

## Description of tadpole *Rana temporalis* from South India

N. C. Hiragond and S. K. Saidapur\*

Department of Zoology, Karnatak University, Dharwad 580 003, India

The paper describes morphology and morphometry (total length, snout-vent length, internarial, interorbital, snout-narial distances etc.) of *Rana temporalis* tadpoles found in gently-flowing and still water bodies along the streams in the south-western ghats. The mouth is ventral, oral disc is large, teeth are blunt and devoid of cusps. The tadpoles are muddy green/yellowish. In these tadpoles, the spiracle is single, sinistral and adnate with the body. The tail musculature is moderately developed. The dental formula is 2(2)/3(1). There are 2–3 rows of labial papillae. The oral features are well suited for grazing at the substratum, and to adhere to rocks against gentle water currents.

AMPHIBIAN tadpoles exhibit structural diversities that are associated with their habitat, foraging behavior and predator avoidance<sup>1</sup>. The western ghats of southern India harbour over 100 species of anurans, and a dozen apodan species representing many genera<sup>2,3</sup>. However, little is known about the larval biology of these anurans. The present study describes the oral disc, tail musculature, and various morphological/morphometric features of the tadpoles of the bronze frog *Rana temporalis*, from south western ghats of India. The paper also provides identification keys.

The egg masses of *R. temporalis* were collected (1 January 1997) from a stream in Gobral, 60 km away from Dharwad (latitude 15°17'N, longitude 75°3'E), and reared in the laboratory. The hatchlings were maintained in cement cisterns until metamorphosis. The developmental stages were identified as described by Gosner<sup>4</sup>.

The developmental stages of tadpoles were clubbed into 3 groups to study their morphology, and morphometry. The first group included stages 25 to 30, the second 31 to 36, and the third 37 to 42, respectively. For each stage, two animals (12 per group) were used. The various morphometric features of the tadpoles are given in Table 1. Heights of tail, dorsal and ventral fins, the tail muscle, and thickness of tail muscle were recorded at the region where these were greatest.

The tadpoles ranged from 9.5 to 33 mm and muddy green/yellowish. The general morphology of the tadpole is depicted in Figure 1 a–c. Head is triangular in shape. Eyes are small and round. Nares are small, round and lie dorsally nearer to eyes than to the snout. Interorbital space is greater than the internarial space (Table 1). Spiracle is single, sinistral and is adnate with the body.

It lies laterally with an aperture oriented posterodorsally (Figure 1 a). Spiracle is not seen after stage 41. Total length, SVL, the distances between snout–nares, snout–spiracle, and snout–eye increase until the stage 36 (Table 1) and thereafter remain unchanged. In early stages the tail fin is transparent and unpigmented. After stage 26 it becomes slightly pigmented. The tail is pointed at the posterior end. The tadpoles attain their maximum size while in stages 37–42.

The tail musculature is moderately developed. The heights of dorsal and ventral fins, and tail are highest at the center of the tail. The dorsal fin height is greater than the ventral fin (Table 2). The height and thickness of the tail musculature are maximum near the vent.

The oral disc is oriented ventrally prior to stage 42. It turns towards anterior side by stage 42 to occupy an anteroventral position. As given in Table 3 larval denticles appear by stage 25 with a dental formula of 1/2(1) and the latter changes to 2(2)/3(1) by stage 27 and remains unaltered upto stage 40. The dental formula shows the number and arrangement of teeth rows on

Table 1. Morphometric features of *Rana temporalis* tadpoles

| Feature                 | Tadpole stage              |                             |                             |
|-------------------------|----------------------------|-----------------------------|-----------------------------|
|                         | 25–30<br>n = 12            | 31–36<br>n = 12             | 37–42<br>n = 12             |
| Weight                  | 0.08 ± 0.02<br>(0.01–0.22) | 0.20 ± 0.02<br>(0.11–0.32)  | 0.28 ± 0.01<br>(0.22–0.39)  |
| Total length            | 20.42 ± 1.85<br>(9.5–31.0) | 29.21 ± 0.58<br>(26.0–33.0) | 30.63 ± 0.56<br>(25.0–32.0) |
| Snout–vent length       | 6.91 ± 0.7<br>(0.5–3.0)    | 10.41 ± 0.31<br>(9.0–12.5)  | 11.91 ± 0.3<br>(10.5–14.5)  |
| Body circumference      | 4.63 ± 0.40<br>(2.5–7.0)   | 6.25 ± 0.16<br>(5.0–7.0)    | 6.29 ± 0.12<br>(6.0–7.0)    |
| Body diameter           | 12.83 ± 1.35<br>(6.0–23.0) | 15.79 ± 0.42<br>(14.0–18.0) | 16.54 ± 0.50<br>(15.0–21.0) |
| Interorbital space      | 1.67 ± 0.11<br>(1.0–2.0)   | 2.42 ± 0.14<br>(2.0–3.0)    | 3.17 ± 0.16<br>(2.5–4.0)    |
| Internarial space       | 0.98 ± 0.9<br>(0.5–1.5)    | 1.21 ± 0.7<br>(1.0–1.5)     | 1.54 ± 0.10<br>(1.0–2.0)    |
| Narial–eye distance     | 0.82 ± 0.9<br>(0.5–1.5)    | 1.0 ± 0.6<br>(0.5–1.5)      | 1.21 ± 0.7<br>(1.0–2.0)     |
| Snout–narial distance   | 1.13 ± 0.11<br>(0.5–1.5)   | 1.63 ± 0.09<br>(1.0–2.0)    | 1.79 ± 0.12<br>(1.0–2.0)    |
| Snout–eye distance      | 2.25 ± 0.21<br>(1.0–3.0)   | 3.04 ± 0.10<br>(2.5–3.5)    | 3.42 ± 0.10<br>(3.0–4.0)    |
| Snout–spiracle distance | 5.67 ± 0.49<br>(3.0–8.5)   | 7.54 ± 0.17<br>(7.0–8.5)    | 8.0 ± 0.13*<br>(7.5–8.5)    |

Measurements are in mm and weights in mg (mean ± SE).

Figures in parentheses indicate range.

\*Includes 8 readings for stage 37 to 40 (spiracle disappears by stage 41)

\*For correspondence. (e-mail: unikard@ren.nic.in)

the labium. Open figures indicate the total number of teeth rows and figures in parenthesis indicate the interrupted teeth rows. Figures on the left side of the slash (/) refers to anterior labium and that on right side of the slash refers to posterior labium. The second teeth row in upper labium is interrupted by a large medial gap. The first teeth row of lower labium has a small medial gap (Figure 1 d). Teeth rows consist of a series of blunt teeth, devoid of cusps and are arranged uniserially (Figure 1 d, e). The height of individual tooth varies in a row (Figure 1 e). Larval denticles begin disappearing from stage 41. The beak is keratinized with serrated edges. The lower beak is V shaped. The beak disappears by stage 42. Labial papillae are irregular in height. They are arranged in 2-3 rows around the oral disc and are more concentrated at the lateral regions (Figure 1 d). The marginal papillae are longer than those present in the inner rows. The labial papillae start disappearing by stage 42. The oral disc attains its

maximum size (41% of body width) in tadpoles of stage 37-42 (Table 3).

In the laboratory cisterns *R. temporalis* tadpoles completed metamorphosis between 3 and 4 months. The

Table 2. Features of tail musculature and fins in *Rana temporalis* tadpoles

| Feature    | Tadpole stage              |                             |                            |
|------------|----------------------------|-----------------------------|----------------------------|
|            | 25-30<br>n = 12            | 31-36<br>n = 12             | 37-42<br>n = 12            |
| Tail       |                            |                             |                            |
| Length     | 13.42 ± 1.22<br>(6.0-20.5) | 18.88 ± 0.56<br>(16.0-21.5) | 18.7 ± 0.71<br>(12.0-20.5) |
| Height     | 3.21 ± 0.29<br>(2.0-5.0)   | 4.33 ± 0.09<br>(4.0-5.0)    | 4.29 ± 0.13<br>(3.5-5.0)   |
| Fin height |                            |                             |                            |
| Dorsal     | 1.0 ± 0.53<br>(0.75-1.5)   | 1.46 ± 0.10<br>(1.0-2.0)    | 1.46 ± 0.16<br>(0.5-2.0)   |
| Ventral    | 0.58 ± 0.6<br>(0.5-1.0)    | 0.71 ± 0.07<br>(0.5-1.0)    | 0.75 ± 0.08<br>(0.5-1.0)   |
| Muscle     |                            |                             |                            |
| Height     | 1.67 ± 0.20<br>(1.0-3.0)   | 3.0 ± 0.16<br>(2.0-4.5)     | 2.96 ± 0.10<br>(2.5-3.5)   |
| Thickness  | 1.04 ± 0.16<br>(0.5-2.0)   | 1.88 ± 0.07<br>(1.5-2.0)    | 1.8 ± 0.7<br>(1.5-2.0)     |

Measurements are in mm (mean ± SE). Figures in parentheses indicate range.

Table 3. Features of oral disc in *Rana temporalis* tadpoles

| Feature                  | Tadpole stage                        |                                      |  |
|--------------------------|--------------------------------------|--------------------------------------|--|
|                          | 25-30<br>n = 12                      | 31-36<br>n = 12                      | 37-42<br>n = 12                          |
| Orientation of oral disc | Ventral                              | Ventral                              | Ventral*                                 |
| Labial papillae          | Present                              | Present                              | Present*                                 |
| Oral disc width          | 1.58 ± 0.23<br>(0.5-2.5)             | 2.33 ± 0.09<br>(2.0-3.0)             | 2.58 ± 0.15<br>(2.0-3.5)                 |
| Beak                     |                                      |                                      |  |
| Upper/Lower              | Serrated                             | Serrated                             | Serrated*                                |
| Tooth                    |                                      |                                      |  |
| Length                   | Blunt<br>46.7 ± 3.8 µm<br>(30-70 µm) | Blunt<br>52.5 ± 5.5 µm<br>(30-90 µm) | Blunt**<br>55.6 ± 4.4 µm**<br>(40-70 µm) |
| Width                    | 11.3 ± 0.7 µm<br>(10-15 µm)          | 12.1 ± 1.0 µm<br>(10-20 µm)          | 13.8 ± 1.3 µm**<br>(10-20 µm)            |
| Cusps                    | Absent                               | Absent                               | Absent                                   |
| Dental formula           | 2(2)/3(1)***                         | 2(2)/3(1)                            | 2(2)/3(1)**                              |
| Teeth arrangement        | Uniserial                            | Uniserial                            | Uniserial**                              |

\*Includes 10 readings for stage 37 to 41 (labial papillae and beaks disappear by stage 42).

\*\*Includes 8 readings for stage 37 to 40 (larval denticles disappear by stage 41).

\*\*\*Includes 8 readings for stage 27 to 30 (stage 25 and 26 consist dental formula 1/2(1)).

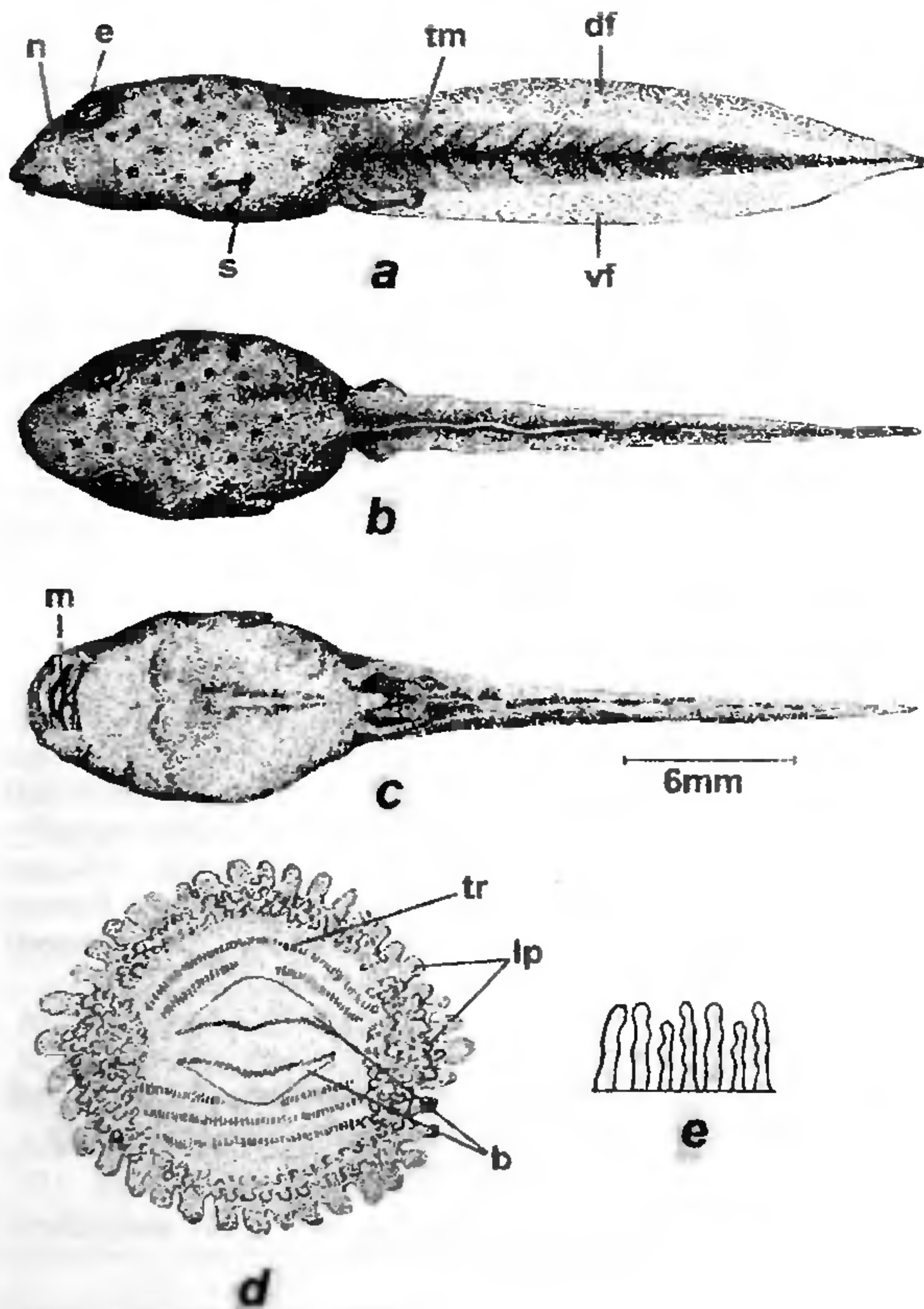


Figure 1. Stage 36 tadpole of *R. temporalis* showing the lateral (a) dorsal (b) and ventral (c) views, oral disc (d) and teeth row (e). Abbreviations: b, beak; df, dorsal fin; e, eye; lp, labial papillae; m, mouth; n, nare; s, spiracle; tm, tail muscle; tr, teeth row; vf, ventral fin.

SVL of newly-formed froglets was between 11 and 14 mm and their body mass ranged from 100 to 170 mg. A characteristic yellowish brown strip is formed on the dorsal side between the snout and the posterior tip. On the lateral sides, a black strip runs from the anterior to posterior end. Snout is pointed. Within a week after metamorphosis, small bronze colour strips appear on either sides of the lower jaw, between the snout and posterior point of the fore limbs, and hence the name, bronze frog. The bronze strips are interrupted below the fore limbs.

The bronze frog typically breeds along the edges of gently-flowing and/or in pockets of still water along the streams of south-western ghats of India. The muddy colour of *R. temporalis* tadpoles matches with the substratum of the stream. The oral armature is well suited for grazing at the bottom. In view of the near permanency of water, the tadpoles may have longer metamorphic duration (3–4 months) to enable body growth and emergence of larger and stronger froglets.

The following features of the tadpole provide the key to their identification. The tadpoles are small and muddy

green/yellowish; head is triangular in shape; spiracle is single, sinistral and lies laterally with an aperture oriented posterodorsally; it is adnate with the body wall; tail fin is transparent and pointed at the posterior end; height of the dorsal fin is greater than that of ventral fin; tail musculature is moderately developed; skin of the tail muscle and tail fins are slightly pigmented; labial papillae are present around the oral disc and are more concentrated at the lateral portions; dental formula is 2(2)/3(1); oral disc is oriented ventrally, it is 37% of body width.

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