

**LIMNONECTES KADARSANI (AMPHIBIA: ANURA: RANIDAE),
A NEW FROG FROM THE NUSA TENGGARA ISLANDS**

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ABSTRACT. - *Limnionectes kadarsani*, a new large species described here is known from Lombok, Sumbawa, Flores, and Adonara in the Nusa Tenggara Islands. This species is distinctive in having robust but slight elongated body in males and subadult specimens, skin covered with few elongated tubercles and a pair of short dorsolateral folds. Adult males have wider head, a distinct enlargement of the exoccipital crest and wider interorbital space and the eye-tympanum distance. *Limnionectes kadarsani* is believed to be closely related to *L. macrodon*, and to a lesser extent to *L. modestus*.

INTRODUCTION

When reviewing the amphibian collection at Museum Zoologicum Bogoriense (MZB) in 1976, one of us (DTI) examined a number of specimens from Lombok, Sumbawa, Flores and Adonara, identified as *Limnionectes* (= *Rana*) *macrodon* or *L. modestus*. They are distinct in several ways from *L. macrodon*, especially by the distinctly enlarged exoccipital crest in adult males. This new form is a large species up to 120 mm in both sexes. At that time, only few species from other regions had been examined. After participating in a number of expeditions to Sumatra, Java, Ambon and Sulawesi, we have now seen an adequate number of species and are now able to understand that the *L. macrodon* populations from Nusa Tenggara islands represent a new species.

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SYSTEMATICS

Limnonectes kadorsani, new species

(Fig. 1)

Rana macrodon, Barbour, 1912 (part); Boulenger, 1920 (part); van Kampen, 1923 (part); Mertens, 1927 (part); Darevskiy, 1964.

Rana modesta, Barbour, 1912 (part); van Kampen, 1923 (part); Dunn, 1928.

Material examined. - Holotype - Adult male (MZB Amph. 2940 (ex.2654)), Jaran Pasang, Lombok, coll. D. Hardjono, 14 Mar.1984.

Paratypes - LOMBOK: - male and female (MZB Amph. 2941-2942 (ex. 2652)), - 2 males and female (MZB Amph. 2943-2945 (ex. 2651)) - 2 males and female (MZB Amph. 2946-2948 (ex. 2653)) - male (MZB Amph. 2654), Jaran Pasang, coll. D. Hardjono, 8-14 Mar.1984 - 2 males and female (MZB Amph. 2949-2951 (ex. 2645)), from West Lombok, no exact locality, coll. Rachmatun, May.1982. SUMBAWA: female (MZB Amph. 120), Batu Dulang, Sumbawa, coll. R. Mertens, Sunda Exp. Rensch, 6 May.1927 - females (MZB Amph. 2935-2936 (ex.193) - males (MZB Amph. 2959, 2960 (ex. 215)), (partly cleaned), Semangkat Atas, coll. R. Mertens, Sunda Exp. Rensch, 11 May.1927 - males and females (MZB Amph. 2952-2956 (ex. 2507)), Sariberu, near Simpasai market, Monta county, Bima, coll. M. Siluba, 7 Feb.1984 - male and female (MZB Amph. 2957-2958 (ex. 2805)), along stream creek near Air Merah, Batu Hijau, coll. K. Martin, Feb.1994. FLORES: 2 males and female, (MZB Amph. 009a-c (3 of 5 ex.)), Wolowaru, coll. R. Mertens, Sunda-Exp. Rensch, 16 Jul.1927 - female (MZB Amph. 214), Bajawa, coll. R. Mertens, Sunda Exp. Rensch, 6 Jul.1927 - 2 females and male (MZB Amph. 2937-2939 (ex.398)), Rana Mese, coll. Fr. J.M. Vianney, 10 Apr.1958. ADONARA: 2 males (MZB Amph. 1025-1026), Hinga, coll. Fr. J.M. Vianney, 10 May.1959. - male (MZB Amph. 1024), Wure, coll. Fr. J.M. Vianney, 3 May.1959.

The description is based on 35 adult specimens, from Lombok (13 ex.), Sumbawa (12 ex.), Flores (9 ex.) and Adonara (3 ex.). In addition, we also examined 28 specimens of young and subadults from the same localities, all from the MZB collection, but not considered as a part of the type series.

Diagnosis. - Body is usually much longer than broad, except in gravid females. The legs are moderate in length and the foot is fully webbed to the toe disk. The colour is brownish to grayish black. A short, fine dorsolateral fold is located at the anterior part of dorsum. A distinct “/ \” or “W” shaped scapular marking is present between the shoulders. Skin is usually smooth in adult specimens, but young specimens have two rows of enlarged tubercles in the mid dorsal of the sacral region.

Description. - A large frog, body much longer than broad, adults up to about 120 mm. Head much wider than long in adult males, in females and young males it is nearly as wide as long (see Fig. 1); distinctly enlarged odontoid processes at end of mandible, larger in adult males; snout rounded, feebly projecting; nostril closer to tip of snout than to eye; canthus rounded, loreal region oblique, slightly concave or straight; eyes pointing obliquely upwards, interorbital narrower than eye diameter; vomerine teeth in two oblique series just behind the level of choanae; tympanum distinct, smaller than eye-nostril distance. Limbs stout, fingers short, length of fingers 3>1>4>2; a distinct fringe of skin along both sides of second and third fingers, not movable; subarticular tubercles well developed. Tips of finger distinctly enlarged, devoid of circum-marginal groove, dorsal groove present. Hindlimbs short; heels slightly overlapping when legs flexed at right angle to the body; tibia about one-half of SVL; toes fully webbed up to swollen tips; toe disks distinctly enlarged; a narrow tarsal fold and a flap along the outer toes and metatarsal. Elongated inner metatarsal tubercle followed with a non-movable skin fold, compressed; no outer metatarsal tubercle.

Skin slightly rugose, with tubercles on the sides of body, a short dorsolateral fold on the anterior portion of the back, a “/ \” or “W” shaped scapular markings. A few short folds, spinules or small tubercles, especially on the posterior part of the back and on the legs. Young specimens with two rows of tubercles on the dorsum between the dorsolateral (paravertebral) region, especially on the sacral region. These tubercles always disappeared in adults, leaving only few elongated folds. Upper eyelids with tubercles, supra-tympanic fold thick. Lower parts of body and legs smooth.

Eggs moderate (2.2 mm in female of 91 mm), with darker animal pole.

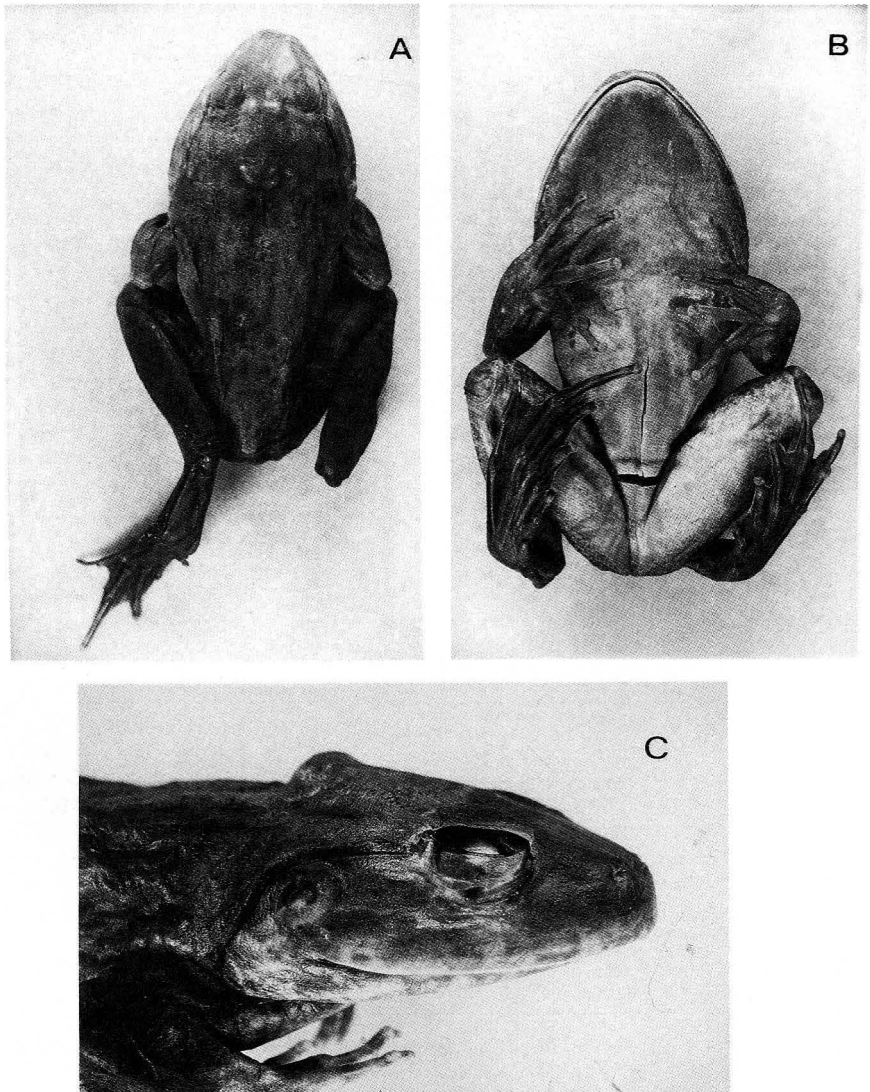


Fig. 1. Holotype of *Limnonectes kadarsani*. A. dorsal aspect; B. ventral aspect; C. Lateral view of the head to show the exoccipital crest enlargement.

Colouration in alcohol. - Uniform grayish black, indistinct bar between the eyes, supratympanic fold widely black coloured. Dorsum more or less uniformly reddish brown to grayish brown, lips with vertical bars; throat and breast dusted with gray. Skin is covered with light tipped tubercles.

Secondary sex characters. - Males are slight larger than females, vocal sacs absent. Females with eggs measure 53-107 mm; males with secondary growth of exoccipital crest measure 54-120 mm. The head is wider in males than females. The head is distinctly enlarged

Table 1. Morphometric data and ratios for *Limnonectes kadarsani*.

CHARACTERS	MALES ^a (N=18)	FEMALES (N=14)	RATIOS	MALES (N=18)	FEMALES (N=14)
SVL	94.06 ± 17.93 54.0 - 120.0	86.47 ± 14.75 53.5 - 107.0	HW / HL	1.10 ± 0.05 1.03 - 1.19	1.14 ± 0.05 1.05 - 1.20
HW	39.66 ± 8.00 23.7 - 55.2	33.36 ± 6.08 20.0 - 42.0	IN / IO	1.06 ± 0.19 0.78 - 1.21	1.15 ± 0.15 0.86 - 1.30
HL	37.94 ± 7.69 21.6 - 46.5	29.40 ± 5.39 18.3 - 36.0	IO / EY	0.63 ± 0.11 0.40 - 0.83	0.56 ± 0.05 0.44 - 0.68
FE	44.96 ± 8.27 28.6 - 57.8	42.72 ± 7.28 27.1 - 51.6	TY / EY	0.58 ± 0.04 0.51 - 0.65	0.53 ± 0.07 0.47 - 0.75
TI	47.49 ± 7.99 29.7 - 60.2	45.04 ± 7.41 29.2 - 55.	EY / SL	1.03 ± 0.10 0.86 - 1.18	1.06 ± 0.06 0.95 - 1.10
FL	68.57 ± 13.72 42.6 - 89.5	66.92 ± 12.47 40.4 - 84.9	TI / SVL	0.51 ± 0.03 0.46 - 0.55	0.53 ± 0.02 0.49 - 0.56
SL	11.54 ± 1.81 8.0 - 15.0	10.69 ± 2.04 6.6 - 13.7	HW / SVL	0.43 ± 0.03 0.37 - 0.48	0.39 ± 0.02 0.36 - 0.41
TY	6.92 ± 1.29 4.5 - 9.0	6.23 ± 1.78 3.4 - 7.5	HL / SVL	0.39 ± 0.02 0.34 - 0.40	0.34 ± 0.02 0.30 - 0.36
EY	12.01 ± 2.28 7.1 - 14.6	11.29 ± 2.24 7.2 - 13.9	FL / SVL	0.74 ± 0.05 0.65 - 0.81	0.78 ± 0.02 0.73 - 0.81
IO	7.64 ± 2.09 4.1 - 11.3	6.33 ± 1.25 3.7 - 8.0	TY / SVL	0.07 ± 0.01 0.06 - 0.08	0.07 ± 0.01 0.05 - 0.12
EN	8.24 ± 1.71 5.4 - 10.6	7.81 ± 1.33 5.1 - 9.7	IN / SVL	0.08 ± 0.01 0.08 - 0.10	0.08 ± 0.01 0.07 - 0.09
IN	7.81 ± 1.51 5.0 - 11.0	7.18 ± 1.18 5.1 - 9.2	EN / SVL	0.08 ± 0.01 0.07 - 0.11	0.09 ± 0.01 0.08 - 0.12
ET	7.84 ± 2.66 3.4 - 14.5	4.74 ± 1.22 2.5 - 6.7	ET / SVL	0.08 ± 0.02 0.06 - 0.13	0.05 ± 0.01 0.04 - 0.07

The first line is mean ± SD; second line is the range. All morphometrical values are in millimeters. Abbreviations of variables are as follows: SVL = snout-vent length; HW = head width; HL = head length; FE = femoral length; TI = tibial length; FL = foot length; SL = snout length; IO = interorbital space; IN = internarial distance; EN = eye - nostril distance; EY = eye diameter; ET = eye - tympanum distance; TY = tympanum diameter.

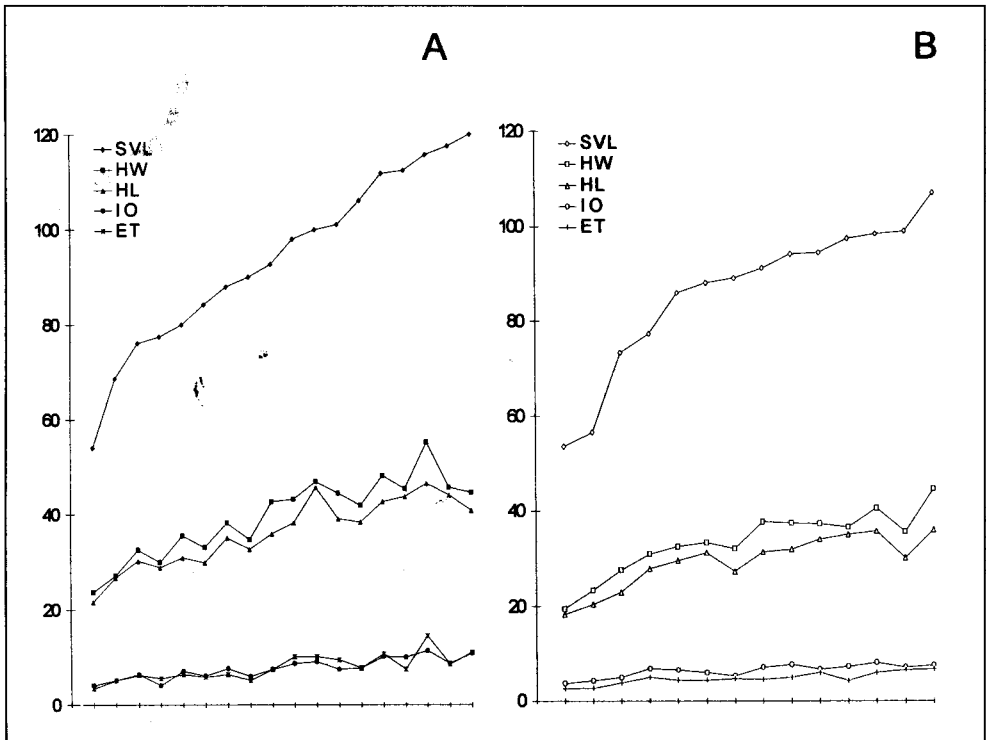


Fig. 2. Some morphometrical differences between males (A) and females (B) of *Limnectes kadarsani* in relation to snout-vent length. See Table 1 for abbreviations of variables.

in adult males, resulting from secondary growth in the posterior portion of the head. The distance between eye and tympanum in extra large males could attain 15 mm, but in large females only between 4 to 6 mm. The measurements of this character are biased by the secondary growth when the specimens reach adulthood as shown in Table 1. The anterior part of the post-occipital is slightly bulging in adult males so that the interorbital becomes wider and the exoccipital crest is distinctly enlarged and could be seen as a raised, visible rounded knob at the posterior part of the head. The bodies of gravid females are stocky and are larger than the head; in the adult males, the head is wider than the body. Some other characters that are significantly different between male and female specimens and are not clear in Table 1, are presented in Fig. 2.

Etymology. - It is our pleasure to name this new species in honor of Dr. Sampurno Kadarsan, the former Director of Museum Zoologicum Bogoriense (MZB, Bogor) during the periods of 1960-1962; 1964-1968 and 1971-1977. For his achievements, he received about eight medals of honour from the Indonesian government. Dr. Kadarsan retired in September 1994, after serving MZB for 40 years (1955-1994). His contributions towards the progress of Museum Zoologicum Bogoriense up until present are immeasurable and incomparable to any Indonesian biologist.

COMPARISON

Barbour (1912), van Kampen (1923) and Dunn (1928) reported the occurrence of *Limnectes modestus* from Lombok Island, presumably based on young specimens. Their

records was concurred by Mertens (1930) and considered that the record was based on young specimens of *L. macrodon*. The specimens examined by Dunn (1928) according to Mertens (1929) were in fact *L. dammermani*. After examining all of the Sulawesi and Moluccan species and comparing them to the Nusa Tenggara populations, we understand why at least a part of the Lombok population was assigned to *L. modestus*. Although maturity is reached at about 55 mm in both species, *L. modestus* is a smaller species (max 80 mm) compared to *L. kadarsani*. There is no distinct secondary sex characters in the overall morphology of *L. modestus*, except for the presence of paired vocal sacs. The differences of SVL and head width between sexes or in young *L. modestus* are not significant. Unless dissected, it is impossible to distinguish young males from young females of both species. In *L. modestus*, both sexes have enlarged odontoid processes, but this structure is only present in males of *L. kadarsani*. Males of *L. modestus* have only slight larger head and more prominent odontoid processes than females. The odontoid processes of males of *L. modestus* directed upwards but in adult females directed backwards at about 45°; the odontoid bones are exposed in both sexes. Beside the enlargement of post-occipital knob and the enlarged odontoid processes, adult males of *L. kadarsani* are much larger with distinct enlarging and widening of head. Young specimens of *L. kadarsani* usually have two rows of tubercles as in *L. modestus*, but these tubercles tend to disappear in adults, leaving only a few small elongated tubercles or spinules. The presence of the tubercles in young specimens seemed to be the main reason why some authors attributed the Lombok's population to *L. modestus* (see Barbour, 1912; van Kampen, 1923; Dunn, 1928). They probably examined some subadult specimens, and could not find the diagnostic characters of *L. kadarsani*.

The presence of two rows of tubercles at the mid-dorsal region between dorsolateral of the sacral regions is not only known in *Limnonectes modestus*, but equally present in several smaller forms related to *L. microdiscus* from Sulawesi as well as in *L. dammermani*. Another species, *L. dammermani* is the only other *Limnonectes* in the Nusa Tenggara Islands. The less toe webbings and small size will distinguish *L. dammermani* from the fully webbed and the much larger sized *L. kadarsani*.

Limnonectes macrodon, to which *L. kadarsani* was attributed (Barbour, 1912; Boulenger, 1920; van Kampen, 1923; Mertens, 1927, 1930; Darevskiy, 1964), is very similar in the overall physiognomy of the body and legs, width of the head and skin texture of the adults. If young specimens of both forms are compared side by side, the prominent skin tubercles in young *L. kadarsani* will distinguish these two forms immediately. Adults of *L. macrodon* could be distinguished immediately from *L. kadarsani* based on the absence of enlargements of exoccipital crest and the much larger size (see note below).

All other large South-East Asian species, *Limnonectes ingeri*, *L. blythi*, *L. ibanorum*, *L. malesianus*, *L. grunniens*, *L. macrocephalus* and *L. magnus* were all easily distinguished by the absence of visible exoccipital crest, hence different from *L. kadarsani* in this regard. In contrast, most young specimens or smaller species are practically indistinguishable from the similar sized *L. kadarsani*. The presence of vocal sacs in males of *L. acanthi*, *L. microtypanum*, *L. heinrichi*, *L. modestus* or *L. visayanus* will distinguish these species from *L. kadarsani*, but female specimens still remain a problem. The presence of small and sharp odontoid processes in females of *L. modestus*, *L. heinrichi* and *L. microtypanum* will be very useful to distinguish them from females and young males of *L. kadarsani*.

According to Dubois's arrangements (1986; 1992), this species should be placed within or close to members of the subgenus *Bourretia* based on the enlargements of the exoccipital

crest and postoccipital bones. As shown above, this new species is very closely related to *L. modestus* or *L. macrodon*. Two other species, *L. blythi* and *L. malesianus* have also slight enlargement of the exoccipital crest in very big males although not distinctly seen bulging from the surface of the skin, and the interorbital space is not widened. Keeping these species together within the subgenus *Bourretia* will only obscure the relationships between East Indonesian *Limnonectes* and such arrangement is not supported by geographical evidences.

Note. - The types of *Limnonectes macrodon* is a composite. To avoid confusion, Kiew (1978) chose a lectotype to solve the problem. All specimens from Java at our disposition consist of *L. blythi* like species, which will be discussed elsewhere (Inger & Iskandar, in prep). Here we present additional data result from our examination of the type series. In fact the type series is also as complicated as its name. Aside the lectotype and some of the paralectotypes, the rest of the type series (not examined by Kiew) consists of one specimen from Ambon, one other from Sulawesi, another single individual from the Philippines and two others from Borneo. The Ambonese specimen belongs to *L. grunniens*, the Sulawesi specimen belongs to an undescribed species (Iskandar, 1996), and the Philippine specimen probably to *L. visayanus*. Those from Borneo, presumed to be young specimens are in fact adult specimens of *L. paramacrodon*.

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