

Riparian Tadpoles of Punjab, Pakistan: *Bufo stomaticus* Lütkin, 1862

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Abstract

The tadpole of common Pakistani toad *Bufo stomaticus* is described. The toad's breeding ecology and mortality are discussed.

Introduction

The Indus Valley is the westernmost part of the Indo-Gangetic plain; it stretches, parallel to the Himalayas, across the Indo-Pakistan subcontinent. It consists of the upper Punjab plain and the lower Indus Delta. Five rivers: the Indus, Jhelum, Chenab, Ravi and Beas, traverse Punjab to join the Indus River as it enters the Sindh Province. A short July–August monsoon spell causes floods, as heavily silted rivers cannot contain it and soon overflow, flooding the valley. Most of the irrigation canals are glutted and the valley looks like an extensive wetland, with scattered swamps, ponds, and puddles. It is the boom reproductive period for local amphibians. Soon the temperate conditions in the valley dry most of the water bodies, and there is general dearth of water. To cope with the drought period and irrigation problem an extensive canal system has been excavated, which ramifies throughout the valley. Apart from irrigation by canals, artificial means, powered wells etc., are employed during the rain deficient period.

Six species of amphibians are known to inhabit the Indus Valley: *Bufo stomaticus*, *Euphylyctis cyanophlyctis*, *Hoplobatrachus tigerinus*, *Limnonectes limnocharis*, *L. syhadrensis*, and *Tomopterna breviceps*. *Tomopterna breviceps* is a rare species in the plain, with spotty distribution. The rest have wide distribution throughout the valley, some invading deep into valleys of the northern and western highland (Khan, 1982a, 1985, 2000, 2002; Khan and Tasnim, 1987). During monsoons every temporary pond, puddle, etc., is utilized for breeding. Male aggregations of different species are frequent; the croaking is deafening as they share the temporary breeding sites (Khan and Malik, 1987). The tadpoles are entirely aquatic, feeding mostly on aquatic bloom. The larval stage is the most crucial period of a frog's life, and unfortunately the least understood, selection forces being strong and highly effective at this stage. The delicate, defenseless tadpole is at the mercy of its environment. However, despite their fragility, tadpoles manage to survive, and amphibians continue to thrive against high odds in the aggressive climate of the Indus Valley (Khan, 1991).

I studied Punjab tadpoles extensively (Khan, 1965; 1968, 1969, 1982a,b), extending my observations on their buccopharyngeal anatomy and feeding ecology for my Ph.D. dissertation (Khan, 1991). Detailed study of external morphology of Punjab tadpoles has never been attempted. The present paper, the first in a series reporting on Indus Valley tadpoles, deals with *Bufo stomaticus*.

Materials and methods

Bufo stomaticus tadpoles are best collected from shallow ponds and puddles. Tadpoles at Stage 35 (Khan, 1965) were selected for description of external morphology, since at this stage it has reached its specific configuration, after this stage metamorphic changes start taking place. Terminology used to describe the tadpole follows Altig et al. (1998).

The tadpoles are scooped from marginal water with a tea-pot strainer or are dredged from pond bottom by a hand-net. To separate tadpoles from mud, the hand-net is kept dipped in water; as the tadpoles swim above it they are scooped up. The tadpoles are kept in clear water for some time to wash debris adhering to body. Tadpoles were killed and fixed in Bouin's Fluid:

Picric acid (saturated aqueous)	75 ml
Formalin (40% aqueous formaldehyde)	25 ml
Glacial acetic acid	5 ml

The fixed tadpoles were stored in dilute Bouin's 1:1 water. The yellow color imparted by picric acid accentuates external morphological features of the tadpole (Khan, 1965, 1982a).

Tadpoles were identified using the following key from Khan (1982a):

1. Oral disc with dark brown keratinized parts-----2
No distinct oral disc with keratinized parts---
----- *Microhyla ornata*
2. Cloacal opening median----- *Bufo stomaticus*
Cloacal opening dextral----- 3
3. Five rows of teeth on anterior labium---
----- *Hoplobatrachus tigerinus*
One to three rows of teeth on anterior labium-----4
4. Three rows of teeth on posterior labium, third small---
----- *Limnonectes limnocharis* and *L. syhadrensis*
Two rows of teeth on posterior labium---
----- *Euphylyctis cyanophlyctis*

Data from at least 10 tadpoles were recorded; all measurements were taken with a vernier caliper; drawings were made using a camera lucida.

Description

The body is ovoid; the tail is rather weak, about twice the

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length of the body, gradually tapering to an obtuse end. The snout is semicircular in dorsal profile. Total length ranges from 17.4 to 17.9 mm. The dorsolateral eyes (vertical diameter 0.63–0.64 mm, horizontal 0.92 mm) are separated by a distance of 1.32 mm. The dorsolateral nostrils are closer to the eye than to the tip of the snout; internarial distance is 0.62–0.64 mm. The sinistral spiracle is closer to the posterior end of the body than to the tip of the snout; it is borne on a tubular spiracle-spout which protrudes from the mid-lateral line of the body. The anal tube is mesoid. The caudal muscle is widest at the base of the tail, gradually tapering toward the tip. Fine, oblique lateral lines indicate tail myotomes close to the base of the tail. The dorsal fin broadest at middle, and extends onto the body dorsum. The ventral fin is narrower and extends parallel below the tail. The fins meet around the tail tip (Figure 1). Tadpoles developing in shallow puddles have abnormally short tails, almost half the normal length, with shorter, broader, fins.

The tail-piece (part of ventral fin from body to cloacal tube) is well developed at Stage 35. The hind limb has a short broad thigh, tarso-metatarsus, and five toes, of which the fourth is typically the longest. There is no indication of webbing between the toes.

Color: Tadpoles are almost black when they emerge from the egg; they swarm in schools along the edges of ponds. At this stage the tadpole is distasteful; as it advances in age, its color changes to light gray and it becomes palatable, agile and secretive. The tadpole becomes aggressive, and distances itself from its siblings to avoid attacks. Formerly a total vegetarian, it becomes an opportune carnivore. At Stage 35 the tadpole is solitary; when disturbed it is quick to escape into deep water.

Tadpoles inhabiting ponds with little vegetation remain light brown in color; however, those developing in ponds with profuse vegetation are spotted with black, so are effectively camouflaged.

Oral disc: The well-developed oral disc (Figure 2) is a part of the ventral profile of the body, with narrower pre-oral and broader post-oral labia. The labia converge inward laterally where they are free to form labial palps; their margin is produced into delicate filiform papillae.

The pre-oral labium has two tooth rows: the outer extends from side to side, while the inner is widely interrupted mesially; three complete tooth rows are on the posterior labium. The dental formula of *Bufo stomaticus* is 2(2)/3.

The dark brown, tiny teeth are keratinized structures, arranged in transverse regular rows, ranging 0.04–0.06 mm in length. The tooth base is a thick cylinder, fixed in a pad of

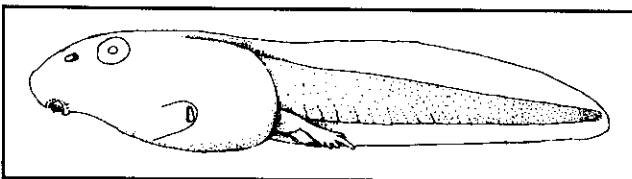


Figure 1. *Bufo stomaticus* tadpole, external morphology.

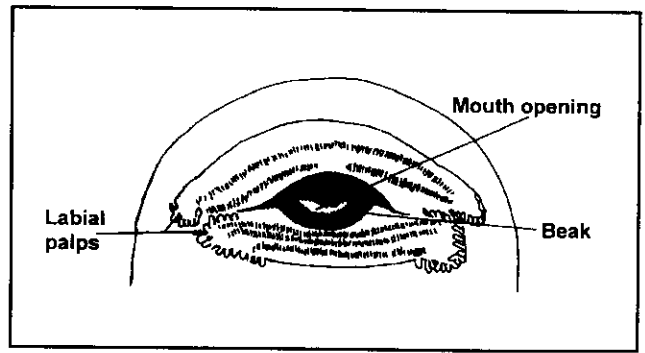


Figure 2. *Bufo stomaticus* oral disc.

tissue; distally the tooth is flattened, spatulate, orally concave. It is laterally cuspidate with 5–6 sharp cusps (Figure 3). Keratinized, dark brown, narrow jaw sheaths form the beak. The pre-oral or upper beak is long, narrow, bow-shaped and edged with sharp serrations. It is cuspidate, round in the middle, and bends out laterally. The posterior sheath is broader, and edged with sharp serrations overlapped by pre-oral sheath (Figure 2).

The labia move freely during feeding. The papillated part of the labial rim is firmly fixed at the surface on which the tadpole is feeding. Rows of teeth are brought into rasping action, by contracting–expanding labials muscles, play against vegetation surface, shearing and shredding, the sharp beak rendering large chunks into small pieces.

Primarily the tadpole is a voracious herbivore; however, it starts supplementing its diet with protein at Stage 35 by devouring its siblings and other tadpoles and bodies of drowned animals (Khan, 1991).

Natural history notes

Bufo stomaticus is the common toad of the Indus floodplain. It extends to about 2000 m in the northern and western mountain foothills (Khan, 1972). It tolerates varying climatic conditions and is especially common in dry semidesert areas (Auffenberg and Rehman, 1997). It is essentially nocturnal; however, during breeding season its activity is mostly diurnal. It emerges at sunset from holes and crevices among stones or brick walls, and roams about widely in vegetation throughout the night, feeding on insects and worms. It is often attracted to light-posts, running and chasing insects as they fall. It ventures freely into inhabited houses, hiding under household articles, occasionally emerging to catch houseflies and roaches. In



Figure 3. *Bufo stomaticus* tooth morphology.



Figure 4. *Bufo stomaticus* "ball" — reproductively active males surround an amplexant pair.



Figure 5. An adult female *Bufo stomaticus*.

drought conditions the toads aggregate in damp places, especially around pumps, to catch splashed water drops on their bodies. The toads squat, pressing their hindquarters against the damp soil to absorb moisture through the skin.

Young toads (snout-vent length 30–40 mm) often climb over the 1.5–2 m high compound walls around houses, taking advantage of irregularities between the bricks.

A summer evening temperature of 13°C, a downpour, noise of flowing water and increased humidity are sufficient elements to trigger breeding activity in the toad (Khan and Malik, 1987). *Bufo* males are first to arrive at the water-catching low lying areas where rainwater is accumulating. They form noisy choruses of guttural notes, "cree, cree, cree, cree, cree" repeated several times. They are very aggressive, fighting each other vigorously, kicking, tugging jumping over each other, in an effort to form pairs. A male will avoid being clasped by another male by vigorously pushing him away, at the same time trying to get a hold on the assailant. However, a female is docile in response to such an attempt; it readily allows a male to get an axillary clasp on its body. The amplexic pair is jumped upon by several suitors, struggling to dislodge the amplexic male. A "ball" of struggling and pushing males is soon formed round the pair, which remains floating for some time (Figure 4). Somehow the female manages to escape with its riding mate to a calm part of the pond to lay eggs. The eggs are strung in a double row in a gelatinous string, which is wound around submerged vegetation (Khan, 1965, 1982b).

Mortality: Road mortality is high in toads. They are crushed under passing traffic as they pursue insects beneath roadside light-posts. Crows and other local birds feast on their exposed viscera (Khan, 1982a, 1990). Moreover, toads are included in the diet of several sympatric animals: *Hoplobatrachus tigeri-*

nus (its carnivorous tadpole devours sympatric *Bufo* tadpoles, while toadlets fall prey to adults); *Varanus bengalensis*; *V. griseus*; *Ptyas mucosus*; *Amphiesma stolata*; *Xenochrophis piscator*; *Bungarus caeruleus*; and *Echis carinatus*. The toad escapes into a burrow or fissure to avoid potential predators; however, if no hiding place is available, it is quick to bury itself in loose soil (Khan and Tasnim, 1992). There is high mortality in recently metamorphosed toadlets, as they fall prey to herons, ducks, sympatric amphibians and hosts of local snakes as they emerge from water. Moreover, as the toad usually breeds in roadside ponds and puddles, many toadlets succumb to traffic as they emerge and scramble about seeking refuge; few manage to reach the safety of surrounding vegetation.

Mortality is greatest during the tadpole stage. Being an opportunistic breeder, *B. stomaticus* breeds in every water body, large or small, most of which soon are dried due to high temperatures, destroying the tadpoles (Khan and Malik, 1987). However, in rare rainier years, intermittent rains keep filling the sites, so that tadpoles metamorphose successfully.

About 80% of Pakistan's agricultural activity occurs in the fertile Indus Valley. The cash crops are regularly sprayed with insecticides. The washout received by the surrounding water bodies may kill the tadpoles, while the affected insects may poison the adult toads that ingest them.

Distribution: The worldwide success of the genus *Bufo* is mostly attributed to its small, simple generalized tadpole, which requires little water for normal development and simple diet (Khan, 1991).

Bufo stomaticus is widely distributed throughout the Indo-Pakistan subcontinent, from Bangladesh through the Ganges Plain, peninsular India, Sri Lanka, Pakistan, Afghanistan, Iran, and reaches to Muscat.

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