Biology and Conservation of the Amphibians, Reptiles and their habitats in South Asia

(Proceedings of the International Conference on the Biology and Conservation of the Amphibians and Reptiles of South Asia, held at the Institute of Fundamental Studies, Kandy and University of Peradeniya, Sri Lanka, August 1-5, 1996)

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Anslem de Silva

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COUNTRY REPORT FOR PAKISTAN
Herpetofauna of Pakistan: Present Status, Distribution and Conservation.

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Location and terrain

Pakistan is the northwestern part of the subcontinent. it is a rhomboidal oblique strip of land covering an area of 310,400 sq miles (88.2 million hectacres). Its southwestern tip, at long. 60° 52' E and lat. 24° N, touches the Arabian Sea coast, on the harsh arid cliffs of Makran coastal ranges. While northern most tip lies in the heights of greater Himalayas at long. 75°22' E and lat. 37°N (Khan, 1980).

Terrain of Pakistan is distinguished into two main topographical features: the north, northwestern and western mountain ranges covering about two third of the country, and the rest comprises of vast Indus plain, through which runs the Indus River and its five tributaries: Jhelum, Chenab, Ravi and Sutlej which meet at Panjnad in the southern Punjab.[MAP.1]

i. The northern vast complex of intricate system of mountains and valleys, consists of the Great Himalayas, Inner Himalayas and Trans-Himalayas, ranging in altitude from 800 to 5714m. A series of low lying sub-Himalayan or Siwalik mountains lie in the south of Himalayan massif, ranging from 571 to 857m in altitude gradually merging with the southern plains. These mountains form the main watershed for Indus River system.

ii. The northwestern hilly tracts mostly comprises Koh Hindu Kush which branches off from Himalayas at Pamir Knot and runs westwards to Afghanistan. It comprises mountains as high as 3428 m. Valleys of Chitral, Swat and Dir lie in Pakistani part of these hilly tracts.

iii. The western highland is a complex chunk of different ranges forming the Balochistan plateau. It comprises of a complex of arid basins, desert field and mountain ranges 286-857 m in height. Geologically it is continuous with the Iranian tableland, and extends into the sea along Makran coast.

The vast Indus plain is a stretch of 25.9 million hectacres of undulating undisturbed plain, stretching from the foot of Himalayas to the shores of Arabian Sea (Khan, 1980). The Indus plain gradually sinks from subHimalayan heights to sea level. Rawalpindi is situated at 500 m, it is reduced to 200 m at Multan, 100 m at Sukkhur, and to 30 m at Hyderabad.

The Indus plain is the most populated and cultivated part of Pakistan. Originally it supported vast fields of grassland habitat with extensive riverine forests. Recent extensively felling, canalization and reclamation has entirely changed the natural complexion of the plains, destroying natural habitat and fauna.

Climate

Pakistan has a complex of continuously varying climates from place to place according to local special ecological conditions. There have been several attempts to categorize climatic regions of Pakistan, but the issue is far from satisfactory resolution (Ahmed, 1951; Khan, 1996). The Tropic of Cancer passes just south of Makran coast, putting Pakistan in the subtropical belt. Here summer is extended and hot and dry with severe winter. Relief comes for animal and plant life from hot, dry and desolate summer in early July to late September when south-western cool moisture-laden monsoons from the Indian ocean sweep across almost the entire country. However, Baluchistan tableland, Makran coastal strip, Chagai Desert in Baluchistan, Thar in Sindh, Cholistan and Thal in Punjab, receive meager rainfall (20-40 mm) and often they do not receive rainfall at all, while 1000-1300 mm rainfall is received by the northern and northwestern mountains. In plains, rain rarely exceeds 300-500mm. Rain water soon dries up resulting in general aridity due to extreme temperature summer peak of 52° and winter low of -22°. These climatic conditions have profoundly affected the vegetation and animal life of the country.

Extensive canalization recently, in the plains has boosted agricultural production, but at the same time the poor drainage system due to subsoil rock layer has caused rise of the watertable turning large tracts of land into water-logged and salt fields. Such soil conditions coupled with increasing aridity, the annual rate of desertification is alarming, large tracts are turning into barren areas annually (Table 2).

Population

Pakistan has a well documented ancient past in the archaeological sites in Bolan valley, Baluchistan which is as old as 6,000 B.C. while in Indus valley civilizations of Harappa and Mohenjodaro dates back to 2500 and 3000 B.C.

Punjab and Sindh are most populated parts of Pakistan, harbouring about 80 % of the 98 million total population of the country.

Forest cover

Due to complex nature of constantly varying climatic conditions, vegetation drastically vary from place to place in Pakistan. Several attempts, in past, have failed to give a satisfactory mapping system of vegetation for Pakistan (Roberts, 1991). Here they range from littoral mangroves, riverine forests, swamps, thorn forests, sand dune deserts, scrub forests, pine forests, deciduous forests, temperate forests, coniferous forests to cold Himalayan deserts. Each vegetational association has its characteristic fauna of mammals, birds and amphibians and reptiles (Khan, 1996;MAP 2).

A few years back 4.7 million hectacres were recorded as covered by forests. This has been reduced to 1.2 million hectacres now due to felling and human pressures. However, due to recent efforts of Forest Department belts of riverine plantations have cropped up, while tropical thorn forests form the main natural feature along the sea coast, sand dunes deserts in southern Baluchistan, southeastern Sindh, southeastern and northwestern Punjab are under great pressure. Efforts are under way to preserve this unique vegetation which provides effective cover to local mammals, birds and reptiles. For this purpose several areas are declared as wildlife sanctuaries, game reserves and wetlands protecting natural vegetation and animal life.

Herpetology

Detailed faunal studies on Pakistan (Khan, 1980, 1986; Roberts, 1977, 1991) reveal the fauna is of transitional nature between the Palaearctic and the Oriental zoogeographical regions, with considerable representation of the Ethiopian elements.

Table 3 details out composition of Pakistani herpetofauna. It consists of 22 families, 77 genera and 165 species of which 40 species are endemic.

Amphibians are mainly confined to the more rainier northern hilly tracts. Frogs are distinguished in subgenus *Paa* which are endemics of the mountains, and open field frogs of subgenus *Rana* which are widely distributed in plains also. There are two species of torrenticole broad-skulled toads, while narrow-skulled toads descend into plains where they have proliferated into several species (Khan, 1994). Pakistan has 62 species of lizards of which 15 species are endemic, while out of 57 species of terrestrial snakes 16 are Pakistan endemics. Both lizards and snakes are predominantly desrticole.

Threats

Deforestation and over grazing has denuded the natural habitat. Moreover, recent upsurge in reclamation of "waste-land" natural environments of large tracts of land are changed with deteriorating effect on local species, which in some cases are divided in small populations and rapidly die out. Constant human interference and indiscriminate killing has rapidly contributed to depletion of several local species. So far no specific study has been carried out to access percentage of annual loss to animal or natural habitat. Khan (1990) has reported on effect of pesticides on amphibians, largely due to which their natural population are being affected.

Several herp species (*Uromastyx hardwickii*, all species of genus *Eumeces*, *Mabuya* and *Ophiomorous* are locally used by aurevedic practioners in their recipes. Locally no reptile is consumed habitually except by some nomadic tribes who hunt for varanids and turtles. No official figures are available about trade of herp species, however, reports from friends in several western countries indicate that illegal trade in several species like *Uromastyx hardwickii*, *Naja naja*, *N. oxiana*, *Ptyas mucosus*, *Vipera russellii* and *Eristicophis macmahoni* is flourishing unabated despite strict wildlife laws (Khan, 1996).

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Table 1.
Pakistan, fact sheet (data from National Conservation Strategy (NCS), Islamabad).

Land capability (figures in million of hectors)	
total area	88.2
Area surveyed	61.8
Unproductive	24.9
Pasture and forests	16.8
Cultivated	20.0
Cultivable	11.8
forested area	4.5
rangelands	51.3
water logged	40,000 hectors annually
Urban population	28%
Rate of urbanization	5% /annum

Table 2.
Pakistan, deserts (data from fact sheet IUCN).

Main desert areas	Thal and Cholistan in Punjab.
	Thar in Sindh
	Kharan in Balochistan
Extent of dry land areas	Arid=26.9 million hectares
	Semi-arid=15.8 m hect
	Sub-humid=1.2 m hect
	Non-dry land=44.2 m hect
Under threat of desertification	
in arid zone	27 m hect, 30% of total area
Pattern of degradation	i. vegetation loss due to grazing
	ii. erosion by wind
	iii. salinization

Table 3.
Latest figures of herpetofauna of Pakistan (Khan, 1980, 1996).

Family	genera	species	endemics
Amphibians			
Bufonidae	1	11	4
Ranidae	1	10	5
Microhylidae	1	1	-
Chelonians			
Cheloniidae	4	4	-
Dermochilidae	1	1	-
Trionychidae	3	4	-
Emydidae	3	4	-
Testudinidae	2	2	-
Crocodyles			
Crocodylidae	1	1	-
Gavials			
Gavialidae	1	1	-
Lizards			
Gekkonidae	13	33	15
Lacertidae	4	11	-
Scincidae	7	14	-
Varanidae	1	4	-
Snakes			
Typhlopidae	2	2	1
Leptotyphlopidae	1	2	1
Boidae	3	4	1
Colubridae	14	31	11
Elapidae	2	5	1
Hydrohiidae	7	14	-
Viperidae	4	5	1
Crotalidae	1	1	-

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STATUS OF AMPHIBIAN FAUNA OF PAKISTAN

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Abstract:
Despite non-conducive arid conditions, amphibian fauna of Pakistan consists of about 21 species, and it is on the increase as new areas are herpetologically explored, and already known material is carefully studied.

There are definite Himalayan elements in bufonids and ranids. However, in plains southeast Asian frogs and Palearctic toads are dominant. Endemic elements are dominant amoung bufonids. Amphibian populations are under stress from increasing human interference.

Introduction

Hot subtropical conditions in Pakistan are not faverable for amphibians, which are represented by three families, namely Bufonidae, Microhylidae and Ranidae (Khan and Tasnim, 1987). Recently several new species have been added to the list, largely because of collections from new areas and re-examination of museum materials (Mertens, 1969; Dubois and Khan, 1979; Eiselt and Schmidtler, 1973; Khan, 1974, Khan in press, a,b; Khan and Tasnim, 1989).

Despite unfavorable environmental conditions, recent upsurge in reclamation of arid and barren areas has largely helped in more wider distribution of several once little known species (Khan and Tasnim, 1987). More humid northern areas along Himalayan foot-hills, present ideal natural conditions for frogs and toads and support rich populations of common species (Khan, 1979).

The three amphibian families are represented in Pakistan by three genera: *Bufo, Microhyla* and *Rana*, showing the following pattern of distribution.

Family **bufonidae**

Genus *Bufo* is represented by ten species. The broad-skulled toads are represented by high altitude *B. himalayanus* and wide ranging southeast Asian toad *B. melanostictus* which in Pakistan extends throughout subHimalayan ranges. The narrow-skulled toads are represented in the Himalayas by high altitude *B. latastii* and *B. sp* (Khan in press, a). While *B. olivaceous* and *B. surdus* are confined to the Balochistan tableland. The Palearctic *B. viridis* is represented by two subspecies in Pakistan: *B. v pseudoraddei* in Swat, and *B.v. zugmayeri* along western border of Balochistan. *B. stomaticus* is the commonest toad which is distributed widely in the plains and sub-Himalayan hilly tracts and extends in Balochistan and neighboring Iran and Afghanistan Khan, 1972).

Family **Microhylidae**

Family Microhylidae is represented by the south-east Asian species *Microhyla ornata*, which is widely distributed in the subHimalayan hilly tracts and frequents the paddy fields in the nothern Indus valley. Untill recently this species was unknown in the plains (Khan, 1974). Recent extensive canalization and dam building in the plains have promoted its wider distribution.

Family **Ranidae**

Ten species of Pakistani ranid frogs are divided in two groups: Himalayan group, which has been placed recently in subgenus *Paa*, includes northern Himalayan forms *Rana hazarensis, R. harmoachensis, R. viccina* and western Balochistan karez water frog *R. sternosignata*. These frogs are torrenticolous, with nuptial spines. While second group belongs to subgenus *Rana* of which *Euphlyctis cyanophlyctis* is most common littoral species extending into sub-Himalayan ranges. Its spine bearing Balochistani population has recently been described as a new subspecies (Khan, in press b). The toad-frog *Tomopterna breviceps* is widely distributed in sub- Himalayan waters, however in plains it has spotty riverine distribution (Khan and Tasnim, 1987). Common plain forms include the tiger frog *Hoplbatrachus tigrina*, northern cricket frog *Limnonectes limnocharis* and southern cricket frog *R. syhadrensis*. All these species frequent meadows, swamps and marginal seepage pools of irrigation channels.

Ecological stresses

Recent upsurge in human activities in the plains has largely contributed to the habitat destruction of the local amphibians. Khan (1990) has shown that employment of latest mechanized instruments in field have destroyed the hiding places of field resident amphibians. Deep tilling disturbs the hiding amphibians in hole and crevices in earth, and does not give them time to escape being killed by heavy machinery.

The unlimited use of pesticides has contributed to the destruction of local populations. The potential prey of field resident amphibians are killed by the poisonous sprays. The toxic "wash down" which accumulates in ditches and depressions, the usual temporal breeding sites for the local species, kills eggs and developing tadpoles.

Khan (1990) has shown that wider use of *Hoplbatrachus tigrina* in college and school laboratories around the country, has almost exterminated this species in certain areas. Increased traffic on roads has contributed largely in the reduction of local population of common toad *Bufo stomaticus*. Large number of amphibians, mainly toads, are crushed or mutilated by the passing traffic at night, thus affecting natural local populations.

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OROPHARYNGEAL MORPHOLOGY AND FEEDING SPECIALIZATIONS OF AMPHIBIAN TADPOLES

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Introduction

Six species of amphibians:*Bufo stomaticus, Microhyla ornata, Euphlyctis cyanophlyctis, Limnonectes limnocharis, R. syhadrensis* and *Hoplbatrachus tigerinus*, inhabit waters of plains of Pakistan. The same temporal breeding sites are used for both breeding and to pass the tadpole stage. Each species of tadpole has specialized oropharyngeal morphology (Khan 1991, 1996a,b; Khan and Mufti, 1994a,b, 1995, 1996). Though the adults are partially selective in choice of breeding sites and differ in mode of egg laying to avoid competition at adult as well as larval stage (Khan, 1982; Khan and Malik, 1987), sympatric sharing appears to be unavoidable, at potential breeding and development sites.

Tadpoles depend entirely on water for development, feeding, movement and respiration. Similar needs of different species in a common habitat necessitate niche partition to avoid competition and ultimate destruction of one species at the expense of other. To explore this aspect of life of sympatrically developing tadpoles, the following study was undertaken. During this study the main emphasis was to study modifications of basic oral and pharyngeal structures of each species, and their use by the tadpole to exploit a particular part of the common food base in pond ecosystem.

Bufo stomaticus

Tadpole ranges from 17-18 mm in total body length, with globular body and short low finned tail. The antero-ventral oral disc is with dental formula 2(2)/3, labial palps are with numerous short labial papillae. Dark brown teeth range 0.04-0.06 mm in length and are arranged in a single row on dental pad, flat crown is produced into 5-6 sharp cusps on sides. Both halves of beak are sharply serrated. (Khan and Mufti, 1994a, Fig. 1,A,B).

Internal oral and pharyngeal morphology shows interesting details: buccal and branchial cavities are equal in length and breadth; infralabial and lateral ridge papillae are palmate; tongue anlage is transversally oval with four simple papillae; buccal roof and floor arenas are moderately papillated with simple papillae; internal naris is long, oblique with thin narial valves; transverse buccal pockets with moderately thick valves; broad ventral vellum is supported by spicules with jagged posterior margin, dorsal velum is much narrower.

Bowl-shaped branchial basket has three distinct filter cavities; ridged and pitted subvellar secretory tissue; fine pitted buccal secretory tissue; number of filter rows vary from 6-12; extensive pressure cushions; indistinct cilliary grooves; moderately wide esophageal funnel; completely blanketed glottis by ventral vellum; lungs are small crumpled dark sacs, which are nonfunctional structures.

Feeding habits

Bufo stomaticus tadpole inhabits shallow pools and puddles, usually foraging at land-water interface. Fine cirrated beak, multi-cusped sharp denticles suggest its efficient grazing habits on periphytons, microphytes and detritus material. While trough-shaped branchial cavity, pitted and ridged buccal glandular secretory tissue and moderately thick filter ruffle indicate an efficient moderately coarse particulate food processing filtering mechanism (Khan and Mufti, 1994b).

Microhyla ornata

Tadpole varies 17-19 mm in total length, transparent body and tail with characteristic silver-shine on abdomen. Head dorso- ventrally depressed while body and tail are laterally compressed. Tip of the broad finned tail is produced into a terminal vibratile flagellum. Spiracle lies at mid-abdomen, with a prespiracular flap (Khan and Mufti, 1994a).

A typical oral disc with hard keratinized mouth parts is absent. Mouth opening is a horizontal slit with a median U-shaped cleft, which remains open even when mouth is closed. This tadpole occupies unique midstream microphaguous feeding niche, while rest of the sympatric ranid tadpoles are bottom grazers.

Buccal cavity is about 25% of the much-exaggerated pharyngeal region with three large deep filter cavities; filter plates are largely connected with ventral velum; tight filter mesh, 13-23 filter rows on a filter plate; broad ventral vellum is divided in halves in middle by anteriorly carried bulbous trachea with a large glottis guarded by a preglottal papilla; lungs are well developed and functional; broad buccal secretory tissue is fine pitted, while subvellar surface is fine ridged; a lingual anlage, median ridge and lateral ridge papillae are absent; naris imperforate, with a ribbon-shaped narial papilla; each filter cavity has rigged branchial food trap with microscopic openings of secretory glandular tissue borne on fine parallel ridges forming distinct crescentric torus in each branchial cavity; buccal roof arena (BRA) and buccal floor arena (BFA) papillae are coalesced at bases to form fine membranes; buccal pockets are narrow, anterodorsally elongated with distinct connection with pressure cushions, forming an elaborate system to control function of pressure cushions (Khan, 1991, 1996).

Microhyla ornata tadpole is collected at mid-monsoon from deep ponds with heavy planktonic load. Transparent body of the tadpole with broad finned and independently vibratile terminal filament, lateral eyes on a depressed head, ventral single spiracle and abdominal silver shine are adaptations to its nektic habits. The broad buccal, papillary membranes, wide buccal secretory tissue, enlarged branchial baskets, ridged subvellar glandular surface, presence of a torus in deep filter cavities and tight filter mesh, make this tadpole an efficient plankton filtering machine.

Euphlyctis cyanophlyctis

It is the largest of the plains tadpoles 40-43 mm in total length, with bulky body and strong muscular broad finned tail. Anteroventral oral disc has a dental formula 1/2, teeth are cuspless, blunt tipped, 0.13-0.34 mm long, orally curved rod, almost squarish in transverse section, arranged in a single row. Thick broad beak is sharp fine cirrated cutting edged. Broad labial palps are produced into lobulated papillae (Khan, 1991; Khan and Mufti, 1994a).

It is a benthic tadpole, prefering deep permanent ponds with rich accumulating detritus in the form of decaying plant and animal matter, with thriving bacteria and infusoria, etc.

Typical oropharyngeal features are: a pair of branched infralabial papillae; tongue anlage two pairs of bifurcated papillae; buccal floor arena (BFA) and buccal roof arena (BRA) are spacious and densely papillated. BFA center is however densely pustulated displacing laterally the large bifurcated BFA papillae; single prenarial and lateral ridge papilla, five postnarial and three BRA papillae with smaller ones at their basis, mesially BRA is moderately pustullated; thick lipped naris has broken rim; internaril, postnarial arenas are pustulated; the median ridge mesially is drawn into a fine blunted papilla; buccal pockets are large, curved moderately thick lipped; posterior margin of broad ventral vellum is jagged; buccal secretory tissue is large pored, subvellar surface is ridged.

Branchial baskets are about 50% of the oropharyngeal cavity, with three filter cavities, a pair of large pressure cushions is distinct; tight filter mesh, 6-16 filter rows on a filer plate, filter ruffle with three degree of foldings; about 75 % of the glottis exposed, lungs are well developed with air chambers distinct in anterior half; esophageal orifice is large.

Benthic thigmotectic tadpole of *E. cyanophlyctis* invades different types of water bodies. Primarily it is detritivorous, suggested by its wide biting beak, cuspless teeth and unique oropharyngeal morphology. Its heterogeneous particulate food is processed efficiently by its strongly papillated BRA and BFA, pitted and ridged glandular secretory surfaces and filtered on fine tight mesh of filter plates (Khan, 1991; Khan and Mufti, 1995).

Limnonectes limnocharis

Tadpoles of northern cricket frog *L. limnocharis* and southern cricket frog *R. syhadrensis* are morph-ecologically similar. Here morphology of tadpole of *L. limnocharis* is described.

The tadpole ranges from 17 to 19 mm in total length. Ventro-anterior flexor of its buccal floor pushes its oral disc upward and forward, so that it is more anterior than anteroventral. Oral palps are thick, with thick, cylindrical, filiform blunt tipped labial papillae. Dental formula is 2(2)/3. A tooth consists of three tiers of similar pieces, lying on each other, each less than 0.5 mm in length, with free flattened orally curved crown, produced into three sharp cusps, hollow base of each piece fits on the lower piece. Narrow beak blades are finely cirrated (Khan and Mufti, 1994a).

Fine cirrated tipped single infralabial papilla, thick valved transverse nares with short flat cirrated tipped prenarial papilla, inner border of narial valve finely cirrated; single pair of finely cirrated postnarial papillae; fewer BFA simple papillae, arranged in a staggering row, longest with blunts; three fine tipped simple BRA papillae; lateral ridge papilla with cirrated blunts; low, narrow cirrated median ridge; branchial basket about 25% of oropharyngeal region, with two filter cavities; filter ruffle consisting of only primary filter rows, 4-14 on filter plates; buccal glandular zone with fine pits; subvellar tissue fine ridged with a distinct torus in second filter cavity, under vellum; buccal pocket narrow, oblique, tip hooked inward; tongue anlage inconspicuous with two pairs of simple papillae; BFA and BRA broader than long, trough-shaped with sparse papillation; two filter cavities in the branchial basket, 3rd and fourth coalaced with second; filter mesh simple 2o, filter rows moderately separated from each other.

Morphologically this tadpole is more bufonid rather than ranid. It is a grazer as well as microphagous filter feeder. Torus in second filter cavity, helps it to filter ultra fine planktonic material from water, which accumulates as fine follicular matter in the first filter cavity. Its long vibratile tail tip helps it to stay longer at midstream as compared to other ranid and bufonoid tadpoles, but not like microphagous *Microhyla ornata*.

This tadpole frequents marshy grasslands, seepage pools along irrigation channels, torrents, and permanent ponds, which soon develop planktonic blooms and algal growths on which it feeds.

Hoplbatrachus tigerinus Daudin
This strongly built tadpole is 38-40 mm in total length, with dorsal eyes, nonbulging body and strong, muscular, low finned tail. Oral disc is located at anterior end of the head; it is round without oral palps and papillae.

Triserial tooth rows, dental formula is 5(4-4)/(3-3)5. A tooth is a cylindrical keratinized, dark-brown cuspless structure, with its crown gradually becoming attenuated at its pointed tip. Teeth 0.34-0.4 mm in length. Thick dark-brown beak is broad, its preoral half is strongly arched and finely cirrated, mesially produced into a large cirrated tooth, while the post-oral half is sharp non-cirrated and mesially excavated into a U-shaped concavity into which the tooth of the anterior half fits on closure of the beak.

Extra keratinized surfaces in the buccal cavity include a pair of thick long cylindrical lateral narial papilla with keretinized tip, are placed at the angles of the mouth opening and a median keratinized shield at the roof of the buccal cavity. Posterior labium can be widened into a sucker, when necessary, for attachment to rocks and other supports in strong currents.

Three infralabial blunted papillae, first palmate produced into thick fingers, second and third are simple; internal naris small, transverse, with thick valves and single pre- and post-narial blunted papillae; small, transverse, thick lipped buccal pockets; spacious buccal floor arena (BFA) and buccal roof arena (BRA) which are flattish, broader than long; a general reduction in the number of buccal papillation, papillae are short stumpy structures with flat tuberculated tips; buccal musculature is

hypertrophied and very thick; branchial basket is 25-30 % of the oropharyngeal cavity, with a single filter cavity; buccal as well as subvellar secretory tissue is pitted, pits are large distinct, no secretory ridges; lose filter plates with 6-10 filter rows; 2° simple filter ruffle forms very lose filter mesh; glottis exposed with large functional lungs.

Oropharyngeal morphology of *Hoplbatrachus tigerinus* tadpole strongly indicates its obligatory macrophaguous carnivorous habits. It is known to be cannibalistic and predatory on sympatric species, especially on sympatric *Bufo stomaticus* tadpoles. Breeding activity of both species is synchronized, both selecting the same egg laying sites (Khan and Malik 1987; Khan and Mufti, 1994b).

Reduced tongue anlage, lingual, circumnarial, BFA and BRA papillae and the median ridge, buccal and vellar glandular area, which plays key role in food reteriving system in other species, is restricted and inconspicuous in this species as reported in other carnivorous tadpoles (Wassersug, 1980; Inger, 1985; Wassersug and Heyer, 1988). Thick lipped short buccal pockets indicate strong pressure generated in the oropharyngeal passage necessary for transportation of large food particles through buccopharyngeal passage, down into esophageal canal. Abbreviation of branchial basket (18-20% of buccopharyngeal region), single filter cavity, poorly organized filter plates, loose filter ruffle, indicate the rudimentary function assigned to these structures in feeding process of this obligatory marcrophagous tadpole.

Conclusions

All the five tadpole species in riparian waters of Punjab Pakistan, play important regulatory function to maintain energy flow at primary consumer level. The basic pond food resource is being utilized by obligate macrophagous *H. tigerina* and obligate microphagous filter-feeder *Microhyla ornata* tadpoles, the rest are facultative heterophagous, changing their feeding habits by switching from one type of food to another. They become herbivorous-raspers in the presence of vegetation, microphagous filter feeders when pond is choked with planktonic bloom, and resort to carnivory when dead tadpole or some other animal is available and even occasionally turning cannibalistic (Khan, 1991).

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