*Current Herpetology* 22(1): 1–8, June 2003


# Occurrence of a Lotic Breeding *Hynobius* Salamander (Amphibia, Urodela) on Kamishima of the Amakusa Islands, Japan

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**Abstract: We found a salamander of the genus *Hynobius* on Kamishima of the Amakusa Islands, Japan, which is new to this island group. From the characteristics of larval habitat and morphology, this salamander is considered to be a lotic breeder. Until the discovery of this species, only a lentic breeding species (*Hynobius nebulosus*) was known from the Amakusa Islands. Morphologically the present salamander is well differentiated from other lotic breeding *Hynobius* of nearby regions and is closest to the southernmost population of *H. boulengeri* from the Osumi Peninsula among the species or populations examined. In order to determine its taxonomic position, however, genetic analyses using a larger number of comparative specimens are needed. The biogeographic significance of the present finding is briefly discussed.**

Key words: Hynobiidae; *Hynobius*; the Amakusa Islands; Lotic breeding; Biogeography

## INTRODUCTION

The Amakusa Islands is located ca. 15 km west of Kyushu, Japan, and consists of two large islands, Kamishima (225 km$^2$ in area) and Shimoshima (574 km$^2$ in area), and approximately 120 much smaller islets (Fig. 1). Islands of this group are largely low in altitude, with a peak of Mt. Kuratake on Kamishima Island (682 m asl) representing the highest point.

A total of 11 native amphibians (two species of Urodela [*Hynobius nebulosus* and *Cynops pyrrhogater*], and nine of Anura [*Bufo japanicus japonicus*, *Hyla japonica*, *Rana tagoi*, *R. japonica*, *R. nigromaculata*, *R. limnocharis*, *R. rugosa*, *Buergeria buergeri*, and *Rhacophorus schlegelii*]) and one introduced frog (*Rana catesbeiana*) have been recorded from the Amakusa Islands (Okochi and Hayashi, 1992; Maeda and Matsui, 1999; Sakamoto, unpublished data). Because all these species are also very common in the western part of the main island of Kyushu facing the islands, little attention has been paid to the amphibian

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FIG. 1. A map of the Amakusa Islands and the Kyushu Main Island, Japan, showing sampling localities of hynobiid species used in this study. Coarsely dotted and darkened areas represent areas >500 m and 1000 m asl, respectively.

fauna of this island group until now.

Recently, we collected specimens of a *Hynobius* salamander along a small stream of Kamishima Island. The specimens resembled *H. naevius* at a glance, but were not easy to identify. However, this form was obviously a lotic breeder (Sato, 1943), because it had a stout tail, mountain habitat, and stream dwelling larvae with claw-like cutaneous structures. Up to now, *H. nebulosus*, a lentic breeder, has been found in lowlands of Kamishima and Shimoshima Islands as mentioned above. This species possesses a compressed tail with yellowish streaks on its edges, and these morphological characteristics, along with its breeding in the still water, completely differentiate *H. nebulosus* from the salamander in question. From the southern part of Kyushu, three species of lotic breeding *Hynobius* salamanders, *H. naevius*, *H. boulengeri*, and *H. stejnegeri*, have been reported.

In order to assess the taxonomic status of this salamander, we investigated its natural history and compared its morphological characteristics with those of its putative relatives from the main island of Kyushu.

## MATERIALS AND METHODS

The salamander was searched for on 7 April, 7 May, and 14 October 2002, along small streams on Kamishima Island, Kumamoto Prefecture (detailed locality information is not given for conservation reasons). Environmental conditions of the habitat were recorded, and salamanders collected were fully anesthetized and their livers were removed for genetic study. They were then fixed in 10% formalin before final preservation in 70% ethanol.

Four populations of three lotic breeding *Hynobius* species from the central and southern parts of Kyushu Main Island were used for morphological comparisons—one representing *H. naevius*, another *H. stejnegeri*, and the remaining two (one from the Sobo-Katamuki Mountains and the other from Osumi Peninsula) *H. boulengeri* (Fig. 1). Of the three forms of *H. naevius* recognized by Sato et al. (1994) from Kyushu, we used one population of the southern Kyushu type (Sato et al., 1994) that is distributed close to the Amakusa Islands. See Appendix for current locations of voucher specimens.

The following seven morphometric characters were measured; SVL (snout–vent length, from tip of snout to anterior angle of cloaca), HL (head length, from tip of snout to gular fold), HLL (hind limb length), TAL (tail length), HW (head width, measured at jaw articulation), VTL (length of vomerine tooth series), and VTW (width of vomerine tooth series). Measurements were taken to the nearest 0.1 mm with dial calipers. Values of SVL and those of HL, HLL, TAL, HW in relation to SVL were compared among samples. The ratio of VTW to VTL (VTW/VTL), one of the key characters for species identification in this group (Sato, 1943), was also obtained and compared. The number of costal grooves (CG) was counted, and overlap of finger and toe tips (limb overlap, LO) when both forelimbs and hind limbs were adpressed along the body was recorded as the number of costal folds between those tips. In this character, a plus value indicates overlap and a minus value indicates separation. We also counted the numbers of teeth on the vomerine (VTN), upper jaw (UJTN), and lower jaw (LJTN). Differences in SVL and ratio values among samples were statistically tested by Student's t-test and Mann-Whitney's U test, respectively. The definitions of characters followed Matsui (1987). The significance level was 95% in all these statistical tests.

To summarize the morphological relationships among populations studied, we performed canonical discriminant analyses (CDA) with the CANDISC procedure (SAS, 1990). In these analyses, we omitted TAL because not all individuals had intact tails.

## Results

*Habitat, life history, and morphology*

The salamanders were collected in the daytime under fallen leaves and gravel along a small stream (maximum width = 3 m) on 7 April and 7 May 2002. The stream was surrounded by a forest of planted cedars (*Cryptomeria japonica*) and its banks were covered with native plant species. This type of environment was typical of the montane regions on Kamishima Island (Fig. 2A). The bottom of the stream was covered mainly with rocks (Fig. 2B). There were small waterfalls (ca. 1 m in height) near the place where we found salamanders.

Nine males, one female, and two juveniles were collected on 7 May 2002 from one locality. The testes and ovaries of these adults were atrophied. Fourteen larvae were also collected on 14 October 2002 in the moderately flowing stream along which metamorphs had been collected. These larvae were found at night near the banks of the stream.

Morphological data of the adults are summarized in Tables 1–3. Males were smaller in SVL and had relatively longer and stouter limbs than in the single female. In all adults, the head was moderately depressed and body was robust. Six of the ten adults had regenerated tails, and the intact tails were short and thick. The posterior half of the tail was keeled, moderately above and weakly below. The dorsum was brownish gray. The trunk had numerous silvery dots mainly on the lateral and ventral sides, with a few on the dorsal side (Fig. 3). The two juveniles collected in early May measured 32.7 and 33.4 mm in SVL. The

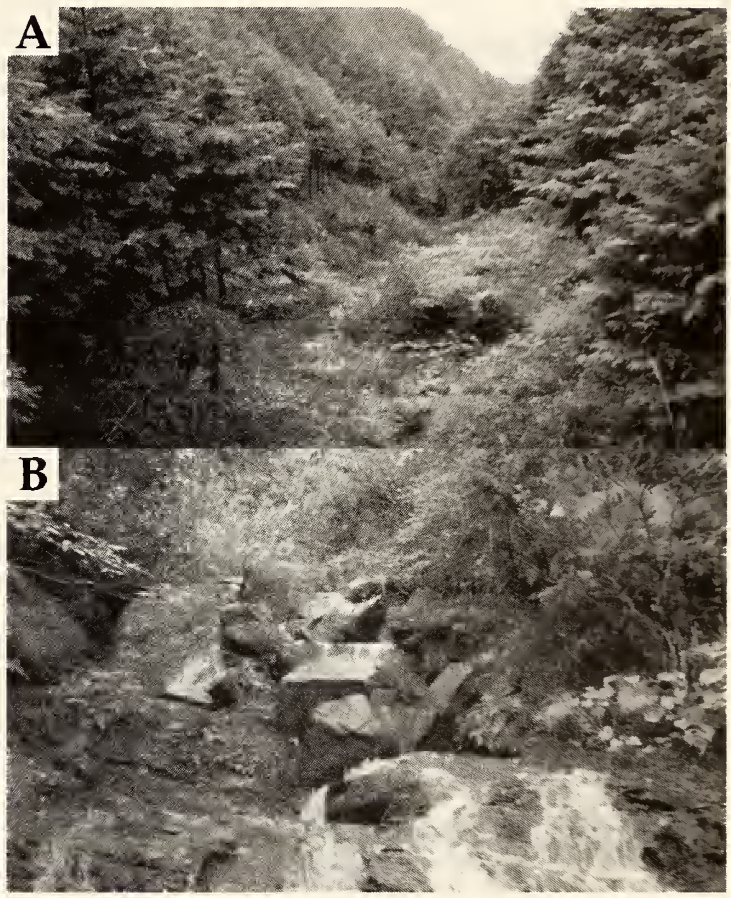


FIG. 2. (A) Overall view of the habitat of *Hynobius* sp. on Kamishima Island, showing the typical vegetation. (B) The stream where adults and larvae of *H.* sp. were found.

FIG. 3. An adult male of *Hynobius* sp. from Kamishima Island.

juveniles had more silvery dots over the whole body surface than the adults.

Fourteen larvae found in October had SVLs ranging from 22.2 to 28.5 ($\bar{x}=25.5$) mm. Five of these larvae were thought to have started metamorphosis because of obvious reductions in their gills and tail fins. All larvae possessed a claw-like dark cutaneous structure on each digital tip. The body was light brown in ground color marbled with dark grey.

*Morphological comparisons*

Because only one female specimen was available from Kamishima Island, we compared only male samples in detail. In SVL, males from Kamishima Island were significantly smaller than those of the species compared except for *H. boulengeri* from Osumi Peninsula (Table 1). Compared with the salamander from Kamishima Island, *H. boulengeri* from the Sobo-Katamuki Mountains had a relatively long head, while *H. boulengeri* from the Osumi Peninsula and *H. naevius* had relatively narrow heads. Also, *H. boulengeri* from the Sobo-Katamuki Mountains and *H. stejnegeri* had longer hind limbs

TABLE 1. Comparisons of SVL ($\bar{x}\pm2SE$, followed by ranges in parentheses, in mm) and ratio (in %) of each character dimension to SVL (medians, followed by ranges in parentheses) in five samples of the *Hynobius* salamanders examined.

| | Sex | n | SVL | HL/SVL | HW/SVL | HLL/SVL | n** | TAL/SVL |
|---|---|---|---|---|---|---|---|---|
| *Hynobius* sp. from the Amakusa Island | M | 9 | 72.1±3.4 (64.8–79.0) | 23.8 (22.1–25.2) | 18.6 (17.0–20.5) | 27.3 (25.8–29.0) | 3 | 66.0 (61.5–66.5) |
| | F | 1 | 83.7 | 22.5 | 17.0 | 26.2 | 1 | 62.6 |
| *H. boulengeri* from the Sobo-Katamuki Mts. | M | 22 | 83.0±2.3* (73.6–92.4) | 24.6* (22.8–26.5) | 17.8 (16.3–20.0) | 30.5* (28.9–33.2) | 16 | 90.5* (82.6–100.6) |
| *H. boulengeri* from the Osumi Pen. | M | 8 | 68.5±2.3 (64.4–73.6) | 23.5 (21.3–25.0) | 17.0* (15.2–18.6) | 28.4 (25.1–30.5) | 4 | 72.5 (69.4–75.1) |
| *H. stejnegeri* | M | 19 | 80.4±1.9* (72.2–87.7) | 23.7 (22.0–25.8) | 18.1 (16.8–20.1) | 29.7* (27.4–32.6) | 15 | 84.3* (76.5–92.2) |
| *H. naevius* from the Sobo-Katamuki Mts. | M | 7 | 58.0±3.2* (51.8–64.2) | 23.9 (23.6–26.0) | 17.4* (15.5–19.0) | 29.5 (26.8–30.2) | 6 | 62.5 (61.0–67.5) |

* Significantly different from male *H.* sp. at $P<0.05$.
** Individuals with regenerated tail excluded.

TABLE 2. Variation in the numbers of costal grooves (CG) and costal folds between adpressed limbs (LO) in the five samples of the *Hynobius* salamanders examined.

| | | | CG | | LO | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sex | n | 13 | 14 | −3 | −2.5 | −2 | −1.5 | −1 | −0.5 | 0 | 0.5 |
| *Hynobius* sp. from the Amakusa Island | M | 9 | 9 | | 2 | 4 | 2 | 1 | | | | |
| | F | 1 | 1 | | 1 | | | | | | | |
| *H. boulengeri* from the Sobo-Katamuki Mts. | M | 22 | 11 | 11 | | | | 4 | 8 | 4 | 5 | 1 |
| *H. boulengeri* from the Osumi Pen. | M | 8 | 6 | 2 | 2 | 1 | 3 | 1 | 1 | | | |
| *H. stejnegeri* | M | 19 | 12 | 7 | | | 6 | 1 | 7 | 3 | 1 | 1 |
| *H. naevius* from the Sobo-Katamuki Mts. | M | 7 | 5 | 2 | | 1 | 4 | 2 | | | | |

TABLE 3. Comparisons in shape of the vomerine tooth series (VTW/VTL: median), and the numbers ($\bar{x}\pm2SE$) of vomerine teeth (VTN), upper jaw teeth (UJTN), and lower jaw teeth (LJTN) among the five samples of the *Hynobius* salamanders examined. Figures in parentheses indicate ranges.

| | Sex | n | VTW/VTL | VTN | UJTN | LJTN |
|---|---|---|---|---|---|---|
| *Hynobius* sp. from the Amakusa Island | M | 9 | 1.05 | 58.2±3.2 | 83.1±3.4 | 78.9±2.9 |
| | | | (0.89–1.32) | (51–65) | (77–92) | (72–85) |
| | F | 1 | 1.13 | 60 | 93 | 86 |
| *H. boulengeri* from the Sobo-Katamuki Mts. | M | 22 | 1.23* | 53.4±2.2* | 84.9±2.3 | 80.8±2.7 |
| | | | (1.00–1.50) | (44–63) | (74–97) | (66–92) |
| *H. boulengeri* from the Osumi Pen. | M | 8 | 1.08 | 51.5±3.7* | 69.9±2.6* | 68.9±2.9* |
| | | | (0.93–1.19) | (42–57) | (63–75) | (62–74) |
| *H. stejnegeri* | M | 19 | 1.07 | 47.0±2.2* | 78.2±3.4 | 77.5±3.1 |
| | | | (0.95–1.35) | (39–58) | (68–91) | (63–90) |
| *H. naevius* from the Sobo-Katamuki Mts. | M | 7 | 0.84* | 45.0±3.3* | 65.1±3.6* | 62.1±5.5* |
| | | | (0.77–0.92) | (39–50) | (58–72) | (52–75) |

* Significantly different from male *H.* sp. at $P<0.05$.

in relation to SVL than the Kamishima salamander (Table 1). The tail length of males from Kamishima Island was significantly shorter than that of males of *H. boulengeri* from the Sobo-Katamuki Mountains and *H. stejnegeri*.

The salamander from Kamishima Island consistently had 13 costal grooves, whereas specimens of each of the other populations examined had either 13 or 14 grooves (Table 2). The frequency of occurrence of 14 grooves was especially high in *H. boulengeri* from the Osumi Peninsula and *H. stejnegeri*. In the salamander from Kamishima Island and *H. boulengeri* from the Osumi Peninsula, the limbs were more widely separated than in the other samples (Table 2).

The salamander from Kamishima Island had a V-shaped vomerine tooth series. The ratio of width to length of the series (VTW/VTL) was larger in the *H. boulengeri* population from the Sobo-Katamuki Mountains (i.e., it had a shallower vomerine tooth series) and smaller in *H. naevius* (i.e., it had a deeper series) than in the salamander from Kamishima Island (Table 3). The salamander from Kamishima Island had more vomerine teeth than the others. Likewise, the number of teeth in upper and lower jaw was greater in the Kamishima Island salamander than in *H. boulengeri* from the Osumi Peninsula and *H. naevius* (Table 3).

TABLE 4. Standardized coefficients for the first three canonical axes (CANs 1–3) of variation of characters.

| Characters | CAN1 | CAN2 | CAN3 |
|---|---|---|---|
| SVL | −0.392 | −0.842 | 0.084 |
| HL | 0.456 | 1.022 | 0.596 |
| HW | 0.595 | −2.494 | 0.848 |
| HLL | 2.382 | 0.658 | −2.977 |
| VTW | 0.853 | 1.538 | 1.578 |
| VTL | −0.665 | 0.029 | 0.148 |
| Proportion | 0.874 | 0.078 | 0.036 |

Standardized coefficients of the six measurements calculated for the first three canonical axes (CANs 1–3) and proportions for these axes are presented in Table 4. Cumulative proportions indicate that CANs 1–3 account for 98.8% of the total variation. The first and second canonical axes account for 87.4% and 7.8% of the total variation, respectively. The high positive coefficient value of HLL was obtained in CAN 1 axis, the high negative value of HW in CAN 2, and high negative value of HLL in CAN 3, and these were the main discriminanting features. The value of VTW was the second contribution for discrimination in all the three axes.

Figure 4 shows two dimensional plots of the first three canonical variables. The salamander from Kamishima Island largely overlapped *H. boulengeri* from the Osumi Peninsula on the first canonical axis. However, on the second and third axes, the two populations tended to be separated from each other.

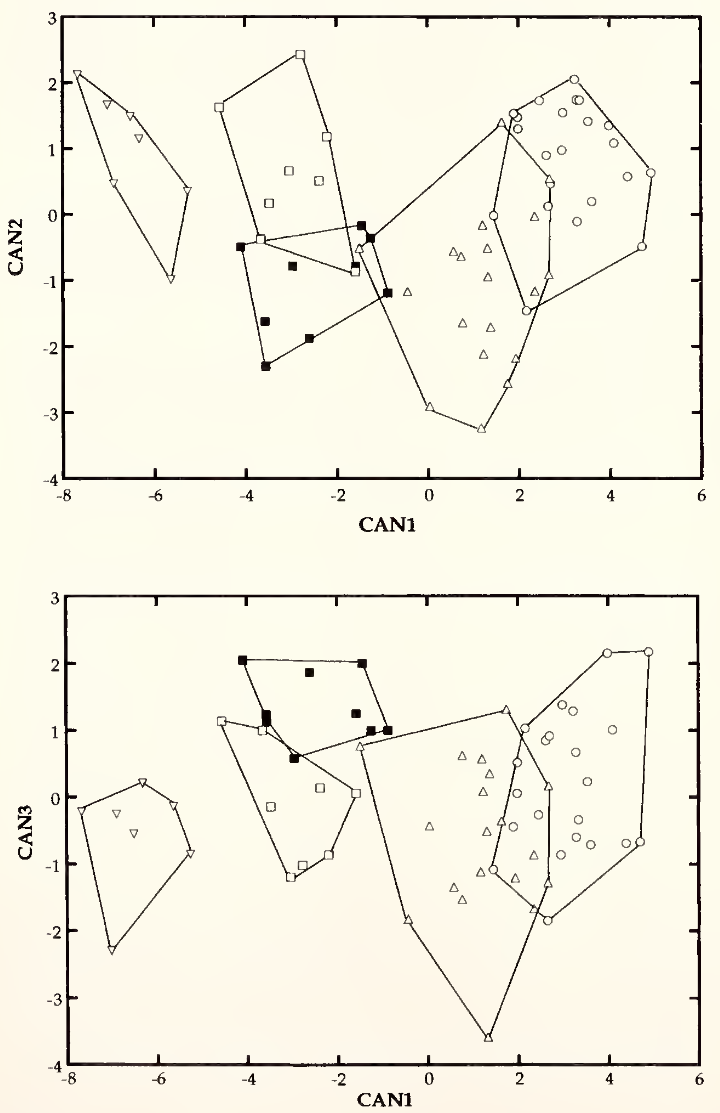


FIG. 4. Two dimensional plots of the first (CAN1) versus second (CAN2) canonical variables (upper) and the first versus third (CAN3) canonical variables (lower). Closed squares, open circles, open squares, open triangles, and reversed open triangles represent scores for specimens of *Hynobius* sp. on Kamishima Island, *H. boulengeri* from Sobo-Katamuki Mountains, Osumi Peninsula, *H. stejnegeri*, and *H. naevius*, respectively.

## Discussion

### *Natural history*

The habitat and external morphology of larvae and adults of the salamander from Kamishima of the Amakusa Islands indicate that this is a lotic breeder (*H. naevius* group of Sato [1943]). The Kamishima salamander seems to breed before May and then stay near the breeding stream. The most important aspects of its natural history such as breeding season, oviposition site characteristics, clutch size, egg diameter, egg sac shape, hatching time, and size of larvae at hatching are totally unknown.

Some larvae seem to start metamorphosis before mid October, and the average size at metamorphosis is estimated as approximately 26 mm in SVL. However, some other larvae may overwinter and metamorphose at a larger size in the following spring or summer, as is usual with other lotic breeding *Hynobius* species (Misawa and Matsui, 1997). Estimated size at metamorphosis (ca. 26 mm) is smaller than that of *H. boulengeri* from the Sobo-Katamuki Mountains and *H. stejnegeri* (ca. 35–50 mm in SVL: Sato, 1954; Nishikawa et al., unpublished), but is similar to that of *H. boulengeri* from the Osumi Peninsula (ca. 25–35 mm: Sato, 2003; Nishikawa et al., unpublished). In *H. boulengeri*, geographically variable size at metamorphosis is thought to induce great variation in adult SVL (Nishikawa et al., 2001).

The two juveniles collected in May were slightly larger than older larvae collected in October, and thus seem to have metamorphosed before winter and increased in size. Sexual maturation seems to be attained at about 60–70 mm in SVL in males, and possibly at a larger size in females.

### *Taxonomic status*

The color pattern of the salamander from the Kamishima Island, characterized by numerous silvery dots scattered on the brownish gray body, is shared with some individuals of *H. boulengeri* from the Osumi Peninsula. Such a pattern is also similar to that of *H. naevius*, although silvery markings are more developed in this species. We found claw-like structures on the larval digital tips of the Amakusa salamander, which is common to populations of *H. boulengeri* from the Kyushu Main Island and *H. stejnegeri* but is absent in *H. naevius* (Sato, 1943; Sato, 1954, 2003).

In SVL of adult males, H. sp. from Kamishima Island is smaller than *H. boulengeri* from the Sobo-Katamuki Mountains and *H. stejnegeri*, and is larger than the *H. naevius* we examined. The present salamander is most similar to *H. boulengeri* from the Osumi Peninsula but differs from it by a relatively wider head and larger numbers of vomerine and jaw teeth. However, the sample size currently available is not sufficient to make a taxonomic decision now, and further morphological analysis based on additional specimens, especially of females, and genetic analysis are needed to determine the taxonomic status of this salamander.

*Biogeographic implications*

In the past, the Amakusa Islands may have experienced frequent connection to and separation from the Kyushu Main Island through the Yatsushiro Sea in between, which is very narrow and shallow (only 15 km wide and mainly 25–55 m deep currently). Occurrence of one of the largest pyroclastic flows from the Aso volcano (ca. 90000 yBP) found in the Amakusa Islands demonstrates the relatively recent land connection of this island group with the Kyushu Main Island (Machida, 2001), and can explain the high similarity of the batrachian fauna between them.

The presence of two *Hynobius* species, *H. nebulosus* and *H.* sp., on Kamishima of the Amakusa Islands is ecologically very interesting because, in contrast to relatively large areas of the Main Islands of Japan, where more than one species occur, no more than one species is known from other small peripheral islands (e.g., only *H. okiensis* on Oki Island, *H. tsuensis* on Tsushima Island, and *H. nigrescens* on Sado Island). This is probably due to the small carrying capacities of these other islands. The exceptional coexistence of two *Hynobius* species on Kamishima Island may be partially attributable to their habitat segregation, with *H. nebulosus* occupying a niche in the lowlands, and *H.* sp. in the mountains. The relatively short period of isolation between the Amakusa Islands and the Kyushu Main Island might also be responsible for the current coexistence of these two species.

*Conservation*

Among the salamanders examined in this study, *H. boulengeri* from a limited area on the Sobo-Katamuki Mountains is protected by Oita Prefecture and *H. stejnegeri* from Kumamoto Prefecture is also locally protected by the prefectural government. These species are also listed in the Red Data Book by the Japan Ministry of Environment (Matsui, 2000). However, *H.* sp. from the Amakusa Islands, first reported here, and the population of *H. boulengeri* from the Osumi Peninsula are not protected at all. Because both of these two morphologically unique populations are surely facing artificial habitat destruction, measures for their conservation urgently need to be taken.

## Acknowledgments

We wish to thank S. Sato for his aid in collecting specimens and two anonymous reviewers for critically reading early drafts. This work was supported by Grants-in-Aid to MM (No. 11640697) from the Ministry of Education, Science, Sports and Culture, Japan, and the Environmental Agency of Japan (now the Ministry of Environment).

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## APPENDIX

*Sampling localities and catalogue number of specimens examined*

Voucher specimens are stored in the Graduate School of Human and Environmental Studies, Kyoto University (KUHE), S. Tanabe's private collection (T), S. Sato's private collection (ST), M. Sakamoto's private collection (SK), Osaka Museum of Natural History (OMNH), and the National Science Museum, Tokyo (NSMT).

*Hynobius* sp. from Kamishima of the Amakusa Islands: Kumamoto Prefecture (adults: KUHE 30332–30339, SK 4; juveniles: KUHE 30340, 30341)

*H. boulengeri* from the Sobo-Katamuki Mountains: Ume-cho, Oita Prefecture and Takachiho-cho, Miyazaki Prefecture (Adults: KUHE 18920, 21619, 22813, 22889, 24878, 24967, 25096, 26142, 27125, 27183, 27184, 28748–28752, 28753, 28754, 28755, 28756; two unnumbered ST specimens)

*H. boulengeri* from the Osumi Peninsula: Tashiro-cho and Koyama-cho, Kagoshima Prefecture (Adults: KUHE 18923, 22892, 24961, 24962, 28539; OMNH H108; NSMT H03664, H04534)

*H. stejnegeri*: Gokase-cho, Miyazaki Prefecture (Adults: KUHE 12983, 14955, 14956, 22815, 22817–22819, 26065–26068, 27156–27560; T 2537, 2808; one unnumbered ST specimen)

*H. naevius*: Ume-cho, Oita Prefecture (adults: KUHE 25098, 27383, 28846, four unnumbered ST specimens)

*Accepted: 15 June 2003*

*Current Herpetology* 22(1): 9–15, June 2003


# A Fossorial Lizard with Forelimbs Only: Description of a New Genus and Species of Malagasy Skink (Reptilia: Squamata: Scincidae)

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**Abstract: A new genus and species of fossorial scincine lizard is described from northeastern Madagascar. This species, having an elongated body and eyes covered by scales, lacking external ear openings and pigmentation throughout the body, resembles *Cryptoscincus* and *Voeltzkowia*. However it differs from these or any other scincid genera known to the present in having small but distinct forelimbs, each with four stout claws, and complete lack of hind limbs.**

Key words: New genus; New species; Scincidae; Madagascar; Fossorial; Limb reduction

## INTRODUCTION

Seven endemic genera of the subfamily Scincinae (Squamata, Scincidae) are known from Madagascar, and most of them consist of fossorial or semifossorial species (Angel, 1924; Brygoo, 1979, 1980a–d, 1981a–c, 1984a–d, 1985; Mocquad, 1909). Recent herpetological surveys on Madagscar led to discoveries of many new species (Raxworthy and Nussbaum, 1993; Nussbaum and Raxworthy, 1995; Andreone and Greer, 2002; Sakata and Hikida, 2003). Due to their largely secretive habits, however, many species of these and related genera are thought to remain undiscovered.

Ecological surveys, carried out by Japanese ornithologists and herpetologists in collaboration with their Malagasy counterparts in Ampijoroa, Ankarafantsika Strict Nature Reserve, northwestern Madagascar (Fig. 1), yielded two specimens of an apparently undescribed skink. This skink differs from any known scincids in having forelimbs only. We thus describe it as a new genus and species.

## MATERIALS AND METHODS

The specimen was fixed with 10% formalin, preserved in 75% ethanol, and deposited in the Zoological Collection of the Kyoto University Museum (KUZ). The following measurements were taken with dial calipers and recorded to the nearest 0.1 mm: snout-vent length (SVL), tail length, head length (snout tip to posterior margin of parietals), snout length (snout tip to anterior corner of eye), head width (the widest point of temporal region), and midbody width. Vertebral characters were determined by radiographs (Softex M-60, Softex Co.).

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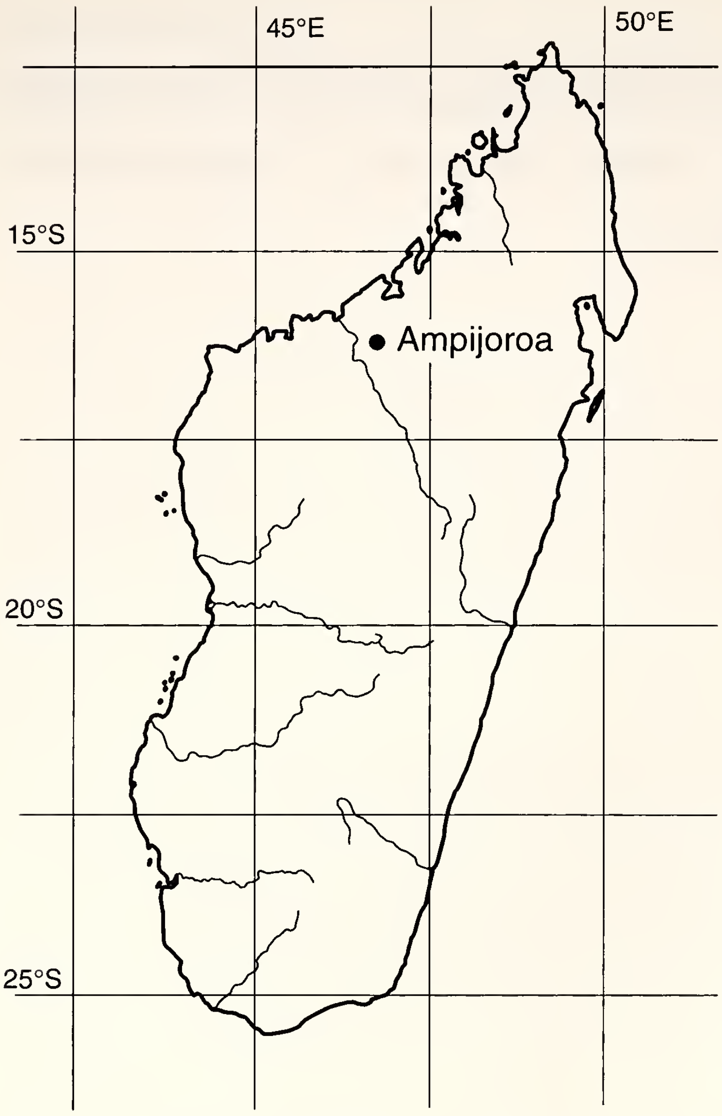


FIG. 1. Map of Madagascar, showing location of Ampijoroa, the type locality of *Sirenoscincus yamagishii* sp. nov.

We defined the scales covering the eyes as ocular(s). Terminology for the other characters follows Sakata and Hikida (2003).

*Sirenoscincus yamagishii* gen. et sp. nov.
Figs. 2 and 3

*Holotype*

KUZ R50922, mature female; Ampijoroa, Ankarafantsika Strict Nature Reserve, northwestern Madagascar (16 20'S, 46 48'E: Fig. 1), 100 m; collected by A. Mori, M. Hasegawa, and I. Ikeuchi, 7 November 1999.

*Paratype*

KUZ R50823, mature female, from the same locality as the holotype, collected by G. Razafindrakoto, as a "dead on the road" specimen, 11 November 1999.

*Generic diagnosis*

The new genus is a member of the subfamily Scincinae (Greer, 1970). It is distinguished from all other taxa in this group by the following combination of characters in derived states (polarity for each of these characters was inferred as relative to *Eumeces*, the putative primitive genus of the family: Greer and Broadley, 2000). Body highly elongated (SVL 11.6–14.0 times head length) with 53 presacral vertebrae; original tail slightly longer than SVL; snout pointed, lower jaw countersunk; neck indistinguishable externally; body scales smooth and transparent without pigmentation; 20 longitudinal scale rows at midbody. Forelimb small (approximately 4.7% of SVL) with indistinct fingers and four stout claws; no hind limbs, shallow groove in their position in other scincines; prefrontals absent; nasal sharply pointed, triangular, positioned at V-shaped notch of rostral; nostril positioned at anterior tip of nasal; frontonasal as large as frontal; frontoparietal absent; loreal single; supraoculars two; superciliaries and movable lower eyelid absent; eye covered with two oculars; supralabials six; infralabials five, anterior three higher than posterior two; external ear opening covered by scales, but small ear groove visible through transparent scale; postmental single.

*Species diagnosis*

The species diagnosis is the same as that for the genus.

*Description of holotype*

Adult female. Head much narrower than body; snout pointed; lower jaw countersunk; nostril anterolaterally oriented, visible from above; ear openings absent, small ear groove visible through transparent scales covering it; neck not distinct; body greatly elongated, with 53 presacral vertebrae; body and tail round in cross section; forelimbs small, with indistinct fingers and four stout claws; hind limbs absent.

Rostral scale large, overlapping nasals, supranasals and first supralabials; nasal sharply pointed and triangular, positioned in

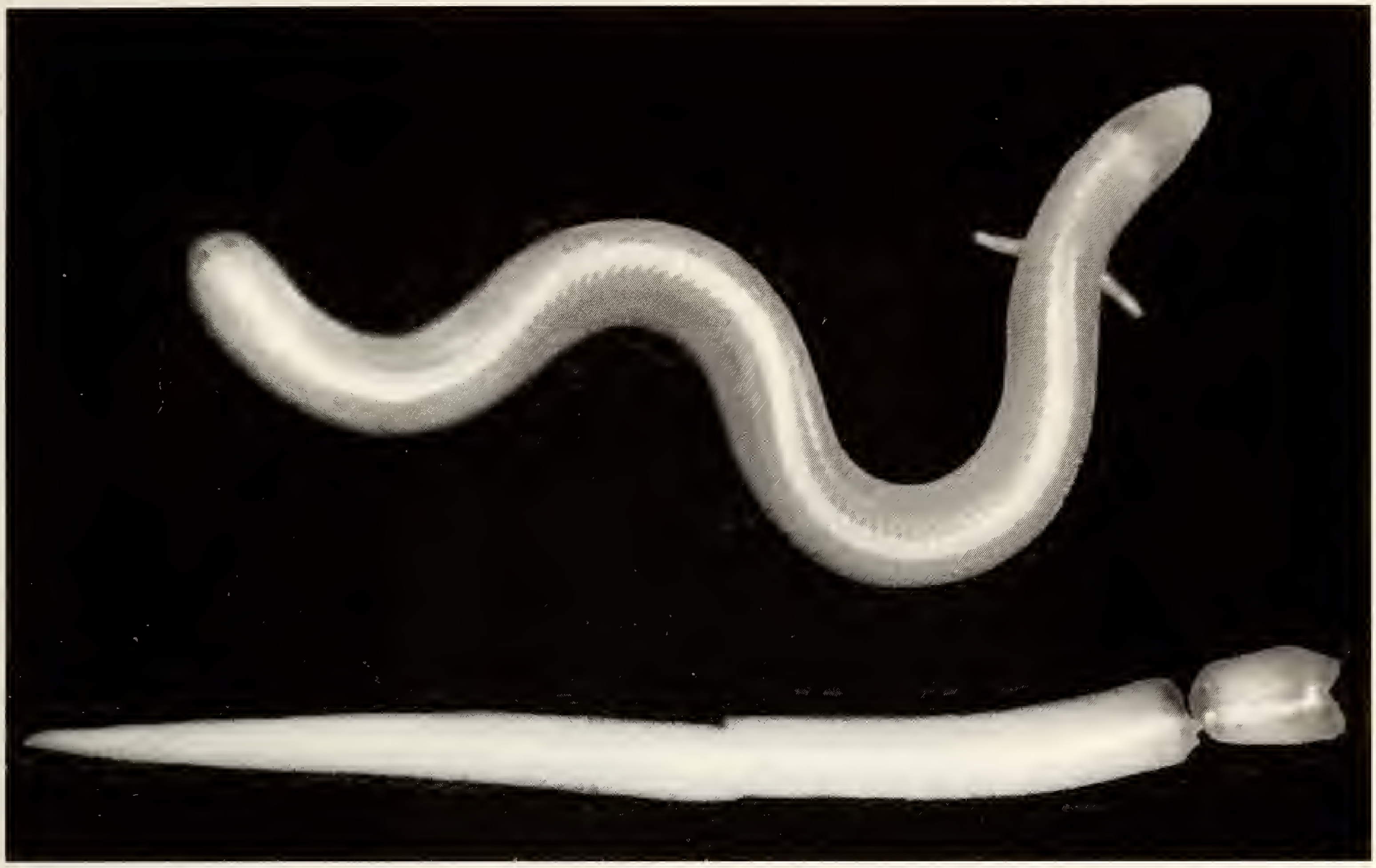

FIG. 2. Holotype of *Sirenoscincus yamagishii* sp. nov. (KUZ R50922) in life, with its autotomized tail.

the V-shaped notch of rostral, overlapping supranasal and first supralabial; nostril located in anterior tip of nasal, in contact with rostral; supranasals two, each overlapped by first supralabial, overlapping loreal and frontonasal, right overlapping left; frontonasal overlapped laterally by loreal, overlapping frontal and first supraocular posteriorly; prefrontals absent; frontal as large as frontonasal, overlapped laterally by first supraocular, overlapping interparietal and a pair of parietals posteriorly; frontoparietal absent; interparietal triangular, with two longer sides converging to a bluntly rounded apex posteriorly, overlapping parietals; transparent spot on interparietal absent; parietals two large, quadrangular, left overlapping right behind interparietal, each overlapped by first and second supraoculars, overlapping upper secondary temporal and first nuchals; two nuchals on left, one on right; supralabials six, three preorbital, one subocular and two postorbital; loreal single, quadrangular, as long as second supralabial, overlapped below by first and second supralabials, overlapping first supraocular and preocular posteriorly; preocular single, overlapped by second supralabial, overlapping first supraocular, first ocular, and third supralabial; presubocular absent; supraoculars two, overlapped by two oculars below, overlapping frontal and parietal above, and primary and upper secondary temporals posteriorly; oculars two, covering eye, overlapped by third supralabial, overlapping supraoculars, primary temporal and fourth supralabial; postsubocular absent; primary temporal one, overlapped by fourth supralabial, overlapping upper and lower secondary temporals and fifth supralabial; upper secondary temporal about half as long as parietal, overlapping lower secondary temporal, nuchal, and anteriormost scale of a lateral body scale row; lower secondary temporal overlapped by fifth supralabial, overlapping sixth supralabial and anteriormost scales belonging to lateral body scale rows; mental slightly larger than postmental, overlapping postmental and first infralabials; postmental overlapped by first infralabials, overlapping the first pair of chin shields; three pair of chin shields, first pair in contact, second separated

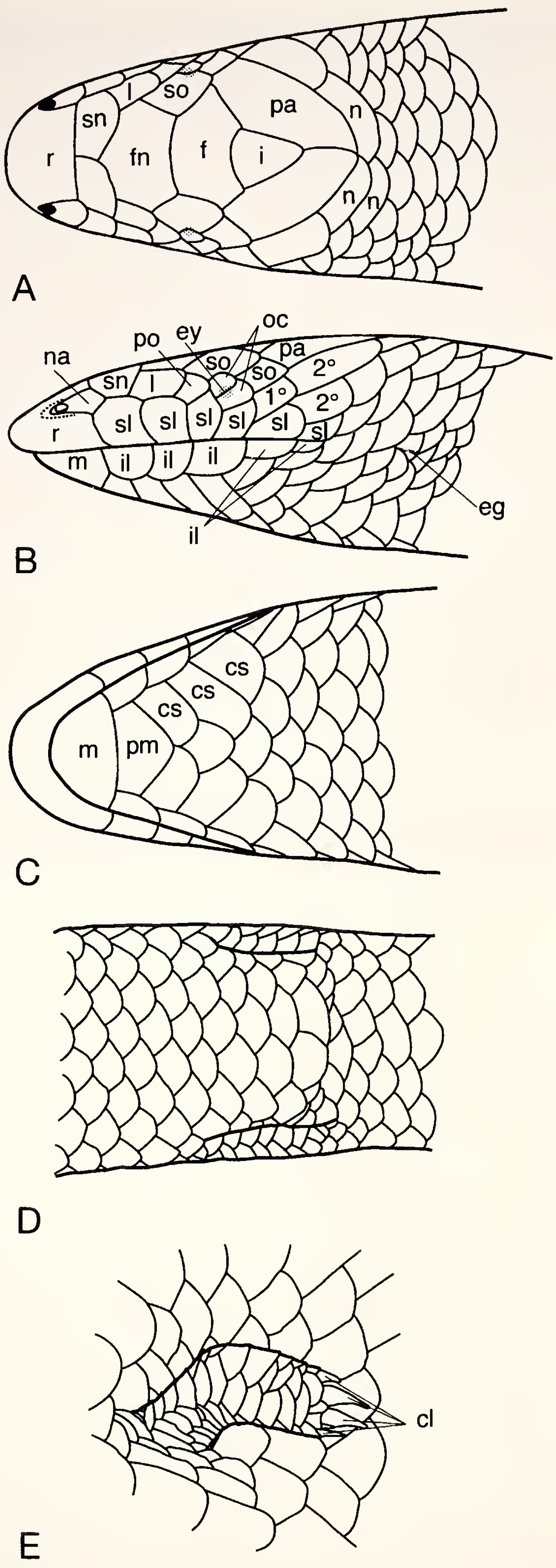


FIG. 3. Dorsal (A), lateral (B) and ventral (C) views of head, ventral view of cloacal region (D), and left forelimb (E) of the holotype of *Sirenoscincus yamagishii* sp. nov. (KUZ R50922). Abbreviations are: 1°, primary temporal; 2°, secondary temporal; cl, claw, cs, chinshield; eg, ear groove; ey, eye; f, frontal; fn, frontonasal; i, interparietal; il, inflalabial; l, loreal; m, mental; n, nuchal; na, nasal; pa, parietal; pm, postmental; po, preocular; oc, ocular; r, rostral; sl, supralabial; sn: supranasal; so, supraocular.

by one scale, and third separated by three scales; five infralabials, second highest, third widest; body and tail covered with smooth cycloid scales; position of hind limb insertion in other scincines having a patch of small scales, followed by short groove; preanal scales two, slightly larger than ventral body scales, right overlapping left; tail broken when captured.

### *Measurements of holotype (mm)*

SVL, 82.5; original tail length, 84.4; head length, 7.1; snout length, 4.0; head width, 4.2; midbody width, 5.2; length of forelimb exclusive of claws, 3.8; fourth finger length, 0.6; distance between nostrils, 1.8.

### *Coloration*

In life, head, body, forelimbs and tail uniformly pinkish white; snout somewhat paler than the other portion of head; black pigmentation of eye visible; autotomized tail somewhat whiter than original portion; scales transparent, without pigmentation; claws white. After preservation, pinkish coloration faded to uniformly white, and then to slightly yellowish after half year in alcohol.

### *Variation*

In paratype, head slightly depressed; forelimb broken; SVL, 86.9; tail length, 53.7; head length, 6.20; snout length, 3.0; head width, 5.4; midbody width, 4.6; distance between nostrils, 1.7. This specimen had more nuchals than holotype—two in left, three in right.

### *Etymology*

The generic name is derived from the Latin words, *siren* (mermaid) and *scincus* (skink), referring to the unique body shape of the type species with forelimbs only. The specific epithet is dedicated to Dr. Satoshi Yamagishi, who was a professor of Kyoto University and the project leader of Ecological Surveys in Ampijoroa, Ankarafantsika Strict Nature Reserve, in which both of the type specimens were obtained.

*Natural history*

The holotype was found under the leaf litter during a night survey. The collectors first found an autotomized tail which was still moving on the leaf litter. Then they searched around there and captured the holotype. The paratype was collected as a dead body on the road. Additionally three tails obviously belonging to the present species ware obtained as stomach contents of two colubrid snakes, *Liophidium torquatum* and *Dromicodryas bernieri*. These two snake species are considered to be terrestrial (Mori et al, unpublished observation). Probably *Sirenoscincus yamagishii* is a common prey item for such terrestrial snakes around the type locality.

## Discussion

All Malagasy scincine lizards known to the present are fossorial or semifossorial exept for three aquatic or semi-aquatic species of the genus *Amphiglossus*; *A. astrolabi, A. reticulatus*, and *A. waterloti* (Brygoo, 1979, 1980a–d, 1981a–c, 1984a–d, 1985, Raxworthy and nussbaum, 1993), showing various degrees of reduction of limbs (from partial reduction of digits on forelimb or hind limb to the complete loss of both limbs), eyes, and ear-openings (Table 1). Among the eight genera, *Amphiglossus* seems to be most primitive in that it usually has four pentadactyl limbs, movable eyelids, and external ear openings. Three genera, *Voeltzkowia, Cryptoscincus*, and *Sirenoscincus*, are obviously extremely adapted to fossorial life in that their bodies are elongated, and eyes and ear openings are covered by scales. Pigmentation in scales is also lost in all the species of these genera exept for three species of *Voeltzkowia*.

Two species of *Voeltzkowia*, formerly assigned to the subgenus *Grandidiernina*, have no forelimbs and reduced hind limbs. The other three species of *Voeltzkowia* and a species of

TABLE 1. Comparisons of the Malagasy scincine genera. Numerals indicate numbers of digits on forelimbs and hind limbs. Symbols: +, present; –, absent; bt, button-like scale; nb, nub; st, styliform.

| Genus/Species | Number of species | Eyes | Ear openings | Forelimbs | Hind limbs |
|---|---|---|---|---|---|
| *Amphiglossus* | | | | | |
| *A. stylus* | 1 | + | – | nb | st |
| *A. crenni* | 1 | + | + | 2–3 | 2–4 |
| other species | 32 | + | + | 5 | 5 |
| *Androngo* | 1 | + | + | 2–5 | 2–5 |
| *Paracontias* | 8 | + | – | – | – |
| *Pseudoacontias* | | | | | |
| *P. angelorum* | 1 | + | – | – | st |
| *P. menamainty* | 1 | + | – | bt | – |
| other species | 2 | + | – | – | – |
| *Pygomeles* | | | | | |
| *P. braconnieri* | 1 | + | + | – | st |
| *P. petteri* | 1 | + | – | – | – |
| *Voeltzkowia* | | | | | |
| *V. fierinensis* | 1 | – | – | – | 2 |
| *V. petiti* | 1 | – | – | – | st |
| other species | 3 | – | – | – | – |
| *Cryptoscincus* | 1 | – | – | – | – |
| *Sirenoscincus* | 1 | – | – | 4 | – |