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First record of the microhylid frog genus *Cophixalus* from western Papua, Indonesia, with descriptions of two new species
(Anura: Microhylidae)

Erster Nachweis der Microhyliden-Gattung *Cophixalus* aus West-Papua, Indonesien, einschließlich der Beschreibung von zwei neuen Arten
(Anura: Microhylidae)

RAINER GÜNTHER

KURZFASSUNG

Von 31 validen Arten der Gattung *Cophixalus* leben 17 auf Neuguinea und benachbarten Inseln. Nur eine davon, *C. biroi*, wurde bisher auch im östlichen Teil von Papua (früher Irian Jaya) nachgewiesen. Bei Exkursionen des Verfassers in den Westen von Papua in den Jahren 2000 und 2002 wurden dort erstmalig Vertreter dieser Gattung gefunden. Es handelt sich dabei um zwei neue Arten, die hier beschrieben werden. Die mit einer Kopf-Rumpf-Länge von 26-28 mm (Männchen) größere Art kommt auf der Insel Yapen im Nordosten der Cenderawasih Bay vor. Sie ist offensichtlich näher mit *C. biroi* verwandt. Fehlende dunkle Streifen an den Kopfseiten und am Vorderkörper sowie Rufe von ein bis zwei Minuten Dauer und mit schnell aufeinander folgenden Silben im zweiten Teil der Rufe (Silbenwiederholungsrate 8 pro Sekunde) grenzen die neue Art jedoch deutlich von *C. biroi* (Silbenwiederholungsrate < 1/s) ab.

Die zweite neue Art wurde im Fakfak-Gebirge auf der Bomberai-Halbinsel (Hals des Vogelkop) angetroffen. Ihre Männchen nehmen mit 20-22 mm KRL eine Mittelstellung in der Körpergröße ein. Von allen anderen Spezies der Gattung unterscheidet sie sich durch das Vorhandensein von langen und deutlich ausgeprägten dorsolateralen Drüsenleisten und durch ihre Stimme. Die aus sanften Pfiffen bestehenden Rufe haben in der Regel drei, seltener vier ungepulste Silben, wobei jede Silbe 0,4 bis 0,5 Sekunden dauert und die dominante Frequenz in einem engen Bereich bei 3 kHz liegt. Phylogenetische scheint diese Art näher mit der Gruppe *C. pipilans* - *C. shellyi* verwandt zu sein.

ABSTRACT

From 31 species of the genus *Cophixalus*, 17 live on New Guinea and adjacent islands. Only one of these, *C. biroi*, has been shown to also occur in eastern Papua (formerly Irian Jaya). None of them has been demonstrated for western Papua thus far. During excursions in western Papua in the years 2000 and 2002 the author found representatives of this genus there. They represent two new species described below. One of them has a snout-urostyle length of 26-28 mm in adult males and lives on Yapen Island in the north-eastern Cenderawasih Bay. It appears to be closely related to *C. biroi* from which it differs in lacking dark stripes on the head sides and anterior flanks and by its distinct advertisement calls. Note repetition rate in "fast" note groups is about 8/s in the new species but less than 1/s in *C. biroi*.

The second new species was encountered in the Fakfak Mountains on the Bomberai Peninsula (neck of the Vogelkop). Its males are 20-22 mm long (snout-urostyle) and it difffers from all congeners by long and prominent dorsolateral glandular ridges and by its advertisement calls. These consist of 3-4 unpulsed whistling notes, each with a 0.4-0.5 second duration and a dominant frequency of around 3 kHz. Note repetition rate is about 1.5/s. There seems to be a closer relationship to the group *C. pipilans* - *C. shellyi*.

KEY WORDS

Amphibia: Anura: Microhylidae: *Cophixalus*; new species, morphology, osteology, advertisement calls, Papua, New Guinea, Indonesia

INTRODUCTION

The history of the genus *Cophixalus* is curious. The name was proposed by BOETTGER in the year 1892 to accommodate "his" new species *Cophixalus geislerorum* from Kaiserwilhelmsland, a former German colony in the north-east of the island of New Guinea. This area is part of Papua New Guinea today. BOETTGER mentioned a com-

plete lack of an omosternum and of procoracoids (including clavicles) as the main characteristics of the new genus. Mainly on the basis of these traits PARKER (1934) arranged ten species within this genus, which were mostly attributed to other genera previously. Thirteen more species were described in the years from 1934 to 1980 within the genus *Cophixalus*. All authors treated *Cophixalus geislerorum* as the type species of the genus.

A re-examination of the types and of some topotypical material of *C. geislerorum* by MENZIES et al. (1980) revealed that this species possesses a reduced clavicle and a procoracoid and therefore should belong to the genus *Oreophryne* (after having a closer look at the holotype of *C. geislerorum*, whose procoracoids and clavicles were obviously damaged during a previous dissection, the present author supports the opinion of MENZIES et al.). Taking this discovery into account, the name *Cophixalus* BOETTGER, 1892 should be replaced by *Oreophryne* BOETTGER, 1895 and, according to the International Code of Zoological Nomenclature, a replacement name had to be found for *Cophixalus*. Such an action would have caused immense confusion concerning the names of more than 40 species in the genera *Cophixalus* and *Oreophryne* known in 1980. In a well considered application to the International Commission on Zoological Nomenclature MENZIES et al. (1980) pointed out why the genus name *Cophixalus* should nevertheless be maintained for those species which were described in this genus assuming that it, among others, lacks procoracoids and clavicles. These authors proposed *Cophixalus verrucosus* (described as *Sphenophryne verrucosa* by BOULENGER in 1898) as the type species of the genus *Cophixalus* and *geislerorum* as a valid species in the genus *Oreophryne*. Their appeal to the International Commission on Zoological Nomenclature was accepted and the generic names *Cophixalus* and *Oreophryne* were placed on the Official List of Generic Names in Zoology (MELVILLE 1984).

Today, 31 species of the genus *Cophixalus* are recognized (FROST 2002). Thirteen of them live in northern Australia, seventeen in Papua New Guinea and one on the island of Halmahera. Only one, *Cophixalus biroi* (MÉHELY, 1901) (see ZWEIFEL 1979), is known to also occur in eastern Papua, Province of Indonesia (formerly West Irian, Papua Barat or Irian Jaya). Together with colleagues from Papua and a German friend the author collected two *Cophixalus* species in western New Guinea which proved to be new to science and which are described below.

MATERIALS AND METHODS

All frogs were collected during two trips to Papua, Province of Indonesia, in the years 2000 and 2002. Most were located by their advertisement calls at night and, after recording their calls, they were collected by hand. Several specimens were photographed in life on the following day, and after anaesthetising with chlorobutanol, they were fixed in 2 % formalin. Tissue samples were taken from some specimens and stored in 70 % ethanol before the animals were fixed in order to enable DNA investigations later. All frogs were preserved in 75 % ethanol prior to their deposition in the museum collection.

Advertisement calls were recorded with a Sony Walkman TCD-D100® Digital Audio Tape (DAT) and a Sennheiser microphone MKE 300® at a distance of 0.50 cm to 2.0 m from the calling animal. Calls were analysed with Avisoft-SAS Lab® software. One paratype of each new species was cleared and double-stained using the alcian blue-alizarin red technique according to a modified method from DINGERKUS & UHLER (1977) for skeletal examinations.

The following measurements were made with a vernier calliper (above 10 mm) or an ocular micrometer in a binocular dissecting microscope (below 10 mm): Length from tip of snout to distal tip of urostyle (SUL), length of tibia (TL), length of tarsus from heel to palm (TaL), length of fourth toe (L4T) and length of third toe (L3T) from tip of toes to proximal end of inner metatarsal tubercle, length of first toe from tip of this toe to distal end of inner metatarsal tubercle (L1T), length of the inner metatarsal tubercle (LMT), transverse diameter of disc of

4th toe (T4D), length of 3rd finger from tip of this finger to base of first finger (L3F), transverse diameter of disc of 3rd finger (F3D), head length from tip of snout to posterior margin of tympanum (HL), head width taken in the region of the tympana (HW), distance between anterior corner of orbital opening and centre of naris (END), internarial distance between centres of nares (IND), horizontal eye diameter (ED), horizontal diameter of tympanum (TyD), distance from an imaginary line connecting centres of eyes to tip of snout = snout length (SL) and distance between supratympanic folds directly behind eyes (FD).

All frogs were given inventory numbers from the Museum für Naturkunde Berlin (ZMB) and were stored in the herpetological collection of this museum. According to recommendations by the Indonesian Institute of Science, Lembaga Ilmu Pengetahuan Indonesia (LIPI), part of the material will be transferred to the Museum Zoologicum Bogoriense in Bogor, Java, and, if proper conditions permit, to a museum in Papua.

The following material from the American Museum of Natural History in New York (AMNH) was compared to the new species:

Cophixalus biroi (MÉHELY, 1901): AMNH 78108-112;

Cophixalus cheesmanae PARKER, 1934: AMNH 74917-920 and 101882-886;

Cophixalus pipilans ZWEIFEL, 1980: AMNH 83000, 83001, 83003 and 83006;

Cophixalus shellyi ZWEIFEL, 1956: AMNH 67610-612, 81147, 81654 and 87202-204;

moreover the lectotype of *Cophixalus montanus* (BOETTGER, 1895) (SMF 4198) and its paralectotype (SMF 4199) as well as the holotype of *Cophixalus geislerorum* (SMF 4199), now *Oreophryne geislerorum*, deposited in the Forschungsinstitut und Naturmuseum Senckenberg Frankfurt/Main (SMF).

Drawings of figures 5 - 7 and 15 - 19 were made by V. HEINRICH (Berlin), that of figures 1 and 11 by N. HOFF (Berlin) and all photographs were taken by R. GÜNTHER.

DESCRIPTION OF THE NEW SPECIES

Cophixalus balbus spec. nov.

Holotype: ZMB 62592 (field number = FN: R. G. 7380). Adult male, collected by R. GÜNTHER, M. KAPISA and I. TETZLAFF about 7 km north of the village of Konti (about 12 km north-east of Serui) on Yapen Island, 1°46'S and 136°18'E, altitude 650 m a.s.l., Papua, Province of Indonesia, 19 May 2000.

Paratypes: ZMB 62591 (FN: R.G. 7341), collected 17 May 2000; ZMB 62593 (FN: R.G. 7381), now an osteological preparation, collected 19 May 2000; ZMB 62594 (FN: 7434) and ZMB 62595 (FN: 7435) both collected 6 April 2002; ZMB 62596 (FN: 7487) collected 11 April 2002 and ZMB 62597 (FN: 7502) collected 12 April 2002. All six paratypes occurred within 200 m of the locus typicus and were collected by R. GÜNTHER. ZMB 62597 is an immature female, all others are adult males.

Diagnosis: With a snout-urostyle length of 26 to 28 mm in five adult males of the type series the new species is one of the larger members of the genus. Compared to the similar sized New Guinean species *C. parkeri* LOVERIDGE, 1948, *C. kaindiensis* ZWEIFEL, 1979, *C. cryptotympanum* ZWEIFEL, 1956, *C. verrucosus* (BOULENGER, 1898) and *C. cheesmanae* it differs by its rather uniform colour and, from the similarly coloured *C. biroi* among others, by its shorter tibiae. Most characteristic are its advertisement calls which clearly differ from all hitherto known *Cophixalus* species. Calls last one to two minutes and consist of series of peeping notes whereby the first notes were uttered in irregular and extended intervals (several seconds) and the last part of a call has notes with regular short intervals. Mean note length is 36 milliseconds, mean internote intervals are 95 milliseconds in the last part of the call.

Description of the holotype (fig. 1): An adult male whose measurements and biometric ratios are given in table 1. Head rather large, as wide as anteri-

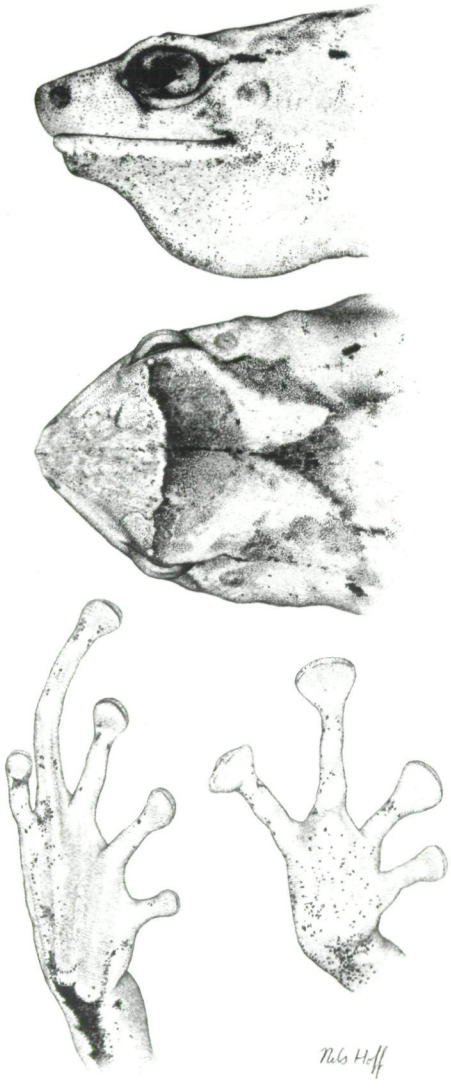

Fig. 1: Holotype of *Cophixalus balbus* spec. nov. (ZMB 62592); head in lateral and dorsal view, right foot and right hand in ventral view.

Abb. 1: Holotypus von *Cophixalus balbus* spec. nov. (ZMB 62592); Kopfregion in Lateral- und Dorsalansicht, rechter Fuß und rechte Hand in Ventralansicht.

or trunk, snout short, its tip roundish and slightly protruding, horizontal eye diameter of same length as distance between eye and naris, canthus rostralis without sharp borders, loreal region straight, internarial distance the same as distance between eye and naris, tympanum barely visible. Tongue large and oval, posterior third free, one flat prepharyngeal and a broader and serrated skin fold anterior to the pharynx. Slit like openings of single subgular vocal sac on both sides of the tongue. Legs moderately long, no webs between fingers or toes, finger tips clearly broader than toe tips, smallest disc on first toe, third toe evidently longer than fifth (for relative length of fingers and toes see fig. 1), subarticular and metatarsal tubercles faintly expressed. Dorsal surfaces of body and legs covered with some small warts, one small whitish wart in the middle of the edge of the upper eyelid (warts were in life more numerous and better expressed than in the fixed animal), supratympanic fold very weak. Ground colour of dorsal surfaces of body and extremities yellowish-brown in life, pale grey in preservative; conspicuous is a dark grey W-shaped mark in the scapular region which is bordered anteriorly by a semicircular spot of the same colour, the anterior border of this spot passes between middle of eyes and is confined by a whitish line. Also conspicuous are a small blackish streak behind posterior eye corner and on upper part of anterior flank as well as a larger dark spot on the anterior carpal region and the posterior tarsus. Dorsal surfaces of fingers and toes with some spots, that of discs unpigmented. The dark red colour of anterior and posterior surfaces of thighs, seen in life (fig. 2), has faded to light yellow in the preserved specimen. Overall impression of ventral surfaces whitish (throat and belly) or yellowish (thighs and tibiae), examined in detail, some faint darker spots are visible. Colour of oval iris in life yellow with dark areas towards the eye corners.

Variation in the type series: All paratypes are, in colour and markings, nearly identical to the holotype. Ground colour in life ranged from more yellowish (fig. 2) to more brownish (fig. 3). The W-shaped figure with its dark anterior part may be more or less intensely pigmented, striking in all animals is a light snout. Surfaces of throat and belly show a variable

Fig. 2: Dorsolateral view of a paratype (ZMB 62591) of *Cophixalus balbus* spec. nov. in life. Note the basic yellowish colour and dark red coloured anterior and posterior thighs.

Abb. 2: Paratypus von *Cophixalus balbus* spec. nov. (ZMB 62591) im Leben. Beachte die gelbliche Grundfärbung und die dunkelrot gefärbten Vorder- und Hinterseiten der Oberschenkel.

Fig. 3: Dorsal view of a greyish-brown paratype (ZMB 62596) of *Cophixalus balbus* spec. nov. in life.

Abb. 3: Dorsalansicht eines lebenden Paratypus (ZMB 62596) von *Cophixalus balbus* spec. nov. mit graubraun gefärbter Oberseite.

Fig. 4: Ventral view of a paratype of *Cophixalus balbus* spec. nov. in life.
Abb. 4: Ventralansicht eines Paratypus von *Cophixalus balbus* spec. nov. im Leben.

pattern of unpigmented and white pigmented areas covered to a greater or lesser extent with small dark spots (fig. 4). In all animals, except the juvenile, throat and chest not more strongly pigmented than abdomen as is the case in many other microhylid species.

Snout-urostyle length of six adult males 26.2 - 28.2 mm, a female with SUL of 22.0 mm had juvenile ovaries. Ratio TL/SUL had values between 0.46 and 0.48, mean 0.47, SD 0.0054. For other biometric traits compare table 1.

Osteology (based on a cleared and double stained paratype, ZMB 62593): Most skull bones of *C. balbus* have the same shape as pictured and characterised by MÉHELY (1901) for *C. biroi* whose data should be taken as a reference point. Following differences in bones of the skull could be identified: *C. balbus* has a shorter and more blunt processus zygomaticus of the squamosal, extensive distal parts of its otoccipitals are cartilaginous, nasals less bent and ventral surfaces of sphenethmoid have two ossification centres not shown by MÉHELY (1901). This author did not represent anything other than cranial elements, therefore shoulder girdle (fig. 5), hyoid apparatus (fig. 6) and sacrum (fig. 7) of *C. balbus* are depicted here. Evident are rather small posteriomedial processes of the hyoid, presence of a presternum (anterior to the coracoids) and anterior margin of transverse processes of the sacrum bent caudad (not craniad as in most cases), sacral-coccygeal articulation bicondylar. All vertebrae rather short and have broad transverse processes, neural arches non-imbricate; this assessment does not agree with a generalisation by TRUEB (1973) according to which all members of the family Microhylidae should have imbricate neural arches.

Etymology: The Latin present participle balbus means stuttering. This spe-

Table 1: Measurements and ratios of various body parts of the holotype (ZMB 62592) and six paratypes of *Cophixalus balbus* spec. nov. With the exception of one juvenile female (ZMB 62597) all specimens are males. Measurements in mm, abbreviations are explained in "Materials and methods".

Tab. 1: Maße und Proportionen verschiedener Körperteile des Holotypus (ZMB 62592) und von sechs Paratypen von *Cophixalus balbus* spec. nov. Mit Ausnahme eines juvenilen Weibchens (ZMB 62597) handelt es sich durchweg um Männchen. Alle Maße in mm, die Abkürzungen sind im Abschnitt "Materials and methods" erklärt.

ZMB-No.	62591	62592	62593	62594	62595	62596	62597
SUL	27.8	27.5	27.7	28.2	26.2	27.2	22.0
TL	13.4	13.0	13.4	13.5	12.4	12.7	10.2
TaL	8.3	8.1	8.1	8.4	7.8	7.9	6.1
L4T	11.9	11.5	12.0	11.6	10.7	11.1	9.3
L3T	9.2	8.6	8.8	8.5	7.8	8.8	7.2
T1L	1.8	1.8	2.0	1.8	2.0	2.0	1.5
LMT	1.4	1.4	1.5	1.5	1.3	1.4	1.1
T4D	1.3	1.2	1.4	1.5	1.2	1.1	1.0
L3F	7.5	7.0	7.6	7.4	6.7	7.0	5.4
F3D	1.7	1.8	1.8	1.9	1.6	1.4	1.4
HL	8.1	7.9	8.2	7.9	7.5	8.1	7.2
HW	11.2	11.3	10.5	10.8	10.0	11.0	8.5
END	2.7	2.5	3.0	2.8	2.5	2.9	2.3
IND	2.7	2.7	3.0	2.8	2.5	2.7	2.1
ED	2.8	2.9	2.8	2.8	2.7	2.8	2.4
TyD	1.3	1.2	1.3	1.2	1.1	1.2	1.0
SL	4.0	3.9	3.8	3.8	3.9	4.2	3.5
FD	8.0	8.0	8.0	8.1	7.5	7.8	6.2
TL/SUL	0.48	0.47	0.48	0.48	0.47	0.47	0.46
TaL/SUL	0.30	0.29	0.29	0.30	0.30	0.29	0.28
T4D/SUL	0.047	0.044	0.051	0.053	0.046	0.040	0.045
T4D/F3D	0.76	0.67	0.78	0.79	0.75	0.73	0.71
HL/SUL	0.29	0.29	0.30	0.28	0.29	0.30	0.33
HL/HW	0.72	0.70	0.78	0.73	0.75	0.74	0.85
END/IND	1.0	0.93	1.0	1.0	1.0	1.07	1.09
ED/SUL	0.101	0.105	0.101	0.099	0.103	0.102	0.109
TyD/ED	0.46	0.41	0.46	0.43	0.41	0.43	0.42
SL/SUL	0.144	0.141	0.137	0.134	0.149	0.154	0.159
FD/SUL	0.29	0.29	0.29	0.29	0.29	0.29	0.28

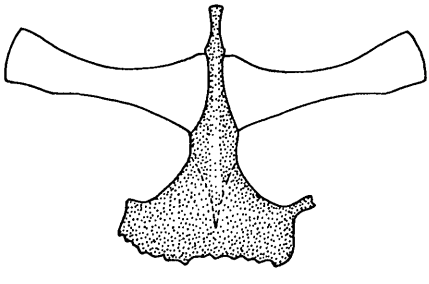

Fig. 5: Shoulder girdle of *Cophixalus balbus* spec. nov. (ZMB 62593).
White: bones, stippled: cartilage.

Abb. 5: Schultergürtel von *Cophixalus balbus* spec. nov. (ZMB 62593).
Weiß: Knochen, gepunktet: Knorpel.

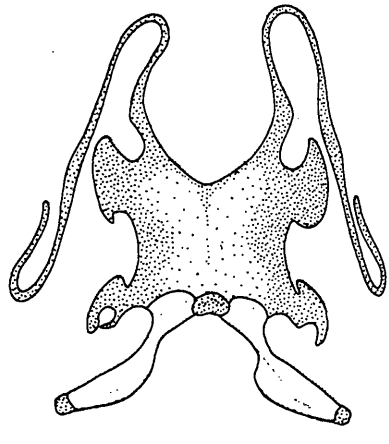

Fig. 6: Hyoid apparatus of *Cophixalus balbus* spec. nov. (ZMB 62593).

Abb. 6: Hyoidapparat von *Cophixalus balbus* spec. nov. (ZMB 62593).

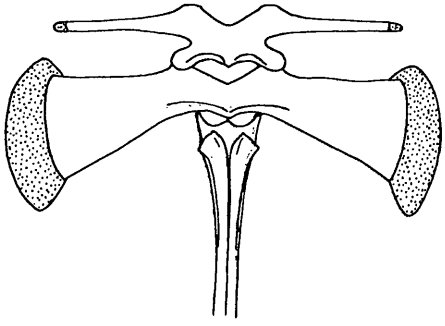

Fig. 7: Anterior part of urostyle bone, sacrum and the 8th presacral vertebra of *Cophixalus balbus* spec. nov. (ZMB 62593) in dorsal view.

Abb. 7: Vorderer Abschnitt des Urostyls, Sacrum und 8. präsacraler Wirbel von *Cophixalus balbus* spec. nov. (ZMB 62593) in Dorsalansicht.

cific epithet refers to the advertisement calls of the new species. Notes and note groups in the first part of the calls follow one another at irregular intervals and moreover note groups are composed of various numbers. This creates the impression of stuttering.

Distribution: All specimens were found within 300 m of the locus typicus at altitudes of 600-700 m in the Waira Mountains about 7 km north of the village of Konti (about 12 km NE of Serui) on Yapen Island, north-eastern Cenderawasih Bay. D. PRICE (pers. comm.) found *Cophixalus* males of 24.4 - 26.4 mm snout-vent length in 100 - 520 m a.s.l. about 25 km west of the locus typicus which most probably also belong to the new species.

Habitat and habits: The slope, including a small valley where the frogs were found, was covered by patches of primary and secondary rain forest. The forest ground was mainly composed of clay and humus and covered by some leaf litter and wood. Ferns and bushes were abundant in places and sparsely distributed in others. All frogs perched on fern fronds or on leaves of shrubs 1.5 to 3.0 m above the ground. The single juvenile female was discovered at a height of 0.50 m immediately at the margin of a small brook. Its stomach contained seven ants, one small curculionid beetle and another small beetle. Distance between calling males was 5 m or more. Rarely more than one male of this species could be heard at the same time. Calling activities started at twilight and ceased at about 10 p.m. Because I did not stay in the frogs' habitat during the second half of the night or during morning hours I am unable to report activities then. Calling males were heard in April, May and September; the site was not visited during any other month.

Cophixalus balbus shares its habitat with species of the following amphibian genera: *Asterophrys*, *Austrochaperina*, *Callulops*, *Choerophryne*, *Copiula* (GÜNTHER 2002a, 2002b), *Hylophorbus* (GÜNTHER 2001), *Oreophryne* (GÜNTHER et al. 2000), *Litoria*, *Rana* (*Papurana*) and *Platymantis*.

Vocalisation: Calls commonly have a duration of one to two minutes and consist of single notes and groups of notes. Typical calls start with single notes at rather long intervals. Intervals at that phase can last up to 10 s. In the further course of the call, intervals become shorter and notes tend to form groups (fig. 8). Neither duration of intervals nor number of notes per group follow a constant pattern in that phase so that the impression of stuttering arises. There is a clear tendency for an increase in note number per group during the call and note groups towards the end of calls may last for 20 s and consist of more than 150 notes. Internote intervals may be of the same length during this last series, but they can also vary, whereby the former intervals can be longer than the latter ones or vice versa. Mean duration of 471 notes from three specimens was 35.7 ms (SD 5.1), minimum 28 ms and maximum 50 ms. Mean interval duration of 358 intervals within fast note sequences was 95 ms (SD 12.0), minimum 69 ms and maximum 134 ms. Notes show a similar amplitude ascent and descent within oscillograms (fig. 9, above) and a weak modulation of frequency within audiospectrograms (fig. 9, below). This can be better seen in time-expanded spectrograms. All notes are unpulsed. Mean note repetition rate in the fast series is about 8 notes per second. Fundamental frequency of the calls is 1.1 kHz and dominant frequency 2.2 kHz. Seven upper harmonics of about the same intensity can be discerned (figs. 9 and 10).

All calls were recorded at temperatures of 23-24 °C.

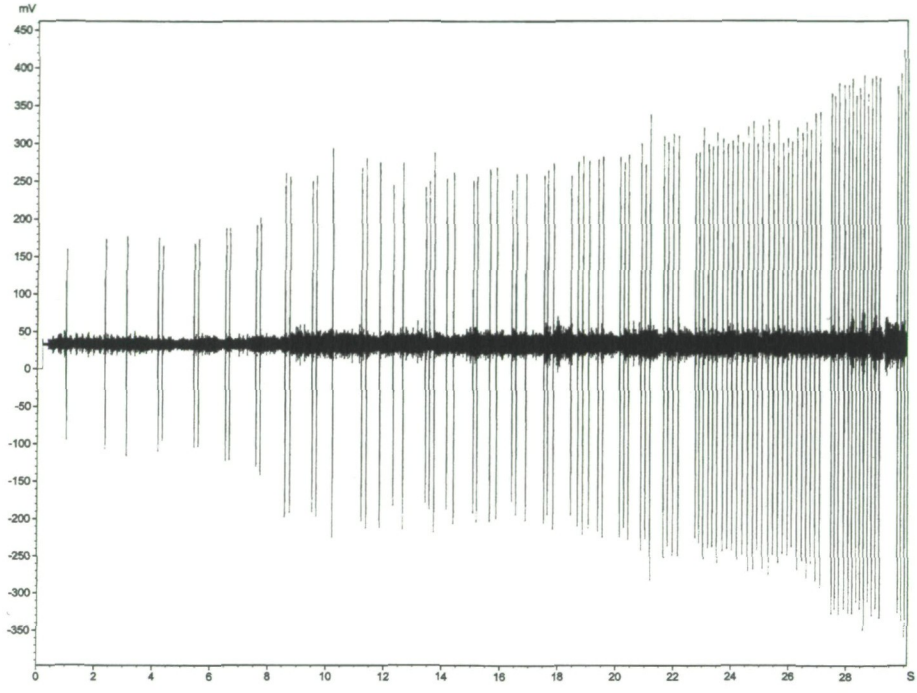

Fig. 8: Oscillogram of an advertisement call of *Cophixalus balbus* in its initial (stuttering) phase.
Abb. 8: Oszillogramm eines Paarungsrufes von *Cophixalus balbus* in der Anfangsphase (Stotterteil).

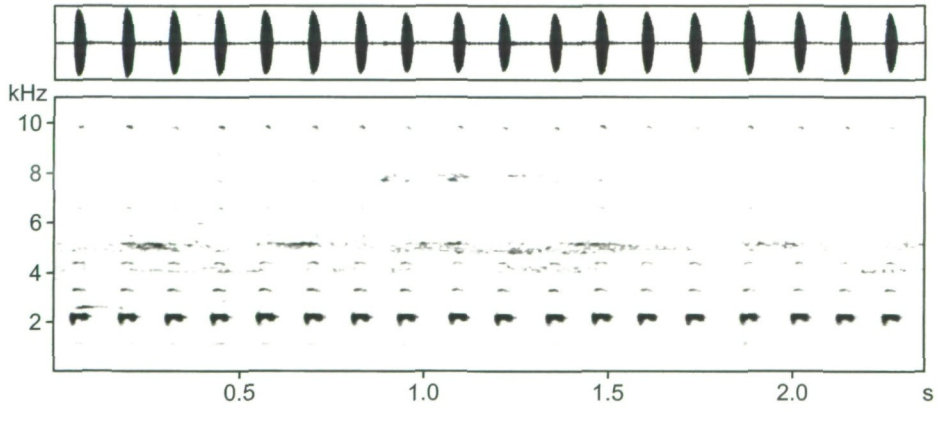

Fig. 9: Oscillogram (above) and audiospectrogram (below) of a section of an advertisement call of *Cophixalus balbus* where notes follow one another in short and regular intervals.
Abb. 9: Oszillogramm (oben) und Audiospektrogramm (unten) eines Ausschnittes aus dem letzten Rufabschnitt von *Cophixalus balbus*, wo die Silbenintervalle kurz und regelmäßig sind.

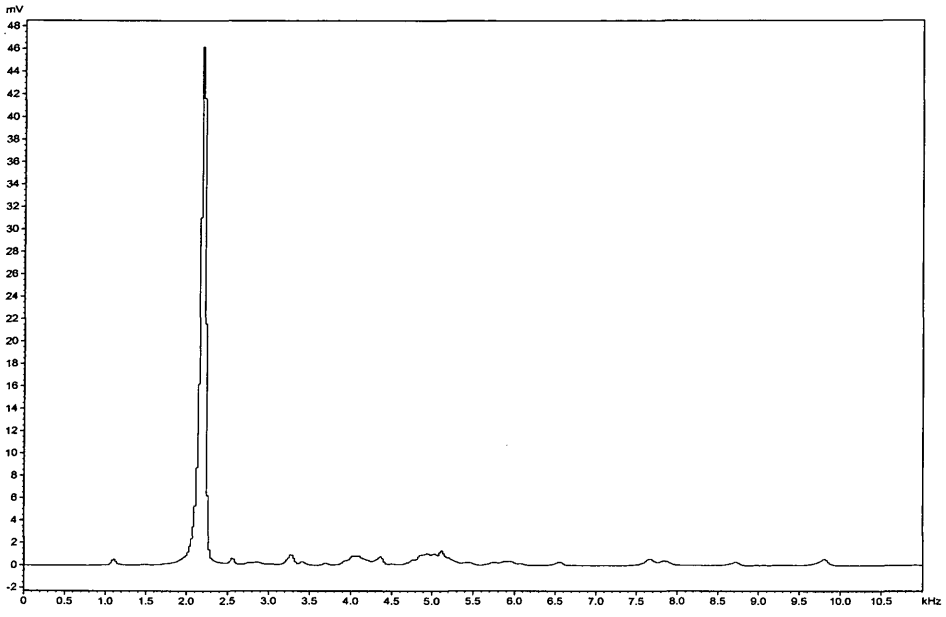

Fig. 10: Distribution of frequencies of an advertisement call note of *Cophixalus balbus*.
Abb. 10: Verteilung der Frequenzen einer Rufsilbe von *Cophixalus balbus*.

Comparisons with other species

According to my previous observations (GÜNTHER 2000, 2001, 2002a, 2002b; GÜNTHER et al. 2001), size of adult specimens of one sex varies only to a small extent in many Papuan microhylid frogs. Therefore species whose males have a mean SUL less than 24 mm or more than 32 mm can generally be neglected from these comparisons. The following species have a similar size and habitus to *C. balbus*: *C. biroi*, *C. cheesmanae*, *C. cryptotympanum*, *C. kaindiensis*, *C. parkeri* and *C. verrucosus*. Considering the data provided by MÉHELY (1901), ZWEIFEL (1956a, 1956b, 1962, 1979), MENZIES (1976) and ZWEIFEL & PARKER (1977, 1989), *C. cheesmanae* has a longer and flatter snout with a more protruding snout tip, a clearer defined canthus rostralis, blackish head sides and pulsed notes in its advertisement calls; *C. cryptotympanum* has a darker dorsal surface, no white coloured superior snout, ocelli in the inguinal region, a light mark from eye to tympanum and a note repetition rate of 3.5 per second; dorsal and ventral surfaces of *C. kaindiensis* are much more intensively coloured and marked and repetition rate of notes is "only" about 2/s; *C. parkeri* is also more strongly pigmented, has no red colour on the anterior and posterior surfaces of thighs and a group of short buzzing notes in mating calls; *C. verrucosus* can be best distinguished by its white spots on a dark background on the anterior and posterior surfaces of the thighs. If one compares the available published drawings and photographs of the above species, *C. biroi* (fig. 1C on page 3, ZWEIFEL 1979) seems to be most closely related to the new species. Comparison of the measurements of five *C. biroi* from the AMNH and seven *C. balbus* revealed the following differences: TL/SUL 0.50-0.52 in *C. biroi*, 0.47-0.48 in *C. balbus*; means 0.51 and 0.48, this difference is statistically highly significant (STUDENT's *t*-value is 8.84 and *p*-value is less than 10^{-4}). There are also differences in the ratio TaL/SUL (0.24-0.29 in *C. biroi* and 0.29-0.30 in *C. balbus*, $t = 2.71$, $p = 0.023$) and TyD/ED (0.43-0.57 in *C. biroi* and 0.41-0.46

in *C. balbus*, $t = 3.34$, $p = 0.0087$). Most striking is a fairly broad dark streak on both sides of the head which may continue to the middle of the flanks in *C. biroi*, clearly shown in the original description by MÉHELY (1901, plate XII, 2) and mentioned also in the redescription by ZWEIFEL (1979). Such dark stripes were never seen in *C. balbus*. Another important feature to distinguish both species is the advertisement call. According to ZWEIFEL (1979) notes of *C. biroi* last about 100 ms and have long internote intervals. Note repetition rate within note groups is less than one note per second (recall 8/s in *C. balbus*). Despite the differences mentioned, there is obviously a close relationship between *C. balbus* and *C. biroi*.

Comparisons with the Australian representatives of the Genus *Cophixalus*, which were treated by ZWEIFEL (1985), revealed clear differences in all cases.

Cophixalus tetzlaffi spec. nov.

Holotype: ZMB 62600 (FN: 7188); adult male collected by R. GÜNTHER, M. KAPISA and I. TETZLAFF 16 km north of Fakfak town on the Bomberai Peninsula (neck of the Vogelkop), Papua, Indonesia, coordinates 2°47'S and 132°16'E, altitude 860 m a.s.l., 2 May 2000.

Paratypes: ZMB 62409 (FN: 7182) and ZMB 62599 (FN: 7181), both collected on 2 May 2000 and ZMB 62598 (FN: 7144) collected on 29 April 2000. ZMB 62409 is now an osteological preparation. All paratypes are adult males and were collected at the same site as the holotype. Collectors were also the same as for the holotype.

Diagnosis: A medium-sized species, adult males have a snout-urostyle length of 20-22 mm; upper surfaces of body and limbs and flanks without larger spots, a black face mask present. Presence of dorsolateral glandular ridges embedded in blackish longitudinal stripes as well as call notes of a mean length of more than 400 ms are unique among the genus *Cophixalus*.

Description of the holotype (figs. 11-13): Head broader than long, canthus rostralis roundish, loreal region slightly concave, snout tip faintly protruding, horizontal eye diameter greater than eye-naris distance, tympanum only partly visible, internarial distance clearly greater than distance between eye and naris. Tongue large and posteriorly broadened and free, one weak, unserrated prepharyngeal fold across the palate and a stronger and serrated fold in front of the pharynx. Long slits on both sides of the tongue form the openings to a subgular vocal sac. Supratympanic ridge short and flat, a small tubercle on each eyelid. Legs moderately long, no webs between fingers or toes, finger tips broader than toe tips, first finger of much smaller size than other fingers and its tip only a little broader than penultimate phalanx, relative finger length 3 > 2 = 4 > 1, third toe clearly longer than fifth, first toe tip by far the smallest, relative length of toes 4 > 3 > 5 > 2 > 1, all subarticular tubercles as well as inner metatarsal tubercle weakly expressed. Dorsolateral glandular folds extend from behind eyes to lumbar region, some warts on lower legs, other dorsal and ventral surfaces smooth. Ground colour in life yellowish-grey during day (light grey at night), in the fixed specimen grey. Conspicuous are a blackish dorsolateral stripe, a blackish head side, a blackish supratympanic fold, an extensive whitish patch from posterior corner of eye to insertion of forearm and white rings at base of the discs of fingers and toes. The cream-coloured line from tip of snout to anus and along posterior surfaces of thighs, shanks and tarsus, clearly seen in life (fig. 12), disappeared almost completely in the fixed animal. Some weakly expressed darker spots are found on various body parts. Underside of body and limbs covered by brownish spots, most dense on throat and chest, fewest on abdomen (fig. 13). No conspicuous coloration of anterior or posterior surface of thighs.

Variation in the type series: Nearly no variation in the four types; basic colour in life could tend to be more yellowish (fig. 12) or more greyish

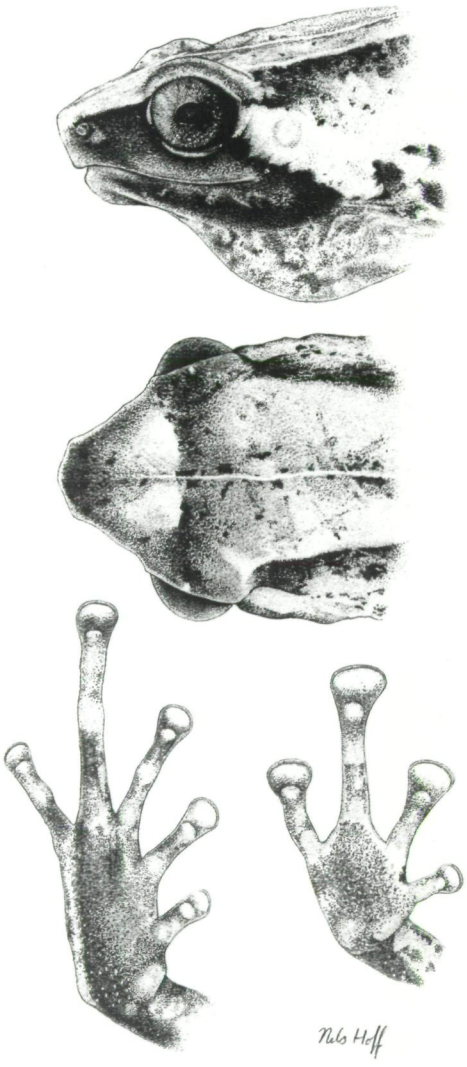

Fig. 11: Holotype of *Cophixalus tetzlaffi* spec. nov. (ZMB 62600); head in lateral and dorsal view, right foot and right hand in ventral view.

Abb. 11: Holotypus von *Cophixalus tetzlaffi* spec. nov. (ZMB 62600); Lateral- und Dorsalansicht der Kopfregion; Ventralansicht vom rechten Fuß und der rechten Hand.

(fig. 14) with or without a whitish vertebral line. It should be noted that the whole body of all specimens appeared very light during their activities at night, while pigmented areas reappeared during transport and especially during the day. Weak differences between the specimens could be observed in intensity of spotting, but not in the general distribution of dark and light spots. Variation in body measurements and ratios was also low (table 2).

Osteology (based on the cleared and stained paratype ZMB 62409, figs. 15-19): There are major overall similarities to the conditions shown by MÉHELY (1901) for *C. biroi* or by ZWEIFEL (1985) for *C. ornatus*. Frontoparietals twice as long as broad, separated by a rather broad fissure; sphenethmoid expressed as a well ossified curved sheet from above attached to the frontoparietals, nasals weakly ossified, prootic and exoccipital with cartilaginous bridge posteriorly, processus zygomaticus of squamosal tapered, quadratojugal completely ossified, lateral wings of parabasal (= parasphenoid) of a weaker ossification stage than cultriform process, ventral surface of sphenethmoid with several ossification zones, no ridge on palatine, its mesial part broad and fused to the sphenethmoid, prevomer (sensu TRUEB 1973) attached to palatine, posteromedial processes of hyoid large, sternum large with a presternum and anchor-shaped lobes posteriorly, vertebral column with eight presacral procoelous vertebrae, neural arches non-imbricate, dilated sacral diapophyses with similar angles anteriorly and posteriorly, sacral-coccygeal articulation bicondylar (ventral view).

Etymology: This species is dedicated to my friend IMMO TETZLAFF (Zepernick) who not only saw the first specimen and helped with field work during two excursions on New Guinea but who also supported my work in many ways in Germany.

Distribution: Known so far only from the locus typicus, about 16 km north of Fakfak town in the Fakfak Mountains.

Habitat and habits: The Fakfak Mountains were originally covered by primary rain forests. During road construction between Fakfak town and Kokas in the 1980s and early 1990s many of the tall trees were cleared near the new road. Great parts along this road were covered by

Fig. 12: Holotype of *Cophixalus tetzlaffi* spec. nov. in life.
Abb. 12: Holotypus von *Cophixalus tetzlaffi* spec. nov. im Leben.

Fig. 13: Ventral view of the preserved holotype of *Cophixalus tetzlaffi* spec. nov. Coloration is nearly identical as in the living specimen.
Abb. 13: Ventralansicht des konservierten Holotypus von *Cophixalus tetzlaffi* spec. nov. Die Färbung ist nahezu identisch mit der Lebendfärbung.

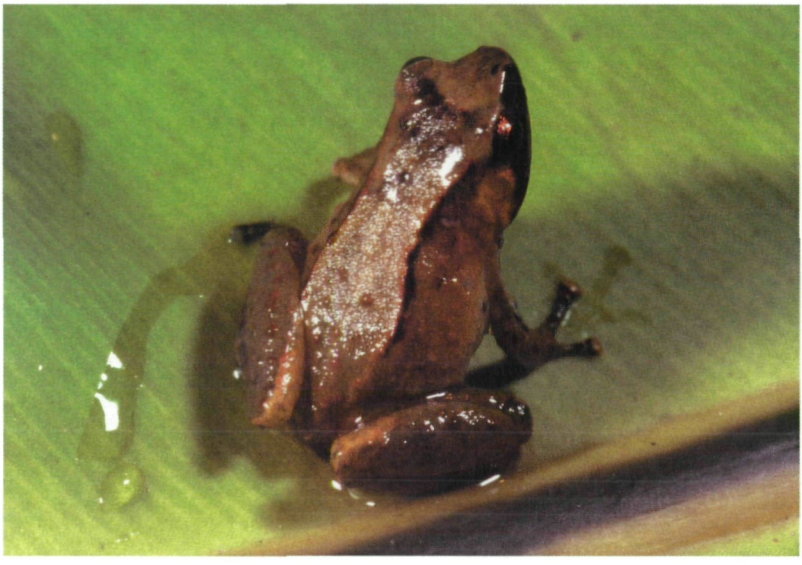

Fig. 14: Paratype of *Cophixalus tetzlaffi* spec. nov. with basic greyish colour in life.
Abb. 14: Paratypus von *Cophixalus tetzlaffi* spec. nov. mit einer grauen Grundfärbung im Leben.

Table 2: Measurements and ratios of various body parts of the holotype (ZMB 62600) and three paratypes of *Cophixalus tetzlaffi* spec. nov. All specimens are adult males, ZMB 62409 is now an osteological preparation. Measurements in mm, for abbreviations see "Materials and methods".

Tab. 2: Maße und Proportionen verschiedener Körperteile des Holotypus (ZMB 62000) und von drei Paratypen von *Cophixalus tetzlaffi* spec. nov. Alle Tiere sind adulte Männchen, ZMB 62409 ist heute ein osteologisches Präparat. Maße in mm, Erklärung der Abkürzungen im Abschnitt "Materials and methods".

ZMB-No.	62409	62598	62599	62600
SUL	21.5	21.2	20.0	22.1
TL	11.5	11.0	10.1	11.2
TaL	7.0	6.7	6.2	7.1
L4T	10.9	10.6	9.7	10.7
L3T	8.3	8.2	7.7	8.2
L1T	1.8	1.5	1.5	1.9
LMT	1.1	0.8	0.8	1.0
T4D	1.0	0.8	0.9	1.1
L3F	5.9	5.7	5.0	5.6
F3D	1.2	1.0	1.1	1.2
HL	7.0	6.5	7.0	7.2
HW	8.0	8.1	8.0	8.1
END	2.0	1.9	1.8	2.0
IND	2.6	2.6	2.4	2.5
ED	3.0	3.1	2.7	2.8
TyD	1.1	1.0	1.1	1.0
SL	3.4	3.3	3.1	3.2
FD	6.0	5.9	5.2	5.8
TL/SUL	0.53	0.52	0.51	0.51
TaL/SUL	0.33	0.32	0.31	0.32
T4D/SUL	0.047	0.038	0.045	0.050
T4D/F3D	0.83	0.80	0.82	0.92
HL/SUL	0.33	0.31	0.35	0.33
HL/HW	0.88	0.80	0.88	0.89
END/IND	0.77	0.73	0.75	0.80
ED/SUL	0.140	0.146	0.135	0.127
TyD/ED	0.37	0.32	0.41	0.36
SL/SUL	0.158	0.156	0.155	0.145
FD/SUL	0.28	0.25	0.26	0.26

secondary forests and plantations when we visited this region in 2000. Only on very steep slopes larger patches of primary forests still could be found. The habitat of the new species was situated at 860 m a.s.l. near the ridge of the mountains. It consisted of dense bushes below some taller trees. The frogs perched on herbaceous vegetation, on lower parts of shrubs or on leaf litter. As a result, perching sites were on somewhat raised structures on the ground, or on low vegetation up to 1 m in height. Frogs lived at high densities in suitable locations. There about ten specimens were vocalising within a circle measuring 10 m in diameter. Minimal distance between two calling males was 1 m.

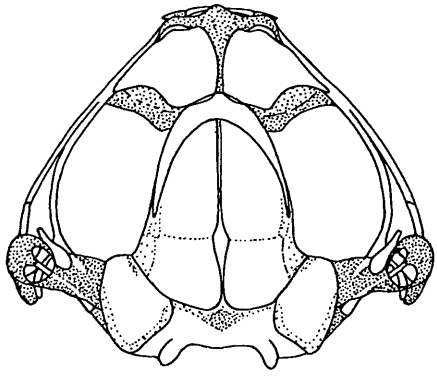

Fig. 15: Skull bones of *Cophixalus tetzlaffi* spec. nov. (ZMB 62409) in dorsal view.

Abb. 15: Schädelknochen von *Cophixalus tetzlaffi* spec. nov. (ZMB 62409) in Dorsalansicht.

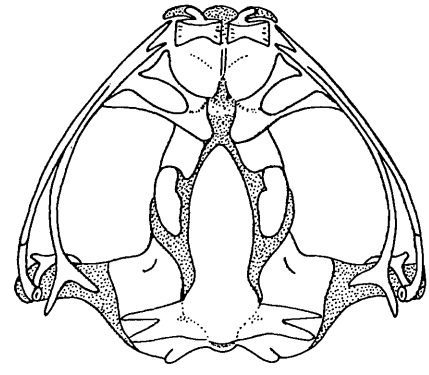

Fig. 16: Skull bones of *Cophixalus tetzlaffi* spec. nov. (ZMB 62409) in ventral view.

Abb. 16: Schädelknochen von *Cophixalus tetzlaffi* spec. nov. (ZMB 62409) in Ventralansicht.

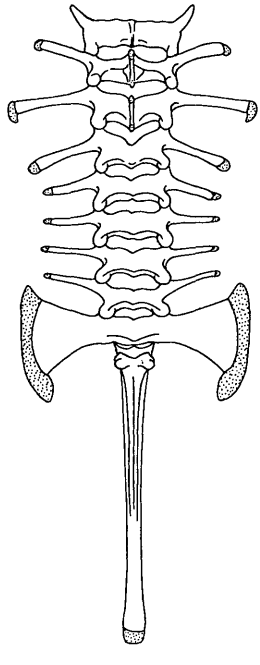

Fig. 17: Dorsal view of vertebral column of *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

Abb. 17: Dorsalansicht der Wirbelsäule von *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

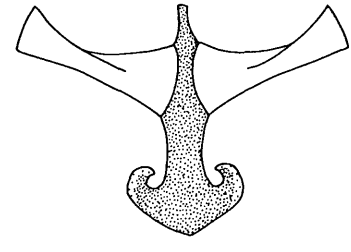

Fig. 18: Shoulder girdle of *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

Abb. 18: Schultergürtel von *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

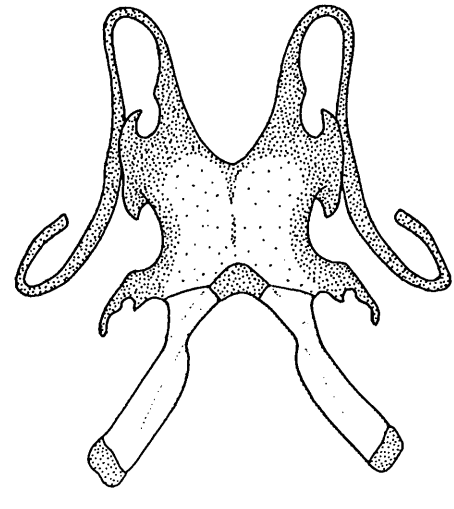

Fig. 19 (right): Hyoid apparatus of *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

Abb. 19 (rechts): Hyoidapparat von *Cophixalus tetzlaffi* spec. nov. (ZMB 62409).

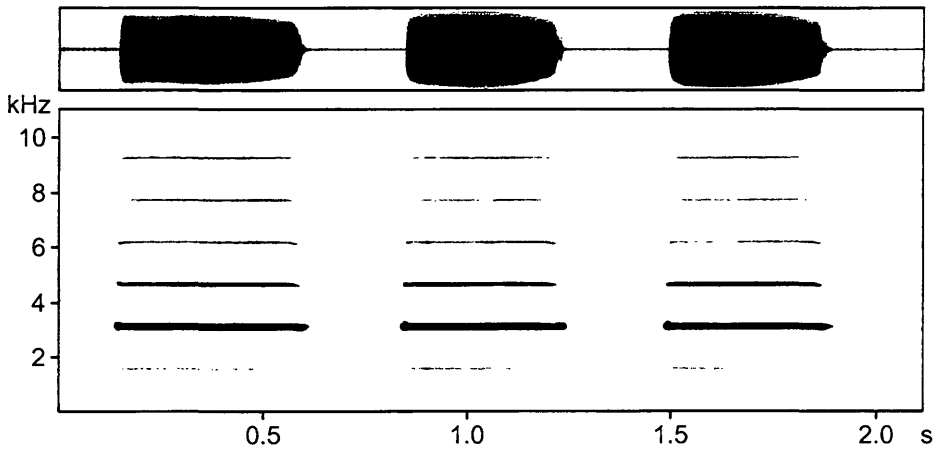

Fig. 20: Oscillogram (above) and audiospectrogram (below) of an advertisement call of *Cophixalus tetzlaffi* containing three notes. Signals which were not generated by the frog were retouched in the audiospectrogram.

Abb. 20: Oszillogramm (oben) und Audiospektrogamm (unten) eines Paarungsrufes mit drei Silben von *Cophixalus tetzlaffi*. Geräuschsignale, die nicht vom Frosch stammten, sind auf diesem Audiospektrogramm retuschiert worden.

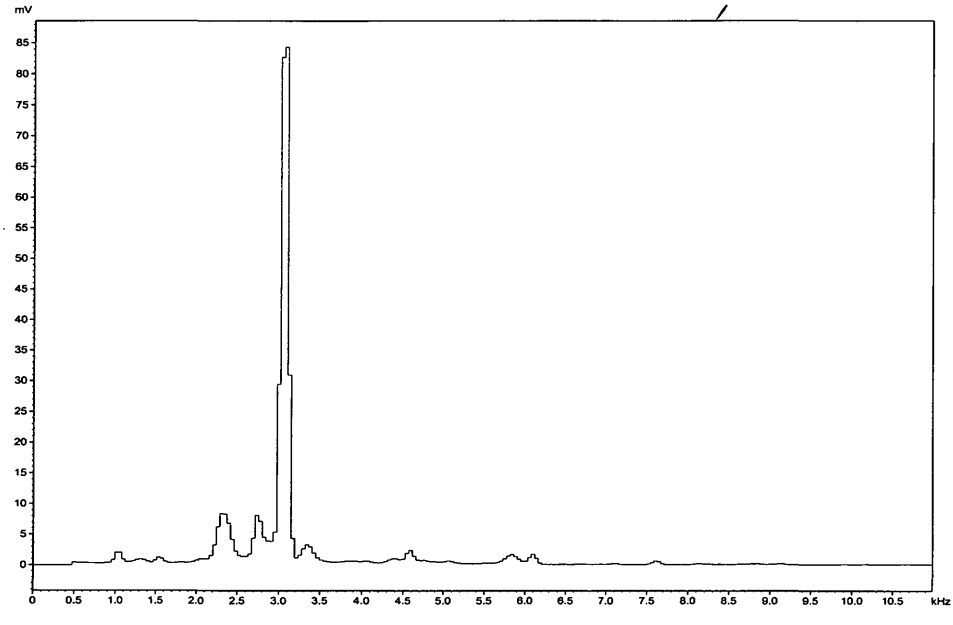

Fig. 21: Distribution of frequencies of an advertisement call note of *Cophixalus tetzlaffi* with higher dominant frequency (3.1 kHz).

Abb. 21: Verteilung der Frequenzen einer Silbe eines Paarungsrufes von *Cophixalus tetzlaffi*; die dominante Frequenz liegt bei 3,1 kHz (höhere Tonlage).

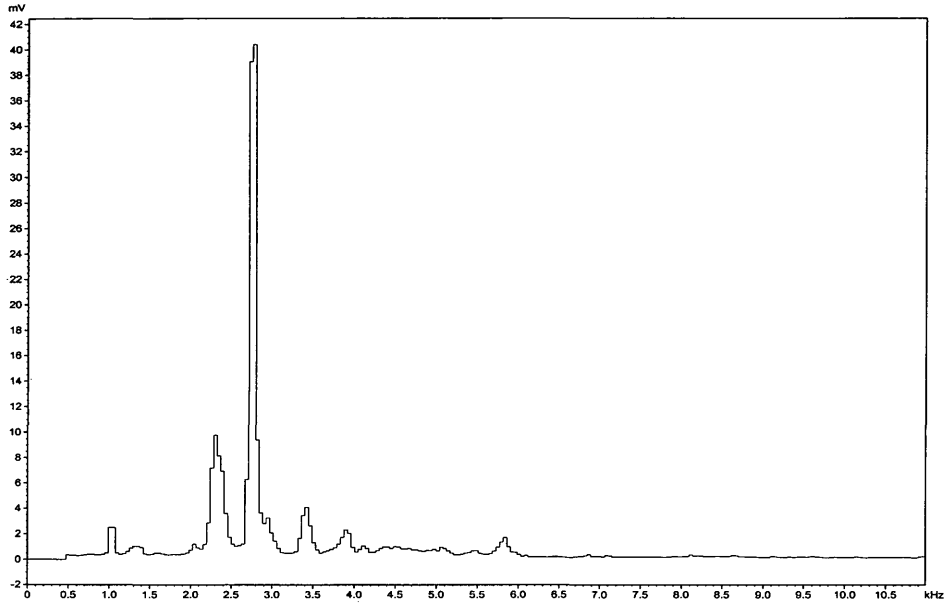

Fig. 22: Distribution of frequencies of an advertisement call note of *Cophixalus tetzlaffi* with lower dominant frequency (2.75 kHz).

Abb. 22: Verteilung der Frequenzen einer Silbe eines Paarungsrufes von *Cophixalus tetzlaffi*; die dominante Frequenz liegt hier bei 2,75 kHz (tiefere Tonlage).

Cophixalus tetzlaffi shares its habitat with species of the following amphibian genera: *Litoria* (4 species), *Rana* (*Papurana*) (3 species), *Asterophrys* (1 species), *Austrochaperina* (1 species), *Callulops* (2 species), *Hylophorbus* (1 species, see GÜNTHER 2001), *Oreophryne* (3 species) and *Sphenophryne* (1 species, see GÜNTHER et al. 2001).

Vocalisation: Males have a large vocal sac. When inflated it is more than half as large as the body. Calls are uttered in series lasting several minutes and each call consists of three or four long peeping or whistling notes. From 32 calls of three males 23 consisted of three notes, 7 of four notes and 2 of two notes. Mean duration of the three-note calls was 1.75 s (SD 0.058), mean duration of the four-note calls was 2.51 s (SD 0.088) and that of the two-note calls was 1.10 s. Mean duration of 89 notes was 422 ms (SD 47.3), minimum 347 ms and maximum 518 ms. 60 internote intervals had a mean duration of 250 ms (SD 20.6), minimum 186 ms and maximum 292 ms. The first note was consistently longer than the following ones. This note could start with a low sound intensity, but in other calls also with the maximum volume. The following notes in general reached their maximum amplitude very quickly and ended very quickly (fig. 20, above). Notes were finely tuned, unpulsed and had no modulation of volume and frequency (fig. 20, below). The first harmonic band above dominant frequency is more pronounced than the other harmonics. Many males called in duets whereby the first male called in a somewhat higher frequency than its companion. We got the impression that the same male was able to vocalise either higher (when it called first) or deeper (when it responded to a call pitched higher). Dominant frequency of a "high-pitched" call was 3.1 kHz (fig. 21) and that of a "low-pitched" call was 2.75 kHz (fig. 22).

All calls were recorded at a temperature of 22.5 °C.

Comparison with other species

Most of the species mentioned in the description of *C. balbus* have, among other distinguishing characters, a significantly greater body size than *C. tetzlaffi*. Males of *C. ateles* (BOULENGER, 1898), *C. bewaniensis* KRAUS & ALLISON, 2000, *C. pipilans* ZWEIFEL, 1980, *C. pulchellus* KRAUS & ALLISON, 2000, *C. shellyi* ZWEIFEL, 1956, *C. sphagnicola* ZWEIFEL & ALLISON, 1982 and *C. tagulensis* ZWEIFEL, 1963 do not reach 20 mm in SUL and in this respect are clearly smaller than the new species. They differ moreover in a set of other morphological features and in vocalisation. The following species fall within the size range of *C. tetzlaffi* and should be treated in more detail: *C. daymani* ZWEIFEL, 1956, *C. nubicola* ZWEIFEL, 1962, *C. parkeri* LOVERIDGE, 1948 and *C. verecundus* ZWEIFEL & PARKER, 1989. *Cophixalus daymani* has much shorter tibiae (TL/SUL about 0.40, in *C. tetzlaffi* 0.52), no vocal sac and ocelli in the lumbar region (ZWEIFEL 1956a); *C. parkeri* differs by much more intensely coloured dorsal surfaces of head, body, limbs and flanks (see photo on page 3, fig.1A in ZWEIFEL 1979), moreover its "groups of buzzing notes" (ZWEIFEL & PARKER 1977) clearly differ from the long whistles of the new species; *C. nubicola* has a different coloration and head shape, a longer first finger and first toe and much shorter tibiae, it has only been found at higher altitudes (more than 3000 m a.s.l.) in the Eastern Highland Province of Papua New Guinea thus far (ZWEIFEL 1962, ZWEIFEL & PARKER 1977); most clearly distinguishing features of *C. verecundus* are its short tibiae (TL/SUL less than 0.40), its characteristic coloration, its very poorly developed finger and toe discs and its "clicklike pulses" of the mating calls (ZWEIFEL & PARKER 1989).

Long dorsolateral glandular ridges and whistling advertisement call notes of 400-500 ms duration are features which *C. tetzlaffi* shares with no other *Cophixalus* species. Fairly small size, relatively small first fingers and first toes with small discs, a black face mask and a habitat in the dense lower stratum of forests are characters which place the new species nearer to the group *C. pipilans* - *C. shellyi* than to any other species of this genus. Comparisons with the Australian members of the genus, whose characteristics were shown by ZWEIFEL (1985), revealed significant differences in all cases.

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