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New Microhylid Frog (*Plethodontohyla*) with a Supraocular Crest from Madagascar

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We describe a new microhylid frog from the rain forests of central eastern Madagascar. *Plethodontohyla coronata* reaches 21–23 mm snout–vent length and is similar to *Plethodontohyla serratopalpebrosa* by having a supraocular crest of three dermal spines. It differs by having a smaller body size, shorter hind limbs, relative finger and toe length, and smaller relative tympanum size. Its first toe is very short, reminiscent of the state in miniaturized species of *Stumpffia*, but the presence of vomerine and maxillary teeth clearly confirm the assignation of *P. coronata* to *Plethodontohyla*. The advertisement call of this fossorial frog is a series of notes with complex frequency modulation.

THE microhylid frogs of Madagascar are considered to belong to three subfamilies: the Dyscophinae, Scaphiophryninae, and Cophylinae (Blommers-Schlösser and Blanc, 1991). Although the Dyscophinae are considered to contain also the Asian genus *Calluella*, the other two subfamilies are endemic to Madagascar. According to preliminary molecular and morphological data (Blommers-Schlösser and Blanc, 1993; Vences et al., 2002), the Cophylinae appears to be a well-defined monophyletic group with seven genera distributed in two main clades: one containing the genera *Cophyla*, *Platypelis*, *Plethodontohyla*, and *Rhombophryne*, the second one containing *Anodonthyla*, *Madecassophryne*, and *Stumpffia*. This subfamily is characterized by specialized reproductive modes, and all genera have nonfeeding tadpoles. In *Cophyla*, *Platypelis*, *Anodonthyla*, and arboreal *Plethodontohyla*, the larvae develop in water-filled tree-holes, whereas fossorial *Plethodontohyla* have terrestrial nests of liquefied jelly, and *Stumpffia* have terrestrial foam nests (Guibé, 1952; Blommers-Schlösser, 1975; Glaw and Vences, 1994).

This diversity in reproductive modes is also accompanied by a high species diversity. The Cophylinae is the largest microhylid subfamily in Madagascar and currently contains 37 species (Glaw and Vences, 1994; Vallan, 2000a; Vences et al., 2003). However, many additional species have already been identified (e.g., Glaw and Vences, 1994) but not yet formally named. In this paper, we describe one distinct species of *Plethodontohyla* and provide data on its advertisement calls.

MATERIALS AND METHODS

Frogs were collected during the night with the aid of headlamps or torches or during the day by localizing calling males. They were euthanised using chlorobutanol, fixed in 90% ethanol, and preserved in 70% ethanol. Specimens are deposited in the Département de Biologie Animale, Université d'Antananarivo (UADBA), Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn (ZFMK); and Zoologische Staatssammlung, München (ZSM).

Measurements were taken with a caliper to the nearest 0.1 mm: SVL (snout–vent length), HW (maximum head width), HL (head length, from the maxillary commissure to the snout tip), ED (horizontal eye diameter), END (eye–nostril distance), NSD (nostril–snout tip distance), NND (internarial distance), TD (horizontal tympanum diameter), HAL (hand length, from the carpal-metacarpal articulations to the tip of the longest finger), FORL (forelimb length, from the axilla to the tip of the longest finger), HIL (hind-limb length, from the cloaca to the tip of the longest toe), FOL (foot length, from the tarsal-metatarsal articulations to the tip of the longest toe), FOTL (foot length including tarsus, from the tibiotarsal articulation to the tip of the longest toe), TIBL (tibia length), IMCL (maximum length of inner metacarpal tubercle). Advertisement calls were recorded with a Tensai tape recorder with external microphone and analyzed using a MEDAV sound analyzing system and the software Spektro 3.2. Temporal measurements are given as range with mean ± standard deviation and number of measured units in parentheses.

Plethodontohyla coronata sp. nov.
Figures 1–2

Holotype.—ZFMK 57459, adult male, collected by F. Glaw, N. Rabibisoa, and O. Ramilison on 19 February 1994 at Ankeniheny, Fivondronona (district) of Moramanga, Faritany (province) of Toamasina, central eastern Madagascar (19°10′S/48°02′E, 900 m above sea level).

Fig. 1. Male holotype of *Plethodontohyla coronata* (ZFMK 57459) from Ankeniheny, central eastern Madagascar.

Paratypes.—ZSM 694/2001, and UADBA-MV 2001.200, two adult males, collected by M. Vences and D. R. Vieites on 16 February 2001 at Mandraka, Fivondronona of Manjakandriana, Faritany of Antananarivo, central eastern Madagascar (18°55′S/47°56′E, 1220 m above sea level).

Diagnosis.—A species of *Plethodontohyla* differentiated from all other cophyline microhylids by the following combination of characters: (1) small adult body size (SVL 21–23 mm); (2) unexpanded disks of fingers and toes; (3) short hind limbs (tibiotarsal articulation not reaching the eye when tympanum is adpressed along the body; ratio TIBL/SVL 39–41%); (4) second finger as long as fourth finger; (5) supraocular crest of three dermal spines.

Description of the holotype.—Specimen in excellent state of preservation. Body moderately stout; head distinctly wider than long, very slightly wider than body; snout rounded in dorsal and lateral views; nostrils directed laterally, protuberant, equidistant to eye and to tip of snout; canthus rostralis distinct, concave; loreal region concave; tympanum distinct, rounded, 59% of eye diameter; supratympanic fold indistinct and curved; tongue ovoid, posteriorly free, broader at its terminal end, not notched; maxillary teeth present; vomerine teeth present, forming small oblong rows posteromedial to choanae; choanae rounded. Arms slender, very faintly marked single subarticular tubercles; indistinct paired outer metacarpal tubercles; inner metacarpal tubercle forming distinct protuberance at prepollex; fingers without webbing; relative length of fingers $1 < 2 = 4 < 3$, fourth finger as long as second; terminal finger disks not enlarged; nuptial pads absent. Hind limbs moderately stout; tibiotarsal articulation reaching tympanum when hind limb adpressed along body; tibia length 39% of SVL; lateral metatarsalia strongly connected; distinct inner and indistinct outer metatarsal tubercles indistinct but present; no webbing between toes; relative length of toes $1 < 2 < 5 < 3 < 4$; third toe distinctly longer than fifth; first finger extremely short, fourth finger much longer than third and fifth. Skin on dorsum leathery with many small granules and without dorsolateral folds. Ventral skin very slightly granular. Above the eyes there is a crest of three small but distinct supraocular dermal tubercles.

Coloration of the holotype.—After eight years in preservative, dorsum light brown with a hour-

glass-marking on the head and neck and many small dark spots coinciding with skin granules, especially dorsolaterally and on the flanks. No cross-bands on limbs except one on the tarsus and one on the forearm. Tympanic region lighter, with a whitish streak running from the eye to the maxilla anterior to the tympanum. Ventrally cream-yellowish with some faint dark marbling, especially on the throat. In life (Fig. 1), coloration was similar, but the pattern was more distinct. The iris was brown with a grey-bluish iris periphery. A color photograph of the holotype was published in Glaw and Vences (1994, plate 144)

Variation.—Only paratype ZSM 694/2001 was available for close examination and direct comparison with the holotype. It largely agrees by morphology and coloration but is slightly smaller. It also has a more distinct general pattern with less distinct dark dorsal spotting, and its metacarpal, metatarsal and subarticular tubercles are slightly more distinct.

Measurements.—The holotype measurements (all in millimeters) are followed by those of the paratype ZSM 694/2001 in parentheses. SVL 22.9 (21.2), HW 8.7 (8.5), HL 7.3 (7.9), ED 2.9 (2.4), END 1.6 (1.4), NSD 1.6 (1.7), NND 2.4 (2.3), TD 1.7 (1.4), HAL 5.0 (4.5), FORL 12.6 (12.2), HIL 30.6 (28.0), FOL 9.2 (8.2), FOTL 14.4 (13.3), TIBL 9.0 (8.7), IMCL 1.1 (1.0).

Etymology.—The specific name is derived from the adjective coronatus (Latin), meaning crowned and referring to the supraocular spines of this new species which are reminiscent of a crown.

Natural history.—The holotype was collected after dusk in the Ankeniheny rain forest. It was not seen calling but was found in the leaf litter after localizing the origin of the call. At Mandraka, several specimens were heard calling from the ground during the day in secondary forest and pine forest. They jumped away when we approached the calling site, indicating that these frogs were active in the open or in rather exposed hiding places. The chorus was very intense shortly after rain but stopped approximately one hour later.

Advertisement calls.—Calls presumably emitted by the holotype were recorded on 19 February 1994 between 1830 and 1900 h, at an air temperature of 23.5 C. Calls were series of 5–12 (9 ± 3, $n = 6$) melodious notes. Temporal call parameters: duration of note series 1641–4468 msec (3162 ± 1119 msec, $n = 6$), note duration 65–88 msec (80 ± 6 msec, $n = 15$), duration of internote intervals 291–331 msec (308 ± 12 msec, $n = 13$), note repetition rate 2.7–3.0/sec (2.8 ± 0.1/sec, $n = 6$). The frequency showed a complex pattern (Fig. 3), usually increasing in the first half of a note and decreasing in the second half. The fundamental frequency was 2000–2450 Hz, the dominant frequency between 3250–3900 Hz (upward modulation) and 4050–4700 Hz (downward modulated part). Harmonics were seen at 6350, 7750, and 8700 Hz. At Mandraka, similar calls were heard but not recorded.

Comparisons.—The new species is distinguished from the cophyline genera *Stumpffia* and *Madecassophryne* by the presence of maxillary and vomerine teeth (vs absence), from *Rhombophryne* by the presence of maxillary teeth (vs absence), and from *Platypelis*, *Cophyla*, and *Anodonthyla* by its unexpanded tips of fingers and toes (vs expanded). Within *Plethodontohyla*, the new species is distinguished from *Plethodontohyla inguinalis* and *Plethodontohyla notosticta* by its unexpanded tips of fingers and toes (vs expanded), and from all species except *Plethodontohyla minuta* (SVL of holotype 22 mm) by its smaller size. The holotype of *P. minuta* differs by having a second finger that is shorter than the fourth (vs same length in *P. coronata*) and by having a less stout body shape.

Supraocular crests are absent in all *Plethodontohyla* except for *Plethodontohyla serratopalpebrosa*, which was described by Guibé (1975) based on a single specimen, which we shortly redescribe here. The female holotype is preserved in the Museum National d'Histoire Naturelle in Paris, France, as MNHN 1975.24. According to the catalog of the Paris museum, this specimen was collected by Ch. P. Blanc at ''Massif du Marojezy (1400 m) dans les fourres.'' Upon examination in November 2002, it showed a uniformly green color, probably because of inadequate attempts to stain cartilage or muscle. The specimen has a relatively slender appearance, with slender and long limbs. The tympanum is distinct, and there is a well-developed straight supratympanic fold. Three supraocular spines are present, of which the anterior two are especially well developed. The second finger is shorter than the fourth finger; the third toe is very slightly longer than the fifth toe on the left foot, whereas it is very slightly shorter on the right foot. The tibiotarsal articulation reaches between eye and nostril. Measurements (in millimeters) are as follows: SVL 30.0, HW 12.2, HL 10.9, ED 3.0, END 2.0, NSD 2.0, NND 3.4, TD 2.5, HAL 9.7,

Fig. 2. Lateral view of head and ventral views of hand and foot of the holotype of *Plethodontohyla coronata* (ZFMK 57459). Arrows point to supraocular crest, indistinct supratympanic fold, and reduced inner toe. The scale bars represent 1 mm.

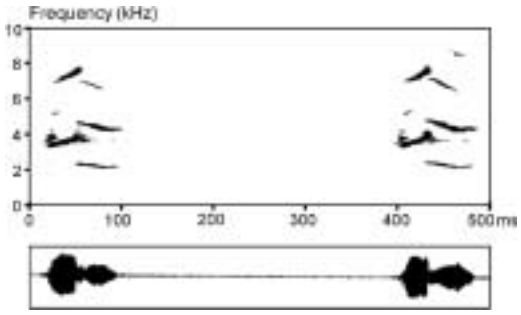

Fig. 3. Sonagram and oscillogram of part of a call (two notes of a longer note series) of *Plethodontohyla coronata*, presumably recorded from the holotype at Ankeniheny, central eastern Madagascar.

FORL 21.7, HIL 51.9, FOL 16.4, FOTL 24.5, TIBL 15.5, IMCL 1.9.

Taking into account these data, there are numerous characters distinguishing *P. coronata* from *P. serratopalpebrosa*: (1) smaller body size (21–22 mm vs 30 mm); (2) second finger of similar length as fourth (vs second finger shorter); (3) third toe distinctly longer than fifth toe (vs third and fifth toes of similar length); (4) indistinct supratympanic fold (vs distinct); (5) shorter hind limbs (tibiotarsal articulation not reaching the eye vs surpassing the eye; ratio TIBL/SVL 0.39–0.41 vs 0.52); (6) smaller tympanum (ratio TD/ED 58–59% vs 83%).

Discussion

The discovery of the morphologically distinct species *P. coronata* at two localities in a well-surveyed region in central eastern Madagascar highlights the incomplete knowledge on the microhylid fauna of Madagascar. This new species and its closest relative, *P. serratopalpebrosa*, are easily recognized by their supraocular crest, yet until recently (Blommers-Schlösser and Blanc, 1991) only a single specimen of *P. serratopalpebrosa* (the holotype from Marojejy in northeastern Madagascar) was known. New surveys in northeastern and eastern Madagascar led to numerous additional records of *P. serratopalpebrosa*: Marojejy (Raselimanana et al., 2000), Anjanaharibe (Raxworthy et al., 1998), Tsaratanana (Raxworthy et al., 1998), Andringitra (Raxworthy and Nussbaum, 1996), Ranomafana region (D. Rakotomalala, pers. comm.).

Some of these specimens examined by us (uncataloged UADBA material from the Marojejy and Ranomafana areas) actually did agree in morphology with *P. serratopalpebrosa* and not with *P. coronata*, but the specimens collected from most of the localities listed above need to be reanalyzed as part of a long overdue comprehensive revision of *Plethodontohyla*.

The largely reduced first toe of *P. coronata* (Fig. 2) reminds the state in the genus *Stumpffia* (see Vences and Glaw, 1991) although this genus maybe more closely related to the largely arboreal genus *Anodonthyla* (Blommers-Schlösser and Blanc, 1993; Vences et al., 2002). Apparently, arboreality and terrestriality have evolved and reversed several times in the cophyline radiation (Vences et al., 2003), casting doubts on the monophyly of genera such as *Plethodontohyla* and *Platypelis*.

Plethodontohyla coronata was originally discovered in 1994 in Ankeniheny. In 2001, we observed the species at Mandraka. The two localities differ in altitude (900 m vs 1200 m asl) and harbor relatively different overall batrachofaunas. It also is remarkable that the Mandraka specimens were not discovered earlier, because this small forest had been surveyed by R. Blommers-Schlösser between 1970 and 1973 and by us in 1991, 1994, and 2000. Also a treefrog, *Boophis ankaratra*, was only recently discovered at Mandraka, although its calls are very conspicuous (Glaw and Vences, 2002). These observations may indicate relatively discontinuous activity of these species.

The new species was found in primary rain

forest at Ankeniheny. At Mandraka specimens lived in secondary forest but still close to a patch of primary rain forest. Hence, the species may depend on presence of such undisturbed habitat and be vulnerable to habitat fragmentation as are other cophylines (Vallan, 2000b). Because the species is at present not known from any protected area, future surveys are needed to assess its possible presence in central-eastern reserves such as Analamazaotra or Mantady.

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