

The tadpole of *Leptobrachium (Vibrissaphora) echinatum* (Amphibia, Anura, Megophryidae)

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ABSTRACT

The tadpole of *Leptobrachium (Vibrissaphora) echinatum* Dubois & Ohler, 1998 from northern Vietnam is described in detail with morphometric data. The internal oral features of this species are given. The comparison of this tadpole with three tadpoles of the closely related consubgeneric species, *Leptobrachium (Vibrissaphora) ailaonicum*, allowed to confirm the specific validity of *Leptobrachium (Vibrissaphora) echinatum*. A comparison with available bibliographic data for other tadpoles of the subgenus allowed us to place this species within the *Leptobrachium (Vibrissaphora) boringii* group together with *Leptobrachium (Vibrissaphora) ailaonicum*.

KEY WORDS

Amphibia,
Anura,
Megophryidae,
Leptobrachium (Vibrissaphora),
Vietnam,
tadpole,
description,
internal oral features.

RÉSUMÉ

Têtard de Leptobrachium (Vibrissaphora) echinatum (Amphibia, Anura, Megophryidae).

Le têtard de *Leptobrachium (Vibrissaphora) echinatum* Dubois & Ohler, 1998 du nord du Vietnam, est décrit en détail avec des données morphométriques. Les caractéristiques de la cavité bucco-pharyngée de cette espèce sont également données. La comparaison de ce têtard avec trois têtards de l'espèce la plus proche au sein de ce sous-genre, *Leptobrachium (Vibrissaphora) ailaonicum* a permis de lever l'ambiguïté quant à la validité de *Leptobrachium (Vibrissaphora) echinatum*. Sa comparaison avec les informations bibliographiques disponibles pour les autres têtards du sous-genre a permis de proposer de placer cette espèce dans le groupe de *Leptobrachium (Vibrissaphora) boringii* auprès de *Leptobrachium (Vibrissaphora) ailaonicum*.

MOTS CLÉS

Amphibia,
Anura,
Megophryidae,
Leptobrachium (Vibrissaphora),
Vietnam,
têtards,
description,
anatomie bucco-pharyngée.

INTRODUCTION

The genus *Leptobrachium* Tschudi, 1838 (*sensu lato*) includes 17 taxa distributed in two subgenera: *Leptobrachium* (*Leptobrachium*) and *Leptobrachium* (*Vibrissaphora*) Liu, 1945 with respectively 12 and five species (Dubois & Ohler 1998; Lathrop *et al.* 1998; Matsui *et al.* 1999). The most conspicuous character which differentiates the two subgenera is the presence of keratinized spines on the upper lip in the males of the latter subgenus. Except for this character and for different sexual size dimorphism, the adults of these two subgenera are quite similar. Likewise, it is generally admitted in literature that their tadpoles are distinguishable by a conspicuous character: the tadpoles of the subgenus *Leptobrachium* (*Vibrissaphora*) have a colored Y at the basis of the tail (Liu *et al.* 1980). However, this character can be found in some tadpoles of the subgenus *Leptobrachium* as discussed later.

Until now very little information has been published about the tadpoles of *Leptobrachium* (*Vibrissaphora*) (Pope 1947; Liu & Hu 1961; Yang *et al.* 1983; Chen *et al.* 1984). Several investigations were made by our team from November 1997 to August 1998 in Vietnam which allowed the discovery of a new species of *Vibrissaphora* (Dubois & Ohler 1998) and the collection of its tadpoles of various development stages. This paper is devoted to the description of rheophilous tadpoles, including their oral internal features. Morphological tadpoles characters and particularly internal oral features are useful in systematics of anuran amphibians (Wassersug 1980; Chou & Lin 1997). This description would be usable subsequently in resolving problems in systematic status of *Vibrissaphora* in relation to the genus *Leptobrachium* and its position among the Megophryidae.

ABBREVIATIONS

bh	maximum height of body;
bw	maximum width of body;
ed	maximum diameter of eye;
ht	maximum height of tail;
lf	maximum height of lower tail fin;
ltrf	labial tooth row formula;
MNHN	Muséum national d'Histoire naturelle, Paris;
NMNS	National Museum of Natural Sciences, Taiwan;

nn	internarial distance;
np	naro-pupilar distance;
odw	oral disk width;
pp	interpupilar distance;
rn	rostro-narial distance;
ss	distance from tip of snout to opening of spiracle;
su	distance from tip of snout to insertion of upper tail fin;
svl	snout-vent length;
tl	total length;
uf	maximum height of upper tail fin;
vt	distance from vent to tip of tail.

MATERIALS AND METHODS

Field work was conducted in July and August 1998 in the Hoang Lien Nature Reserve at Sa Pa, Lao Cai Province, Vietnam, in collaboration with the English NGO Frontier Vietnam Forest Research Project. The tadpoles were collected at the foot of the Mont Fan Si Pan (the highest point of the country at 3143 m), at 22°19'N, 103°47'E, between 1600 and 2090 m. They were found in pools of still water of little forest streams (Fig. 1). Data about climate and vegetation of the site are available elsewhere (Tordoff *et al.* 1999). A total of 117 tadpoles in developmental stages ranging from 25 to 44 (Gosner 1960) were preserved in a mixture of equal parts of 4% formaldehyde and 70% ethanol. All the specimens are deposited in the collections of the Muséum national d'Histoire naturelle of Paris (collection numbers MNHN 1998.8585-8701). Terminology of external parameters follows Gril-litsch *et al.* (1993), labial tooth row formula for individual tadpole and for series of tadpoles follows Dubois (1995), terminology of internal oral features follows Wassersug (1976) and developmental stages were determined according to Gosner (1960). Most measurements (Fig. 2) were taken with a digital hand caliper except ed, lf, nn, np, odw, pp, rn and uf which were taken with a graduated ocular attached to a stereomicroscope. A few measurements (bh, ht) were taken with both methods depending on the size of the tadpole. Drawings were made with the help of a camera lucida.



FIG. 1. — Natural habitat of the tadpoles of *Leptobrachium (Vibrissaphora) echinatum*.

ECOLOGICAL CONSIDERATIONS

The adults were discovered thanks to their call, a long note with a low-pitched frequency, emitted from beneath the stream stones. The male attracts the female which lays a mass of whitish eggs under a stone. Tadpoles at all stages were collected at the same place at the same time (from stage 25 to metamorphosis), which seems to indicate that tadpoles have a slow development and spend several years in the water. This phenomenon has also been noticed in other pelobatid species such as *Ophryophryne microstoma* Boulenger, 1903 and *Leptolalax bourreti* Dubois, 1983 (pers. obs.) or in the genera *Scutigera* Theobald, 1868 and *Oreolalax* Myers & Leviton, 1962 (Liu & Hu 1960). Chen *et al.* (1984) noticed the same fact and thought that the tadpoles spend two winters in the water. In the strict syntopy of these tadpoles I collected tadpoles of *Amolops* sp., *Leptolalax bourreti*, *Megophrys* sp. and *Paa bourreti* (Dubois, 1987).

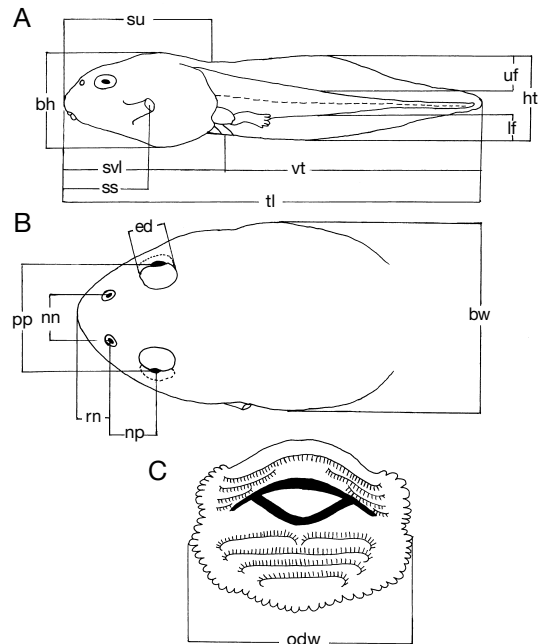


FIG. 2. — Definition of measurements on a tadpole; **A**, in lateral view; **B**, in dorsal view; **C**, in ventral view.

TABLE 1. — Variation of labial tooth row formula (**ltrf**), snout-vent length (**svl**), total length (**tl**) and maximum of height of tail (**ht**) with stage. For svl, tl and ht the mean values \pm standard deviation in mm, the range in parentheses in mm and last the number of tadpoles examined are given.

Stage	ltrf	svl	tl	ht
25	1:(5+5)-(6+6)/(4+4)-(5+5):1 17	20.3 \pm 1.74 (16.4-23.9) 17	52.3 \pm 4.84 (43.2-62.8) 17	10.3 \pm 0.99 (8.21-12.2) 17
26	1:(5+5)-(6+6)/(4+4)-(5+5):1 14	22.1 \pm 1.94 (17-25.1) 14	58.5 \pm 5.50 (45.4-67.5) 13	11.6 \pm 1.34 (9.58-14.4) 14
27	1:(5+5)-(6+6)/(4+4)-(5+5):1 20	24.9 \pm 1.87 (21.1-28.2) 20	65.2 \pm 5.21 (55.2-71.9) 20	12.6 \pm 0.94 (10.5-14.1) 20
28	1:(5+5)-(6+6)/(4+4)-(6+6):1 13	26.6 \pm 1.51 (24.1-29.4) 13	70.0 \pm 5.22 (62.6-79.8) 13	12.5 \pm 3.46 (11.7-14.4) 13
29	1:(5+5)/(4+4)-(5+5):1 6	28.1 \pm 3.21 (23.6-31.5) 6	74.8 \pm 6.58 (65.3-81.7) 6	14.3 \pm 1.47 (12.2-15.5) 6
30	1:(5+5)-(6+6)/(5+4)-(5+5):1 8	28.2 \pm 1.77 (24.6-30.1) 8	75.6 \pm 2.3 (72.5-78.8) 6	14.6 \pm 0.89 (13.1-16.0) 8
31	1:(5+5)-(6+6)/(4+4)-(5+5):1 9	29.4 \pm 3.14 (25.0-34.9) 9	77.6 \pm 7.06 (69.1-88.6) 6	14.8 \pm 1.49 (13.1-16.7) 8
33	1:6+6/5+5:1 1	33.0 1	88.2 1	17.0 1
34	1:(5+5)-(6+6)/(4+5)-(5+5):1 6	31.8 \pm 2.18 (29.7-35.9) 6	85.7 \pm 6.73 (79.7-97.6) 6	16.6 \pm 1.15 (15.4-18.5) 6
35	1:6+6/5+5:1 2	34.2 \pm 0.62 (33.7-34.6) 2	94.2 \pm 0.09 (94.1-94.3) 2	17.8 \pm 0.36 (17.6-18.1) 2
36	1:6+6/5+5:1 7	35.7 \pm 2.28 (33.2-39.2) 7	96.7 \pm 6.49 (88.8-106.9) 7	18.5 \pm 1.33 (16.9-20.6) 7
37	1:6+6/5+5:1 5	37.3 \pm 1.95 (33.9-38.9) 5	104.1 \pm 6.00 (95.4-111.8) 5	20.1 \pm 0.57 (19.6-21.1) 5
38	1:(5+5)-(6+6)/5+5:1 4	39.9 \pm 1.31 (38.0-40.8) 4	117.0 \pm 2.44 (114.1-118.5) 3	21.9 \pm 1.51 (20.6-23.8) 4
43	/	39.9 \pm 1.58 (37.7-41.2) 4	91.8 \pm 15.19 (71.0-104.7) 4	16.4 \pm 0.60 (15.9-17.1) 3
44	/	40.6 1	62.4 1	/

DESCRIPTION OF TADPOLE

The labial tooth row formula (ltrf) and gross morphometric parameters (svl, tl and ht) for larvae in all developmental stages are presented in Table 1. Detailed morphometric data for tadpoles in developmental stages 35-38 are presented in Table 2.

The following description is based on tadpoles in stages 35 (MNHN 1998.8666), 37 (MNHN 1998.8658), 38 (MNHN 1998.8657), and 43 (MNHN 1998.8663 and 8664).

In dorsal view, body elliptical, snout nearly rounded (Fig. 3). Eyes moderate (diameter about 0.08 time body length), bulging, separated by

TABLE 2. — Morphometric data in mm for tadpoles in advanced developmental stages (35-38); measurements of tadpoles of *L. (V.) allaonica*. Abbreviations: **bh**, maximum height of body; **bw**, maximum width of body; **ed**, maximum diameter of eyes; **ht**, maximum height of tail; **lf**, maximum height of lower tail fin; **MNHN**, collection number of the tadpole; **nn**, intermarial distance; **np**, narro-pupillar distance; **odw**, oral disk width; **pp**, interpupillar distance; **m**, rostro-narial distance; **ss**, distance tip of snout-opening of spiracle; **su**, distance tip of snout-insertion of upper tail fin; **svl**, snout-vent length; **tl**, total length; **uf**, maximum height of upper tail fin; **vt**, distance vent-tip of tail.

MNHN	stage	ss	su	svl	vt	tl	uf	lf	ht	bh	ed	bw	pp	nn	rn	np	odw
<i>allaonica</i>	35	15.8	31.6	32.8	51.4	83.2	4.56	3.80	15.8	17.9	2.81	19.4	10.5	6.84	3.19	5.78	8.40
1998.8666	35	17.8	27.6	34.6	58.3	94.3	6.38	5.17	18.1	16.6	2.63	17.1	10.5	6.84	3.34	5.47	9.00
1998.8698	35	18.5	28.8	33.7	59.7	94.1	6.38	5.17	17.6	15.5	2.92	17.6	10.8	6.99	4.10	5.62	9.10
1998.8628	36	17.5	27.6	35.1	59.8	94.2	6.84	5.32	17.8	17.3	2.92	17.9	11.3	7.45	2.89	5.93	9.10
1998.8622	36	18.1	27.6	34.6	57.8	91.2	6.23	5.17	18.3	15.4	2.63	17.3	10.4	6.99	3.65	5.32	8.90
1998.8667	36	18.1	26.8	33.2	54.6	88.8	5.62	5.32	16.9	15.5	2.89	16.8	10.4	6.84	3.04	5.02	8.90
1998.8668	36	17.9	29.0	34.8	62.8	97.4	6.69	4.71	17.6	16.0	2.74	16.7	10.9	6.69	3.19	5.32	9.10
1998.8669	36	18.6	27.3	34.7	60.5	94.9	6.54	4.71	18.5	15.8	2.66	16.7	10.6	7.14	3.19	5.47	9.10
1998.8699	36	21.2	32.1	38.7	64.5	103.5	7.30	5.93	20.1	16.3	3.11	19.1	11.9	7.60	4.10	5.62	9.20
1998.8700	36	20.8	32.3	39.2	67.0	106.9	6.99	5.93	20.6	18.2	3.33	19.8	11.8	7.90	3.50	6.23	9.70
1998.8629	37	20.3	33.1	38.9	65.3	104.3	6.99	5.32	19.8	17.7	3.29	19.0	12.3	7.60	3.34	6.08	10.4
1998.8654	37	19.8	31.1	37.6	69.1	106.8	7.45	5.32	20.0	17.5	2.59	19.0	11.4	7.14	3.19	6.38	9.80
1998.8655	37	20.2	32.0	37.8	72.9	111.8	7.60	6.08	21.1	18.2	3.00	19.3	12.0	8.06	2.89	6.08	9.40
1998.8658	37	18.6	28.1	33.9	60.7	95.4	6.69	5.32	19.9	16.7	2.96	17.8	10.6	6.84	3.19	5.62	8.70
1998.8697	37	20.4	29.7	38.2	64.5	102.5	6.99	6.08	19.6	17.3	3.03	19.3	12.2	7.90	3.50	6.23	9.90
1998.8670	38	21.5	32.8	40.6	74.6	114.1	6.99	5.93	20.6	18.0	2.89	21.0	12.3	7.90	3.65	6.69	9.90
1998.8656	38	20.1	31.8	38.0	/	/	7.30	5.93	20.8	17.8	3.29	17.9	11.8	7.90	3.19	6.23	9.50
1998.8657	38	22.9	33.0	40.8	76.8	118.5	7.60	6.54	22.3	19.2	3.37	21.0	12.6	7.90	3.65	6.99	10.10
1998.8701	38	22.1	34.1	40.4	78.5	118.2	8.06	7.30	23.8	18.1	3.33	21.4	13.1	8.21	3.80	6.46	10.80
<i>allaonica</i>	38	21.2	34.4	38.9	73.4	110.2	8.06	4.56	21.6	20.93	3.40	22.0	12.6	7.90	3.34	7.14	9.90



FIG. 3. — Dorsal view of the tadpole of *Leptobrachium (Vibrissaphora) echinatum* (MNHN 1998.8669, stage 36, svl 34.7 mm and tl 94.9 mm).

distance of about 1.5 time internarial distance, directed laterally and positioned dorsolaterally, not visible in ventral view. Nares oval, moderate, rimmed with about 10 little projections, directed more laterally than anterolaterally and positioned more dorsally than laterodorsally, slightly closer to snout than to pupils. In profile, body slightly depressed, snout rounded (Fig. 4). Spiracle sinistral, slightly conical, short, attached to body wall except the tip free, positioned laterally to weakly dorsolaterally, oriented posterodorsally. Spiracular opening oval, just below level of the apex of myotomes of caudal muscle. Tail musculature strong, straight in the proximal half and gradually tapering in its distal half, almost reaching tail tip. Tail fins shallow in its proximal half then moderate in its distal half, not extending onto body; dorsal fin parallel to caudal muscle in its first half, then convex, higher than ventral fin which follows tail musculature in its first half and which is more or less convex in its distal half. Point of maximum height of tail located just before halfway of tail length, tail tip obtuse but with its end rounded (bluntly pointed). Anal tube large, medial, slightly curved towards the right, conical, directed posteriorly; opening very close to body; covered by a large flap of skin which is linked to ventral tail fin by its left side and free by its right side (opening dextral).

Oral disk ventral, rather large (about 0.5 time maximum width of body), non-emarginated, directed more ventrally than anteroventrally,



FIG. 4. — Profile view of the tadpole of *Leptobrachium (Vibrissaphora) echinatum* (MNHN 1998.8669, stage 36, svl 34.7 mm and tl 94.9 mm).

bordered by a row of moderately large, conical papillae (Fig. 5). Upper labium with a short medial gap of about two papillae width, lower labium with a medial extension. Few submarginal papillae occur inside the mouth, at corner of the mouth and near external end of the tooth rows. Their number variable, from one to eight on each side of the upper part (with a majority of cases with one or two) at level of rows A4 or A5 and from five to 12 on each side of lower part (with an average from six to eight) clustered in front of the more external rows (except the most external) when some papillae and in front of each labial teeth rows when numerous papillae. Itrf 1:5+5/4+4:1 in the early stages (25, 26 and few individuals in stage 27) and 1:6+6/5+5:1 in the late stages (28 and following stages). Denticulate papillae often present. The external rows are restricted to the central portion of labium and are the only rows without gap. Relative lengths of tooth rows: $A_2 > A_3 > A_4 > A_5 > A_6 = A_1$ and $P_4 > P_3 > P_2 > P_1 = P_5 > P_6$ for the advanced stages (stages 35 and more) with well-developed labial tooth rows. Labial teeth raised on a conspicuous fleshy base. Labial tooth rows frequently composed of two or several rows juxtaposed. Jaw sheaths strong, coarsely serrated, the upper with a larger serration at the center, entirely black, upper beak arch-shaped, lower beak V-shaped.

Lateral line system conspicuous and well-developed in all individuals, visible even without magnification, present on sides of body and head, on snout, around eyes, on belly, along apex of myotomes of caudal muscle and along basis of upper fin.

The body wears several pairs of glands: two pairs set transversally to body axis at the level of gills; two pairs set transversely to body axis at the posterior end of body (one on the middle of flanks, the other in front on the insertion of hindlimbs); one or two smaller pairs, very close to insertion of caudal muscle. Several glands irregularly scattered on the lower flanks and on the proximal part of the junction of the two fins with caudal muscle. It is important to remark that the number of pairs of these glands increases during develop-

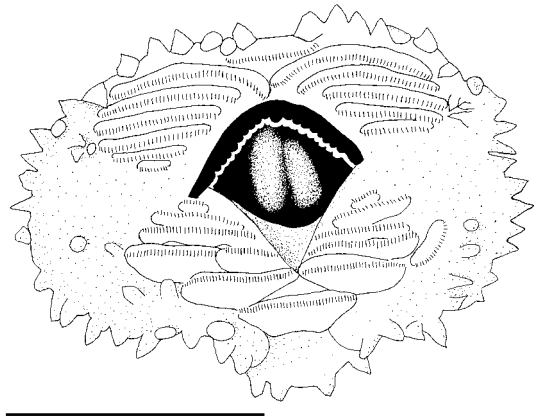


FIG. 5. — Oral disk of the tadpole of *Leptobrachium (Vibrissaphora) echinatum* (MNHN 1998.8654, stage 37). Scale: 5 mm.

ment, but even in the early stages (stages 25 and 26) one or two pairs at the level of gills and one or two pairs in front of hindlimbs are present (Fig. 6).

Coloration

Color and pattern in life: top and flanks of body light brown-grey forward to dark grey with greenish spots backward in gradation. Belly color identical with iridiophores. A beige-orange Y-shaped marking at the base of tail (the base of the Y extending only on the upper fin). Tail musculature and fins brown-grey at the base to orange at the tip in gradation with few rare scattered black spots. Most tadpoles with numerous iridiophores forming spots on the snout and flanks.

In preservative, back of body and head, and flanks, uniformly brown, snout and belly brown-grey to utterly grey. The Y-shaped marking at the base of the tail very faded and ochre-brown colored. Tail musculature ochre to light brown with light greenish spots. Fins opaque light grey with the same spots which are more densely distributed on the distal half of the tail. Spiraculum, oral disk and little developed hindlimb (until stage 38) whitish.

Coloration in preservative of tadpoles near metamorphosis (stages 43 and 44) (Fig. 7): the white points at the place of future keratinized



FIG. 6. — Ventral view of the tadpole of *Leptobrachium* (*Vibrissaphora*) *echinatum* (MNHN 1998.8669, stage 36, svl 34.7 mm and tl 94.9 mm).

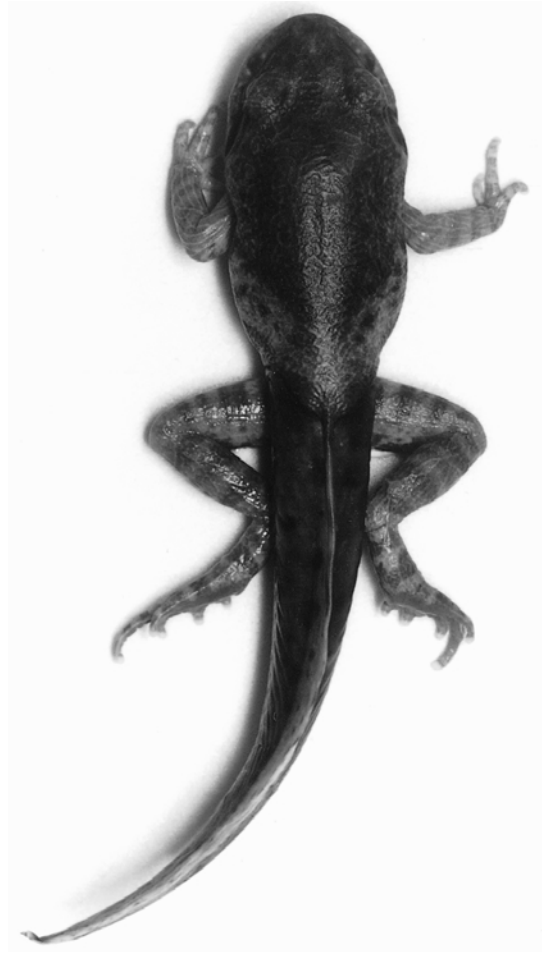


FIG. 7. — Dorsal view of tadpole of *Leptobrachium* (*Vibrissaphora*) *echinatum* (MNHN 1998.8664, stage 43, svl 39.8 mm and tl 101.3 mm).

spines on upper lip visible and the network of low ridges present on the skin of back, head and limbs (as well as on hands and on feet). The Y-shaped marking at the base of tail developed, grown and the extremities reached the base of forelimb. The limbs are strongly developed whereas the tail is not yet resorbed. The bands are present on limbs. The glands all disappeared except in ventral side at the level of forelimb. Otherwise axillary and femoral glands present. Lateral line disappeared except on the non-reticulated places (tail, and sides and front of head).

INTERNAL ORAL FEATURES

FLOOR (FIG. 8)

Prelingual arena sandglass-shaped; two pairs of multifurcated palps, the first pair (the most anterior or one) with five digitations on each present in front of the arena, the second one with height digitations on each; between them three pairs of fine and small papillae transversely directed. Behind these structures a third pair of single finger-like prelingual papillae pustulose on their internal side. Tongue anlage bifurcated at the front, becoming wider in its posterior part, rear concave, without

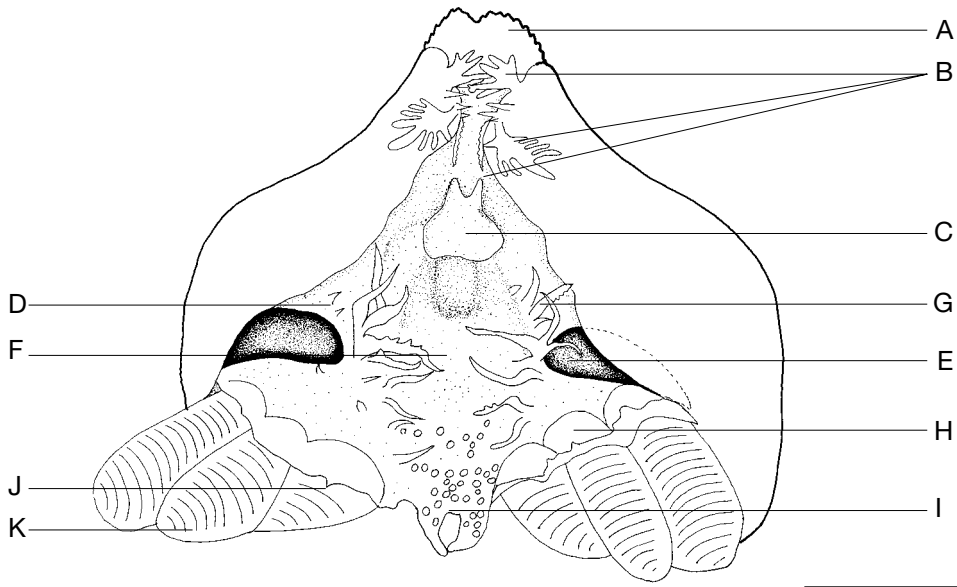


FIG. 8. — Floor of the buccal cavity of the tadpole of *Leptobrachium (Vibrissaphora) echinatum* (MNHN 1998.8654, stage 37); **A**, lower beak; **B**, prelingual papillae; **C**, tongue anlage; **D**, pre-pocket papilla; **E**, buccal pocket; **F**, buccal floor arena (bfa); **G**, bfa papilla; **H**, ventral velum; **I**, median notch; **J**, marginal projection; **K**, branchial basket. Scale bar: 5 mm.

papillae. A depression behind tongue anlage. Buccal floor arena defined by about seven big pustulose papillae in each lateral border, those in front of the buccal pockets trifurcate, most curved transversely; interior of arena smooth, posterior end with few pustules. Buccal pockets elongate oval, transverse, at mid-distance between tongue anlage and medial end of ventral velum; about two pre-pocket papillae. Ventral velum with spicular support; its medial portion set off by notch with a pair of large papillae covered with about 40 pustules encroaching on the posterior end of the buccal floor arena; margin with three projections. Branchial baskets largely exposed, longer than wide; three gill chambers oblique on each side; filter ruffles with tertiary folds.

ROOF (FIG. 9)

Prenarial arena smooth, with few pustules and a pair of prenarial papillae anteriorly directed in the posterior end of the arena in front of the anterior narial wall. Choanae small, almost square, transverse; one curved prenarial papillae on each side, anterior narial wall high and folded in Ω -shape;

posterior narial wall very low with two little papillae. Postnarial arena with three papillae, the bigger one in central position, the two other on each side. Two long postnarial papillae, the internal one bifurcate (from the base or only at the end), pustulose, with their tip also bifurcated, the second one simple and pustulose as well, all anteriorly directed. Medial ridge triangular with 10 digitations on its edge and two little papillae on its posterior side, slightly higher than wide. Lateral ridge papillae large and bifurcate, antero-medially directed. Buccal roof U-shaped, defined by about 15 slender, pustulose papillae transversely directed; interior of arena with less than 10 shorter, pustulose or smooth, papillae. In the most posterior part of the arena presence of about 10 pustules. Posterolateral ridge long, beginning more or less far on the side of the buccal roof, U-shaped, continuous with dense pustules, in the medial part the layer of pustules grows reaching the posterior end of the dorsal velum on a short distance. Glandular zone limited to the lateral side of the dorsal velum, widest zone about six pits. Dorsal velum continuous.

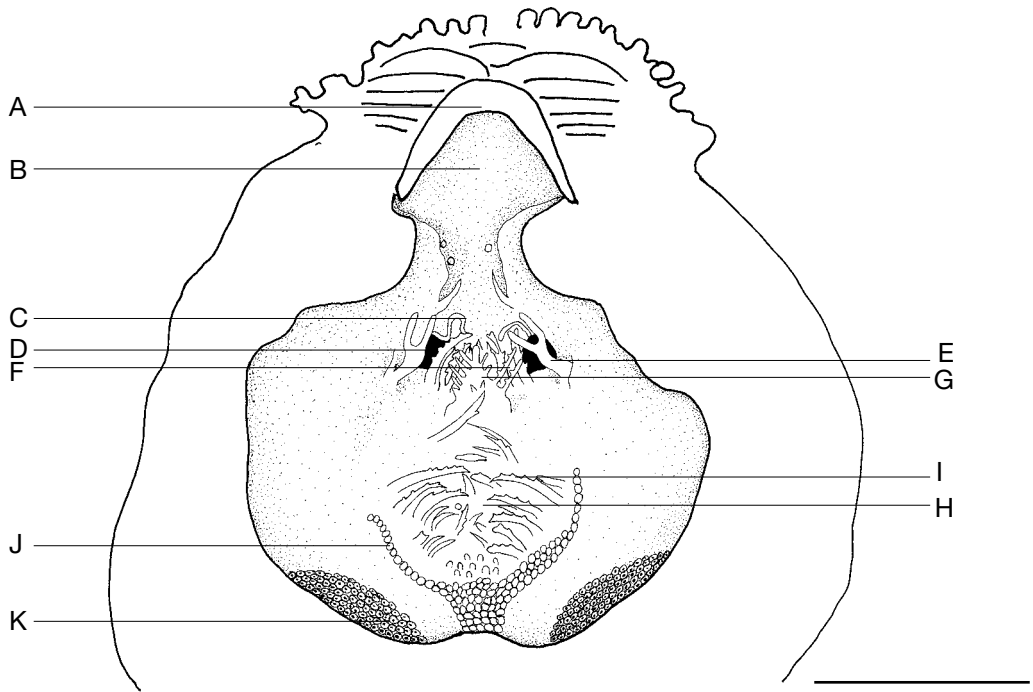


FIG. 9. — Roof of the buccal cavity of the tadpole of *Leptobrachium (Vibrissaphora) echinatum* (MNHN 1998.8654, stage 37); **A**, upper beak; **B**, prenarial arena; **C**, prenarial papilla; **D**, choana; **E**, laterial ridge papilla; **F**, postnarial arena; **G**, median ridge; **H**, buccal roof arena (bra); **I**, bra papilla; **J**, posterolateral ridge; **K**, glandular zone. Scale bar: 5 mm.

DISCUSSION

Very little information is available for comparison between the different species of *Leptobrachium (Vibrissaphora)*. The tadpoles of different species of this subgenus share characters that are also valid for the tadpole of *Leptobrachium (Vibrissaphora) echinatum*: “Tadpole large and robust, the large ones measuring about 120 mm in total length; a conspicuous light color “Y”-shaped marking on the border-line between the back and the base of tail; labial teeth formula I:5-5/I:4-4 or I:6-6/I:5-5; horny jaws very strong” (Liu *et al.* 1980).

Yang *et al.* (1983), in their description of *Leptobrachium (Vibrissaphora) ailaonicum* (Yang, Chen & Ma, 1983), gave only the labial tooth row formula which is 1:5+5/4+4:1 (with variations for the lower labium including 4+3 or 3+3). Chen *et al.* (1984) gave some measurements for the three size classes found together in the same place: total length, body length, tail length, forelimbs length

and hindlimbs length. Unfortunately the size classes include several stages and do not allow accurate comparisons. All the information given in the paper of Ho *et al.* (1999) was taken from the literature previously cited (except for the ltrf which is spread to 1:5+5/5+5:1). These authors assumed that *Leptobrachium (Vibrissaphora) echinatum* is a synonym of *Leptobrachium (Vibrissaphora) ailaonicum*. Fortunately I had the opportunity to examine three tadpoles in stages 29, 35 and 38 (NMNS 3247) collected by Prof. W.-H. Chou on Dawei Mountain (2000 m), Yunnan, China and identified by Prof. D.-Q. Rao as *Leptobrachium (Vibrissaphora) ailaonicum*. The comparison of stages 35 of the two species (Table 2) indicates that the tadpole of *Leptobrachium (Vibrissaphora) ailaonicum* has the same body proportion as that of *Leptobrachium (Vibrissaphora) echinatum* but all the characters of the tail (uf, lf, ht and vt) are smaller in the former species (which has a ltrf 1:5+5/4+4:1). The same general remark can be done for the tadpole in stage

TABLE 3. — Range of the variation of ltrf for each *Leptobrachium (Vibrissaphora)* species.

Species	ltrf	Bibliographic references
<i>L. (V.) ailaonicum</i>	1:5+5/(3+3)-(5+5):1	Yang <i>et al.</i> 1983; Ho <i>et al.</i> 1999; this paper
<i>L. (V.) boringii</i>	1:6+6/5+5:1	Liu & Hu 1961
<i>L. (V.) echinatum</i>	1:(5+5)-(6+6)/(4+4)-(6+6):1	this paper
<i>L. (V.) leishanense</i>	1:5+5/4+4:1	Hu <i>et al.</i> 1973
<i>L. (V.) liui liui</i>	1:(5+5)-(4+4)/4+4:1	Liu & Hu 1962
<i>L. (V.) liui yaoshanense</i>	1:(5+5)-(4+4)/4+4:1	Hu <i>et al.</i> 1981

38 (ltrf 1:5+5/5+5:1) although the most striking differences are in lf, bh and bw whereas in stage 29 (ltrf 1:5+5/5+5:1) the gross morphometric proportions are quite similar between the two species (svl = 28.7 and tl = 76.7). The oral disk of both species is similar. So the tadpoles of the two taxa are very similar but show differences in ltrf, vt (tail length) and fins proportions, and bh and bw. These differences in addition to those brought to the fore in the adult (Dubois & Ohler 1998) are sufficient to assert that *Leptobrachium (Vibrissaphora) echinatum* is a good species. *Leptobrachium (Vibrissaphora) boringii* was described by Liu (1945) but without a description of the tadpole. Later the author described the tadpole of this species under the name *Scutigera* sp. (Liu 1950) and Liu & Hu (1961) copied the description of adult with addition of tadpole. The drawing of the mouth allows to notice that the number of submarginal papillae is higher than in *Leptobrachium (Vibrissaphora) echinatum*, that the papillae gap of upper lip is larger, that there is no free space below the lower beak and that the extension at the center of the lower labium is lacking. Likewise coloration is different as well as proportions (bh, bw, ss, ht and vt) which are larger in *Leptobrachium (Vibrissaphora) boringii* for an equivalent size. The tadpole of *Leptobrachium (Vibrissaphora) liui liui* (Pope, 1947) was initially described by Pope in 1931 under the name *Megophrys hasseltii*, then redescribed later (Pope 1947) by the same author under its current specific name. Some proportions such as the body width and the tail length are smaller in *Leptobrachium (Vibrissaphora) echinatum* than in *Leptobrachium (Vibrissaphora) liui liui*. Oral disks of both species show great similarities. The tadpole of

Leptobrachium (Vibrissaphora) sp. described by Liu & Hu (1959) was determined by Fei *et al.* (1990) as *Leptobrachium (Leptobrachium) chapense*.

All the ltrf (Table 3) given for the tadpoles of *Leptobrachium (Vibrissaphora)* (except for the tadpole of *Leptobrachium (Vibrissaphora) boringii*) are included between five and seven rows for the upper labium and four and seven for the lower labium. The key to Chinese Amphibia (Fei *et al.* 1990) corroborates this remark and separates *Leptobrachium (Vibrissaphora) boringii* from the other species on the base of ltrf and the size of the tadpole. The sample of tadpoles of *Leptobrachium (Vibrissaphora) echinatum* described here must be placed with *Leptobrachium (Vibrissaphora) boringii* as regards those two parameters. Although the key must be corrected since the tadpole in stage 38 of *Leptobrachium (Vibrissaphora) ailaonicum* examined here has a size larger (110.2 mm) than the maximum size (90 mm) based on which the division of the two groups is made.

In the tadpole of *Leptobrachium (Vibrissaphora) echinatum*, the ltrf varies greatly from one individual to the other (e. i. for a stage 28 ltrf could vary from 1:5+5/5+5:1 to 1:6+6/6+6:1). Generally the ltrf is 1:5+5/4+4:1 from stages 25 to 28, 1:5+5/5+5:1 from stages 28 to 33 and 1:6+6/5+5:1 from stages 33 to 38. Furthermore frequent malformations in the tooth rows such as supernumerary rows, cut rows, a succession of several little portions of rows instead of an entire row were observed in the tadpoles of this sample. The internal oral features of a second species of *Vibrissaphora*, *Leptobrachium (Vibrissaphora)*

boringii has been described (Huang *et al.* 1991). A great similarity is observed between the two species. The major differences turn on the following points: in the floor, the third pair of prelingual papillae bifurcate in *L. (V.) boringii*, single in *L. (V.) echinatum*, many fewer pre- and post-pocket papillae in the latter species; in the roof, presence of numerous pustules inside and outside the buccal roof arena in *L. (V.) boringii* whereas they are almost non-existent outside the arena and fewer inside in *L. (V.) echinatum*.

The tadpoles of *Leptobrachium (Vibrissaphora)* are similar to those of the genus *Oreolalax* with which they share a general external morphology and the same oral disc morphology (including remarkably developed mandibles, little number of submarginal papillae, little middle gap in papillae row on upper labium and extension in the middle part of the lower labium) although their number of rows of keratodonts is smaller. This observation corroborates the remark of Liu (1945) on the similarity in adult morphology.

The tadpoles of the subgenus *Leptobrachium* have been little described but the available information (Pope 1931; Inger 1966, 1983, 1985) showed that the oral disk morphology is quite similar in general aspect to that of the tadpoles of *Leptobrachium (Vibrissaphora)* (ltrf, denticulate papillae, marginal papillae) except for the tadpole of *Leptobrachium (Leptobrachium) nigrops* (Berry & Hendrickson 1963) which differs greatly (submarginal papillae and denticulate papillae lacking, ltrf 3+3/3+2:1). Fei *et al.* (1990) noticed that the tadpoles of the Chinese population of *Leptobrachium (Leptobrachium) chapaensis* bears a dark "Y" marking at the base of the tail like in *Leptobrachium (Vibrissaphora)* tadpoles likewise tadpoles collected in Annam (Vietnam) in 1927 by M. Delacour and identified as *Leptobrachium cf. hasseltii* MNHN 1927.0084-0085 and MNHN 1989.3500-3512 (pers. obs.). So this character is not proper to delimit the subgenus *Vibrissaphora*. The most striking difference I found between the tadpoles of these two subgenera I could studied is the difference in size: *Leptobrachium (Vibrissaphora)* tadpoles are much bigger than *Leptobrachium (Leptobrachium)* tadpoles, although it seems that

tadpoles of other species that those I had in hand (*L. (V.) leishanense*, *L. (V.) liui liui* and *L. (V.) liui yaoshanense*) are smaller (Fei *et al.* 1990). The internal oral features of the tadpoles of the two subgenera display a great similarity in number, structure and arrangement (Huang *et al.* 1991; pers. obs.). So the similarities of morphology and buccopharyngeal anatomy noticed in the tadpoles of the two subgenera support their congeneric status.

Fei *et al.* (1995) proposed to recognize two groups within the subgenus *Vibrissaphora* according to the presence or absence of vocal sac, number of keratinized spines on the upper lip and especially the difference in the property of the crystalline lens protein. Their division sorts *L. (V.) ailaonicum* and *L. (V.) boringii* in the *V. boringii* species-group and *L. (V.) leishanense*, *L. (V.) liui liui* and *L. (V.) liui yaoshanense* in the *V. liui* species-group. *Leptobrachium (V.) echinatum* should be placed in the *V. boringii* species-group with regard to the secondary sex characters and of its tadpole (similar ltrf and size). However, the oral disk morphology of *L. (V.) echinatum* is closer to *L. (V.) liui liui* than to *L. (V.) boringii*. We, therefore, need more accurate descriptions of the tadpole of each species to search for characters that would be more reliable to define species groups and to differentiate each species from the others.

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