1.2	1.5	1.5	
T1D	0.9	0.8	0.9	0.8	0.7	1.2	1.0	1.0	0.8	0.9	0.9	
F1D	0.8	0.8	1.0	0.8	0.8	1.2	1.0	1.1	0.8	0.9	1.0	
HL	7.3	7.1	8.0	7.0	6.7	8.8	7.8	8.0	7.6	7.1	7.5	
HW	8.3	8.2	9.5	8.2	7.8	9.7	9.0	9.4	8.7	8.3	9.4	
END	2.1	2.0	2.4	1.8	2.0	2.3	2.1	2.5	2.0	2.0	2.0	
IND	2.3	1.9	2.0	1.7	1.8	2.7	2.1	2.3	2.1	1.9	2.3	
ED	3.0	2.8	3.3	3.1	2.7	3.5	3.2	3.6	3.0	3.2	3.4	
TyD	0.7	0.8	0.8	0.7	0.9	1.2	1.0	0.7	0.9	0.9	0.9	
EST	2.8	2.9	3.3	2.6	2.8	3.2	3.1	3.4	3.3	2.9	2.8	
SL	4.0	4.1	4.2	3.9	3.7	4.6	4.3	4.2	3.8	3.9	4.2	
TL/SUL	0.50	0.49	0.47	0.46	0.48	0.43	0.43	0.46	0.47	0.48	0.49	0.47 ± 0.023
TaL/SUL	0.34	0.34	0.32	0.32	0.34	0.31	0.31	0.30	0.32	0.34	0.32	0.32 ± 0.014
T4L/SUL	0.42	0.41	0.39	0.41	0.40	0.37	0.41	0.45	0.40	0.42	0.44	0.41 ± 0.022
T4D/SUL	0.050	0.050	0.056	0.049	0.056	0.047	0.063	0.063	0.054	0.060	0.059	0.055 ± 0.005
F3D/SUL	0.055	0.058	0.069	0.059	0.056	0.051	0.068	0.076	0.059	0.075	0.068	0.063 ± 0.008
T4D/F3D	0.91	0.83	0.83	0.83	1.00	0.93	1.00	0.83	0.92	0.80	0.87	0.89 ± 0.07
F3L/SUL	0.30	0.30	0.30	0.29	0.30	0.31	0.29	0.32	0.28	0.30	0.32	0.30 ± 0.012
F1D/SUL	0.040	0.038	0.043	0.039	0.041	0.044	0.045	0.046	0.039	0.045	0.045	0.042 ± 0.003
T1D/SUL	0.045	0.038	0.039	0.039	0.036	0.044	0.045	0.042	0.039	0.045	0.041	0.041 ± 0.003
T1D/F1D	1.13	1.00	0.90	1.00	0.88	1.00	1.00	0.91	1.00	1.00	0.90	0.97 ± 0.07
HL/SUL	0.36	0.34	0.34	0.34	0.34	0.32	0.35	0.34	0.37	0.36	0.34	0.35 ± 0.014
HW/SUL	0.41	0.39	0.41	0.40	0.40	0.35	0.41	0.39	0.42	0.42	0.42	0.40 ± 0.02
HL/HW	0.88	0.87	0.84	0.85	0.86	0.91	0.87	0.85	0.87	0.86	0.80	0.86 ± 0.027
END/IND	0.91	0.91	1.20	1.06	1.11	0.85	1.00	1.09	0.95	1.05	0.87	1.0 ± 0.11
ED/SUL	0.149	0.149	0.142	0.153	0.137	0.128	0.145	0.151	0.146	0.161	0.153	0.147 ± 0.009
TyD/ED	0.23	0.23	0.24	0.23	0.33	0.34	0.31	0.29	0.30	0.28	0.26	0.28 ± 0.04

Fig. 6. *Oreophryne flavomaculata* sp. nov. holotype in life, dorsolateral view.

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Fig. 7. *Oreophryne flavomaculata* sp. nov. paratype SAMA R69682 in life, dorsolateral view.

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Fig. 8. *Oreophryne flavomaculata* sp. nov. paratype SAMA R69682 in life, lateral view of the right body side.

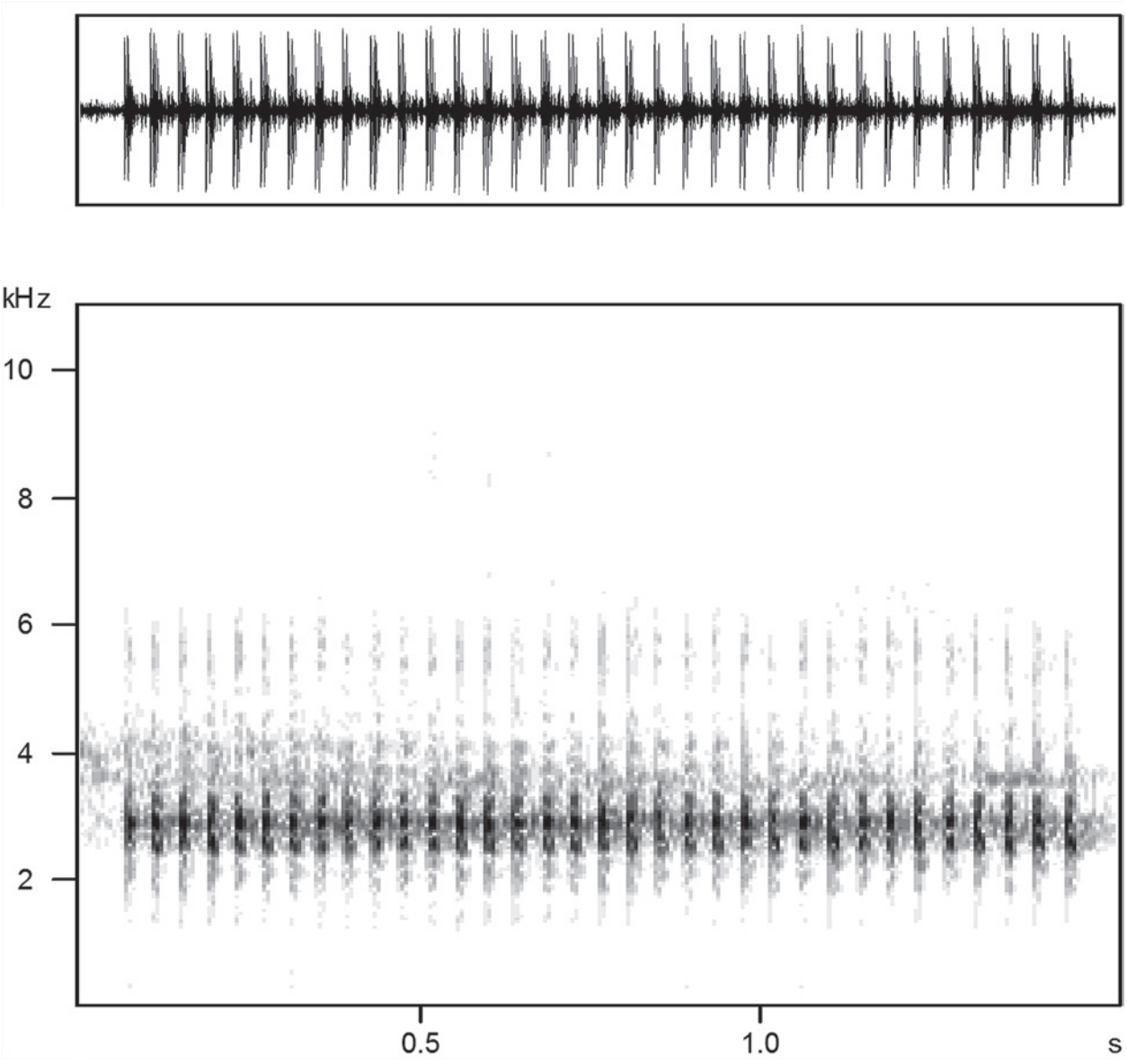

Fig. 9. Wave form (above) and spectrogram (below) of an advertisement call of *Oreophryne flavomaculata* sp. nov. with 34 notes.

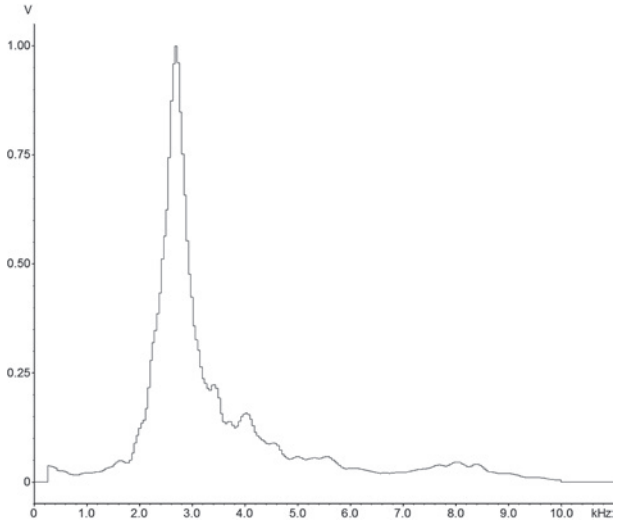

Fig. 10. Power spectrum of an advertisement call of *Oreophryne flavomaculata* sp. nov.

character was not noted before female 83557 was cleared and stained, so it is possible that females do not exhibit this feature. Ventral surfaces vary from uniform off-white to finely speckled and roughly mottled with brown.

Distribution and ecological notes. The new species is known only from two locations at 900 m and 1,300 m asl in very wet, lower-montane rainforest in the Kikori River Basin of Southern Highlands Province, PNG (Fig. 1). Males normally called from leaves ~ 3–5 m high in the forest understorey at night during and after heavy rain. This species was abundant at the type locality in mossy forest at the summit of Iagifu Ridge near Moro, but was difficult to capture there because of its tendency to call from elevated perches in steep, broken limestone karst terrain.

Vocalisation. Four calls from two males, recorded at an air temperature of 18 °C, were analysed. The advertise-

ment call is a loud rattle of 1.40 – 2.30 s duration, mean 1.85 ± 0.39 s. The calls contain 34 – 49 strongly pulsed notes (Fig. 9), mean 41.8 ± 6.2 notes/call. Notes consist of about 5 irregular pulses that are too close together to measure accurately (Fig. 9). Mean note repetition rate is 22.8 ± 1.59, range 21.3 – 24.3 notes/s. Mean note length is 14.4 ± 2.1 ms, range 10 – 21 ms, n = 167; and mean inter-note length is 31.1 ± 3.2 ms, range 23 – 38 ms, n = 163. Notes start at maximum amplitude, and amplitude of pulses decreases irregularly during the call. All notes have a similar maximum amplitude, but note length and inter-note length are variable. Most frequencies scatter between 2 and 6 kHz; the dominant frequency is at 2.8 kHz and there is a weak harmonic band around 8 kHz (Fig. 9).

Etymology. The specific epithet *flavomaculata* is a feminine compounded Latin adjective; flavus, – a, – um means yellow and maculatus, – a, – um means spotted. It refers to the conspicuous yellow spots in the inguinal region exhibited by most specimens.

Comparisons with other species. About 30 *Oreophryne* species have a cartilaginous connection (vs. a ligamentous connection as in the new species) between procoracoid and scapula and are not considered further in this paragraph. About 20 species have a ligamentous connection between procoracoid and scapula. The probable maximum size range of *O. flavomaculata* sp. nov. males is from 19 – 25 mm SUL, and the species has a rattling advertisement call. Therefore, males smaller or larger than this range and/or with peeping, squeaking, or trilling calls can be separated from the new species on the basis of these characters. There remain 14 species in the size range of *O. flavomaculata* and with rattling or unknown advertisement calls which will be compared more closely: *O. albopunctata* has noticeable basal webs on toes (no webs in *flavomaculata*) and shorter tibiae (TL/SUL 0.40 – 0.43) in comparison to *O. flavomaculata* (TL/SUL 0.43 – 0.50); adult *O. ampelos* are larger (three males 26.3 – 31.5 mm and seven females 31.3 – 35.1 mm) than *O. flavomaculata* (nine males 19.7 – 23.6 mm, two females 23.8 – 27.4 mm) and do not exhibit dark brown blotches on dorsal and lateral surfaces; *O. atrigularis* has a sharp-edged canthus rostralis (rounded in *O. flavomaculata*), a blackish "facemask" (missing in *O. flavomaculata*) and its advertisement calls consist of a long series of scratchy notes while *O. flavomaculata* utters single rattles; *O. biroi* has distinct basal webs between toes and longer rattling advertisement calls with a lower note repetition rate (call duration 3.7 s with note repetition rate of 18.1/s),vs. call duration in *O. flavomaculata* 1.4 – 2.3 s and repetition rate 21.3 – 24.3 notes/s; *O. ezra* has webbed toes, a blue iris (silvery in *O. flavomaculata*) and advertisement calls with a long introductory note (missing in *O. flavomaculata*); *O. furu* has basal webs between toes, no yellow spots in the inguinal region and most advertisement call notes consist of three pulses (five pulses in *O. flavomaculata*); *O. geislerorum* has basal toe webbing and a unique advertisement call with more than 45 notes/s; *O. hypsiops* has webbed toes, smaller eyes (ED/SUL 0.106 – 0.122 vs. 0.128 – 0.161 in *O. flavomaculata*) and calls with 7.25 – 10.3 notes/s; *O. kapisa* is smaller (SUL of males 16.4 – 20.5 mm), has a higher note repetition rate (25.9 – 27.2 notes/s vs. 21.3 – 24.3 notes/s) and a higher dominant frequency in its calls (3.6 kHz vs. 2.8 kHz); *O. mertoni* has partially webbed toes, and only a single specimen is known to date, from the geographically remote Wokam Island (Aru Islands). *O. roedeli* has a blackish dorsal colour with numerous tiny white dots and large yellow flecks on hind limbs. O. *wapoga* has a sharp edged canthus rostralis and with 4 – 6 notes/s completely different advertisement calls. *O. wolterstorffi* has distinct webs on toes and smaller discs on fingers (F3D/SUL 0.050 vs. 0.055 – 0.076) and toes (T4D/SUL 0.045 vs. 0.047 – 0.063). None of the compared species has conspicuous yellow spots (off-white in preservative) in the inguinal region like *O. flavomaculata*.

Oreophryne pseudunicolor sp. nov.

Holotype. SAMA R69686 (Field number: FN SJR 3199), adult male, Darai Plateau, Gulf Province, Papua New Guinea (07°07.771'S, 143°36.806'E; 400 m a.s.l.), collected by S. Richards on 28 July 2003.

Paratypes. SAMA R69685 (FN SJR 3197), ZMB 83561 (SJR 3146), ZMB 83562 (FN SJR 3170), same data as holotype but collected on 30, 22 and 26 July 2003 respectively; SAMA R69684 (FN SJR 2433), ZMB 83560 (FN SJR 2452), adult males, Gobe Ridge Road, Southern Highlands Province, Papua New Guinea (06°48.869S, 143°46.459E; 900 m a.s.l.), collected by S. Richards on 28 October 2001; PNGNM unregistered (FN SJR 2085), female, Gobe Ridge Road, collected by S. Richards on 19 May 2002; SAMA R69687 (FN SJR 3296), gravid female, Libano, Southern Highlands Province, Papua New Guinea (06°23.944'S, 142°58.568'E; 270 m asl) by S. Richards on 11 August 2003.

Diagnosis. A medium- to large-sized species of the genus *Oreophryne* with a snout-urostyle length in adult males (n = 5) from 25.9 – 31.4 mm and in adult females (n = 2) from 30.1 – 34.7 mm. Connection between procoracoid and scapula ligamentous. No webs between fingers, distinct basal webs between all toes; fifth toe same length as third; finger discs generally wider than toe discs (ratio T4D/F3D 0.83 – 1.00); shanks fairly short (TL/SUL 0.39 – 0.43). Eyes of medium size (ED/SUL 0.110 – 0.131), eye-naris distance greater than internarial distance (END/IND 1.00 – 1.25). Dorsal and lateral body surfaces in life uniform brownish-grey with numerous tiny white dots (tubercles). In preservative, lateral and dorsal body surfaces uniform light grey to middle-brown with less contrasting whitish dots. Advertisement call a series of 9 – 15 whistling or 'peeping' notes of 2.8 – 4.8 s duration, with notes unpulsed and lasting on average 80 ms; note repetition rate is 2.9 – 3.4 notes/s and dominant frequency is at 2.6 kHz.

Fig. 11. *Oreophryne pseudunicolor* sp. nov. preserved holotype in dorsal view.

Fig. 12. *Oreophryne pseudunicolor* sp. nov. preserved holotype in ventral view.

Fig. 13. *Oreophryne pseudunicolor* sp. nov. preserved holotype, right hand in ventral view.

Fig. 14. *Oreophryne pseudunicolor* sp. nov. preserved holotype, right foot in ventral view.

Description of the holotype (Figs. 11–14). Adult male with a SUL of 27.2 mm. Additional measurements and ratios are listed in Table 2. Head broader than long (HL/HW 0.83); tip of snout truncate with a small median protuberance at the tip in dorsal view (Fig. 11) and truncate in lateral view; nostrils very near tip of snout, directed laterally and not visible from above, distance between nares clearly less than distance between eye and naris (END/IND 1.25); canthus rostralis in dorsal view straight; loreal region sloped, weakly concave and its upper margin (canthus rostralis) rounded; tongue wide, long, with a very small posterior indentation; prepharyngeal ridge with only hints of denticles; vocal slit visible on left side of mouth floor, that on right side not clearly recognizable; tympanum small (about one-third of eye diameter), its upper margin covered by skin; a weak supratympanic fold. Legs moderately short (TL/SUL 0.42); fingers unwebbed and with broad and grooved terminal discs (disc of third finger twice width of penultimate phalange), their relative lengths 3>4>2>1; metacarpal and subarticular tubercles weakly expressed. All toes with wide and grooved terminal discs, discs of third toe same width as disc of fourth toe (T4D/F3D 1.0), distinct basal webs between toes, weakly developed metatarsal and subarticular tubercles, relative lengths of toes 4>5~3>2>1. A few low, inconspicuous tubercles on all dorsal surfaces, ventral surfaces smooth.

Colour in preservative. All dorsal surfaces uniform brown with some small white tubercles, mainly on lateral surfaces of body. Tympana somewhat lighter than surrounding surfaces. Some small light spots on margin of upper eye lid. Ventral surfaces uniform off-white.

Colour in life: Dorsally head and body uniform grey-brown, limbs lighter grey-brown; all dorsal and lateral surfaces with small whitish tubercles. Iris golden with dark brown venation that is mainly longitudinally oriented.

Morphological variation in the type series. Measurements and body ratios of the type specimens are presented in Table 2. Paratypes differ in colour only slightly from the holotype. All specimens have a uniform dorsal colouration, six are brownish-grey and two are greyish-brown in preservative; in life parts of the dorsal surfaces may be more brownish and parts may be more greyish as in SAMA R69687 (Fig. 15). In most specimens the

Table 2. Body measurements and body ratios of the type series of *Oreophryne pseudunicolor* sp. nov. SAMA R69686 is the holotype; all types are adult males except PNGNM unregistered and SAMA R69687 which are adult females and ZMB 83562 which is subadult.

Reg.-No.	PNGNM unregistered	SAMA R69684	ZMB 83560	ZMB 83561	ZMB 83562	SAMA R69685	SAMA R69686	SAMA R69687	Mean ± SD
SUL	34.7	31.4	29.8	25.9	22.4	27.4	27.2	30.1	
TL	13.7	13.0	12.3	10.7	9.1	11.8	11.4	11.6	
TaL	9.2	8.8	8.0	7.0	6.2	7.4	7.3	7.7	
T4L	13.5	13.0	12.2	10.3	8.6	11.8	11.4	11.5	
T4D	2.2	2.1	2.0	1.6	1.4	2.0	1.8	2.0	
F3L	10.4	9.1	9.1	7.0	6.2	8.1	7.5	8.6	
F3D	2.5	2.4	2.4	1.8	1.6	2.1	1.8	1.9	
T1D	1.6	1.6	1.5	1.0	1.1	1.2	1.2	1.5	
F1D	1.9	1.8	1.5	1.1	1.2	1.4	1.2	1.6	
HL	9.5	9.6	8.6	7.9	7.2	8.1	8.5	8.6	
HW	12.4	11.6	10.8	9.2	8.3	10.0	10.2	10.0	
END	3.3	3.0	2.3	2.1	2.2	2.2	2.5	2.6	
IND	2.7	2.5	2.3	2.0	2.1	2.1	2.0	2.2	
ED	3.9	4.1	3.7	3.0	2.7	3.6	3.1	3.3	
TyD	1.3	1.2	1.0	0.8	0.9	1.0	1.0	1.1	
EST	4.2	3.8	3.0	3.1	2.8	3.0	3.4	3.5	
SL	4.8	4.5	3.8	3.6	3.7	4.1	4.0	4.4	
TL/SUL	0.39	0.41	0.41	0.41	0.41	0.43	0.42	0.39	0.41 ± 0.014
TaL/SUL	0.27	0.28	0.27	0.27	0.28	0.27	0.27	0.26	0.27 ± 0.006
T4L/SUL	0.39	0.41	0.41	0.40	0.38	0.43	0.42	0.38	0.40 ± 0.015
T4D/SUL	0.063	0.067	0.067	0.062	0.063	0.073	0.066	0.066	0.066 – 0.003
F3D/SUL	0.072	0.076	0.081	0.069	0.071	0.077	0.066	0.063	0.072 ± 0.006
T4D/F3D	0.88	0.88	0.83	0.89	0.88	0.95	1.00	1.05	0.92 ± 0.074
F3L/SUL	0.30	0.29	0.31	0.27	0.28	0.30	0.28	0.29	0.29 ± 0.013
F1D/SUL	0.055	0.057	0.050	0.042	0.054	0.051	0.044	0.053	0.051 ± 0.005
T1D/SUL	0.046	0.051	0.050	0.039	0.049	0.044	0.044	0.050	0.047 ± 0.004
T1D/F1D	0.84	0.89	1.00	0.91	0.92	0.86	1.00	0.94	0.92 ± 0.059
HL/SUL	0.27	0.31	0.29	0.31	0.32	0.30	0.31	0.29	0.30 ± 0.016
HW/SUL	0.36	0.37	0.36	0.36	0.37	0.36	0.38	0.33	0.36 ± 0.015
HL/HW	0.77	0.83	0.80	0.86	0.87	0.81	0.83	0.86	0.83 ± 0.034
END/IND	1.22	1.20	1.00	1.05	1.05	1.05	1.25	1.18	1.13 ± 0.097
ED/SUL	0.112	0.131	0.124	0.116	0.121	0.131	0.114	0.110	0.120 ± 0.008
TyD/ED	0.33	0.29	0.27	0.27	0.33	0.28	0.32	0.33	0.30 ± 0.028

Fig. 15. *Oreophryne pseudunicolor* sp. nov. paratype SAMA R69687 in life, dorsolateral view.

whitish tubercles disappeared in preservative to a large extent. In about half of the specimens the head is lighter dorsally than the remaining dorsal surfaces. In only one specimen (ZMB 83562) the middle dorsum is covered by a reticulum of whitish flecks. Ventral surfaces in all specimens are uniformly off-white.

Distribution and ecological notes. *Oreophryne pseudunicolor* is abundant in the lowland and hill forests of the Kikori Basin, where males normally call from elevated perches on leaves up to 30 m above the ground. Males also call from within hollow vines and small holes in branches and tree trunks, and calling males have occasionally been found guarding clutches of eggs within these well-protected calling and nesting sites. The loud whistling or 'peeping' sound produced by this species is a conspicuous component of the acoustic environment at night throughout the Kikori Basin at altitudes between ~200 and at least 900 m a.s.l. The taxonomic status of populations of whistling *Oreophryne* from east and west of the Kikori Basin (e.g. Richards *et al.* 2015) requires confirmation; based on currently available information *O. pseudunicolor* is known with certainty only from the lowlands and foothills of Gulf and Southern Highlands Provinces of south-central Papua New Guinea (Fig. 1).

Vocalisation. Fifteen calls from two males recorded at an air temperature of 22 °C were analysed. The advertisement call is a series of loud and melodious whistling or 'peeping' notes. Mean call length is 3.85 ± 0.61 s, range

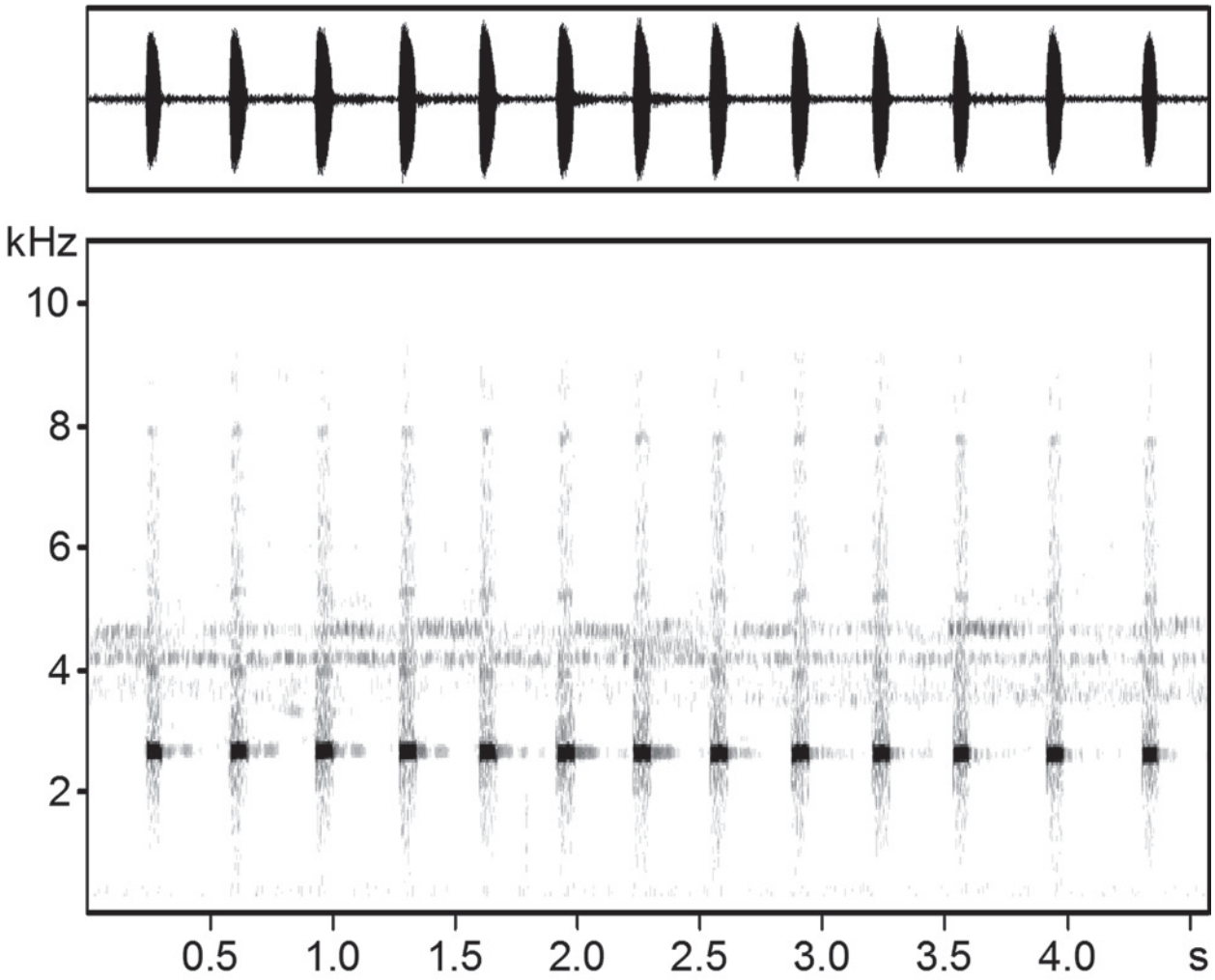

Fig. 16. Wave form (above) and spectrogram (below) of an advertisement call of *Oreophryne pseudunicolor* sp. nov. with 13 notes.

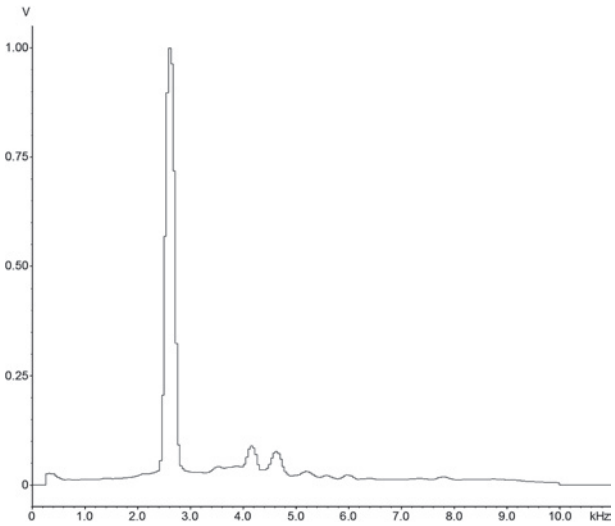

Fig. 17. Power spectrum of an advertisement call of *Oreophryne pseudunicolor* sp. nov.

2.8 – 4.8 s. The calls contain 9 – 15 notes, mean 12.3 ± 1.62 notes/call. Call notes are unpulsed and without frequency modulation (Fig. 16). Mean of means of note length 77.9 ± 3.6 ms, range of means 72 – 83 ms, total range of 184 notes 61 – 90 ms; mean of means of internote length 255.4 ± 16.4 ms, range of means 234 – 280 ms, total range of 157 internote intervals 223 – 365 ms. Mean note repetition rate 3.2 ± 0.13, range 2.97 – 3.36 notes/s. Most frequencies scatter between 2.4 and 2.8 kHz. The dominant frequency is at 2.6 kHz (Fig. 17) and there are some weak upper harmonics up to 8 kHz.

Etymology. Pseudunicolor is a compounded Latin adjective meaning "seemingly unicolor" and refers to the similarity of the new species to *Oreophryne unicolor*.

Comparisons with other species. About 30 *Oreophryne* species have a cartilaginous connection (vs. a ligamentous connection as in the new species) between procoracoid and scapula and are not considered further in this paragraph. About 20 species have a ligamentous connection between procoracoid and scapula. The probable maximum size range of *O. pseudunicolor* sp. nov. is from 24 – 38 mm SUL, and the species has a whistling advertisement call. Therefore, species smaller or larger than this range and/or with rattling, squeaking, or trilling calls can be separated from the new species on the basis of these characters. There remain seven species in

the size range of *O. pseudunicolor* that have whistling calls, or for which the advertisement calls are unknown, and these will be compared more closely: *O. ezra* has a blue iris (golden in *O. pseudunicolor*) and, among other characters, a smaller body size (males 22.3–26.1 mm and female 25.4 mm SVL vs. 25.9–31.4 mm in males and 30.1–34.7 mm in females of *O. pseudunicolor*). *O. geislerorum* is also smaller (males up to 26.6 mm SVL and females up to 29.4 mm SVL) than *O. pseudunicolor* and has a "unique" advertisement call with 18–40 harsh notes (Zweifel *et al.* 2003) . With a SVL of 22.3–23.1 mm in males and 24.6–25.9 mm in females, *O. hypsiops* is clearly smaller than *O. pseuduniclor*, moreover it differs in colour pattern (spotted vs. uniform dorsum) and in advertisement calls (20–28 notes per call uttered at about 7–10 notes/s vs. 9–15 notes per call uttered at a rate of 2.9–3.4 notes/s in *O. pseudunicolor*). *O. mertoni* is, according to Zweifel *et al*. (2003) probably endemic to the Aru Islands and has a colouration different from *O. pseudunicolor*. *O. parkeri* has a rugose dorsal surface with numerous blackish and white spots (vs. a smooth, uniform grey dorsal surface in *O. pseudunicolor*), a narrower head (mean HW/SVL 0.325 vs. 0.360 in *O. pseudunicolor*), a shorter internarial span (range IND/SUL 0.059–0.070 vs. 0.073–0.094 in *O. pseudunicolor*) and different advertisement calls (notes per call in *O. parkeri* 21–34 and range of notes/s 5.0–5.6; notes/call in *O. pseudunicolor* 9–15 and repetition rate 2.9–3.4 notes/s). *O. woltertorffi* is known only from the holotype (ZMB 16853) measuring 22.2 mm SUL and it has longer legs (TL/SVL 0.44 vs. 0.39–0.43) and narrower finger discs (F3D/SUL 0.050 vs. 0.063–0.081) than the new species.

The two species of *Oreophryne* most similar to *O. pseudunicolor* are *O. ampelos* and *O. unicolor*. *O. ampelos* was described by Kraus (2011) from the Hindenburg Range and Star Mountains of far western Papua New Guinea at altitudes between 840 and 1,280 m a.s.l. In its possession of a ligamentous connection between the procoracoid and scapula, in having webbing between the toes, and in sharing broadly overlapping values of most measurements and ratios, *O. ampelos* is difficult to distinguish from *O. pseudunicolor*. Unfortunately the advertisement call of *O. ampelos* is not known, precluding comparisons of this important diagnostic character. However several consistent differences in body shape and colouration indicate that the two species are distinct from each other. *O. ampelos* can be readily distinguished from the new species by its distinctly wider head (ratio HW/SVL 0.37–0.42 vs 0.33–0.37 in *O. pseudunicolor*) and there are also smaller but statistically significant differences in limb length (TL/SUL $p = 0.017$) and size of toe discs (T4D/SUL; $p = 0.023$). There are also consistent differences in dorsal colouration between the species. *O. ampelos* was described as having a "*dorsal pattern of brown punctations on a pale straw-yellow ground color which gives an overall appearance of a uniformly light tan, uniformly dark tan, or mottled light and dark tan animal*" (Kraus 2011). Two of the paratypes examined by Kraus (2011) also had a wide, light tan mid-vertebral stripe bordered by narrower dark brown stripes. *O. pseudunicolor* has never a straw-yellow colour (in life or preservative), always exhibiting a uniform grey-brown dorsum with tiny pale tubercles and flecks (Fig. 15) with, at most (in very rare cases), scattered blotches of tan on the mid-dorsum.

Another species very closely related to the new species is *O. unicolor*. There are no clear differences in measurements and body colouration except colour of the iris which is reddish in *O. unicolor* and golden in *O. pseudunicolor*. However, differences in advertisement calls and in sequences of the 16S rDNA gene are evidence for the specific status of both species. The call notes of *O. unicolor* last 149–194 ms (mean 167 ± 10.6 ms, $n = 66$) those of *O. pseudunicolor* last 61–90 ms (mean 78 ± 3.6 ms, $n = 184$). Note repetition rate in calls from *O. unicolor* varied between 1.5–1.8 notes/s, mean 1.68 notes/s and in calls from *O. pseudunicolor* between 2.9–3.4 notes/s, mean 3.2 ± 0.13 notes/s. A pairwise distance calculation of 417 sites of the 16S RNA gene showed a p-distance of 8.6 % in each case between *O. unicolor* from the type locality (ZMB 70188 from the Wondiwoi Mts, Wandammen Peninsula, West Papua Province) compared with three specimens of *O. pseudunicolor* (SAMA R 69684, ZMB 83561, and ZMB 83562) whereas p-distances between these three specimens of *P. pseudunicolor* were 0.2–0.7 % (Stelbrink & von Rintelen, pers. comm.).

We found other frogs of the genus *Oreophryne* in the Kikori region that are smaller than both *O. pseudunicolor* and *O. unicolor*, but are otherwise as similar to *O. unicolor* in their body ratios as *O. pseudunicolor* is to that species. Furthermore, the smaller Kikori frogs have whistling advertisement calls more similar to the geographically distant *O. unicolor* than to sympatric *O. pseudunicolor*. Their p-distances of the 16S RNA gene to *O. unicolor* varied between 4.8 and 5.5 % and to *O. pseudunicolor* between 7.7 and 8.2 %. Thus, according to calls and 16S rDNA these frogs are more closely related to *O. unicolor* than *O. pseudunicolor* is. We have also examined a morphologically similar series of *Oreophryne* from the southern slopes of the central cordillera to the north-east of the Kikori Basin that has a more yellowish ground colour (as described for *O. ampelos*) and whistling calls.

It appears that a number of morphologically and acoustically similar *Oreophryne* species with whistling calls occur in the forests of southern New Guinea. On the basis of present knowledge the taxonomic status of these frogs is not clear and we refrain from naming additional populations until additional acoustic and genetic studies have been undertaken.

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