

New Microhylid Frog (*Plethodontohyla*) from Madagascar, with Semiarboreal Habits and Possible Parental Care

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ABSTRACT.—We describe a new microhylid frog of the endemic Malagasy subfamily Cophylinae and designate a lectotype for *Plethodontohyla notosticta*. *Plethodontohyla mihanika* sp. n. has enlarged terminal disks on all fingers and toes, a distinct border between its dorsal and lateral coloration, and a pointed snout. The new species is recognized by its longer hind limbs, smaller body size (SVL 26–31 mm), and advertisement call. Together with *P. notosticta* and possibly *Plethodontohyla inguinalis*, the new species forms a partially arboreal subgroup within the otherwise terrestrial *Plethodontohyla*. The eggs of the new species are most likely laid in strings, which may be a preadaptation to egg transport by the parents. Males cohabit with eggs, tadpoles, and recently metamorphosed juveniles, suggesting parental care as known from other cophylines.

Intensive studies during the last decade have resulted in a much improved knowledge of the herpetofauna of Madagascar. The increase in number of recognized species of amphibians and reptiles has been dramatic (Glaw and Vences, 2000; Nussbaum et al., 1999). However, a number of groups remain unreviewed.

Among Malagasy frogs in the family Microhylidae, many new species have been identified (e.g., Glaw and Vences, 1994; Raxworthy and Nussbaum, 1996) but are not yet formally named. The endemic Cophylinae are classified in seven genera (Blommers-Schlösser and Blanc, 1991; Glaw and Vences, 1994). Including the most recent description (Vallan, 2000a), the subfamily currently consists of 36 nominal species and is one of the most speciose vertebrate lineages in Madagascar. Cophylines are characterized by derived reproductive modes, which, as far as is known, involve development of nonfeeding tadpoles in water-filled tree-holes, terrestrial jelly, or foam nests, and parental guarding of eggs and tadpoles (Guibé, 1952; Blommers-Schlösser, 1975; Glaw and Vences, 1994; Köhler et al., 1997). Cophylines include terrestrial as well as arboreal taxa, and, according to the phylogeny of Blommers-Schlösser and Blanc (1993), these ecological adaptations evolved convergently within different lineages of the subfamily.

As defined by Blommers-Schlösser and Blanc (1991), the genus *Plethodontohyla* contains mainly terrestrial species with unexpanded digital tips. Two species, *Plethodontohyla inguinalis* and the type species *Plethodontohyla notosticta*, have moderately sized disks at the tips of the fingers and toes. *Plethodontohyla notosticta* is semiarboreal and breeds in tree holes (Blommers-Schlösser, 1975; Glaw and Vences, 1992). In this paper we describe a new arboreal *Plethodontohyla*, similar to *P. notosticta* but easily distinguished from it by external morphology and advertisement call.

MATERIALS AND METHODS

Frogs were collected during the night, with the aid of headlamps or torches, by opportunistic searching and by localizing calling males and during the day by examination of water-filled tree-holes. They were killed using chlorobutanol, fixed in 10% formalin or 90% ethanol, and preserved in 70% ethanol. Specimens are deposited in the Muséum National d'Histoire Naturelle, Paris (MNHN); University of Michigan, Museum of Zoology (UMMZ); 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 rictus to the snout tip), ED (horizontal eye diameter), END (eye-nostril distance), NSD (nostril-snout tip distance), NND (internarial

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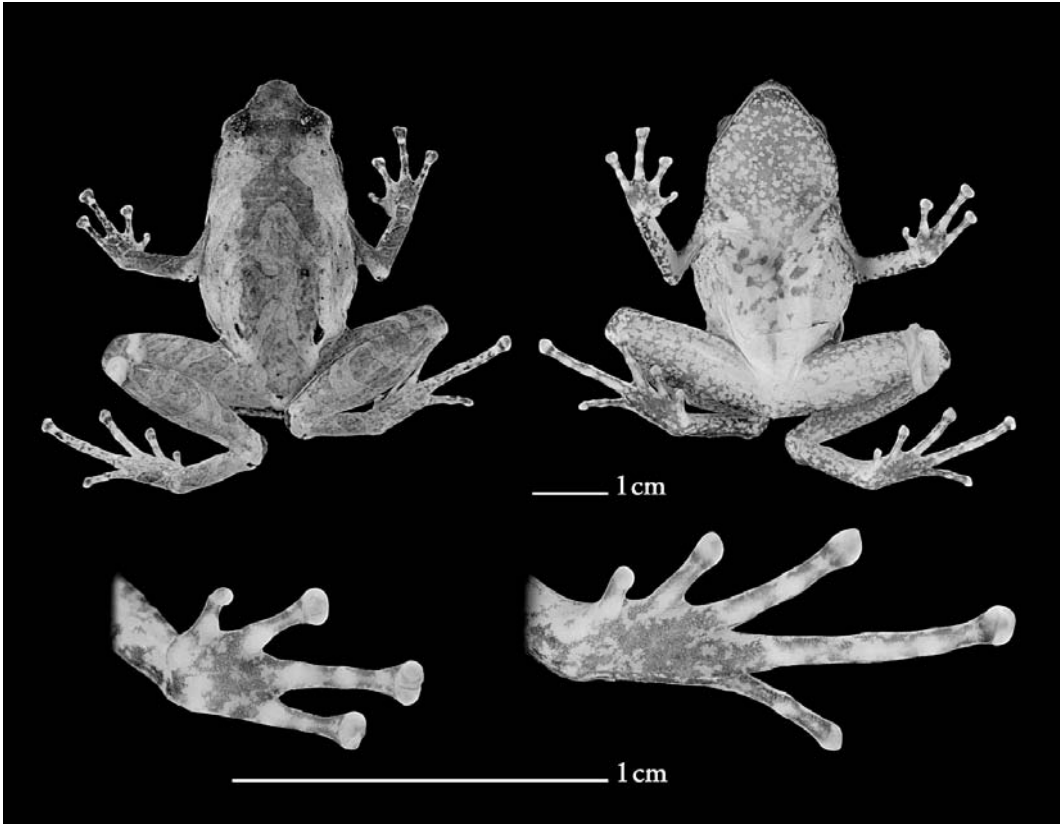


FIG. 1. *Plethodontohyla mihanika*, female holotype UMMZ 211375 from Zahamena in dorsal and ventral view, and ventral views of its left hand and foot.

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). Sex and maturity of all specimens was ascertained by dissection and inspection of gonads. Advertisement calls were recorded with a Tensai recorder with external microphone and analyzed using a MEDAV sound analyzing system using the software Spekro 3.2. Temporal and metric measurements are given as range with mean \pm SD and number of measured units in parentheses.

Plethodontohyla mihanika sp. n.

Figures 1–2

Holotype.—Adult female, UMMZ 211375, collected by C. J. Raxworthy, J. B. Ramanamanjato,

A. Raselimanana, A. Razafimanantsoa and A. Razafimanantsoa on 15 March 1994 close to the Namarafana River in Zahamena Reserve (17°44'S, 48°58.5'E, 440–460 m above sea level), Vavatenina Fivondronana, Toamasina Province, eastern Madagascar.

Paratypes.—UMMZ 191233, adult female, collected by C. J. Raxworthy on 8 March 1990, six km NNW of Amberomanitra village (16°51'S, 49°16'E, 400 m above sea level), Soanierana Ivongo Fivondronana, Toamasina Province; UMMZ 198911–198917, three adult males, two adult females, one subadult specimen and one unsexed cleared and stained specimen, collected by C. J. Raxworthy between 26 January and 5 February 1991, at Vatoharanana Camp, Ranomafana National Park (21°17'S, 47°25.5'E, 950–1050 m above sea level), Ifanadiana Fivondronana, Fianarantsoa Province; UMMZ 211370, adult male, collected by same collectors as holotype on 2 March 1994, close to the Volotsangana River, Zahamena Reserve (17°42'S, 48°46'E, 870 m above sea level), Ambatondrazaka Fivondronana, Toamasina Province; UMMZ 211371, adult female, collected by same collectors as holotype



FIG. 2. *Plethodontohyla mihanika*, male paratype ZSM 1087/2001 from Andasibe (SVL 27.3 mm).

on 3 March 1994, Rangovallo Ridge, Zahamena Reserve (17°40.5'S, 48°45.5'E, 1250 m above sea level), Ambatondrazaka Fivondronana, Toamasina Province; UMMZ 211373, adult male, collected by same collectors as holotype on 4 March 1994, Rangovallo Ridge, Zahamena Reserve (17°40.5'S, 48°45.5'E, 1150 m above sea level), Ambatondrazaka Fivondronana, Toamasina Province; UMMZ 211374, 211376–211378, four adult males, collected by same collectors and at same site as holotype on 14–17 March 1994, at 420–460 m above sea level; UMMZ 225593, adult female, collected by O. Ramilison, N. Rabibisoa and D. Foley on 20 January 1998 at Ampahanana forest (near Fierenana; 18°29.53'S, 48°26.68'E, 1000–1200 m above sea level), Moramanga Fivondronana, Toamasina Province; UMMZ 225594, subadult specimen, collected by O. Ramilison, N. Rabibisoa and D. Foley on 28 January 1998 at Sahanomanana near Fierenana (18°29.82'S, 48°28.21'E), Moramanga Fivondronana, Toamasina Province; ZFMK 57455, adult male, collected by F. Glaw, N. Rabibisoa and O. Ramilison on 18–20 February 1994 at Ankeniheny (approximately 19°10'S, 48°02'E, approximately 1000 m above sea level), Moramanga Fivondronana, Toamasina Province; ZFMK 57456, adult male, collected by F. Glaw and M. Vences on 1–4 January 1994 at Andasibe (18°56'S, 48°25'E; approximately 850 m above sea level) at

the border of the Analamazaotra Reserve, Moramanga Fivondronana, Toamasina Province; ZSM 1087/2001 (originally ZFMK 60008), adult male, collected by F. Glaw 14–18 January 1995 at Andasibe; ZSM 5/2002, adult male, collected by M. Vences, I. Somorjai and L. Raharivoloniaina in December 2001 at Andasibe; MNHN 1962.932–934, three adult males, collected by J. Arnoult at Andasibe.

Diagnosis.—A species of *Plethodontohyla* differentiated from all other cophyline microhylids by the following combination of characters: (1) moderate adult body size (SVL 26–31 mm); (2) slightly pointed snout tip; (3) expanded disks of fingers and toes; (4) long hind limbs (ratio TIBL/SVL > 0.52; tibiotarsal articulation always reaching beyond eye when hind limbs are adpressed along body); and (5) sharp dorsolateral color border along supratympanic and dorsolateral folds.

Description of the Holotype.—Specimen in excellent state of preservation (Fig. 1). Ventral skin with transverse cut applied for gonad examination. SVL 29.7 mm (for other measurements, see Table 1). Body moderately slender; head slightly wider than long, not wider than body; snout slightly pointed in dorsal and lateral views; nostrils directed laterally, very slightly protuberant, nearer to tip of snout than to eye; canthus rostralis distinct, concave; loreal region concave;

TABLE 1. Measurements (all in millimeters) of holotype and 21 paratypes of *Plethodontohyla mihanika*. Abbreviations used: M (male); F (female). Measurements in the last two columns are given as range with mean \pm standard deviation in parentheses.

	<i>P. notosticta</i> lectotype (M) BMNH 1947.2.10.40	<i>P. mihanika</i> holotype (F) UMMZ 211375	<i>P. mihanika</i> males (N = 16)	<i>P. mihanika</i> females (N = 5)
Snout-vent length	29.7	34.4	26.4–29.9 (28.3 \pm 1.0)	29.0–31.1 (30.0 \pm 0.8)
Head width	11.0	12.0	9.7–11.2 (10.3 \pm 0.4)	10.0–11.2 (10.7 \pm 0.5)
Head length	10.5	11.1	9.0–10.4 (9.5 \pm 0.3)	9.6–10.1 (9.8 \pm 0.2)
Tympanum diameter	2.3	1.9	1.6–2.2 (1.9 \pm 0.2)	1.8–2.4 (2.1 \pm 0.2)
Eye diameter	3.5	3.4	2.4–3.5 (3.0 \pm 0.3)	2.7–3.2 (2.9 \pm 0.2)
Eye–nostril distance	1.9	2.3	1.7–2.5 (2.1 \pm 0.2)	1.9–2.3 (2.1 \pm 0.2)
Nostril–snout tip distance	1.6	1.9	1.4–2.2 (1.7 \pm 0.2)	1.6–2.1 (1.9 \pm 0.2)
Nostril–nostril distance	3.1	3.2	2.7–3.5 (3.1 \pm 0.2)	3.1–3.7 (3.4 \pm 0.2)
Hand length	7.8	9.5	7.4–9.4 (8.4 \pm 0.6)	7.7–8.2 (8.0 \pm 0.2)
Forelimb length	20.0	20.6	16.7–20.5 (19.0 \pm 1.1)	18.4–20.3 (19.2 \pm 0.8)
Hind-limb length	52.3	46.6	44.0–54.5 (49.6 \pm 2.3)	47.9–54.4 (51.1 \pm 3.0)
Foot length	14.7	13.8	12.9–15.3 (14.3 \pm 0.6)	14.4–15.6 (14.9 \pm 0.6)
Tibial length	17.0	15.0	15.5–17.7 (16.6 \pm 0.8)	16.3–18.4 (17.2 \pm 0.8)
Inner metacarpal tubercle length	2.6	2.1	1.6–2.1 (1.8 \pm 0.2)	1.5–1.9 (1.7 \pm 0.2)

tympanum distinct, rounded, 66% of eye diameter; supratympanic fold distinct and straight; tongue ovoid, very broad, posteriorly free and slightly notched; maxillary teeth present; vomerine teeth distinct, forming transverse rows posterior to choanae starting close to maxillae and almost in median contact; choanae ovoid. Arms slender, faintly marked single subarticular tubercles; indistinct paired outer metacarpal tubercles; large inner metacarpal tubercle, forming distinct protuberance at prepollex; fingers without webbing; relative length of fingers $1 < 2 < 4 < 3$, fourth finger clearly longer than second; finger disks distinctly enlarged; nuptial pads absent. Hind limbs slender; tibiotarsal articulation reaching snout tip when hind limb adpressed along body; tibia length 57% of SVL; lateral metatarsalia strongly connected; distinct inner and indistinct outer metatarsal tubercles present; only traces of webbing between toes; relative length of toes $1 < 2 < 5 < 3 < 4$; third toe distinctly longer than fifth. Skin on dorsum smooth, with clearly visible dorsolateral folds continuous with supratympanic folds; ventral skin smooth.

In preservative, dorsum light brown with darker brown broad inverted V-shaped marking on anterior dorsum continuous with brown patch between eyes. Pair of black spots present in inguinal region. Faintly recognizable symmetrical markings visible on dorsum. Sides of head and tympanic region dark brown, sharply bordering lighter dorsal coloration along canthus rostralis and supratympanic fold, which are ventrally bordered by black. Limbs light brown with indistinct darker crossbands. Ventrally, throat and chest brown with regular light spots, belly cream with dark markings anteriorly, limbs brown with irregular light markings.

Variation.—Morphologically, all paratypes agree well with the holotype. Most have the inverted V-shaped marking on the back and the pair of black inguinal spots. All specimens share the dark coloration on the sides of the head, which sharply borders the lighter dorsal color along the supratympanic fold. Color slides of the paratype ZSM 1087/2001 (Fig. 2) from Andasibe and of specimens from Zahamena and Ranomafana, show that the general color and pattern in life are very similar to that in preservative. The iris was bluish to greenish in its lower and, especially, upper part and reddish brown in its lateral parts, in specimens from these three sites.

Females are slightly larger than males. In the type series, male SVL is 26.4–29.9 mm (28.4 \pm 1.0 mm, $N = 15$) compared to females in which the SVL is 29.0–31.1 mm (29.9 \pm 0.7, $N = 6$). Mean male size is 95% of mean female size (Mann-Whitney U -test; $P < 0.01$). No significant differences between sexes were found by U -tests in three ratios which were suspected to be sexually dimorphic based on our experience in other Malagasy frog species, namely relative hind-limb length (HIL/SVL; $P = 0.47$), relative tympanum diameter (TD/SVL; $P = 0.07$) and relative size of inner metacarpal tubercle (IMCL/SVL; $P = 0.34$). The subadult specimens UMMZ 198917 and 225594 measured 19.2 and 22.6 mm SVL.

Etymology.—The specific name is noun in apposition derived from the Malagasy verb *mihanika* (=to climb), pronounced “me-hawneek-a,” and refers to the arboreal habits of the species.

Natural History.—During the day, one specimen (ZFMK 57455) was observed at Ankeniheny in a fallen and coiled *Ravenala* leaf on the forest floor. The small water-body in this leaf also

contained eggs in one or few distinct strings, similar to the clutches of European midwife toads (*Alytes*). These egg strings, figured and described by Glaw and Vences (1994) as *Plethodontohyla* sp. a., contained 111 eggs averaging about 3 mm in diameter. The distance between adjacent eggs in the string was 2 mm. When studied, the clutch was broken into several pieces, and it was therefore not possible to determine the original number of separate strings. The largest string piece contained 41 eggs (see Glaw and Vences, 1994:fig. 152). A part of this clutch is deposited in the ZSM collection (uncataloged). Dissected females (UMMZ 191233 and 225593) contained 40 and 45 yellowish oocytes with a dark brown pole and a diameter of 2 and 2.5 mm, respectively. Calling males were observed at Andasibe and Ankeniheny on vertical tree trunks at heights of about 2 m. The inflated vocal sacs are large, single, and subgular. Each note results from one expiration, and the sac remains largely inflated between notes. In ridge forest at Ranomafana, a calling male (UMMZ 198911) was found in a small water-filled tree cavity at 2000 h. Two other adults at this site (UMMZ 198912–13) were found in separate water-filled bamboo stems that had been previously cut open along a trail. UMMZ 198912 was found with several metamorphosed juveniles, and UMMZ 198913 was with tadpoles. Calling males were also found at Zahamena (UMMZ 211370, 211377) on a tree trunk and leaf blade between 1 and 5 m high. Another adult male (UMMZ 21178) was found in the base of a water-filled palm frond lying on the forest floor.

Distribution.—The new species is known from (1) Amberomanitra, Ambatovaky Reserve, (2) the type locality Zahamena (2a, Namarafana River; 2b, Volotsangana River, 2c Rangovallo Ridge), (3) Andasibe, (4) Ankeniheny, (5) Fierenana (5a, Ampahanana; 5b, Sahanomanana), and (6) Vatoharanana Camp, Ranomafana National Park. All these sites are at low to mid altitudes in eastern Madagascar (Fig. 3). Altitudinal range is 400–1250 m above sea level.

Calls.—Recorded close to Andasibe on 14 January 1995 (1925 h), at 24.5°C air temperature (most likely from ZSM 1087/2001). Calls were a regular series of melodious notes (Fig. 4). Note duration was 150–172 msec (159 ± 6 msec, $N = 12$) and duration of internote intervals was 4027–7155 msec (5297 ± 1006 msec, $N = 11$), resulting in a note repetition rate of 11/min. Fundamental and dominant frequencies were 1900–2200 Hz; up to three harmonics at 3950–4400, 5950–6550, and 8000–8600 Hz were visible on the sonagrams (Fig. 4). Neighboring males emitted alternating calls.

Comparison.—Among *Plethodontohyla*, the new species is distinguished from *Plethodontohyla*

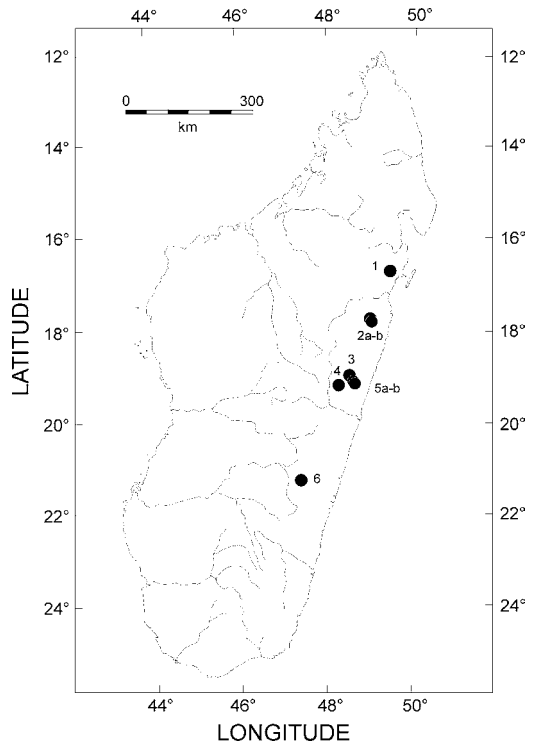


FIG. 3. Distribution of *Plethodontohyla mihanika*. Numbers of localities correspond to those in the text.

alluaudi, *Plethodontohyla bipunctata*, *Plethodontohyla brevipes*, *Plethodontohyla coudreaui*, *Plethodontohyla guentherpetersi*, *Plethodontohyla laevipes*, *Plethodontohyla minuta*, *Plethodontohyla ocellata*, *Plethodontohyla serratopalpebrosa*, and *Plethodontohyla tuberata* by the expanded terminal disks of the fingers and toes. Within the genus, it shares this character only with *Plethodontohyla notosticta* and *Plethodontohyla inguinalis*. From *P. inguinalis* it is distinguished by its much smaller size (26–31 mm vs. 55–100 mm) and the shape of the snout tip (slightly pointed vs. rounded). *Plethodontohyla mihanika* differs from *P. notosticta* by having longer hind legs: its tibiotarsal articulation always reaches at least beyond the eye, sometimes even beyond the snout tip when the hind limb is adpressed along the body (vs. generally reaching only the tympanum, at most the posterior eye corner in *P. notosticta*). Relative tibia length (ratio TIBL/SVL) is 0.524–0.646 (0.584 ± 0.027) in *P. mihanika* (Table 1) and 0.436–0.502 (0.469 ± 0.022) in nine *P. notosticta* specimens including the lectotype (see below). Furthermore, *P. mihanika* is smaller than *P. notosticta* (26–31 mm vs. 35–42 mm SVL). In contrast to many *P. notosticta*, the supratympanic and dorsolateral folds of *P. mihanika* are usually not marked with a distinct white line (although

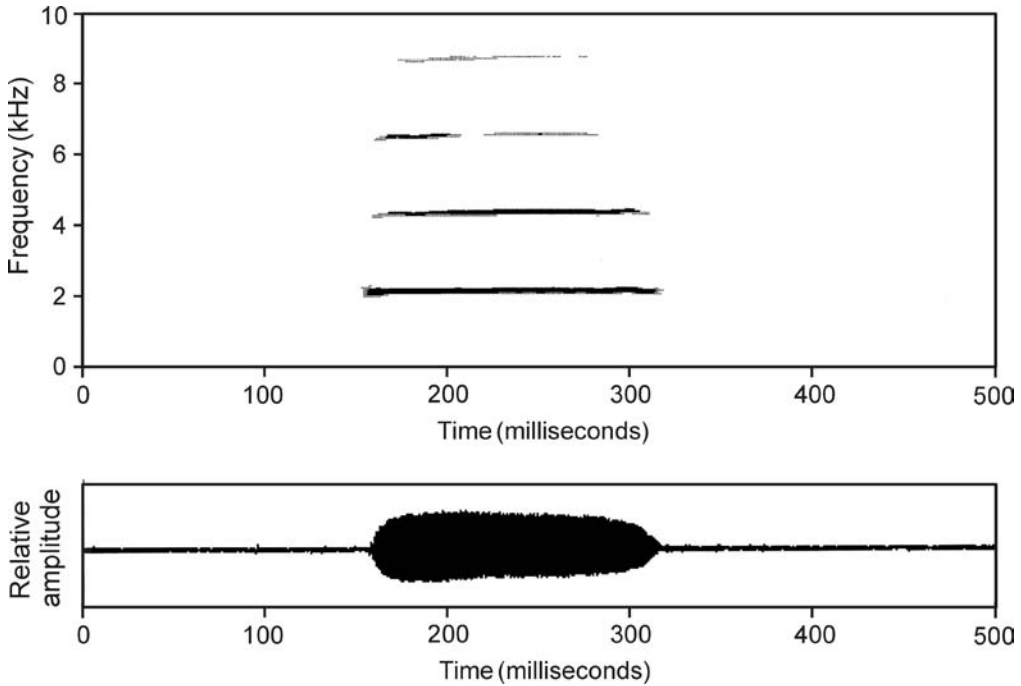


FIG. 4. Sonogram and oscillogram of the advertisement call (one note of a note series) of *Plethodontohyla mihanika* from Andasibe.

a less distinct beige line is sometimes visible in life; see Fig. 2), and the posterodorsal surface of the shanks never bears a network of strongly marked beige and brown crossbands. *Plethodontohyla notosticta* in life had an overall light brownish iris (see Glaw and Vences, 1994, color plates 137 and 138), whereas the iris is light blue in *P. mihanika*. The advertisement call is also different consisting of slowly repeated notes in *P. mihanika* (note repetition rate 11/min) compared to much faster repeated notes in *P. notosticta* from Nosy Boraha (note repetition rate 26/min; Glaw and Vences 1992).

Because of its arboreal habits, *P. mihanika* could possibly also be misidentified as belonging to the genera *Platypelis* or *Cophyla*. It differs externally from all species of these genera, however, by its well-delimited dorsolateral color border and slightly pointed snout (vs. absence of a dorsolateral color border and rounded snout).

Comments.—Analysis of preserved specimens attributed to *P. notosticta* revealed significant morphological heterogeneity, suggesting that these specimens actually represent a complex of cryptic species. One form appears to be a moderately sized species with a strongly pointed snout (e.g., UMMZ 211368–211369 from Zahamena and MNHN 1973.748–750 from Marojejy; SVL 26.0–32.0). A revision of this complex is beyond the scope of this paper, however. Blommers-

Schlösser and Blanc (1991) gave a size range of 35–40 mm SVL for *P. notosticta*, and most specimens identified as this species are larger and have shorter hind limbs than the new species. Glaw and Vences (1994) reported SVL values of approximately 40 mm for a reproducing pair from Nosy Boraha, which agrees well with the size of samples in the MNHN collection (SVL 39.5–41.9 in MNHN 1931.30, 1974.1556–1558, and 1984.21–23).

Two characters, longer hind limbs and smaller size, also clearly differentiate *P. mihanika* from the type material of *Mantipus pulcher* Ahl, 1929, which is the single junior synonym of *P. notosticta* (identified by Guibé, 1978) and is reported to measure 34 mm SVL and to have a tibiotarsal articulation reaching the tympanum or posterior corner of the eye.

*Lectotype Designation for
Plethodontohyla notosticta*

Because *P. mihanika* is most similar to *P. notosticta*, it is important to have an unambiguous definition of the latter name. *Plethodontohyla notosticta* has been described based upon three syntypes from two localities, Mahanoro (BMNH 1947.2.10.39) and Anzahamaru (1947.2.10.40–41; Günther, 1877). The latter two specimens were examined by us. BMNH 1947.2.10.41 is a juvenile of 20.1 mm SVL and 8.5 mm TIBL, whereas

BMNH 1947.2.10.40 is an adult male. It is a robust specimen with short legs (for measurements, see Table 1), with a distinct pattern of dark and light vermiculations on the posterodorsal shank, a pair of distinct dark spots on the posterior dorsum, and a pair of minute spots on the central dorsum. We hereby designate this specimen as the lectotype of *Callula notosticta* Günther, 1877, the remaining two specimens BMNH 1947.2.10.39 and 1947.2.10.41 becoming paralectotypes.

DISCUSSION

Cophyline microhylids are known for their derived reproductive modes, which include non-feeding tadpoles developing in tiny water bodies like water-filled treeholes or aerial plants and those that complete their development in a terrestrial nest (Guibé, 1952; Blommers-Schlösser, 1975; Glaw and Vences, 1994). Indications of parental care have been found in all genera. Males of the arboreal *Platypelis*, *Cophyla*, and *Anodontohyla*, as well as of *P. notosticta*, have been found together with eggs and tadpoles, and in *Platypelis grandis* tadpoles reared without a male die within a few days (Blommers-Schlösser, 1975). In terrestrial cophylines, paternal care is probable, but females may be involved as well; males of *Stumpffia* produce foam nests (Glaw & Vences, 1994), a male and a female of *Madecassophryne* have been collected close to a terrestrial clutch (Blommers-Schlösser and Blanc, 1991), and two adults of *Rhombophryne* have been found together with a number of recently metamorphosed juveniles (Köhler et al., 1997). Therefore, parental care is probably a shared character of all cophylines. Although our observations of male *P. mihanika* in the same water-filled cavities as their eggs and tadpoles are not definitive evidence, it appears that these male specimens were guarding their offspring as is known for *Platypelis grandis* (Blommers-Schlösser, 1975).

No detailed data on the structure of clutches of most cophylines have so far been published. *Plethodontohyla mihanika* is the only species in which egg strings have been recorded. This clutch structure may be typical for this species and derived from a more general condition in cophylines. Photographs of eggs of *Platypelis barbouri* (e.g., Glaw and Vences, 1994:fig. 136) indicate that egg capsules have two narrower ends which might represent attachment points to each other shortly after egg deposition. Eggs obtained from two of *P. notosticta* were single and not attached to each other (Glaw and Vences, 1992). The significance of egg deposition in strings is unknown, but a hypothesis can be drawn considering the descriptions of two instances of egg-carrying Malagasy anurans: Boettger (1913) described a frog specimen with eggs around its forelimbs, and C. P. Blanc

collected a specimen on the Tsaratanana summit with eggs around its hind limbs (Blommers-Schlösser and Blanc, 1993). Unfortunately, both these specimens were lost, and their identity and the details of the attachment of the eggs to the limbs are uncertain. They may have belonged to cophyline species which, like *P. mihanika*, deposit their eggs in strings and occasionally are able to transport them.

The phylogeny and systematics of the subfamily Cophylinae are largely unresolved. Blommers-Schlösser and Blanc (1991) provided a first phylogenetic hypothesis, according to which the genera *Plethodontohyla*, *Rhombophryne*, *Platypelis*, and *Cophyla* form a clade which is sister to a lineage containing *Stumpffia* and *Anodontohyla*. A preliminary DNA phylogeny of Vences et al. (2002) corroborates *Anodontohyla* (arboreal) as the sister group to *Stumpffia* (terrestrial), rather than to the arboreal *Platypelis* and *P. notosticta*. However, the monophyly of all these genera remains uncertain. This is especially true of *Plethodontohyla*, the most species-rich cophyline genus, which contains both arboreal and terrestrial species.

The new species described herein increases the number of *Plethodontohyla* with enlarged finger disks to three: *P. notosticta*, *P. mihanika*, and *P. inguinalis*. These species also share an inversed V-shaped dorsal marking and a dorsolateral color border (see figures in Glaw and Vences, 1994), which suggests they may be a monophyletic group. *Plethodontohyla notosticta* and *P. mihanika* are partially arboreal, and at least a low degree of arboreality may also be predicted in *P. inguinalis*. Further osteological and molecular data are necessary to assess the relationships of arboreal and terrestrial taxa in *Plethodontohyla* and among cophylines in general. The preliminary data available indicate this group may be particularly suited for evolutionary studies concerning adaptations for arboreal and terrestrial adaptive zones.

Many cophylines seem to depend on large forested areas more than other amphibians, and they may be more vulnerable to habitat fragmentation (Vallan, 2000b). Although several other Malagasy frog groups live along brooks and streams and are able to survive in small fragments of gallery forest, some arboreal cophylines probably need a continuous habitat with a sufficient number of treeholes and similar water-filled cavities, and most terrestrial cophylines need a continuously humid leaf litter. This is also indicated by the apparent absence of the whole subfamily from arid western Madagascar (Blommers-Schlösser and Blanc, 1991; Glaw and Vences, 1994). *Plethodontohyla mihanika* is known from four protected areas in eastern Madagascar, namely Ambatovaky, Zahamena, Analamazaotra and

Ranomafana. It may also occur in several other reserves such as Mantadia, but certainly this and other cophylines are impacted by forest destruction, and their status should therefore be monitored.

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