

## INTRODUCTION

The amphibians are ecologically and economically important group of animals which have played a significant role in various scientific spheres and contributed directly to economy of the country. Amphibians, specially the anurans, have been exploited for food and as medicine in India and abroad. Recently, frog legs have earned for the country millions of rupees in foreign exchange each year. These creatures have become laboratory animals for medical research on the important aspect of standardization of human pregnancy test. The most important medical research in recent years reveals that 'Serotonin', a hormone like substance found in the secretion of parotid glands of toads produces 'Antiserotonin' which may be used in treating Schizophrenia, Bronchial Asthma and several allergic diseases. Their educational value and significant role in controlling harmful insects and pests that damage our crops have made them most useful biological animals among the vertebrates. In addition, amphibians are used by anglers as bait for catching freshwater sharks.

Nevertheless, this vital faunal component of our country has not attracted due attention of zoologists and environmentalists, particularly in the northwestern India, and probably this is the reason why there is no comprehensive account of this group in India since the last complete review of Amphibia in India by Boulenger (1890). However, in recent years several papers describing new taxa and reviewing species of many areas have been published which certainly added much to our knowledge. In spite of the existence of these works, there is much yet to be understood concerning amphibians of India. This is so because of obvious reason that a sincere collection and systematic study of amphibians in this country has not been taken up as extensively as it demanded. It is, therefore, not surprising that

diversified amphibian fauna of north-western India is little known. Amphibians of the Himalaya (High altitude) are vividly different from those of plains of India, and have adapted to this environment in a most befitting manner. The study of high altitude amphibia is, therefore, of much scientific importance.

Amphibians form a very important link in evolutionary history of vertebrates. In recent times, they have evolved into three diverse groups or orders. The first of these Gymnophiona or Apoda, commonly called as limbless frogs. The second Caudata or Urodela, commonly known as newts and salamanders. The third and largest order of modern amphibians Salientia or Anura to which frogs and toads belong. In India, this group of vertebrates represented by all the three types but predominant component is Anura. In north-western India, amphibian fauna represented by only the Anura.

In western Himalaya, district Dehradun is ecologically important area where different habitats, comprising hills and valley exists and provide varied kinds of ecological niches. The variety of environmentally important areas support a wide variety of well known amphibians. The study of amphibians of this area is significant both from scientific and systematic points of view as well. In spite of the importance of this group, it is seen that not much attention has been paid to this group in this region. Amphibian fauna of Western Himalaya has attracted the attention of Guenther (1858, 1864), Boulenger (1882, 1890, 1920), Annandale (1909, 1912, 1917), Nieden (1923, 1926), Acharjee and Kripalani (1951), Dubois (1975), Waltner (1974), Tilak and Husian (1977), Tilak and Mehta (1983), Tilak and Ray (1985) etc.

The first mention of amphibians of district Dehradun could be found in publication of Boulenger (1920) who recorded only two species of Genus *Rana* (*R. blanfordi* and *R. formosa*) from Mussoorie. Recently, Waltner (1974) reported sixteen species of amphibians from Western Himalaya without referring to any material from district Dehradun. The information on amphibia of district Dehradun is extremely poor and richly deserve a thorough survey and study of the entire fauna of this region. The present study, therefore, a detailed survey of amphibians of district Dehradun from localities comprising permanent and temporary aquatic habitats in the valley and montane and submontane regions, has been conducted. The results of this venture, which is first of its kind, are presented here. A careful survey and study has yielded sixteen important species of amphibians of this region, out of which two species of genus *Amolops* and one species of genus *Rana* (*Paa*) are new to science and three are new distributional records.

A salient feature of present work is collection and study of complete life-history stages from fertilized ovum to four-limbed froglet stage of all ten species recorded and associated with their adults. The detailed study of individual keratodonts of larval dentition indicates that the morphology of this part is taxonomically important. The importance of study of larval forms of different anurans acquires significance because of the fact that they can act as an indicator of distribution of a particular species even if an adult of the same is by chance not procured or collected. The osteological studies of some species provide characteristic features of taxonomic importance.

The results of present study are encouraging and serve as a basis for further methodical survey of amphibians in all seasons of the year even in adjoining areas of Western Himalaya. Discovery of sixteen species of amphibians in the district should prove beneficial to agriculturists, scientists and environmentalists.

## HISTORICAL RESUME

The amphibians of district Dehradun have been paid scant attention so far and hence information on them is not adequate. Whatever little information is available, it is found in the publication of Boulenger (1920) who recorded two species of amphibians from Mussoorie hills; these were *Rana blanfordi* Boulenger, and *Amolops formosus* Guenther (= *Rana formosa*), of 125 species under genus *Rana* Linnaeus described from South Asia. Dubois (1974), in his work on amphibians of Nepal referred *Amolops formosus* Guenther (= *Rana formosa* Boulenger) from Mussoorie, the material is available in the British Museum of Natural History, London. Tilak and Ray (1985) recorded a new species *Rana* (*Paa*) *tuberculata* from Chakrata Hills of Dehradun.

It is considered appropriate to mention here some of important works on amphibians of the areas adjoining district Dehradun, such as Garhwal and Kumaon of Uttar Pradesh, Himachal Pradesh, Jammu and Kashmir and Ladakh of Western Himalaya as a whole, so as to gain additional data required for study of interrelationship among different taxa of amphibians. However, some of the important works relevant to the current study are mentioned here.

Annandale (1908) commented on *Rana vicina* Stoliczka taken from Garhwal, at an altitude of 1829 mts. by Hodgart. Some high altitude amphibians from Jammu and Kashmir were studied by Annandale (1917) who recorded the occurrence of *Rana pleskii* Guenther in Kashmir at an altitude of 3962 mts. Boulenger (1919) added *Aleurophryne mammata* Guenther, to the list of Batrachians inhabiting Kashmir. Acharjee and Kripalani (1950) made some collections from Kangra and Kulu Valley and recorded only five species of amphibians of which distribution of *Amolops formosus* Guenther (= *Rana himalayana* Boulenger) only in this region has been confirmed. The earlier record of this species from this area

was in doubt due to the fact old registered collection of this species collected by Newnham (1891) is now not traceable in the Indian Museum, Calcutta. Waltner (1974) listed sixteen species of amphibians from Western Himalaya but without indicating exact locality data. Tilak and Hussain (1977) extended the range of an interesting microhylid frog (*Uperodon systoma* Schneider) to the adjoining area of district Sharanpur. Duda and Sahi (1977) published a checklist of herpetofauna of Jammu and Kashmir. Dubois (1978) reported some of his interesting observations on genus *Scutiger* Theobald from Kashmir and Ladakh and also described a new species, *Scutiger occidentalis* from this area. Tilak and Mehta (1983) recorded nine species of frogs from adjoining district of Sirmour, Himachal Pradesh.

Since the studies on amphibian fauna of northwestern India are meagre, this author should not but depend on general and particular works published on this group in other parts of India in order to acquaint himself with a better understanding of the fauna of district Dehradun. It will be appropriate to mention here that studies on Indian amphibians have long been neglected with the result our knowledge about the group continuous to be inadequate.

Blyth (1854) listed some of the types of amphibians and described some new taxa deposited in the Museum of Asiatic Society. Guenther (1858, 1864) worked out preserved perpetological collections made by Brian Hodgson. Anderson (1871) in his report on Indian reptiles, recorded only two species from Agra, in addition to twenty three species reported from Eastern India and Burma. Theobald (1873) studied some type specimens represented in the Asiatic Society's Museum. Boulenger (1882) thoroughly worked out the entire preserved amphibian collections found in the British Museum and thereafter published a Catalogue of the Batrachia Salientia. S. Ecaudata. Thurston (1888) published a significant work on South Indian amphibia, based on collections available in the Government

Museum, Madras. Boulenger's (1890) work in the Fauna of British India series provided necessary stimulus to further studies and still a standard source of reference on the subject and is in demand even after lapse of a century. Sclater (1892a, 1892b) published lists of amphibians and reptiles found in the Indian Museum, where he has not mentioned about any collection from Dehradun. Van Kampen (1923) has given a detailed account of some selected Indian species. Ahl (1931) added much to our knowledge of the family Rhacophoridae. Parker (1934) published a well illustrated and an authoritative monograph on the microhylid frogs of the world. Gorham (1974) has given a concise Checklist of World Amphibians. Leim (1974) dealt with the revision of old world tree frogs of family Rhacophoridae. Inger *et. al.* (1985) published an account of some amphibians inhabiting Ponmudi, Kerala. Dutta (1985) has made a commendable contribution by giving correct spelling of *Rana tigerina* Daudin, which has long been misspelt as *Rana tigrina*. Inger and Dutta (1987) summarised the problems and lacunae of amphibian studies in India and gave a list of amphibians of India with statewise distribution for each species.

Besides the above works, Annandale (1907-1919), Rao (1920, 1922, 1937), Nieden (1923), McCann (1932, 1934), Mukherjee (1933), Bhaduri (1944, 1945), Bhaduri and Kripalani (1954, 1955), Roonwal and Kripalani (1961), Daniel (1962, 1963, 1975), Mansukhani and Murthy (1964), Behura (1965), Yazdani and Chanda (1971), Pillai and Chanda (1973, 1976, 1979, 1981) and Pillai and Yazdani (1973) have considerably added to the knowledge of amphibians from southern, north-eastern and western India. Hejmadi *et. al.* (1977, 1979, 1980) carried out pioneering investigations on the life-history of some amphibians of Orissa. Sarkar (1984) studied amphibian fauna of Calcutta and its environs. Chanda (1986) recorded fourteen species of amphibians from Sikkim and Darjeeling of which *Rana senchalensis* was described as a new species from Darjeeling.

## PHYSIOGRAPHY OF THE STUDY AREA

The study area in district Dehradun comprises montane, submontane and valley covering an area of about 2000 sq. km. situated between latitude 29° 58' and 31° 02' N, longitude 77° 35 and 78° 20' E. Altitude varies from 305 mts. at the confluence of Motichur stream and the River Ganga on south-east and 3017 mts at Kharamba peak of Chakrata hills in north-west.

Dehradun is bounded in north and north-east by Uttarkashi, in east by Tehri Garhwal, south-east by Pauri Garhwal and Bijnor, on south and south-west by Saharanpur districts of Uttar Pradesh, and in west and north-west by Sirmour and Simla districts of Himachal Pradesh.

The rugged topography of extreme northern part of Chakrata Tehsil consists of a succession of precipitous mountains and deep gorges and turbulent streams ultimately merging with main stream of the river Yamuna, which runs on western part of Doon Valley and is characteristic feature. The area is rich in hill stream species of amphibians.

The Mussoorie town and its adjoining area contribute to seasonal and perennial streams flowing down Doon Valley towards base of the Shwalik ranges. During monsoon these streams turn into torrents and drain immense volume of water including loose silt and gravel which continuously spread over the flat beds of Doon Valley. The gravel and boulders give shelter to developing subadults of amphibians in stream beds. Chakrata hills and Mussoorie – Bhadrang range together form a part of the lesser Himalaya.

Doon Valley proper, which harbours majority of amphibians, is an undulating parallelogram. It is about 80 km long from north-west to south-west and about 16 km wide in the middle, is a distinct ecobiome in district Dehradun of the Himalayan foothills.

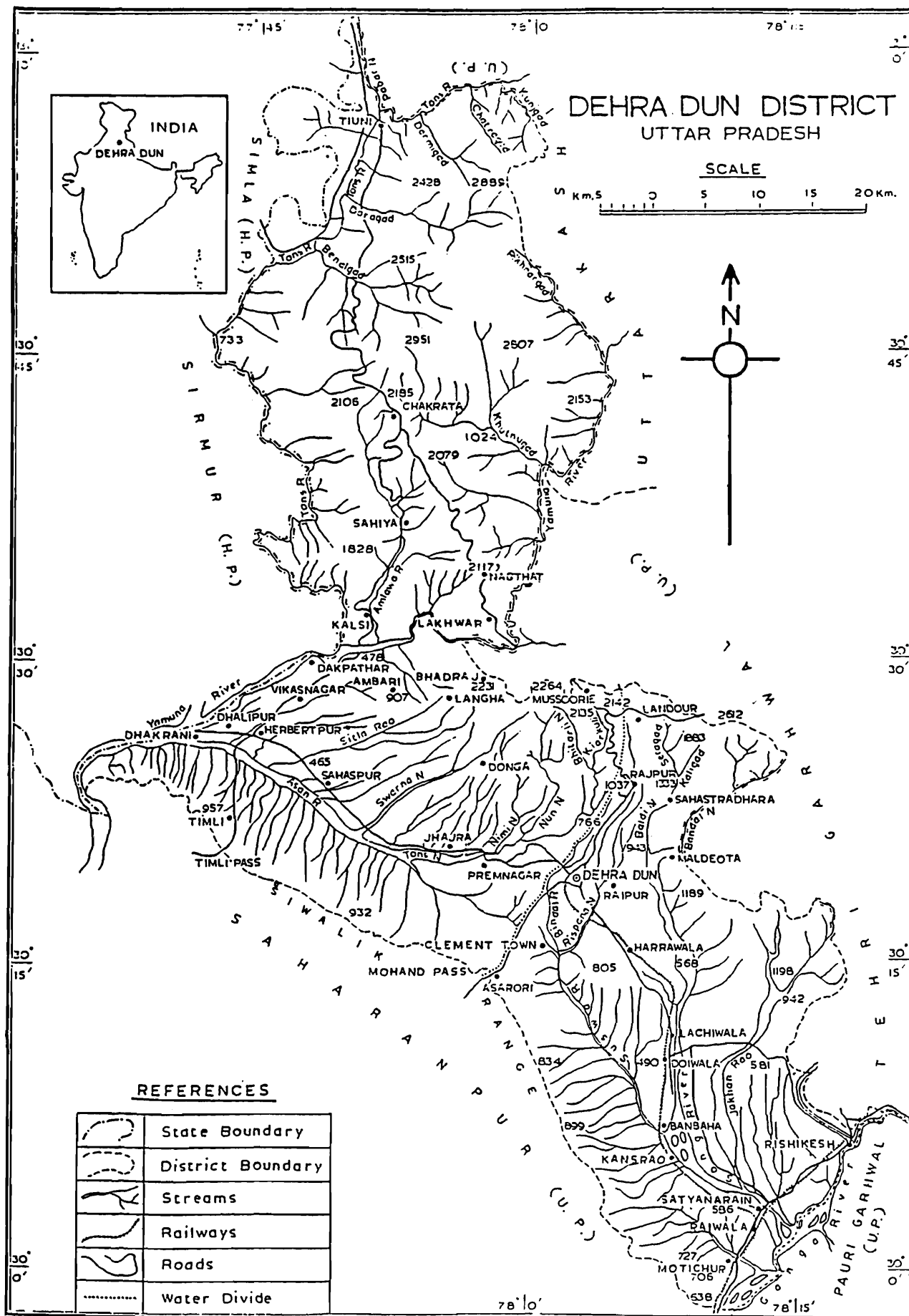
The disruption of essential ecological process, caused by exploitation of natural resources in violation of the ecological norms, causes serious threat to animals and plants of this region. Doon Valley is bounded on north-east by lesser Himalayan Ranges, and on eastern half of its south-west by the Shiwalik Ranges. The two most important rivers of North India, the Ganges and Yamuna, demarcate its south-eastern and north-western boundaries respectively. The fragility of Doon Valley is accentuated by presence of a major boundary fault passing through northern parts of Valley and by unusually heavy rainfall of about 2,000 mm per year. Doon Valley ecobiome comprises two distinct sub-catchments : one formed by drainage basin discharging into the River Ganga a little south of Rishikesh, and another formed by drainage basin discharging into the River Yamuna near Rampur Mandi. Thus, Doon Valley forms a sub-catchment for the Ganga-Yamuna river system which carries the vital water resources for the northern part of the Indian sub-continent.

## VEGETATION OF STUDY AREA

The vegetation of monsoon ponds, ditches and puddles that are located along roadsides and close to dwelling places, where majority of amphibians breed, show remarkable assemblage of plants. The water plant *Lemna perpusilla* forms a dense green cover on the surface of waters which in turn give protection to the tadpoles. The algae like *Chara* and *Nitella* constitute the submerged vegetation which act as a major food item for the larvae of amphibians, the marshy borders of these water depressions are inhabited by *Alternanthera sessilis*, *Hygrophilla polysperma* and *Eclipta prostrata*, besides grasses such as *Panicum repens*, *P. paludosum* and *P. orbiculare*.

The sal forest is dotted with several depressions and swamps. During monsoon, muddy zone is dominated by *Limnophila rugosa*, *Bacopa monnieri*, *Veronica anagallis aquatica*, *Hygrophilla polysperma* and *Monochoria vaginalis*, besides

PLATE I



sedges such as *Cyperus eleusinoides*, *C. corymbosus*, *Scirpus juncooides*, *Fimbristylis quinquangularis*, and grasses such as *Paspalum vaginatum*. Plants like *Smithia conferta*, *Polygonum barbatum gracile*, *Cyathocline purpurea*, *Sonchus brachyotus* and *Cyperus corymbosus* are common along the edges of these depressions. Adjacent to these areas, where ground is moist but not marshy, dominated by *Centella asiatica*, *Hydrocotyle sibthorpioides*, *Lindernia crustacea*, *Elephantopus scaber*, *Scleria caricina*, *Digitalia longiflora* and *Eragrostis unioloides*.

The submontane zone extends up to an altitude of 1,500mts. above mean sea level and comprises mostly *Shorea robusta*, *Cedrella toona*, *Eugenia jambolana* and *Ficus glomerata* occupy moist slopes. The components of mixed deciduous forests include, *Dalbergia sissoo*, *Anogeissus latifolia*, *Lagerstroemia parviflora*, *Terminalia belerica* and *T. chebula*. Swamp forests are characterised by *Salix tetrasperma*, *Bischofia javanica*, etc. At higher elevations (1,000 – 1,200 mts.), *Pinus roxburghii* forests occupy elevations of more than 2,000mts. Pine is associated with *Quercus incana* and *Rhododendron arboreum* in between altitude 1,200 – 1,500mts. The drier belts, however, are characterised by xeric elements like *Acacia catechu*, *Mallotus philippinensis* and *Zizyphus jujuba* with dense patches of thorny succulents such as *Euphorbia royleana* on the steep slopes. Other species include, *Cassia fistula*, *Butea monosperma*, *Dendrocalamus strictus*, *Engelhardia colebrookiana*, *Phoenix sylvestris*, *Sapium insigne*, and *Tectona grandis*. The common shrubs are : *Calotropis* sps., *Adhatoda vasica*, *Colebrookia oppisitifolia*, *Murraya koenigii*, *Rhus parviflora*, *Woodfordia fruticosa*, etc. Grass patches are usually characterised by *Eulaliopsis binata*, *Heteropogon contortus*, *Bothriochloa* sps., *Dichanthium* sps., *Arthraxon prionodes*, *Arundinella setosa*, *Themeda anathera*. Submontane zone, characterised by tropical and subtropical types of vegetation.

The montane zone extends from an altitude of 1,500mts to 3,300 mts approx. above mean sea level. This zone is dominated by vast and gregarious trees of conifers such as *Pinus roxburghii*, *P. wallichiana*, *P. gerardiana*, *Cedrus deodara*, *Abies pindrow*, *A. spectabilis*, *Taxus wallichiana*, *Tsuga tomentosa*, *Juniperus* Sps. and *Cupressus torulosa*. Different species of *Quercus* (oak) such as *Q. incana*, *Q. floribunda*, *Q. semicarpifolia*, etc. form an important element of vegetation. The other broad leaf species occurring in the lower and upper montane mixed forests include, *Acer caesium*, *A. pictum*, *Ulmus wallichiana*, *Aesculus indica*, *Corylus jacquemontii*, *Juglans regia*, *Betula utilis*, *Olea ferruginea*, *Dodonea viscosa*, *Pistacia integerrima*, *Puncicagranatum* sp. etc.

**Climate :** The climate is partly tropical and partly temperate. During monsoon it rains from mid-June to mid-August, mean annual temperature varies from 0°C to 40°C. The total average rainfall is about 2000 mm per annum, 85% of which is recorded in the months of June, July, August and September. The year may be divided climatically as below :

**Dry Summer :** It begins from March – April when average temperature is 15°C to 35°C, and extends to mid-June when maximum temperature sometimes reaches upto 38°C. This period is generally dry except occasional rains.

**Wet Summer or Monsoon Season :** It begins from mid-June. The South-West monsoon winds blow from western to eastern coast via Bay of Bengal and result in rains for about four months (late June, July, August and September). The temperature ranges from 20°C to 30°C; humidity increases to about 85%.

**Winter :** It commences from November when average maximum temperature is about 20°C. The rainfall during this season ranges from 50 to 50 mm.

Past few years, climate has had a tendency of getting to extremes probably due to increase in human settlement, urbanisation and industrialisation which reduce the vegetation and keep on changing soil pattern resulting in disturbed ecological conditions.

**Selected Aquatic Habitat of Study Area :** Aquatic habitats in study area may be classified into two groups :

**Permanent Aquatic Habitat :** There are number of permanent habitats in the form of rivers, hill streams and slow running streams, viz., the Ganga, the Song, the Suswa, the Yamuna, the Amlawa, the Tons, the Asan and their tributaries. Water is permanent and flow very fast. Water has low and steady temperature and contains sufficient oxygen. The pH fluctuates a little, between 8.0 – 9.5 and water remains alkaline. Though gradient is very steep, bed is stable because of large stones and boulders which are closely pressed to each other and to the floor of the channel. Water movement, whether it is fast or slow, is a main factor in shaping the substratum of a river or a stream. The dried up water bodies formed below submerged stones are important for the survival of tadpoles.

**Temporary Aquatic Habitats :** These are formed as a result of seasonal rainfall by the south-west

monsoon and constitute small isolated bodies of water. The water is warm and stagnant and is characterized by (i) an unusually low quality of dissolved electrolytes, especially lime which is about a tenth of the quantity normally occurring in the streams, (ii) mild acidic nature. The pH in the early stages of their formation is about 9.0 while with the ageing of the pond, it decreases to as much as 6.0 (iii) high content of humid materials which imparts yellowish to brownish colour to the water. In addition, substratum which consists of mud, rotting vegetation and organic material exerts a strong influence on the property of water in the pools. A vigorous decomposition process which releases much CO<sub>2</sub> is constantly at work in these pools. Although the oxygen concentration is very low, tadpoles cannot leave water owing to their prime need to survive and to propagate further. The localities, viz., ponds near Harrawala, Defence colony, Selakui, Langha road, Jassowala, Sahaspur and several roadside water-pools were selected for the purpose of study. Apart from these, cemented garden tanks were frequently visited to collect different stages of life-history of frogs and toads.

The major differences of condition obtaining in permanent and temporary aquatic habitats are given in table 1.

**Table 1 :** Differences of conditions prevailing in Permanent and Temporary Aquatic habitats.

<i>Conditions</i>	<i>Permanent aquatic habitats</i>	<i>Temporary aquatic habitats</i>
<i>Velocity of water</i>	<i>Present (low or high)</i>	<i>Absent</i>
<i>Substratum</i>	<i>Stony</i>	<i>Muddy</i>
<i>pH reaction</i>	<i>Alkaline</i>	<i>Acidic</i>
<i>Temperature</i>	<i>Stable</i>	<i>Fluctuates considerably</i>
<i>Salinity</i>	<i>Low</i>	<i>Varies appreciably</i>
<i>O<sub>2</sub> concentration</i>	<i>High</i>	<i>Low</i>
<i>CO<sub>2</sub> concentration</i>	<i>Low</i>	<i>High</i>
<i>Humic material</i>	<i>Comparatively much less, turbidity negligible</i>	<i>Considerable, giving a yellowish to brown colour to the water</i>
<i>Aquatic vegetation</i>	<i>Negligible</i>	<i>Appreciable</i>
<i>Expanse</i>	<i>Free</i>	<i>Confined</i>

## MATERIALS AND METHODS

The material for present study was collected by frequent visits to permanent and temporary aquatic habitats including nearby forests, tree-holes, under-logs, under-stones, under-leaf-litters. As the majority of amphibians are nocturnal in habit, they are collected by hand nets. Larval stages were collected by a dip-net fitted with a wire rim bolted to a stick about 2 to 3 m long. Collection of larval stages from ponds and banks of rivers was done with help of this net by pulling it through weeds and dragging it along periphery of pond. The larval stages were collected by hand-nets of smaller mesh-size. Adults were narcotised and killed by dipping them into 4 to 8% formaldehyde solution in a plastic container. After retaining them for 48 hours, transferred to spirit (70% alcohol) for long-range preservation and study. Tadpoles of earlier stages were preserved in 1 to 2% formaldehyde solution, advanced stages were preserved directly in 4% formaldehyde solution. Permanent preparations of mouth parts, specially keratinized portions, were made by excision, cleared by Xylene and finally mounted on microslides. Osteological preparations were made by treating formalin preserved specimens with 2% KOH and alizarin staining.

**Rearing of Developmental Stages :** In order to study entire life history, breeding males and females in pairs were picked up with least disturbances, shifted and placed in an aquarium for releasing their spermatozoa and eggs. It may take several hours to lay the spawn. As they usually release their eggs at night, this process observed only at night. After releasing the spermatozoa and ova, pairing couples are taken out from aquarium. Adults released after recording their measurements and identification, rare forms are, however, preserved for further studies.

Among the larval forms, hindlimb stage and some initial stages were only selected for study and description; this would suffice to correlate them with their adults and distinguish them from each

other. Since rearing of tadpoles is time-consuming and a laborious task it was decided to study life history of species in the area where they are normally distributed.

**Taxonomic Study of Adults :** Well preserved adults were taken up for study of their morphological, morphometric and meristic characters. In certain cases where a long series of specimens were available, skeletons were prepared for study of osteology and correlation of these characters for their identification.

Following morpho-measurements were taken for taxonomic studies :

1. *Snout to Vent Length* : This measurement was taken by a good divider; one point of divider is placed at tip of snout and other at tip of the anal opening (vent). Distance between two tips of divider was measured by placing them on a millimetre scale and reading was recorded.
2. *Head Length* : Head length was measured from extreme angle of jaws to tip of snout.
3. *Head Width* : Maximum width at angle of jaws of both sides.
4. *Snout Length* : Snout length measured from anterior point of eyes to tip of snout.
5. *Nostril to Eye* : Distance between posterior edge of nostril and anterior edge of eye.
6. *Nostrils to the tip of Snout* : Distance between anterior edge of nostrils to tip of snout.
7. *Eye Diameter* : Distance between anterior and posterior edges of eye orbit.
8. *Width of Upper Eyelid* : Transverse distance between medial and outer edge of eyelid.
9. *Inter-Orbital Width* : Distance between two orbits.

10. *Inter-Narial Distance* : Distance of one nostril to other.
11. *Tympanum Diameter* : Distance measured between anterior and posterior edges of tympanum.
12. *Forelimb Length* : From axil to tip of longest finger in stretched condition.
13. *Length of First & Second Fingers* : The length from tip of individual finger to base of angle formed between two adjacent fingers, and from same point length of second finger is measured.
14. *Length of Third & Fourth Fingers* : The length is measured likewise from tip of respective finger to base of angle formed with adjoining finger.
15. *Length of Hind Limb* : From vent to tip of longest toe.
16. *Thigh Length* : From vent to tibio-femoral joint.
17. *Tibial Length* : From tibio-femoral joint to tibio-tarsal joint.
18. *Tibial Diameter* : Maximum width of tibia.
19. *Foot Length* : From anterior margin of inner metatarsal tubercle to tip of longest toe.
20. *Length of Toes* : Each toe is measured from its tip to base of angle (without muscular attachment). Where muscle is more pronounced (as in *Bufo*), toes are measured from a imaginary horizontal line drawn in between two metatarsal tubercles to tip of individual toe.
21. *Length of Metatarsal tubercle* : Distance between anterior and posterior edges of tubercle.
22. *Width of Discs* : Maximum transverse distance between edges of disc.

23. *Tibiotarsal articulation* : Distance between acetabular joint and articulation of tibia and tarsus.
24. *Tarso-metatarsal articulation* : Distance between tarsal joint to the tip of inner metatarsal tubercle.

### Morphological Characters

1. *Oral Disc* : Fleshy disc bordering mouth.
2. *Rostrodonts* : Keratinized rostral coverings (Beaks); upper one is supra-rostrodont and lower is infra-rostrodont.
3. *Keratodonts* : Upper and lower labial teeth.
4. *Labial teeth row* : The keratodonts are arranged in a horizontal. Sometimes obliquely placed rows on upper and lower jaws. Some of them may be medially interrupted while others are uninterrupted or entire.

### Measurements used for larval study

1. Distance between tip of snout to tip of tail.
2. *Head and body length* : Tip of anterior margin of snout to caudal base.
3. Maximum width of head and body.
4. *Tail length* : From base of vent to tip of tail.
5. *Interocular distance* : Distance in between two eyes.
6. *Internarial distance* : Distance in between two nostrils.
7. *Height of Caudal muscle* : Vertical height from ventral to dorsal aspect at base.
8. Height of dorsal caudal membrane.
9. Height of ventral caudal membrane.

(All measurements were taken in millimetres).

**Table 2 : Amphibian Fauna of District Dehradun, Uttar Pradesh**

Order	Families	Genera	Species
Anura	Ranidae	<i>Amolops</i> Cope, 1865	** <i>Amolops afghanus</i> (Guenther, 1858) * <i>Amolops chakrataensis</i> sp. nov. <i>Amolops formosus</i> (Guenther, 1875) * <i>Amolops jaunsari</i> sp. nov.
		<i>Rana</i> Linn. 1758	<i>Rana crassa</i> Jerdon, 1853 <i>Rana cyanophlyctis</i> Schneider, 1799 <i>Rana limnocharis</i> Boie (in Grav.), 1829 <i>Rana tigerina</i> Daudin, 1802 * <i>Rana (Paa) tuberculata</i> Tilak & Ray, 1985
		<i>Tomopterna</i> Dum, & Bibr. 1841	<i>Tomopterna breviceps</i> Schneider, 1799
	Bufonidae	<i>Bufo</i> Laurenti, 1768	** <i>Bufo himalayanus</i> (Guenther, 1864) <i>Bufo melanostictus</i> Schneider, 1799 ** <i>Bufo stomaticus</i> Luetken, 1863
	Rhacophoridae	<i>Polypedates</i> Tschudi, 1839.	<i>Polypedates maculatus</i> (Gray, 1832)
	Microhylidae	<i>Microhyla</i> Tschudi, 1839 <i>Uperodon</i> Dum. & Bibr. 1841	<i>Microhyla ornata</i> (Dumeril & Bibron, 1841) <i>Uperodon systoma</i> Schneider, 1799

\* New taxa

\*\* New distributional records.

The drawings have been prepared with the help of Camera Lucida fitted over a low power wide field Stereomicroscope. The morphometric data of several hundreds of specimens of the species studied here are recorded in tables and preserved as base-line data but not reproduced in this work in toto; however, they are presented under each species in a consolidated form after working out the ratios of only such characters which reveal taxonomic differences between the allied taxa.

### SYSTEMATIC ACCOUNT

A total of 1497 specimens were collected from various ecological habitats of district Dehradun (Uttar Pradesh) during 1983 – 1987. All these specimens were preserved and examined in laboratory for taxonomic identification.

The study revealed the occurrence of 16 species belonging to 7 genera, and 4 families of Amphibia in this region of Uttar Pradesh. Of these, 3 species

are new to science and 3 species are reported for the first time (Table 2).

The study further indicates the fact that amphibian fauna of this area is quite rich and is similar to that of Burma, Nepal and Pakistan in addition to the amphibian fauna found elsewhere in India.

A detailed identification key is given for taxonomic characterisation. The key is chiefly based on morphological features of adult and tadpole, osteological features of adult, breeding habits, types of habitat and skin colouration.

### Key to the Species of Amphibians of District Dehradun (U. P.)

1. Maxillary teeth absent; coracoids and precoracoids connected by an arched cartilage (the epicoracoid) of one side overlapping that of other side; transverse processes of

sacral vertebra dilated; parotoids present ...  
 ..... (Arcifera) ... (Bufonidae : *Bufo*)..(2)

Maxillary teeth present; coracoids firmly united by a simple epicoracoid cartilage; precoracoids if present, each resting with its distal extremity upon the coracoid, or connected with latter by epicoracoid cartilage; transverse processes of sacral vertebra cylindrical; no parotoids(Firmisternia) ... (4)

2. Head without elevated cranial ridges and no concavity on frontoparietals; body covered with dark grey patches, ventrally immaculate; parotoids flat, elongated (tadpoles lighter in colourations with expanded anterior end; three rows of lower labial teeth (keratodonts)) ...  
 ..... *Bufo stomaticus* Luetken.

Head with elevated cranial ridges and concavity present on medial aspect of frontoparietals; parotoids large; kidney shaped .....(3).

3. Head with cornified elevated cranial ridges; body covered with spiny tipped glands on dorsal aspect; tympanum large, more than half diameter of eye; lateral rim of upper jaw not expanded; parotoids kidney shaped; dorsally dark grey or black cornified spinules with elevated glands; whole body rough; tadpoles blackish, with globular anterior end, tail membranes thin .....  
 ..... *Bufo melanostictus* Schneider

Head with flat, low and blunt non-cornified cranial ridges; body covered with flat irregular shaped porous warts or glands on dorsal aspect; ventral glands smaller in size and uniformly set; tympanum small, less than half diameter of eye; parotoids elongated with anterior end wider than the posterior; dorsally olive, ventrally immaculate; tadpoles black with thick tail membrane .....  
 ..... *Bufo himalayanus* Guenther

4. Head more or less long; eyes large; tongue notched and free behind; maxillary and vomerine teeth present; transverse processes of sacral vertebra cylindrical; more aquatic; hind limbs long; extensive webbing in between toes; tadpoles with well developed rostradonts and keratodonts; spiraculum sinistral (placed on left side).... (Ranidae & Rhacophoridae)  
 ..... (5)

Head small; eyes small; maxillary and vomerine teeth absent; tongue entire and free behind; more terrestrial; hind limb short; webbing in between toes less pronounced; tadpoles without oral dentition; spiraculum ventro-median ..... (Microhylidae).....(6)

5. Tree dwellers; with rudiment of web between fingers; waist narrow; digital pads ventrally biconvex; intercalary ossicle present inbetween penultimate and distal phalanges; earlier stages of development in foam-nest; tadpoles with sinistral spiraculum and anal opening dextral .....(Rhacophoridae)  
 ..... *Polypedates maculatus* Gray

Terrestrial and aquatic forms; no web between fingers; body streamlined to flabby; digital pads ventrally uniform; intercalary ossicle absent; developmental stages in water; sinistral spiraculum and anal opening median .....Ranidae..... (7)

6. Body globular in shape with distinct reticular patch of dark brown and white on dorsal aspect; hind limb robust; foot with two shovel-shaped metatarsal tubercles; tadpoles well blotched ..... *Uperodon systoma* Schneider

Body elongated, small with ornamental golden colouration on dorsal aspect; hindlimb uniform without shovel-shaped metatarsal tubercle but one inner elongated and outer small knob like metatarsal tubercle present; tadpoles transparent .....  
 ..... *Microhyla ornata* Dum. & Bibr.

7. Metatarsals separated by web; inner metatarsal tubercle not shovel-shaped; more aquatic (*Rana* and *Amolops*) .....(8)

Metatarsals not separated by web; inner metatarsal tubercle shovel-shaped; more terrestrial and burrowing form .....  
..... *Tomopterna breviceps* Schneider

8. Digital tips swollen, not dilated into discs; tadpoles usually with less than four rows of upper labial teeth and without ventral sucker .....*Rana*....(9)

Digital tips dilated into discs with circummarginal groove; terminal phalanges 'T' shaped; tadpoles with ventral abdominal sucker .....*Amolops*....(13)

9. Male with secondary sexual character in the form of spines on first and second fingers; females with large oval first finger equal to the second; hill stream dwellers; tadpoles (hindlimb stage) with more than four rows of upper labial teeth *Rana (Paa) tuberculata* Tilak and Ray

Male with secondary sexual character as nuptial pads on the first finger and with distinct vocal sacs; females with small ova; pond and ditch dwellers; tadpoles (hindlimbed stage) with upper three rows of labial teeth ..... *Rana (Rana)*....(10)

10. Inner metatarsal tubercle shovel-shaped; heels not overlapping ..... *Rana crassa* Jerdon

Inner metatarsal tubercle not shovel-shaped; heels overlapping ..... (11)

11. Three phalanges of fourth toe free of web; outer metatarsal tubercle small; living near edge of water .....*Rana limnocharis* Boie in Gravenhorst Toes with extensive web upto the tip; no outer metatarsal tubercle ..... (12)

12. Inner metatarsal tubercle small, blunt; first

finger longer than the second finger; subarticular tubercles well developed; digital tips rounded and obtuse; more terrestrial than aquatic .....*Rana tigerina* Daudin

Inner metatarsal tubercle digitiform; first and second fingers almost equal; subarticular tubercles indistinct; digital tip pointed; more aquatic than terrestrial .....*Rana cyanophlyctis* Schneider

13. Smaller in size; head width equal to its length; first and second fingers equal; posterior part of thigh blotched into a reticulum .....*Amolops jaunsari* sp. nov.

Larger in size; head wider than long; first finger shorter than second; posterior part of thigh not blotched ..... (14)

14. The discs of fingers quite large; length of third finger 2.5 to 3 times of snout length; two digits of fourth toe bear a fringe of web; body green with brilliant brown spots; limbs spotted .....*Amolops formosus* Guenther

The discs of fingers smaller in size; length of third finger 1.5 to 2.00 times in snout length; webbing in between toes starts from base of disc; dark olive throughout; limbs cross barred ..... (15)

15. Dorsal aspect with discontinuous, beaded dorsolateral glandular folds; pineal ocellus absent .....*Amolops afghanus* Guenther

Dorsal aspect with distinct dors-lateral glandular folds; pineal ocellus present .....  
..... *Amolops chakrataensis* sp. nov.

#### Genus *Amolops* Cope, 1865

*Amolops* Cope (1865) *Nat. Hist. Rev.* : 117 (Type species : *Polypedates afghana* Guenther 1858.

*Staurois* Cope (1865) *Nat. Hist. Rev.* : 117.

**Distinguishing Features** : Pupil horizontal, vomerine teeth obliquely placed between choanae,

broad tongue deeply notched and free behind. Tips of fingers and toes dilated into distinct discs bearing crescentic groove, separating upper and lower surfaces. Fingers free. Toes extensively webbed. Outer metatarsals entirely separated by web or nearly so. Omosternal style not forked at the base. Terminal phalanges with transverse expansion (T-shaped). Tadpoles with ventral abdominal sucker.

**Distribution :** India : Eastern and Western Himalaya (alt. 1500 to 3000 mts.)

Elsewhere : The Himalaya; Nepal; Southern Yunnan; The hills of Burma as far south as Tenasserim and Siam.

#### Known Indian Species :

1. *Amolops afghanus* (Guenther, 1858)
2. *Amolops Chakrataensis* sp. nov.
3. *Amolops formosus* (Guenther, 1875)
4. *Amolops jaunsari* sp. nov.
5. *Amolops monticola* (Anderson, 1871)

#### *Amolops afghanus* (Guenther, 1858) (Plate II, III & VIII)

*Polypedates marmoratus* Blyth (1865) *J. Asiat. Soc. Beng.*, **24** : 188.

*Polypedates marmoratus* Anderson (1871) *Proc. Zool. Soc.*, London. : **209**; and *Anat. Zool. Res. Yunnan* : 842; Stoliczka (1872) *Proc. Asiat. Soc. Bengal* : 108.

*Polypedates afghana* Guenther (1858) *Cat. Batr. Sal. Brit. Mus.* : **81** (Type locality : Afghanistan; Types in British Museum). Guenther (1864) *Rept. Brit. India.* : 432.

*Amolops afghanus* : Cope (1865) *Nat. Hist. Rev.* : 117; Inger (1966) *Fieldiana : Zool.*, **52** : 1–402; Dubois (1974b) *Bull. Mus. natn. Hist. nat.*, (3) n°**213**, (Zool. 143) : 356–357; Gorham (1974) *Checklist of World Amphibians upto January 1, 1970* : **127**; Pillai & Chanda (1979) *Rec. Zool. Surv. India*, **75** : 385–387; Pillai & Chandra (1981) *Rec. Zool. Surv. India*, **79** (1–2) : 159–168; Sarkar & Sanyal (1985) *Rec. Zool. Surv. India*, **82** (1–4) : 285–295; Pillai & Murthy (in Majpuria) 1986) *Wild life wealth of India* : 186–209; Inger & Dutta (1987) *J. Bombay nat. Hist. Soc.*, **83** (Suppl.) : 135–146.

*Ixalus kakhienensis* Anderson (1879) *Ant. Zool. Res. Yunnan* : **845**, pl 78, fig. 6.

*Ixalus argus* Annandale (1912) *Rec. Indian Mus.*, **8** : 16–17, 33, pl. 3,

*Rana afghana* : Boulenger (1882) *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, : 69–70; Boulenger (1887) *Ann. Mus. Genova* (2) V : **420**; **420**; Annandale (1912) *Rec. Indian Mus.*, **8** : 7–36; Smith (1929), *Rec. Indian Mus.*, **31** : 77–80; Smith (1940) *Rec. Indian Mus.*, **42** : 465–486.

*Rana latopalmata* Boulenger (1882) *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, : **13**, 464; Boulenger (1890) *Fauna Brit. Ind., Rept. & Batr.*, : 441, 462–463; Boulenger (1893) *Ann. Mus. Genova* (2) XIII : 337; Boulenger (1893) *Proc. Zool. Soc. London.*, : 526, pl XLII, fig 3; Cochran (1930), *Proc. U. S. Nat. Mus.*, Washington, **77** : 5.

*Rana (Hylorana) latopalmata* Boulenger 1920 *Rec. Indian Mus.*, **20** : 123, 128, 130, 217–219.

*Staurois latopalmata* : Bourret (1942) *Les Batr. de l'Indochine, Inst. Ocean.*, Hanoi., : X–547.

*Staurois afghana* : Kripalani (1952) *Rec. Indian Mus.*, **50** : 359–365. Tilak & Mehta (1983) *Res. Bull. (Sc.) Punjab Univ.*, **34** (III–IV) 157.

*Staurois afghanus*, Noble (1931) *Biology of Amphibia* : 521; Pope & Boring (1940) *Peking Nat. Hist. Bull.*, **15** : 47; Liu (1950) *Fieldiana Zool. (Mem.)*, **2** : 358; Kripalani (1953) *Rec. Indian Mus.*, **50** : 359; Kripalani (1961) *Rec. Indian Mus.* **59** : 243.

**Material Examined :** One adult female, 6 exs of male and 52 exs of tadpoles collected from Garkigad, nearly 15 kms. east of Kalsi-Barkot Road, dated 20.V.78 by Dr. Raj Tilak & Party.

**Description :** Head dorsoventrally flattened. Tip of snout rounded, slightly projected beyond the lower jaw. Head wider (24 mm) than long (22 mm). Snout longer than maximum diameter of eye (8 mm). Nostrils nearer tip of snout than anterior corner of eye. Nostrils nearly oval with a small fleshy expansion on hinder part. Canthus rostralis rounded, loreal region concave. Inter-orbital distance equal to width of upper eyelid. Tympanum more or less rounded, its Maximum diameter (2 mm) equals its distance to eye. Presence of small vestige of pineal ocellus. Maximum diameter of eye 1.25 times of typanum. Vomerine teeth in two short series of 4 to 5 teeth, almost perpendicular to the axis of body, closer to each other than to choanae and longer than distance between them. Maxillary teeth well developed. Tongue wide, papillated, notched behind. Supratympanic flod present, continues from posterior corner of eye to angle of jaws.

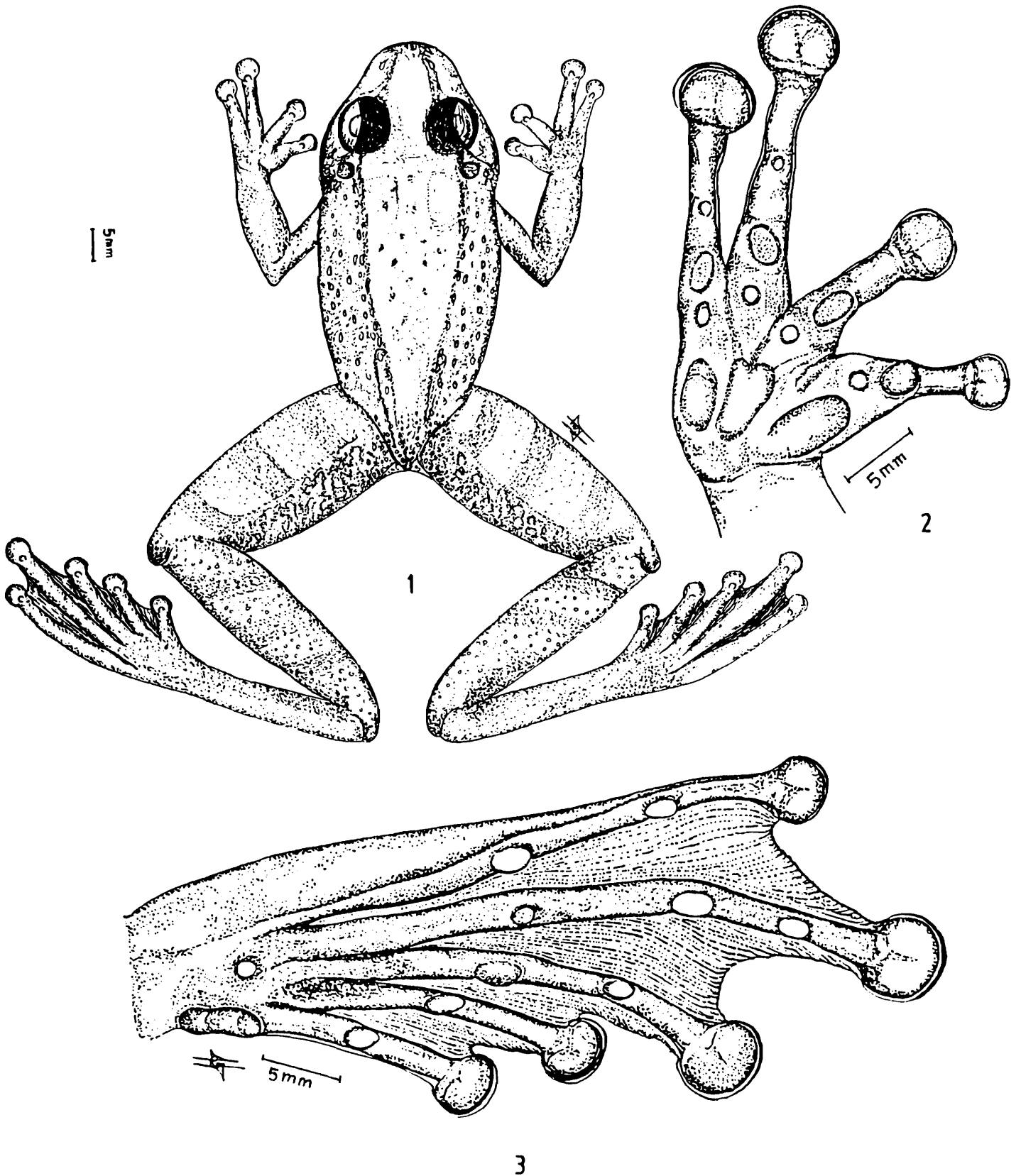
Well developed forelimbs. Fingers with terminal discs. A distinct groove present on upper surface of fingers at junction between penultimate and last phalanx. Discs flattened, rounded, much wider than long, with circummarginal groove. Disc of first finger less developed and smaller than the rest. Proximal sub-articular tubercles of fingers prominent, longer than wide. Distal tubercle indistinct. Internal metacarpal tubercles prominent but small. Two twin palmer tubercles elongated, flattened, moderately prominent. Distal part of foreleg more muscular than proximal part. First and second finger almost large and quite separated from each other. Third finger the longest. fourth finger slightly greater than second. The first and second metacarpals free just above the base, whereas third and fourth adhere to each other throughout their length.

Hind limbs moderately long, rather strong and well developed, suitable for leaping, jumping and swimming. Tibiotarsal articulation extends upto tip of snout but not beyond. Heels overlapping strongly when limbs folded at right angles to the body. Length of tibia 3.5 times of its width, slightly longer than distance from the base of inner metatarsal tubercle to the tip of longest (fourth) toe. Tips of toes with broad disc. External metatarsals separated by web. Webbing complete to the base of disc of each toe. Two distinct metatarsal tubercles. Outer metatarsal tubercle small and circular, inner elongate almost half the length of inner toe. The proximal subarticular tubercle longer than wide. Middle subarticular tubercle round, distal subarticular tubercle indistinct.

**Colouration :** Skin of upper parts dark olive. Lateral aspects of body darker than rest of the body. Upper parts of limbs cross barred with dark brown colouration mottled with cream base. Ventrally immaculate except the margin of lower jaw, which speckled with brown. Dorsal aspect with round flattened elevated glands whereas laterodorsal aspect bears elongated glands of higher numbers and closely set. There is discontinuous row of elongated glands resembles dorsolateral glandular folds. The colouration of glands is darker than body.

**Larval Morphology :** Tadpole (25–27mm) : Oral disc with wavy margin at the angles. Mouth ventral and horizontal guarded by upper rostradont and lower rostradont. Upper rostradont or suprarostradont curved medially like inverted 'V' with serrations along the margin. The infrarostradont is also serrated along margin, comparatively smaller and 'V' shaped enclosed by suprarostradont. Both rostradonts entirely keratinized and black. Keratodonts are multidenticate with pointed tips. Supra-angular keratodonts arranged horizontally of which outer two are continuous (uninterrupted) and four interrupted. Upper one of Infra-angular keratodonts

PLATE : II



*Amolops Afghanus* Guenther

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view)

continuous and notched medially. Middle one also continuous but medial notch indistinct. The inner interrupted by central projection of infrarostrodont. Nostrils oval and placed in a depression, open laterally, visible from latero-dorsal aspect. Eyes dorsally placed. Spiracular opening tubular ventro-laterally placed. Vent basicaudal, opening posteriorly at the junction of ventral fin and abdomen. Tail tip rounded. Dorsal fin originates as a fleshy crest on the antero-medial aspect of caudal muscle. Caudal base almost equal to the height of the trunk. Axis of the tail straight.

**Osteological Characters :** The skull is flattened dorsoventrally. Nasals are of large and separated from each other. Frontoparietals are rectangular, united in middle. Pectoral girdle is typical firmisternal with an omosternum entire. Episternum

is a small rounded plate of cartilage. Xiphisternum much wider than omosternum, with a broad, flat xiphoid cartilage.

**Habitat :** These frogs always inhabit near hillstreams and adjoining areas, usually conceal themselves under boulders facing water bodies, whenever disturbed, they dive into water and hide themselves under stones lying on the bottom of fast flowing streams. They breed during the month of April to June. The advanced stage of tadpoles have been collected during May to August, although different stages of tadpoles are available in fast flowing streams throughout the year. Probably, there is a phenomenon of over wintering in these tadpoles; this phenomenon is characteristic life history of frogs inhabiting fast flowing streams in hills where water temperature is low and the

**Table 3 :** Measurements of finger and disc of right palm of *Amolops afghanus*

	I	II	III	IV
Length of finger	8	8.50	12	9
Width of phalangeal discs	2.25	2.75	3.10	3.00

**Table 4 :** Measurements of toe and disc of right foot of *Amolops afghanus*

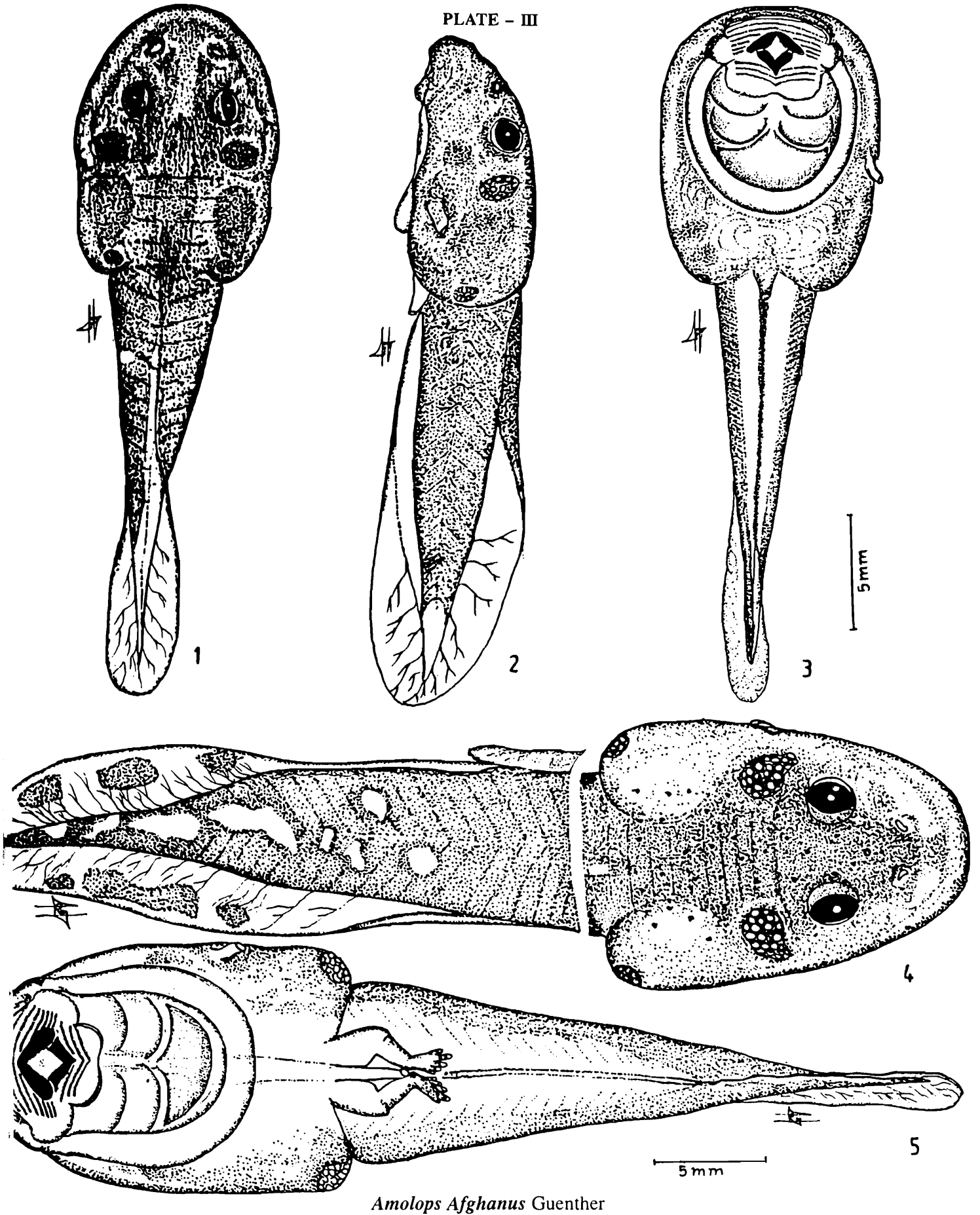
	I	II	III	IV	V
Length of toe	9	12	19	22.5	20
Width of toe disc	2.50	3.00	2.75	2.75	2.50

**Table 5 :** Measurements of three different stages of tadpoles of *Amolops afghanus*

	26 mm stage without limbbud	54 mm stage Hind limb with 5 toes	62 mm stage Hind & fore limbs
Total length	26	54	62
Head & Body length	11	22	22
Tail length	15	32	40
Maximum width of Body	12	13	19
Internarial distance	2.5	4	4.5
Interocular Distance	5	7	7.5
Height of Caudal base	4	8	8

(All measurements are in millimetre scale)

PLATE - III



*Amolops Afghanus* Guenther

Fig. 1. 10 days' old Tadpole (Dorsal view); 2. 10 days' old Tadpole (Lateral view); 3. 10 days' old Tadpole (Ventral view); 4. 25 days' old Tadpole (Dorsal view); 5. 25 days' old Tadpole (Ventral view)

growth of tadpole is slow. They do not complete their course of development by the end of summer unlike that of many species of frogs in plains where water is comparatively warmer and abundant only during rainy season.

**Remarks :** Boulenger (1992) recognised *Polypedates afghana* Guenther, (1858), under the genus *Rana*. Later he (Boulenger, 1920) synonymised *Rana afghana* (Guenther, 1858) and *Amolops afghanus* (Cope, 1865), under *Rana (Hylorana) latopalmata* Boulenger. Bourret (1942) and Liu (1950) included this species in the genus *Staurois* Cope, 1865; Kripalani (1952, 1953, 1961) followed. However, this consideration is not well based because the tadpoles of *Staurois* are indeed without a ventral abdominal sucker (Dubois, 1974b). Inger (1966) confirmed the valid generic status of *Amolops* Cope (1865), which is characterised by peculiar gastromyzophorous (with ventral abdominal sucker) larvae and adaptation to the torrential stream-dwelling habit, re-established the genus *Amolops* Cope and included *afghanus* in it.

Kripalani (1952) has tried to differentiate the tadpoles of *Amolops formosus* (= *Staurois himalayana*) and *Amolops afghanus* (= *Staurois afghana*) based on larval dentition. In the present study the larval forms of different stages of *Amolops afghanus* show oral dentition which is variable from earlier stage to the forelimbed stage, and show both the probabilities. Therefore, distinction between tadpoles of both species is arbitrary. It is, therefore, felt inappropriate at this stage to correlate with certainty the larval forms bearing with a ventral abdominal sucker of *Amolops formosus* tadpole, unless the different stages of development are collected and reared from amplexant pairs of this species. In the present study various larval stages were reared in the laboratory and correlated with juvenile and adult of *Amolops afghanus*. Further, the tadpoles of same were also collected from stream where adults and subadults were collected.

The present study reveals that all tadpoles of *Amolops afghanus* are immediately recognizable by their abdominal sucker. The sucker, which occupies essentially the entire ventral surface of body behind oral disk, has raised lateral and posterior borders. These raised margin begins immediately behind lateral corners of oral disk. In almost all forms examined, there is a band of keratinized tissue just inside the lateral and posterior margins of sucker. Normally, an oval or round patch of similar material lies on each side just medial to the inframarginal band in front half of the sucker.

***Amolops chakrataensis* sp. nov.**

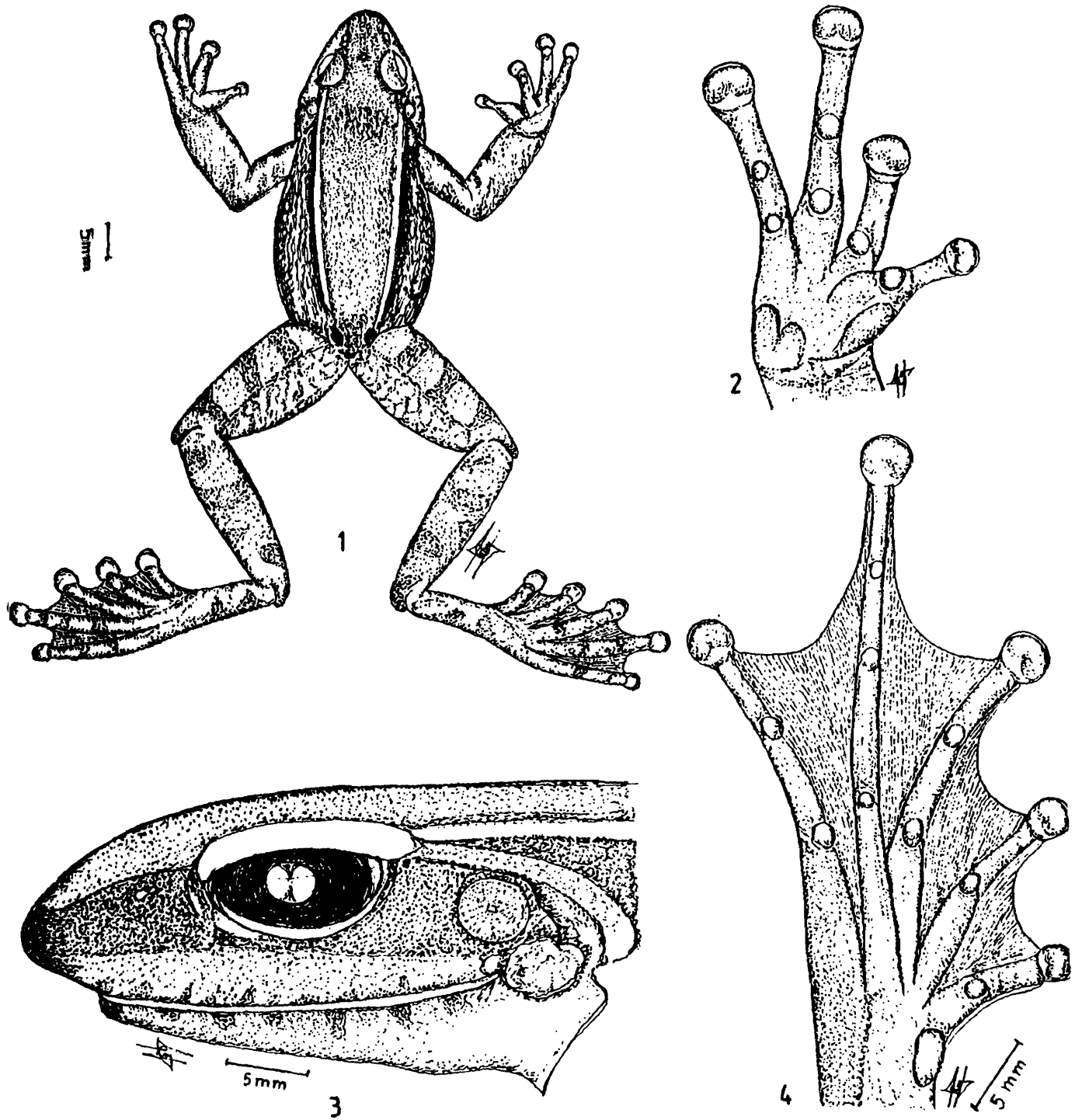
(Plate IV & VII)

**Diagnosis :** A medium sized frog with female 55 mm (tip of snout to vent length), eye small (6 mm), diameter of eye greater than snout (7 mm); head wider (17 mm) than long (16 mm). Posterior of thigh bloched dark brown and creamy yellow. Length of tibia (27.5 mm) equal to half of the distance between snout tip to vent (55 mm).

**Holotype :** NRS/ZSI A-25 collected from a hill stream, nearly 14 kms. north-west of Chakrata on Tuni road, Tehsil Chakrata, Dehradun. Date : 11.III.85, Coll. P. Roy.

**Description :** Body moderately stout; head wider (17 mm) than long (16 mm) snout obtusely pointed, projecting well beyond the lower jaw. Head dorsoventrally flattened. Upper eyelids not elevated, almost in level with interorbital space. Eye diameter (6 mm) slightly shorter than length of snout (7 mm). Internarial distance (6 mm) slightly greater than interorbital distance (5.5 mm). Nostrils nearer anterior corner of eye than tip of snout. Interorbital distance greater than upper eyelid. Diameter of tympanum (3 mm) almost half the diameter of eye. Pineal ocellus clearly visible, just on the middle line connecting anterior corners of orbits. The distance between tympanum and posterior corner of eye almost equal to the diameter of

PLATE - IV



*Amolops chakrataensis* Sp. nov.

Fig. 1. Adult female (Dorsal view); 2. Hand (ventral view); 3. Foot (Ventral view); 4. Head (Lateral view)

tympanum. Canthus rostralis distinct, oblique, loreal region concave. There is a glandule almost equal to diameter of Tympanum, situated just above jaw commissures. Supratympanic fold distinct, commencing from posterior corner of eye and extending downwards laterally near the shoulder joint. Tympanum concealed below supratympanic fold. Vomerine teeth feeble, arranged obliquely in groups. Tooth bands separated by a distance slightly less than the width of one group, groups on line connecting rear rims of choanae; tongue broad, well notched behind, without well developed papilla. Body dorsally flat with little slope anteriorly. Two distinct elevated dorsolateral glandular folds commencing from posterior corner of upper eyelid, extend dorsolaterally upto sacral region, where they subdivide into small glands surrounding anal aperture. The distance between two folds is wider in anterior region than in posterior region. Lateral aspect of belly and shoulder region covered with elongated glands. Abdomen was full of ova during March.

Upper arm slender whereas the fore-arm more muscular and stout. Fingers long and slender, terminating in well developed discs. Discs almost equal to diameter of tympanum, as long as wide with distinct circummarginal groove, separating upper surface from that of lower. Length of first finger (7 mm) almost equal to the snout length. Disc of first finger less in dimension than that of second, third and fourth. First finger (7 mm) shorter than second (7.5 mm) and fourth finger (8.5 mm). Third finger longest (12 mm). No supernumerary tubercles on metacarpals. Two elongated palmer tubercles present. Subarticular tubercles well developed and rounded, placed on digital joints except distal joints of penultimate phalanges. On dorsal aspect there is an elevated fold of skin with groove on outside at the joints of distal and penultimate phalanges. This fold of skin facilitates easy and flexible movement of the disc with penultimate phalanges. This is perhaps an adaptation to the hill-stream dwelling frogs which need firm flexible movement against fast-

flowing water and for jumping from one rock to other.

Hind leg moderate, not slender. Heels strongly overlapping when limbs are folded at right angles to body; diameter of tibia (6mm) approximately 4.66 times in its length (28 mm). Length of thigh (27 mm) less than length of shank (tibia). The diameter of thigh (12 mm). 2.25 times in its length. Length of foot (28mm) equal to length of shank. Length of tarsus 8 mm. Tibiotarsal articulation reaching only tympanum or just posterior corner of eye. Toes terminating into discs smaller than those of fingers. Outermetatarsals separated by web near to the base. Toes almost completely webbed. The web reaching discs of all toes except a fringe on penultimate phalanx of fourth toe. Fourth toe, longest (21.5mm). Third toe (17 mm) as long as fifth toe. First toe (7.5 mm) smaller than second toe (11 mm). Elongated bean-shaped inner metatarsal tubercle equal to its distance from first subarticular tubercle (proximal) of first toe. Subarticular tubercles of toes well developed and arranged in a manner as in other species of the genus. No outer metatarsal tubercle. There is a fold of skin on dorsal aspect of knee and ankle joints, forming a groove towards distal face.

**Colouration :** Uniformly slaty brown on dorsal aspect. Lateral aspect below the dorsolateral glandular fold is dark green. A dark blackish-brown canthal streak running through loreal region up to tympanic area. Golden yellowish band on upper jaw. Lower jaw with brown patches on outer margin. The dorsolateral glandular folds with golden yellowish colour whereas margins are with black throughout. The ventrolateral aspect of belly mottled with brown and yellow. Ventrally immaculate. Fore and hind limbs dorsally bear brown cross bars on olive ground colour and cream colour on ventral side. The digits are barred with brown colour. Posterior aspect of thigh dark brown, mottled with irregular light spots forming a reticulum. Abdomen and ventral surface of legs with scattered spots of brown pigments.

**Larval Morphology :** It was not possible to associate the larval forms with the adults.

**Habitat :** This frog was collected under rock in a stagnant pool near a fast-flowing hill stream in remote area off Chakrata Hill. Stream is bordered on both sides with thick forest of Deodar, water of the stream was extremely chill

**Etymology :** The specific name is derived from the type locality Chakrata, where these rare forms of hill stream amphibians are found.

**Affinities :** Inger and Dutta (1987) recognised *Amolops monticola* (Anderson, 1871) as a distinct

species which was previously described under genus *Hylorana* (Anderson, 1871). Boulenger (1890) placed species under genus *Rana*. Subsequently, same author (Boulenger, 1920) put species under genus *Rana*, subgenus *Hylorana*. The distribution of *Amolops monticola* is restricted to district Darjeeling, West Bengal, being its type locality. *Amolops chakrataensis* sp. nov. is distributed in a remote hilly terrain of Chakrata hill at an altitude of 2800 mts. (approx.), which is zoogeographically quite isolated from Darjeeling in the Eastern Himalaya. The present species is morphologically close to *Amolops monticola*, but differs from it in many characters tabulated below:

<i>Amolops chakrataensis</i> sp. nov. (♂)	<i>Amolops monticola</i> (Anderson) (♀)
1. Head wider than long.	1. Head as long as wide.
2. Interorbital distance greater than width of upper eyelid.	2. Interorbital distance equal to the width of upper eyelid.
3. Nostrils nearer the anterior corner of eye.	3. Nostrils equidistant from anterior corner of eye and snout tip.
4. First finger smaller than the second.	4. Length of first and second fingers are equal.
5. Tibial diameter less than five times (4.66) in its length.	5. Tibial diameter 5 to 6 times in its length.
6. Tibiotarsal articulation extends upto tympanum.	6. Tibiotarsal articulation extends beyond tip of snout.

***Amolops formosus* (Guenther, 1875)**  
(Plate V & VII)

*Polypedates formosus* Guenther (1875), *Proc. Zool. Soc. London.* : 573, pl. ixv. fig. B. (Type locality : Khassia).

*Rana formosa* : Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata, Brit. Mus.* : 70; Boulenger (1890), *Faun. Brit. India, Rept. & Batr.*, 463–464; Boulenger (1907), *Rec. Indian Mus.*, 1 : 151; Smith (1951), *Ann. Mag. nat. Hist. Ser.* 12, (4) : 727; Swan and Leviton (1962), *Proc. Calif. Acad. Sci.*, ser. 4, 32 : 108. Waltner (1974), *J. Bombay nat. Hist. Soc.*, 72(3) : 894.

*Rana himalayana* Boulenger (1888), *Ann. Mag. nat. Hist.*, ser. 6, 2 : 507 (Type locality : Darjeeling) Boulenger (1890), *Faun. Brit. India, Rept. Batr.* : 463; Acharjee and kripalani (1951), *Rec. Indian Mus.*, 49 : 183–184.

*Rana (Hylorana) himalayana* Boulenger (1920), *Rec. Indian Mus.*, 20 : 219–220.

*Rana (Hylorana) formosa* Boulenger (1920), *Rec. Indian Mus.*, 20 : 220–221.

*Staurois formosus* : Bourret (1942) (*Inst. Ocenograph. de l' Indo-Chine, Hanoi.* : 421.

## PLATE - V

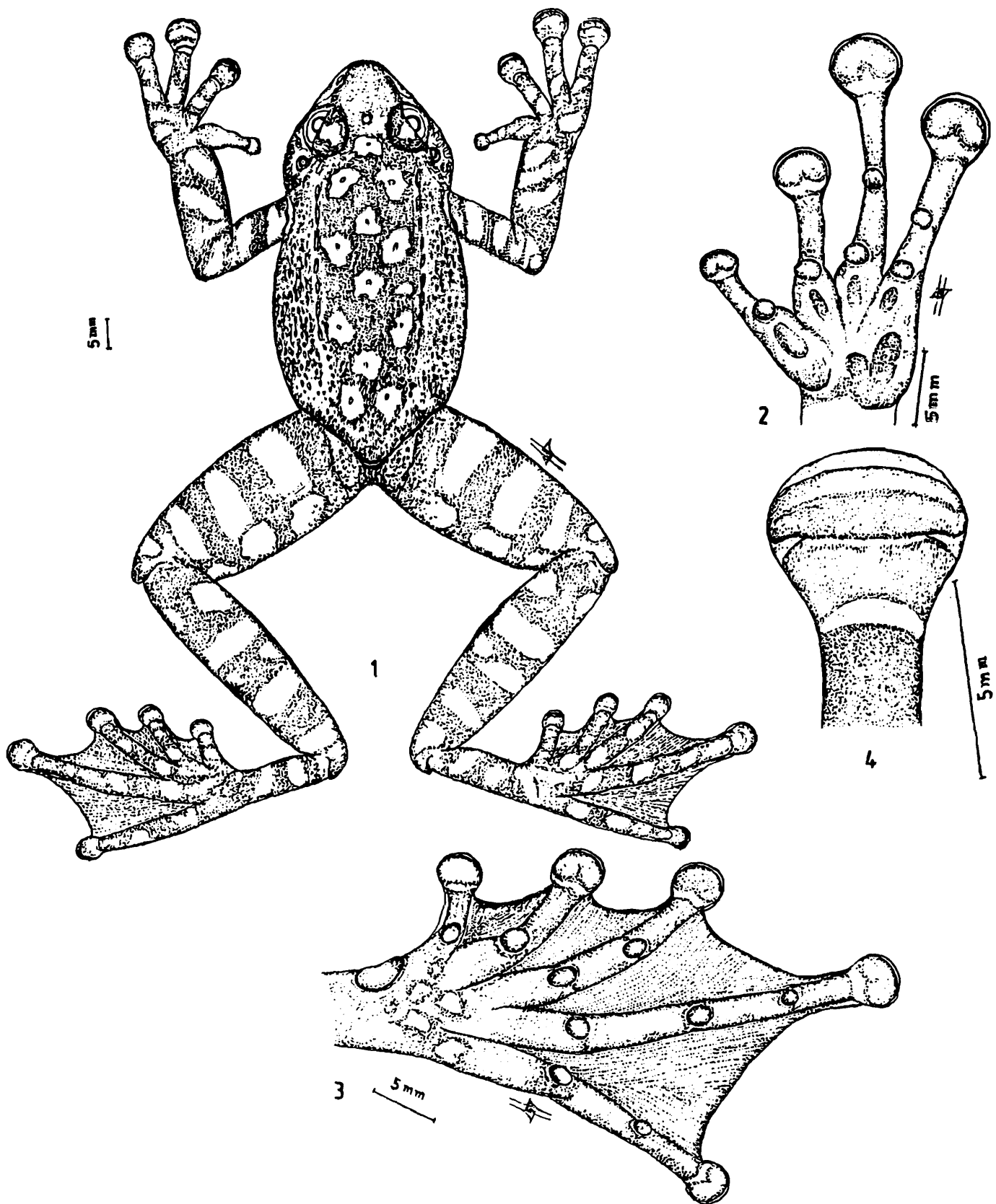
*Amolops formosus* Guenther

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. Digital tip (Dorsal view)

*Staurois himalayana* : Bourret (1942), *Inst. Ocenograph. de l' Indo-Chine*, Hanoi., : 422.; Kripalani (1952), *Rec. Indian Mus.*, **50** : 359–365; Kripalani (1953), *Everyday Sci.*, Hoshiarpur, 2 : 57–61; Kripalani (1961), *Rec. Indian Mus.*, **59** : 243–244; Swan and Leviton (1962), *Proc. Calif. Acad. Sci.*, ser. 4, 32 : 141.

*Amolops formosus* : Dubois (1974), *Bull. Mus. natn. Hist. nat.*, (3) no. 213, (Zool. 143): 357–362; Gorham (1974), *Checklist of World Amphibians up to 1 January 1970*: 128; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, **83** (supplement) : 137, 141.

**Material Examined** : Four examples (3♂ + 1♀), collected from a waterfall, 5 kms. north-west of Chakrata, Date : 14.III.85, by P. Ray & Party.

**Description** : Head much depressed, wider than long. Length of head 1.17–1.25, length of snout 2.22 – 2.75, maximum diameter of orbit 3.05–3.33 and internarial distance 3.66 – 4.23 times in width of head. Length of head 3.47 – 3.64, length of tibia 1.81 – 1.93, length of foot 1.77 – 1.84 and length of palm 2.74 – 2.86 in tip of snout to vent length. Tip of snout rounded, feebly projecting beyond lower jaw. Snout shorter than maximum diameter of orbit. Canthus rostralis rounded. Nostrils with a posterior knob, nearer tip of snout than anterior corner of eye, width of upper eyelid almost equal to the interorbital width. Internarial distance greater than interorbital distance but equal to maximum diameter of orbit. Loreal region oblique and concave. Distinct tympanum almost 1/3 to diameter of orbit. Greater part of tympanum concealed under supra-tympanic fold which is running from posterior corner of eye to axils. Small glandules surrounding angle of jaws and extra tympanic area. Dorsolateral folds indistinct.

Distal part of forelimb stronger and muscular than proximal part. First finger smallest and third the longest. First finger 1.81 – 1.87 second finger 1.32–1.38 times in the length of third finger. Fingers with large disc, wider than long with circummarginal groove separating upper surface from lower, which gives maximum flexibility to finger discs. Length of third finger being 2.5 to 3 times of snout length. On the dorsal aspect of swollen tip of digits, there is a transverse groove with a dermal fold corresponding to internal transverse bar of 'T' shaped bone of ultimate

phalange. Subarticular tubercles distinct and oval. Supernumerary tubercles elongated, indistinct, present on ventral aspect of each metacarpal zone. Two palmer tubercles close to each other, outer elongated and longer than inner one.

Hind limb long. Tibiotarsal articulation extends upto tip of snout in life but in preserved condition it extends upto anterior corner of eye or nostrils but not beyond. Heels strongly overlapping, when limbs are folded at right angles to body. Length of tibia almost equal to length of foot. Diameter of tibia 3.20 – 3.76 times in its length. Toes with large disc those of third and fourth digits, the largest, webbing extensive two distal phalanges of fourth, toe bear a narrow fringe of web. Third and fifth toes having complete web upto disc. The discs more triangular than round, with a raised fold above the junction of penultimate and distal phalanges. Length of first toe 2.30–2.94, length of second toe 1.71–1.84, length third toe 1.27–1.45, length of fifth toe 1.15–1.26 times in length of fourth toe. Subarticular tubercles oval, distinct. Outermetatarsals separated near base. Inner metatarsal tubercle single, elongated and 2.25–3.25 times in length of first toe. No outer metatarsal tubercle.

**Osteological Characters** : Two premaxillae meet in the middle line. The maxilla is a long slender bone bearing teeth. Two pearshaped nasals widely separated from each other. Rectangular frontoparietals. Ethmoid largely exposed between nasals and on anterior extremity of frontoparietals. Pectoral girdle firmisternal type. Clavicles strong horizontally placed, xiphisternum stout and short bone with bilobular xiphoid cartilage. The terminal phalanges with 'T' shaped bone.

**Colouration :** Ground colour is bright green with irregular distinct chocolate coloured patches at regular intervals throughout dorsal aspect. Upper surface of limbs including foot and palm with similar colouration as of the body. The chocolate brown patches are speckled with light green. Supratympanic fold is light brown. Ventral side silvery, intermingled with brown. Iris golden green. Brown coloured cross bands on thigh, shank and ankle. Anal region suffused with black tubercular glands.

**Larval Morphology :** Not yet confirmed.

**Habitat :** Beautifully coloured frogs are extremely scarce with only a sparse population found near undisturbed torrential hill streams. Present collection from Chakrata hills is first ever collected from this region. Subsequent to its description by Boulenger (1920) from Eastern Himalaya, (Khasi hills and Darjeeling area) the species has never been reported from any other locality. They live on rocks near torrential streams, if disturbed, they quickly jump into running water and swim under water. It is observed that they are fast swimmers against strong current of water. Moreover the colouration of body is so identical to the algae-laden boulders and pebbles that it is hardly possible to make out its presence when submerged under water.

**Captive Behaviour :** Out of four examples collected from Chakrata, two adults (♂ ♀) were kept in the aquarium for two months at Dehradun where they survived well. The temperature of their original habitat at Chakrata was much lower than Dehradun, water in the aquarium was kept cool by adding ice cold water but the current of water could not be maintained with the result they did not breed in captivity. They were found pairing but the female did not lay the spawn. They were supplied with large sized Cockroaches, which they overpowered. It is observed that the tongue is not much functional in capturing insects as a whole. To find out their proper diet, a preserved specimen

was dissected. The stomach contents contain some aquatic tubicolous insects and molluscs. Large discs help these frogs to adhere on rocks near torrential stream. The whole body is impregnated with mucous glands which secrete a slippery substance that probably helps frog to swim under running water. These frogs never skit on the surface. Their movement is basically restricted to hill stream. They need extremely humid and moist climate and cold running water to survive under captive condition.

*Amolops jaunsari* sp. nov.

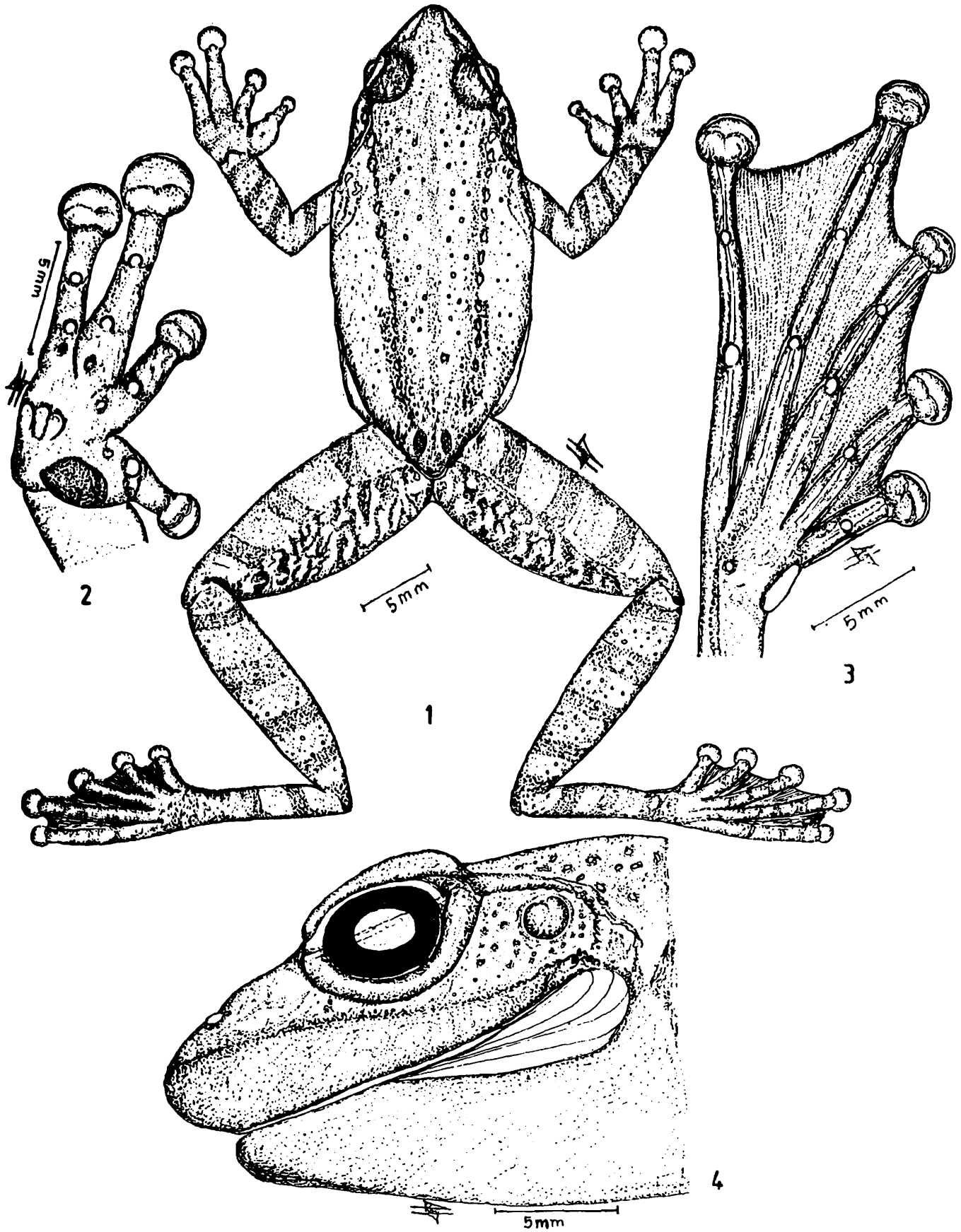
(Plate VI & VII)

**Diagnosis :** This species is a comparatively smaller form of *Amolops* with eyes large, diameter of eye is shorter than snout, head wide, rear thigh blotched with dark olive suffused with creamy base.

**Holotype :** NRS/ZSI-A"23, An adult male from Amlawa river, nearly 2 kms. upstream near Sahiya, Chakrata Tehsil, District Dehradun, 16 March 1985, Coll. P. Ray.

**Description :** Body moderately stout, head as long as broad; head almost triangular; tip of snout obtusely pointed, projecting well beyond the lower jaw, eyes elevated, canthus rostralis sharp, slightly concave, lores concave near eye and elevated towards jaw margin. Nostrils lateral with a posterior knob, just below canthus rostralis, almost equidistant or slightly nearer to the tip of snout than anterior corner of eye. Internarial distance almost equal to interorbital distance. Upper eyelid equal to interorbital distance. Tympanum distinct, small, surrounded by small elevated glands. Distance between the posterior corner of eye and the tympanum is equal to horizontal diameter which equals diameter of disc of first finger. Vomerine teeth weak, in small oblique groups, separated by less than width of each group; groups of teeth lie on an oblique line connecting rear rims of choanae. Tongue deeply notched, wide. Paired subgular vocal sacs form gular pouches at corners

PLATE - VI



*Amolops Jaunsari* sp. nov.

Fig. 1. Adult male (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. Head (Lateral view)

of throat; vocal openings just inside commissures of jaws.

Forelimbs moderate. First finger almost equal in length of second finger. The tips expanded into distinct disc having circummarginal groove. The disc of third and fourth finger large, no fringe of dermal fold along the fingers. A small supernumerary tubercle on palmer surface of each metacarpal. Nuptial pad distinct, well granulated, covering ventrolateral aspect on base of first metacarpal. Palmer tubercle elongated and trilobed. Round distinct sub-articular tubercles present on each phalangeal joints of metacarpal and phalanges except distal joints.

Hindlimbs long slender. The diameter of tibia almost five times its length. Heels overlapping when limbs are folded at right angles of body. Toes ending in disc, similar to that of fingers but in less dimensions. Webbing complete, starting below base of disc, narrow fringe of dermal fold on the outer aspect of inner toe. Inner metatarsal tubercle elongated equal to distance between its dermal margin and proximal subarticular tubercle of first toe. Outer metatarsal tubercle rounded and distinct. The diameter of disc of first, second and fifth toes are equal whereas the disc of third and fourth toes are smaller in dimension and equal to each other.

Skin of upper parts glandular, supratympanic fold elevated at posterior corner of eye and continues as a faint line towards axil. A series of beaded dorso-lateral glands extend from posterior corner of eye to the sacral region. Sides of trunk coarsely glandular. Dorsal aspect of fore-arm and tibia covered with white tipped spinules. Ventral aspect thin and smooth.

**Colour in Life :** Dorsum dark olive green, lores with indistinct dark marking below canthus, upper lips with light brown with obscure lighter spots. Iris golden green, a blackish-brown band extends from posterior margin of eye up to the sacral region, the band is widest anteriorly with its

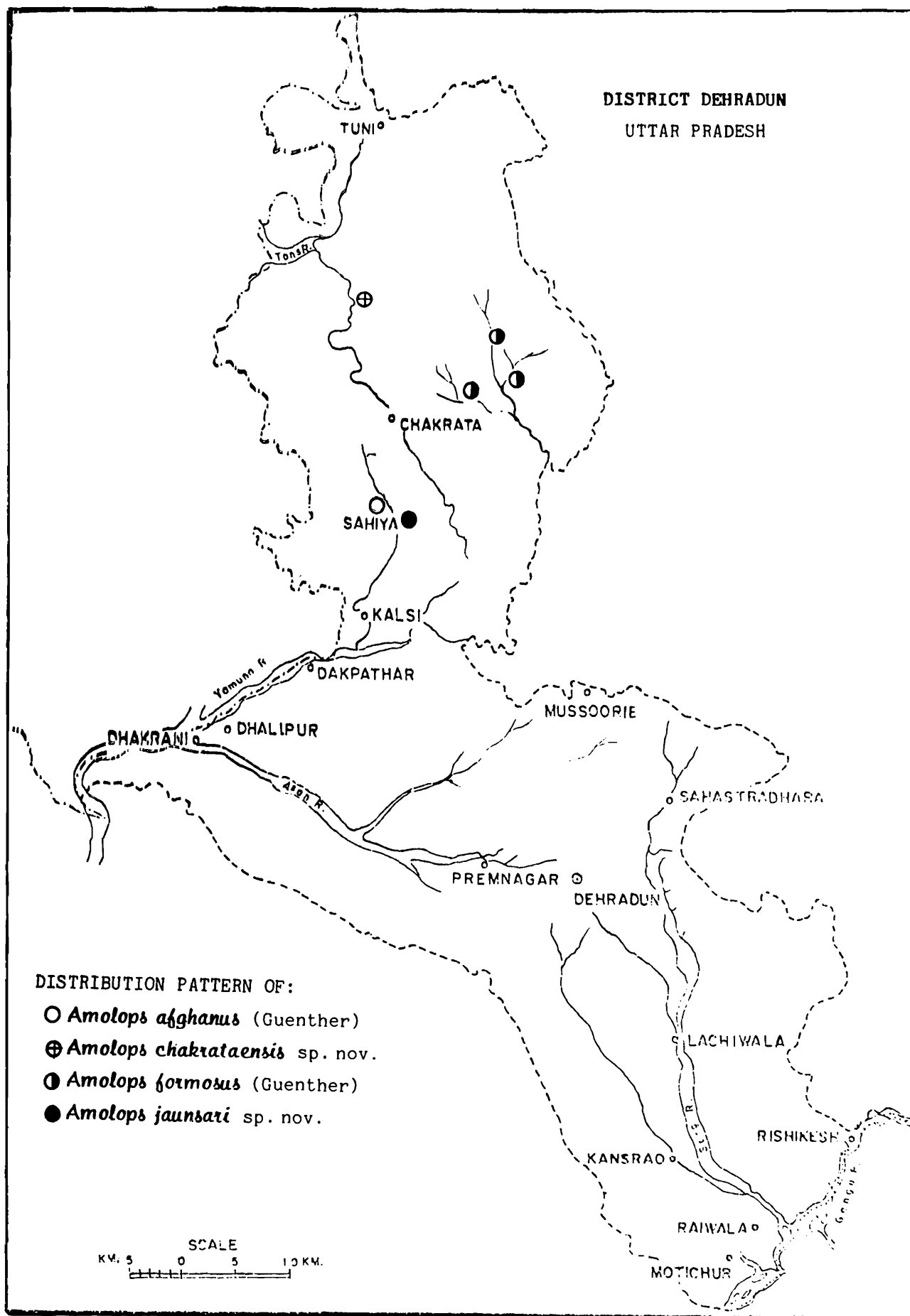
dorsal boundary clearly demarcated and ventral boundary gradually fading into a brownish marblings. Limbs marked with alternating light and dark brown cross bars, darker bars are wider than light bars. Posterior aspect of thigh dark brown mottled with light green and cream colour forming a beautiful reticulum. Throat and anterior part of breast region mottled with dark brown. Abdomen and ventral aspect of limbs immaculate.

**Etymology :** The specific name is derived from type locality where the famous 'Jaunsar' tribals afford protection to this rare and interesting small amphibian.

**Habitat :** These extremely rare small hill stream dwelling species collected from aquatic vegetation on the edge of famous Amlawa river, where many interesting amphibians and their developing stages are seen. These frogs are very delicate and agile, slight disturbance makes them alert and immediately they jump into hill stream and conceal themselves under boulders and pebbles. Their colour pattern is so camouflaging with surrounding substratum on the stream, that it is hard to detect them.

**Relationship :** The present species differs from all other allied species of the genus *Amolops*, by its smaller size and specific colour pattern of posterior aspect of thigh. It differs from *Amolops afghanus* (Guenther) and *A. formosus* (Guenther) by its equal length of first and second fingers whereas the former two species having their first finger smaller than second finger. The head width of *A. afghanus* is greater than its length, but in the new species the head width is equal to its length. *A. formosus* is quite different by its larger disc diameter and brilliant green with brown patches on dorsal aspect. It is quite different from *A. chakrataensis* sp. nov. by its complete webbing between toes against two phalanges of fourth toe free of web and without outer metatarsal tubercle in *A. chakrataensis* sp. nov.

PLATE - VII



**Genus *Rana* Linnaeus, 1758**

(Plate II, III &amp; VIII)

*Rana* Linnaeus (1758), *Syst. Nat.*, ed. 10 : 210.

*Rana* Wagler (1830), *Syst. Amph.* : 204; Tschudi (1838), *Class. Batr.*, 78; Dumeril and Bibron (1841), *Erpet. Gen. VIII* : 335; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 8; Cope, (1865), *Nat. Hist. Rev.* : 117; Boulenger (1882) *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*: 6; Boulenger (1890), *Fuan. Brit. India, Rept. and Batr.* : 438; Boulenger (1920), *Rec. Indian Mus.*, XX : 4; Van Kampen (1923), *Amph. Indo. Austr. Arch.* : 161.

**Distinguishing Features :** Tongue free and deeply notched behind. Vomerine and maxillary teeth present. Fingers free; toes webbed with simple or dilated tips. Outermetatarsals separated by web at least on the basal half. Omosternum and sternum with bony style. Pupil round, horizontal, rhombic and very contractile.

**Distribution :** Cosmopolitan, except southern parts of South America and New Zealand.

**Known Indian Species :**

1. *Rana alticola* Boulenger, 1882
2. *Rana andamanensis* Stoliczka, 1870
3. *Rana annandalii* Boulenger, 1920
4. *Rana assamensis* Sclater, 1892
5. *Rana aurantiaca* Boulenger, 1904
6. *Rana beddomii* (Guenther, 1875)
7. *Rana bilineata* Pillai & Chanda, 1981
8. *Rana blanfordii* Boulenger, 1882
9. *Rana brachytarsus* Guenther, 1875)
10. *Rana brevipalmata* Peters, 1871
11. *Rana cancrivora* Gravenhorst, 1829
12. *Rana crassa* Jerdon, 1853
13. *Rana curtipes* Jerdon, 1853
14. *Rana cyanophlyctis* Schneider, 1799
15. *Rana danieli* Pillai & Chanda, 1977
16. *Rana diplosticta* (Genther, 1875)
17. *Rana doriae* Boulenger, 1887
18. *Rana garoensis* Boulenger, 1920
19. *Rana gerbillus* Annandale, 1912
20. *Rana hascheana* (Stoliczka, 1870)
21. *Rana hexadactyla* Lesson, 1834
22. *Rana intermedius* Rao, 1937
23. *Rana keralensis* Dubois, 1980
24. *Rana khasiana* (Anderson, 1871)
25. *Rana laticeps* Boulenger, 1882
26. *Rana leithii* Boulenger, 1888
27. *Rana leptodactyla* Boulenger, 1882
28. *Rana leptoglossa* (Cope, 1868)
29. *Rana liebigii* Guenther, 1860
30. *Rana limnocharis* Boie, 1835
31. *Rana livida* (Blyth, 1855)
32. *Rana malabarica* Tschudi, 1838
33. *Rana mawphlangensis* Pillai & Chanda, 1977
34. *Rana minica* Dubois, 1975
35. *Rana murthii* Pillai, 1979
36. *Rana nicobariensis* (Stoliczka, 1870)
37. *Rana nilagirica* Jerdon, 1853
38. *Rana phrynoderma* Boulenger, 1882
39. *Rana sauriceps* Rao, 1937
40. *Rana semipalmata* Boulenger, 1882
41. *Rana sikimensis* Jerdon, 1870
42. *Rana sternosignata* Murray, 1885
43. *Rana syhadrensis* Annandale, 1919
44. *Rana taipehensis* Van Denburgh, 1909
45. *Rana temporalis* (Guenther, 1864)
46. *Rana tenuilingua* Roa, 1937
47. *Rana tigerina* Daudin, 1803
48. *Rana travancorica* Annandale, 1910
49. *Rana tuberculata* Tilak & Ray, 1985
50. *Rana vicina* Stoliczka, 1872

***Rana crassa* Jerdon, 1853**

(Plate VIII, XII &amp; XIII)

*Rana crassa* Jerdon (1853) *J. Asiat. Soc. Bengal.*, 22 : 531; Theobald (1968), *Cat. Rept. Acs. Soc. Mus.*, : 79; Jerdon (1870), *Proc. Asiat. Soc. Bengal.*, : 68, Anderson (1871b), *Proc. Zool. Soc. London.*, : 199; Annandale and Rao (1918), *Rec. Indian Mus.*, 15 : 35; Boulenger and Annandale (1918) *Rec. Indian Mus.*, 15 : 61–63; Bhaduri (1944), *J. Bombay nat. Hist. Soc.*, 44 : 481–484 Chakko (1968), *Proc. Indian Acad. Sci.*, Section B, 67 : 234; Sarkar (1984), *Rec. Zool. Sury. India.*, 81.(3 & 4) : 228; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Suppl.) : 137.

*Hoplobatrachus ceylanicus* Peters (1863), *Mont. Berl. Acad.*, : 449; Guenther, (1864), *Rept. Brit. India.*, : 410.

*Rana (Hoplobatrachus) ceylanica* : Guenther (1872), *Ann. Mag. Natg. Hist.*, (4) IX : 87.

*Rana tigrina* : Guenther (1875), *Proc. Zool. Soc. London.*, : 567.

*Rana tigrina* (part) : Boulenger (1882), *Cat. Batr. Sal. s. Ecaud. Brit. Mus.*, ed. 2., : 26; Thurston, (1888), *Cat. Batr. Sal. Apoda. South India.*, : 54; Boulenger, (1890) *Fauna Brit. India.*, : 449.

*Rana tigrina* var. *ceylanica* : Boettger (1892), *Ber. Offenb. Ver. Nat.*, : 94.

*Rana tigrina* var. *crassa* : Boulenger (1918a), *Rec. Indian Mus.*, : 15 : 57. Boulenger (1920), *Rec. Indian Mus.*, 20 : 17–21.

*Rana (Dicroglossus) crassa* : Dubois (1974), *Bull. Mus. natn. Hist. nat. Paris.*, (3) n° 213 (*Zool.* : 143). 379.

*Rana tigrina crassa* : Gorham (1974), *Checklist of world Amphibians upto 1 January 1970.*, 153.

*Rana (Rana) crassa* : Daniel (1975), *J. Bombay nat. Hist. Soc.* 72 (2) : 513.

**Material Examined** : 60 examples (40, 20). Lachhiwala, Motichur and Kansro, district Dehradun. 9.VII.84, 19.VIII.85 and 23.VII.86 P. Ray.

**Description** : Head slope more than that of allied species (*Rana tigrina*). Tip of snout rounded and less pointed. Outer rim of the upper jaw expanded on sides of head as seen from above. Head broader than long being 1.06 – 1.15 times in its length. Diameter of eye 1.42 – 1.56 times in length of snout. Tip of snout projecting beyond mouth. Canthus rostralis obtuse, loreal region oblique, more or less concave. Nostrils nearer tip of snout than to anterior corner of eye. Interorbital distance much narrower than upper eyelid. Tympanum distinct. Diameter of eye 1.33 – 1.40 times of diameter of tympanum.

Fore-limbs stout and flabby. Fingers obtusely pointed, first longer than second; third finger, the longest; fourth finger little shorter than second. Subarticular tubercles distinct and moderate.

Hind limb short. Thigh and shank more muscular. Tibial length 1.80–2.59 times of its diameter. Toes with swollen tips. Webbing complete. Subarticular tubercles prominent. Inner metatarsal tubercle almost equal to length of inner toe. Tibiotarsal articulation extends upto posterior margin of tympanum but not beyond that. Heels quite apart when hind limbs are folded at right angle to the body. A distinct dermal fold on outer side of fifth toe and feeble one on inner side of first toe. Inner metatarsal tubercle much more prominent, sharp edged and situated forward on foot, almost parallel to basal part of toe. A slight concavity on inner aspect of shovel-shaped metatarsal tubercle.

The dorsal longitudinal glandular folds 9-10 in number and occupy entire dorsum, but not continuous. White tipped spinules scattered on whole of dorsal aspect but densely set on the dorsal aspect of hind legs and anal region. Supratympanic fold strong and commences from posterior corner of eye to shoulder.

## PLATE - VIII

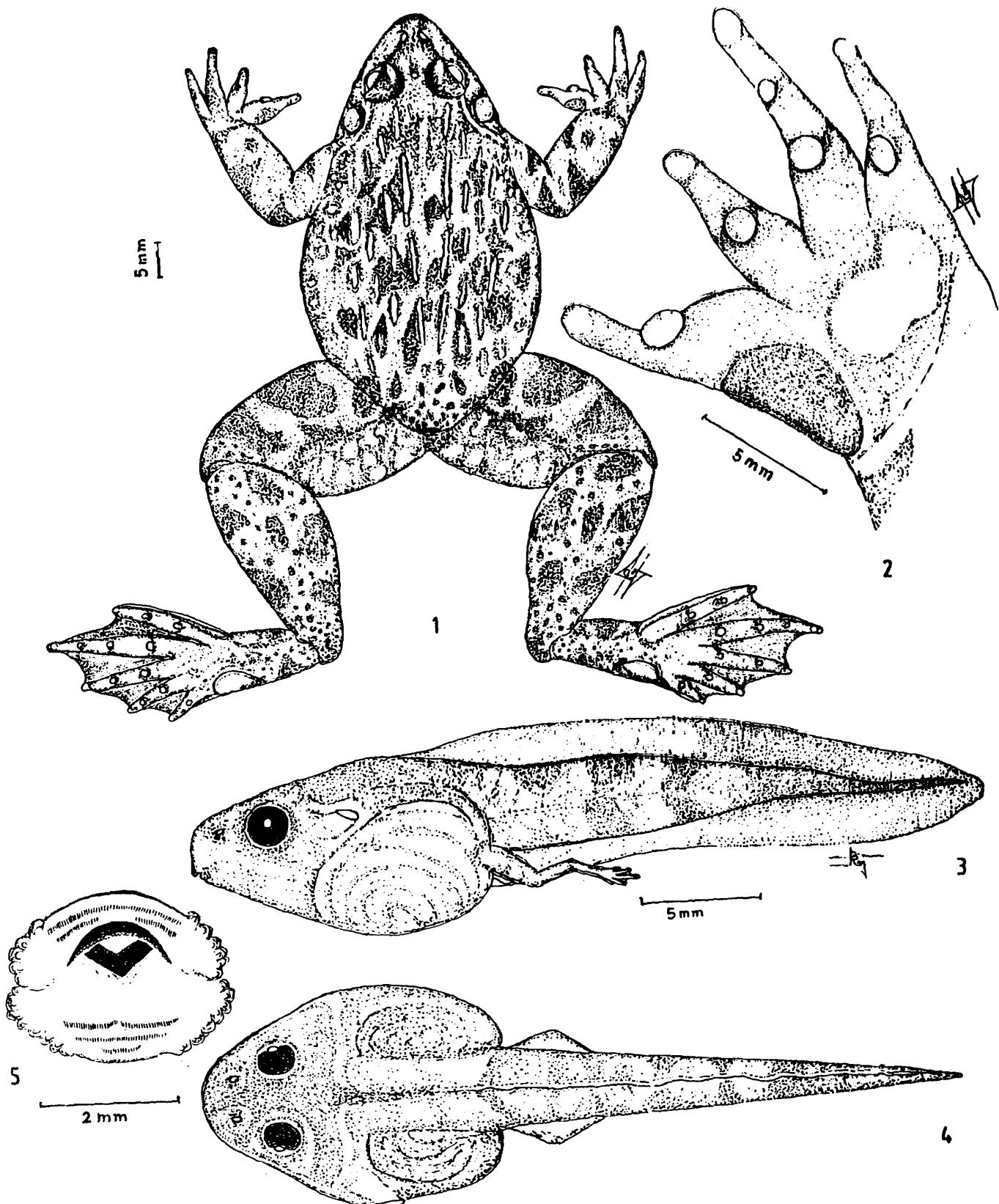
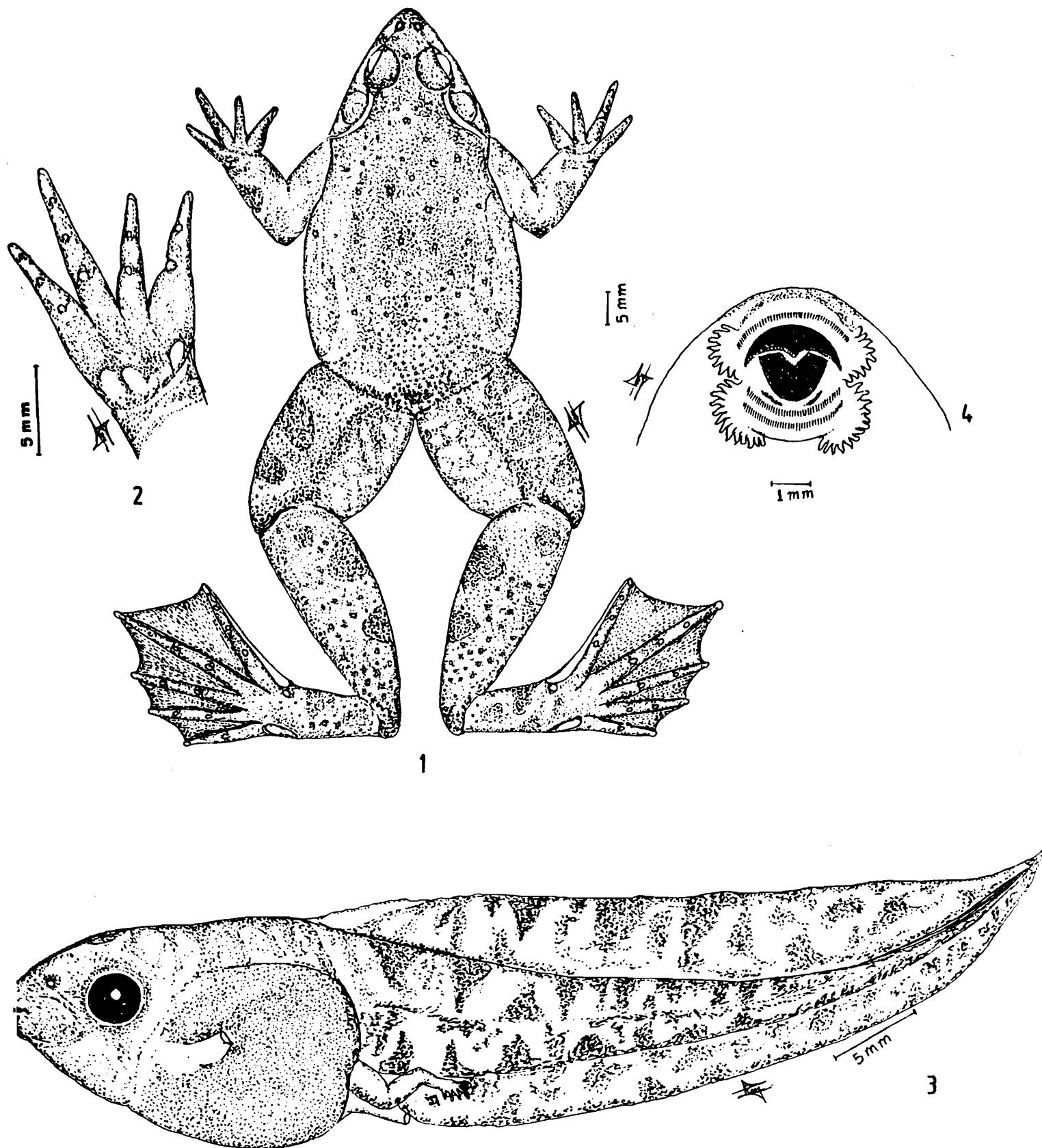
*Rana crassa* Jerdon

Fig. 1. Adult male (Dorsal view); 2. Hand (Ventral view); 3. 10 days' old Tadpole (Lateral view); 4. 10 days' old Tadpole (Dorsal view); 5. Oral disc of same Tadpole (Ventral view)

PLATE - IX



*Rana cyanophlyctis* Schneider

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. 15 days' old Tadpole (Lateral view); 4. Oral disc of same Tadpole (ventral view)

**Colouration :** The juveniles of *R. crassa* completely differ in colouration from those of *R. tigerina*. *Rana crassa* is greyish throughout with black rounded spots dorsally. Limbs more dark than rest of the body. The margin of lower jaw with bold brown bars. In males, throat is completely speckled with brown.

**Sexual Dimorphism :** Males with two lateral vocal sacs. During breeding season the dorsal aspect of metacarpals bear nuptial pad.

**Larval Morphology :** Tadpole with well developed hindlimbs. Length of head and body about one and a half its width and more than half the length of tail. Nostrils about equally distant from tip of snout as from spiraculum which is left sided, directed upward. Tip of tail obtusely pointed. Vent situated at junction of posterior belly margin and ventral caudal membrane. Mouth ventral, oral gap small, corners of upper lip bordered with one and lower lip with two series of papillae. Rostradonts are black and serrated at the margin. Upper row of keratodonts uninterrupted following an interrupted row of keratodont. Lower lip with three rows of uninterrupted keratodonts of which inner one slightly notched at the middle.

Dorsal aspect dark grey, spotted with brown, white below. Caudal muscle dark brown with black scattered spots. Caudal membrane more or less transparent except on the margin.

**Distribution :** India : Madras, Maharashtra, Orissa, West Bengal, Uttar Pradesh,

**Elsewhere :** Ceylon (Sri Lanka), Nepal.

**Habitats :** This frog is quite rare in Dehradun and surrounding areas. The frogs are burrowers and specimens collected are mostly from their burrows made on elevated sides of rainwater pools. The species is closely allied to *Rana tigerina* and can only be distinguished by its toad-like flabby shape of body and highly developed shovel shaped metatarsal tubercles. They usually come out during breeding season preferably during monsoon rains. Some of the juveniles were collected from under-stones even from loose soil in forested zone. The breeding habit of these frogs has not been recorded earlier.

**Remarks :** The two ranid species viz. *Rana tigerina* and *Rana crassa* have long been confused with each other. Annandale (1918), and Boulenger (1920), have believed *Rana crassa* to be a variety of *tigrina* (= *trigerina*). The present studies in field and laboratory reveal that it is a separate species and breeds independently although in a same pool where *tigerina* is breeding. According to Daniel (1975), these species are sympatric but the author thinks that the two species differ not only morphologically but also in their breeding calls. It indicates that they are two distinct species closely allied to each other. The distribution of *Rana crassa* ranges from Ceylon to foothills of the Himalaya and extends upto District Dehradun. The species is of common occurrence in Terai region of Uttar Pradesh where its population far exceeds that of *Rana tigerina* particularly in the forested zone. The differences between the two species are tabulated below :

<i>Rana crassa</i> Jerdon	<i>Rana tigerina</i> Daudin
1. Adult size 65 mm- 95 mm.	1. Adult size 101 mm 118 mm.
2. Colour of juveniles and adults grey, with small blackish spots scattered on the entire dorsum.	2. Colour of juveniles and adults a brilliant yellow, golden or greenish with dark stripes that merge with the background.
3. No vertebral streak on the dorsal side.	3. Distinct yellow vertebral streak on median line of dorsum.
4. Head slope is very much pronounced towards the tip of snout.	4. Slope is gradual.

<i>Rana crassa</i> Jerdon	<i>Rana tigerina</i> Daudin
5. Length of snout 1.42 - 1.56 times the diameter of eye.	5. Length of snout 1.63 - 1.85 times the diameter of eye.
6. Tibiotarsal articulation reaching posterior border of tympanum and not beyond.	6. Tibiotarsal articulation reaching eye and nostrils, sometimes beyond that.
7. Heels not overlapping.	7. Heels strongly overlapping.
8. Strong, compressed and shovel shaped inner metatarsal tubercle, its length being as long as the inner toe.	8. Weak, soft, blunt and elongated inner metatarsal tubercle, its length being 0.33 to 0.60 times the length of inner toe.
9. Male breeding call, "Ghrrung, Ghrrung, Ghrrung".	9. Male breeding call "Gheng-or-Gheng, Gheng-or-gheng, Gheng-or-Gheng"
10. Burrowing in habit and very fast moving by jumping in small gaps.	10. Seeks shelter in abandoned holes close to the water and moves by long, muscular leaps.

*Rana cyanophlyctis* Schneider, 1799  
(Plate IX & XIII)

*Rana cyanophlyctis* Schneider (1799), *Hist. Amp. I.* : 137 ; Peters (1863), *Mon. Berl. Ac.* : 78 ; Guenther (1864), *Rept. Brit. India.* : 406 ; Steindachner (1867), *Novara. Amph.*, : 20 ; Stoliczka (1972), *Proc. iat. soc. Bengal.* : 102 ; Blanford (1976), *Zool. E. Persia.* : 433 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, ed. 2 : 17 ; Boulenger (1890), *Fauna Brit. India Rept. Batr.* : 422 ; Sclater (1892b), *List Batr. India Mus.* : 12 ; Anderson (1895), *Proc. Zool. Soc. London.* : 660 ; Ferguson (1904), *J. Bombay nat. Hist. Soc.*, XV : 500 ; Boulenger (1912), *Fauna. Mal. Pen. Rept.* : Annandale and Rao (1918), *Rec. Indian Mus.*, XV : 30 ; Acharjee and Kripalani (1915), *Rec. Indian Mus.* 49 : 176 ; Gorham (1974), *Checklist of world Amphibians up to 1 January 1970.* : 113. Daniel (1975), *J. Bombay Hist. Soc.* 72 : 508. Pillai and Chanda (1979), *Rec. Zool. Surv. India.*, 75 : 388 ; Pillai and Chanda (1981), *Rec. Zool. Surv. India.* : 162 ; Sarkar (1984), *Rec. Zool. Surv. India.*, 81 (3 & 4) : 224 ; Pillai and Murthy (1986), in Majumuria. : 193 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.* 83 (Suppl.) : 138.

*Rana bengalensis* Gray (1834), *Ills. India Zool.* I, pl. LXXXII, fig 2 ; Kelaart (1852), *Prodr. Vaun. Zevr.*, 1 : 192.

*Rana leschenaulti* Dumenil and Bibron (1841), *Erpet. Gen. VIII* : 342 ; Cantor (1847), *Cat. Mal. Rept.* : 138 ; Guenther. (1858), *Cat. Batr. Sal. Brit. Mus.* : 11.

*Dicroglossus adolfi* Guenther (1860), *Proc. Zool. Soc. London.* : 158 ; Guenther (1864), *Rept. Brit. India.* : 402.

*Rana ehrenbergii* Peters (1863), *Mon. Berl. Ac.* : 70 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata.* : 18.

*Dicroglossus cyanophlyctis* : Deckert (1938), *Sber. Ges. naturf. Freunde Berl.* : 128.

*Rana cyanophlyctis cyanophlyctis* : Parker (1941), *Rept. Amph. Brit. Mus. Exp. S. W. Arab.* (1937-38) 1 : 4 ; Kirtisinghee (1957), *Amph. Ceylon* : 12 ; Taylor (1962), *Univ. Kans. Sci. Bull.* 43 : 282 ; Mertens (1969), *Stuttg. Naturk.*, 197 : 82.

*Rana (Dicroglossus) cyanophlyctis cyanophlyctis* : Dubois (1974), *Bull. Mus. Natn. Hist. nat. Paris.* (3) n°213. (Zool. 143) : 378.

**Distribution :** India : Throughout.

Elsewhere : South Arabia, Baluchistan, Nepal, Ceylon, Pakistan.

**Material Examined :** 143 examples (112 + 31) collected from different localities of district Dehradun except beyond 2,000mts. altitude.

**Description :** Head moderate, much depressed. Snout pointed, tip slightly acuminate. Vomerine teeth in two small oblique series extending beyond hinder edge of choanae, equally distant from each other and from the latter ; in some specimens they are closer. Tongue deeply notched behind, cornua at the back of tongue longer and more pointed with a median process between them. Width of head 1.23-1.64 times in length of head. Length of snout 1.00-1.21 times in maximum diameter of eye. Canthus rostralis distinct. Loreal region oblique with concavity. Nostrils equidistant from eye and to tip of snout. In some examples, nostrils are nearer to tip of snout. Interorbital distance is greater than interorbital distance. Width of upper eye lid 1.53 to 1.91 time in interorbital width. Diameter of tympanum .65 - 1.00 times in length of eye.

Forelimbs moderate with more or less obtusely pointed fingers. First finger 1.00 to 1.15 times length of second finger. Third finger the longest. Fourth finger almost equal to second. All fingers pointed to same direction. Subarticular tubercles are small. Palmer tubercles also less developed. All fingers are almost of equal thickness.

Hindlimb muscular, thigh robust, toes webbed to the tip. Tibiotarsal articulation extends upto tympanum and eye. Heels just meet when limbs are folded at right angles to body. Tibia shorter than foot. Length of tibia 2.5 to 3.5 times of its diameter. Tips of toes swollen into small knob like structure. The web in between toes very extensive. The fourth toe is the longest, Outermetatarsals separated by web nearly up to base. Subarticular tubercles are small and feeble. A distinct dermal

fringe on the outer aspect of fifth toe present. Inner metatarsal tubercle small, pointed and digitiform. No outer tubercle.

Skin with small tubercles and warts on back. A strong fold from posterior corner of eye to shoulder present. Lower parts smooth. In some specimens, there are porous warts or glands surrounding thoracic region in a girdle and continue laterally along each side of the belly to the groin.

**Osteological Characters :** The skull is more triangular in shape. Nasals large and in contact with each other and with frontoparietals. Sphenethmoid entirely covered by the nasals. Zygomatic branch of squamosal long. Omosternal style formed at the base. Xiphisternum entire with broad expanded epicoracoid cartilage. Clavicles strong. Terminal phalanges obtuse.

**Colouration :** Colouration extremely varied ; adults olive to dark brown ; dorsal region with dark spots and a cream coloured band along each flank. Spots on the limbs well marked. Lower parts white, cream, marbled or spotted, ornamentation in lower part sometimes transforming into a reticulum.

**Sexual Dimorphism :** Males quite smaller than females, with blackish external vocal sac on each side, projecting through a longitudinal slit close to posterior half of mandibular ramus ; the slit as long as or a little longer than eye.

**Larval Morphology :** After fertilization, the ovum takes 40 to 45 days for completing its metamorphosis into a miniature frog-let. The oral dentition starts appearing in 6 to 7 days old tadpoles. Initially, upper and lower rostradonts appear and soon after upper row and lower two rows of keratodonts appear in 8 to 10 days old tadpoles.

Tail of the hindlimbed tadpoles 1.5 to 2 times as long as body. Tail membrane blotched with

brown. Tip of tail acutely pointed. Dorsal crest extending on to the body. Rostrodonts are black and well serrated, surrounded by large circular lip with a single row of upper labial keratodonts and two rows on lower lip. Tadpoles are frequently found in almost all aquatic environments during monsoon months.

**Habitat and Breeding Habit :** These frogs are most commonly noticed throughout the year near water pools. They are also found in good numbers near paddy fields. They hibernate under rocks or potholes close to a water body. During winter months, they congregate in groups near small water holes. It is observed that in winter, they are found in good number under floating aquatic vegetation ; when disturbed, they dive under water for a little while and emerge along the edge of water body. In rainy season, they are very active and most probably, they are the first among amphibians to breed in the season. The males emit a peculiar sound 'Tirr-r-r-r, Tirr-r-r-r-r, Tirr-r-r-r,'

with a continuous pitch on the surface of water during day and night. They breed on the edge of running streams where stagnant pools are available. The eggs are black in colour when they are laid in a gelatinous matrix.

They feed on almost all type of insects found in and around their habitat but Orthoptera, Hemiptera, aquatic Coleoptera and Dermaptera seem to be the most common constituents in the food items.

**Remarks :** It is the commonest form of anuran recorded from this area. This frog skits on the surface of water and it is commonly called as Skitter frog or sometimes called as Skipper frog. As its technical name (*Cyanophlyctis*) implies, it is recognised by the presence of rounded dark spots on its back and limbs. It is observed that it can tolerate considerable amount of contamination and organic pollution in temporary water pools. It is also reported from brackish water.

*Rana limnocharis* Boie (in Gravenhorst), 1829  
(Plate X & XIII)

*Rana limnocharis* Boie (in Gravenhorst) (1829), *Delic. Zool. Vrat.*, : 41 ; (Boie) Wiegmann, (1835) *N. Acta. Acad. Leop. Carol.*, 17 (1) : 225 ; Boulenger (1890), *Faan. Brit. India, Rept. and Batr.*, : 450 ; Boulenger (1903) *Fasc. Malayanses Zool.*, pt I : 134 ; Stejneger (1907), *Bull. U. S. Nat. Mus. LVIII* : 127, figs. 107-110 ; Van Kampen (1909), *Nat. Tijdschr. Ned. Indie.*, LXIX, : 35 ; Boulenger (1912) ; *Vert. Faun. Malaya Penins. Rept. Batr.*, London., : 236 ; Smith (1917), *J. Nat. Hist. Soc. Siam* : II : 165 ; Annandale (1917), *Mem. Asiat. Soc. Bengal.*, VI. : 132, pl. V, fig 2, 2b, 3b, 6 ; Annandale and Rao (1918), *Rec. Indian Mus.*, V : 33 ; Van Kampen (1923), *Amph. Indo-Aust. Arch.*, : 167 ; Leviton et al. (1956), *Occas. Pap. Nat. Hist. Mus. Stanford Univ.*, 1 : 6 ; Swan and Leviton (1962), *Proc. Calif. Acad. Sc.* ser. 4, 32 (6) : 108 ; Hejmadi (1974), *Prak. Utkal. Univ. J. (Sc.)* : II (1 & 2) : 91 ; Pillai and Chanda (1979), *Rec. Zool. Surv. India.*, 75 : 388 ; Pillai and Chanda (1981), *Rec. Zool. Surv. India.*, 79 : 161 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Suppl.) : 138.

*Rana limnocharis limnocharis* : Boulenger (1920), *Rec. Indian Mus.*, 20 : 28. Inger, (1954), *Fieldiana Zool.*, 33 : 193-531 ; Taylor (1962), *Univ. Kans. Sci. Bull.*, 43 : 265-599 ; Inger (1966), *Fieldiana Zool.*, 52 : 1-402 ; Tilak and Mehta (1983), *Res. Bull. (Sci.) Punjab Univ.*, 34 (3 & 4) : 159, figs 2 ; Sarkar *Rec. Zool. Surv. India.*, 81 (3 & 4) : 229-230.

*Rana (Rana) limnocharis* : Daniel (1975), *J. Bombay nat. Hist. Soc.*, 72 (2) : 515-516.

*Rana (Dicroglossus) limnocharis limnocharis* : Dubois (1974), *Bull. Mus. Nat. Hist. nat. Paris.* Ser. 3e, no 213 (*Zool. 143*) : 382.

*Rana (Dicroglossus) limnocharis* : Annandale (1917), *Mem. Asiat. Soc. Bengal.*, VI : 128.

## PLATE X

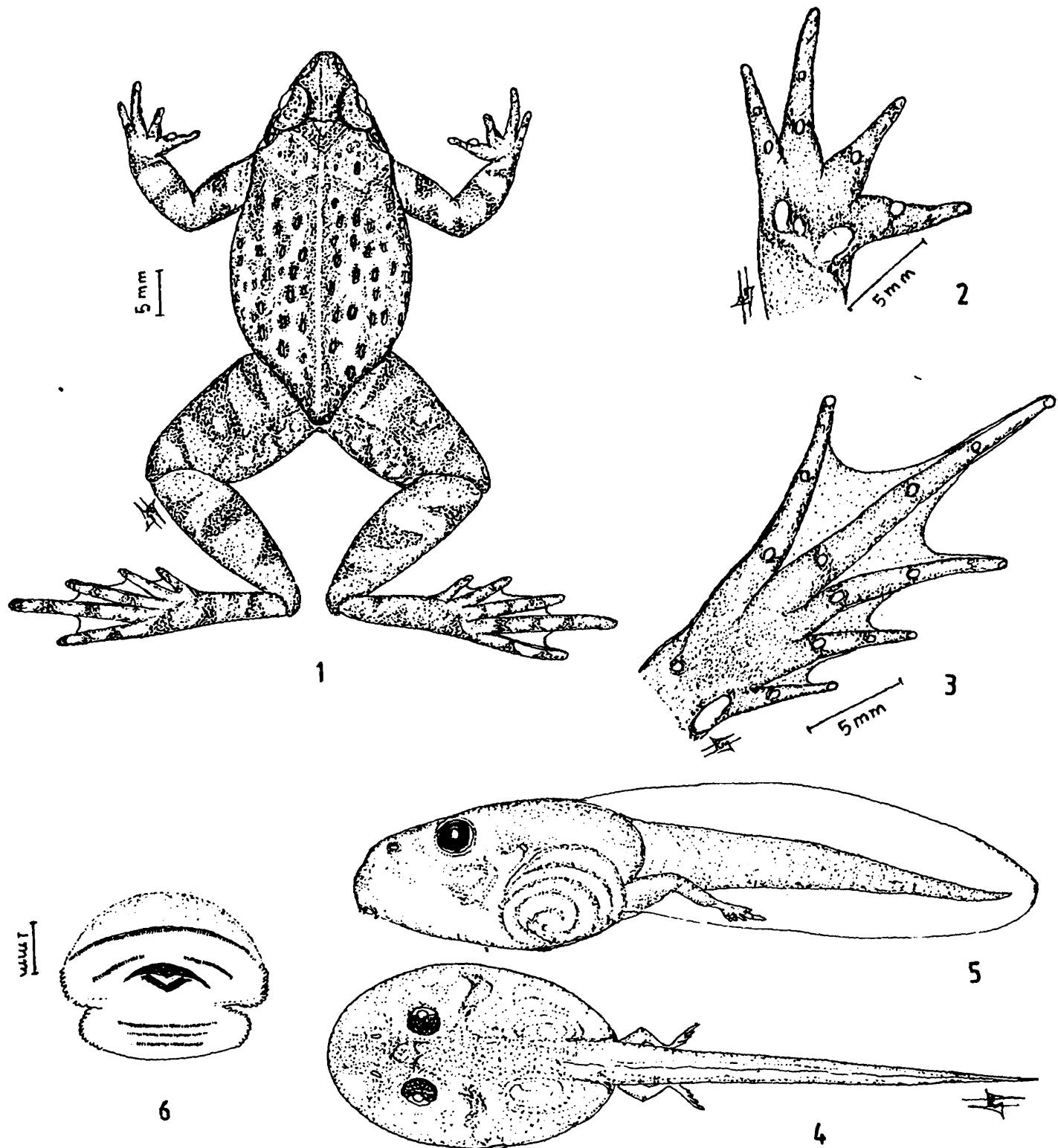
*Rana limnocharis* Boie (in Gravenhorst)

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view);  
4. 10 days' old Tadpole (Dorsal view); 5. 10 days' old Tadpole (Lateral view);  
6. Oral disc of same Tadpole (Ventral view)

*Rana gracilis* wiegmann (1835), *N. Acta. Acad. Leop. Carol.*, XVII (i) : 255 ; Peters (1863), *Mon. Beri. Ac.* : 78 ; Anderson (1871), *Proc. Zool. Soc. London.*, : 200 Guenther (1875), *Proc. Zool. Soc. London.*, : 567 ; Anderson (1879), *Anat. Zool. Soc. Yunnan.*, : 840.

*Rana nilagirica* Jerdon (1853), *J. Asiat. Soc. Bengal.*, 21 : 531 ; Boulenger (1904), *Spol. Zeyl.*, II : 73.

*Rana agricola* Jerdon (1853), *J. Asiat. Soc. Bengal.*, 21, 531.

*Rana vittigera*, (Part), Guenther (1858), *Cat. Batr. Sal. Brit. Mus.*, 9.

*Rana gracilis* Guenther (1864), *Rept. Brit. India.*, : 409 ; Stoliczka (1870), *J. Asiat. Soc. bengal.*, 39 : 142; Boulenger (1882). *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*, : 28.

*Rana wasl* Annandale (1917), *Mem. Asiat. Soc. Bengal.*, VI : 131, pl. V. fig. 5.

**Material Examined** : 79 examples (57 +, 22 -), collected from all localities upto 2500 mts. in district Dehradun.

**Description** : Head as long as broad. Tip of snout obtusely pointed, projecting beyond anterior extremity of lower jaw. Snout as long as eye. Canthus rostralis obtuse. Loreal region oblique, concave. Nostrills equidistant from eye and tip of snout or nearer the latter. Interorbital space narrower than upper eyelid. Internarial distance greater than interorbital distance. Tympanum distinct, 0.50 to 0.66 times in diameter of eye. vomerine teeth in two oblique series between choanae or extending a little beyond their posterior level.

Fore limbs moderate. Fingers obtusely pointed, first extending beyond second. Third finger longest, almost equal to length of snout. In some specimens, this finger is slightly longer than snout. Fourth finger the shortest, almost equal to that of second finger. Subarticular tubercle well developed and very prominent.

Hind limb stout, moderately long. When hind limbs are folded at right angles to the body, heels more or less overlap. Tibiotarsal articulation extends upto posterior corner of eye. Toes obtusely pointed but slightly swollen at tips. Webbing between toes conspicuous (half webbed). Almost

two and half digits of fourth toe free from web and one each of the rest of the toes without webbing. Outer metatarsals separated nearly to the base, web along outer side of metatarsals and fifth toe in form of a narrow fringe. Subarticular tubercles well developed, and prominent. Inner metatarsal tubercle oval or oblong, blunt 1/3rd to 2/3rd length of inner toe. Outer metatarsal tubercle distinct, round and small. Length of tibia approximately half the combined length of head and body. Length of tibia 2.75 to 3.25 times of its diameter.

Skin of back with narrow longitudinal glands. Supratympanic fold distinct, continues laterally upto shoulder. Lower parts smooth. Anal region and posterior side of thigh near anus glandular.

**Osteological Characters** : Skull triangular in shape. Nasal bones large, in contact with each other, narrowly separated from frontoparietals, ethmoid slightly exposed. Frontoparietals narrow, flat. Zygomatic process of squamosal moderately long. Omosternum forked at the base. Terminal phalanges obtuse.

**Colouration** : Upper surface grey, brown, olive, even black with darker spots, with a 'V' shaped mark between the eyes ; some specimens with a broad or narrow yellow, white, orange coloured

vertebral streak. Dorsal aspect strewn with small pinkish warts. Posterior aspect of thigh yellow, marbled with dark brown. Hind limbs with irregular dark crossbars. Fore limbs also with dark crossbars but indistinct. Lips with dark vertical bars. Under surface whitish.

**Sexual Dimorphism :** Males are smaller in size with a vocal sac on each side, forming loose folds on the throat, which is brown to blackish on the sides. Fore limbs robust in males with a strong dark coloured nuptial pad on inner side of first finger.

**Larval Morphology :** Hind limb stage tadpole : Head and body oval. Internarial distance half the width of head in this region. Length of body about 1.50 to 1.65 times of its width. Length of tail 1.75 to 1.89 times in length of body. Nostrils equally distant from eye and tip of snout. Eyes dorsally placed. Tip of tail obtuse. Rostrum black, serrated. Mouth disk small, transverse. Upper lip edged with one uninterrupted upper row of keratodonts and widely interrupted lower row. Angle of oral disc papillated. Lower lip with three uninterrupted rows of keratodonts. Spiracle tubular on left side. The tadpoles of this species are characterised by their cream coloured body and less pigmented tail.

**Distribution :** India : All over the plains, Himalaya extending upto at 2500 mts.

Elsewhere : East Asia, from Japan and China to Pakistan, Ceylon (Sri Lanka), Malayan Peninsula, Phillipines, Borneo and Lombok.

**Habitat and Breeding Habit :** These small frogs are abundantly available near small hill streams and water logged areas near paddy fields. Most of the collections were made along the edge of hill streams. The population of the species is more dense in eastern parts of the district Dehradun.

When disturbed, they jump and skit over water and again come back to the edge. They are more terrestrial than aquatic. During breeding season, males croak which sounds like "Trrirr '-' Trrirr '-' Trrirr" It is very difficult to locate them because of their colouration which is absolutely similar to the vegetation. These frogs breed during monsoon (June to July) or even in August. In the present study, tadpoles of this species have been reared for first time in laboratory.

The breeding males and females were kept in a secluded cemented water tank, covered with wire net of small mesh. The tank was absolutely kept clean and filled with pond water. The spawn was laid in the tank ; it took 43 days to complete its life cycle and produce small golden coloured froglets. The tadpoles of this species are characterised by very delicate body.

**Remarks :** Boulenger (1920) has recognised *Rana limnocharis* Boie (in Gravenhorst) along with var. *nilagirica* Jerdon, var. *syhadrensis* Annadale, and var. *Andamanensis* Stoliczka. These varieties differ from each other and the forma typica by their body size, pattern of webbing and the length of first and second fingers. Dubois (1975) has indicated that the subspecies are likely to increase number due to presence of sibling species under *limnocharis* group. However, during the present study it has been observed that *limnocharis* is a highly variable group revealing characters of different sub-species within a single population collected from same area. Hence, the population of this group from various regions of India needs an in-depth study and detailed analysis of sub-specific differences. It has been further observed in field that representatives of *Rana limnocharis* show differences in their colouration, webbing pattern etc. in live specimens. These differences are likely to be obliterated in preserved state.

***Rana tigerina* Daudin, (1803)**  
(Plate XI, XII & XIII)

*Rana tigerina* Daudin (1803), *Hist. Rain. Gren. Crap.*, : 64, pl. XX ; Stejneger (1907), *U. S. Nat. Mus. Smithsonian Inst.*, 58 : 139-142 ; Leviton et al., (1956), *Occ. Pap. Nat. Hist. Mus. Stanford Univ.*, 1 : 3-4 ; Swan and Leviton (1962), (correction) *Proc. Calif. Acad. Sci.*, ser. 4, 32 (60 : 107 ; Tayler (1962), *Univ. Kans. Bull.*, 43 : 300 ; Minton (1966), *Bull. Amer. Mus. Nat. Hist.*, 234 : 105 ; Hejmadi (1974), *Prak. Utkal. Univ. Journ. (Sc.) II (1 & 2)* : 89 ; Daniel (1975), *J. Bombay nat. Hist. Soc.* 72 (2) : 512 ; Sarkar (1984), *Rec. Zool. Surv. India.*, 81 (3 & 4) : 227 ; Dutta (1985), *J. Bombay nat. Hist. Soc.*, 82 : 220 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Suppl.) : 138.

*Rana tigrina* : Merrem (1820), *Tent. Syst. Amph. Mar.*, : 174 ; Dumeril and Bibron (1841), *Erpet. Gen. VIII* : 375 ; Kelaart (1852), *Prodr. Faun. Zeyl.*, : 192 ; Guenther, (1858) *Cat. Batr. Sal. Brit. Mus.*, : 9 ; Peters (1863), *Mon. Berl. Ac.*, : 77 ; Guenther (1875), *Proc. Zool. Soc. London.*, : 567 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*, : 26 ; Boulenger (1890) *Fuan. Brit. India, Rept. and Batr.*, : 449 ; Flower (1896), *Proc. Zool. Soc. London.*, : 901 ; Flower (1899), *Proc. Zool. Soc. London.*, : 891, pl. LIX, fig. 2 ; Ananandale (1917), *Mem. Asiat. Soc. Bengal.*, VI : 122 ; Boulenger (1918), *Rec Indian Mus.*, 15 : 51, 65 ; Annandale (1918), *Rec. Indian Mus.*, 15 : 55, 60 ; Acharjee and Kripalani (1951), *Rec. Indian Mus.*, 49 : 177 ; Tilak and Mehta (1983), *Res. Bull. (Sc.) Punjab Univ.*, 34 (3-4) : 160.

*Rana tigrina tigrina* : Boulenger (1920). *Rec. Indian Mus.*, 20 : 17.

*Rana tigerina tigerina* : Martens (1969), *Stuttg. Beitr. Naturk.* : 197.

*Rana (Dicroglossus) tigerina tigerina* : Dubois (1974), *Bull. Mus. natn. Hist. nat. Paris*, ser. 3, n° 213 (*Zool*) 143 : 381.

*Rana picta*, Gravenhorst, (1829), *Delic. Mus. Zool. Vratisl.*, I : 39.

*Rana brama* Lesson (in Belang), (1834), *Voy. Ind. or. Rept.*, : 329.

*Rana malabarica* (non Dumeril and Bibron) : Kelaart, (1852), *Podr. Faun. Zeyl.*, : 191.

*Rana occipitalis* Guenther, (1858), *Cat. Batr. Sal. Brit. Mus.*, : 130, pl. XI ; Bocage, (1866), *J. Sci. List.*, I : 73 ; Boettger, (1881) *Abh. Senck. Ges.*, XII : 416 ; Boulenger, (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*, : (1895), *Herp. Angola.*, : 155 ; Werner, (1908), *Sitzb. Ak. Wien.*, CXVI (1) : 1887.

*Pyxicephalus fodiens* Peters, (1860), *Mon Berl. Ac.*, : 186.

*Rana hydraletis* (Boie), Peters, (1863), *Mon. Berl. Ac.*, : 78.

*Rana bragantia* Bocage, (1864), *Rev. Mag. Zool.*, : 253.

*Rana tigrina* var. *pantherina* (Fitz.), Steindachner, (1867), *Novara. Amph.*, : 14-17, pl. i.

*Rana burkilli* Annandale, (1910), *Rec. Indian Mus.*, 5 : 79 ;

*Rana rugulosa* (non wiegmann), Annandale, (1917), *Mem. Asiat. Soc. Bengal.*, VI : 126 ; Smith, (1917), *J. Nat. Hist. Soc. Siam.*, II : 263 ; Annandale, (1918), *Rec. Indian Mus.*, 15 : 60.

**Material Examined** : 27 examples (19 +, 8 ), collected from different localities around district Dehradun upto altitude 1700 mts..

**Description** : Head moderate, smaller than trunk, snout obtusely pointed. Tip of snout projecting

beyond lower jaw. Head broader than long, head width 1.05-1.13 times in its length. Length of snout longer than eye, length of snout 1.63-1.82 times of eye diameter. Canthus rostralis obtuse ; loreal region oblique and concavity on middle.

Nostrils always nearer to tip of snout than anterior corner of eye. Interorbital space narrower than upper eyelid. Tympanum very distinct, 2/3rd diameter of eye, 1.5 to 2.5 times its distance from the latter. Eyes elevated well beyond skull. Vomerine teeth strong, obliquely placed rows in between choanae ; tooth bands close to each other than to choanae. In some specimens, vomerine teeth extend beyond posterior margin of choanae. Lower jaw with two very prominent notches at symphyseal zone which fits into upper jaw.

Fore limbs stout ; fingers obtusely pointed with distinct well developed subarticular tubercles. First finger longer than second, Third finger the longest. Fourth finger almost equal to second or slightly longer. Length of palm including longest finger slightly longer than the fore-arm which is slightly greater than length of upper-arm.

Hind limbs quite flabby and muscular adapted for leaping, jumping and fast swimming. The tibiotarsal articulation reaching upto posterior corner of eye. Heels overlapping when limbs folded at right angles to body. The length of tibia 2.5 to 2.75 times in its diameter. Toes obtuse, somewhat swollen at the tip, Metatarsals separated nearly to base, subarticular tubercles distinct but comparatively smaller in dimension. Inner metatarsal tubercle distinct, blunt, elongated, its length 1.25 to 2.00 times in length of inner toe. Outer metatarsal tubercle absent. A flap of skin on outer aspect of fifth toe present.

Skin of upper parts smooth with elongated prominent longitudinal glandular folds, which are interrupted throughout the entire dorsum. A strong glandular fold from eye to shoulder. Lower parts smooth. Anal region warty. Limbs with rough warts.

**Osteological Characters :** Skull more or less triangular in shape. Nasal bones large and in contact with each other and with frontoparietals. Ethmoid hidden below nasals. Frontoparietals narrow, feebly grooved along mid line. Zygomatic

arch long. Omosternum forked at base with a expanded cartilage at end. Xiphisternum entire with expanded pear shaped xiphoid cartilage. Coracoids more or less distinctly overlapping with their proximal extremities. Clavicles strong, omosternum horizontal and xiphisternum with long bony style. Terminal phalanges obtusely pointed.

**Colouration :** Juveniles brilliantly green and yellow coloured with a distinct yellow vertebral streak. Another yellow oblique band starts from shoulder and continues upto belly as a lateral band. In adults, lateral band fades and turns white. A dark canthal streak present. Limbs with bold patches of dark olive colour. Hinder part of thigh marbled with black and yellow. Lower parts white, immaculate ; occasional specimens with a blotched throat.

**Sexual Dimorphism ;** Males with two lateral vocal sacs of bright blue colour on each side of throat. Fore limbs moderately thickened. A strong nuptial pad on inner side of metacarpal region of first finger.

**Larval Morphology :** The present study shows that developmental stages of *Rana tigerina* Daudin are very much distinct from those of its allied species. The hind-limb stage possess an oral disc with powerful suprarostrodont, and infrarostrodont. Infrarostrodont is notched in the middle to accommodate the pointed beak of suprarostrodont, outer margin is well serrated. Labial teeth rows are variable but a majority bear one outer uninterrupted and two interrupted rows of teeth. Lower labial teeth comprise one small and a long uninterrupted row with one interrupted row with one interrupted row of teeth. Upper and lower lips are medially papillated. Head and body globular. The well blotched tail is about twice as long as body. Depth of tail is almost twice depth of caudal muscle. The tail is attenuated with acutely pointed tip.

**Distribution :** India : Found from base of the Himalaya to South India.

PLATE XI



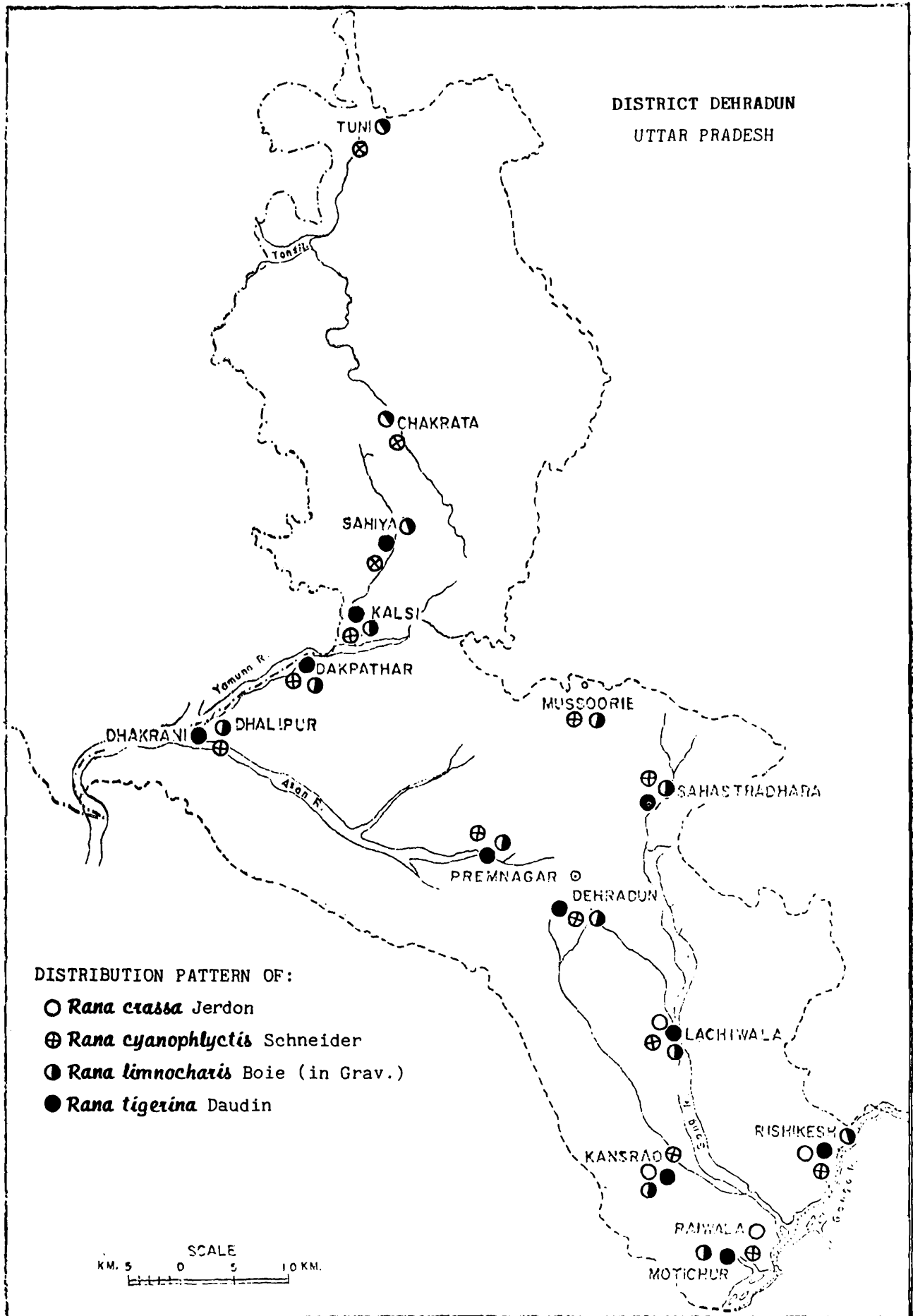
Fig. 1. Photograph of juvenile *Rana tigerina* Daudin  
2. Photograph of juvenile *Rana crassa* (Jerdon)

PLATE XII



Fig. 1. Photograph of male *Rana tigerina* Daudin

PLATE - XIII



Elsewhere : Nepal, Sri Lanka, Burma, Thailand, South China and Taiwan.

**Habitat and Breeding Habit :** The giant edible frog is generally found resting inside bushes on edge of water, to which it retreats immediately even on a slightest disturbance. It hides in burrows and under heaps of dry leaves to protect its moist skin from scorching sun and dry weather. It was found to be very common in Dehradun and its environs. The breeding calls of male is the signal of onset of monsoon for villagers of plains. This frog is more active at night. During breeding season males are very active, in pools fed by rainwater.

**Remarks :** This edible frog of India has till recently been subjected to over exploitation for exporting its legs to earn foreign exchange. This trade has reduced number of the species tremendously and created a threat to ecological balance of nature. These frogs have a high rate of feeding capacity as they can devour several insect pests, mice, shrews, land crabs etc. These frogs conceal themselves near water bodies within bushes and holes from where they can jump into water when frightened. The specific 'Gang'-'Ghang' or 'Gang'-'Ghang' call of this species during the breeding season indicates the onset of monsoon. The population of this species in and around Dehradun is not affected, because in northern India, rate of exploitation of the species in hilly areas has not reached to such detrimental proportion. The perennial water sources in the foot hills provides a natural habitat for this species which thrives well in the cooler months. Moreover, this terrain provides plenty of hiding places particularly in the rocky bed of streams. This species is economically important and can be suitably used for the biological control of pests. This conspicuous and giant of the Indian frogs can be substituted with the commonest skipping frog, *Rana cyanoplyctis* for purposes of dissection and other scientific use in the colleges and medical institutes.

For further augmentation of these species of frogs, artificial breeding should be resorted to. Artificial breeding of frogs is not normally in vogue and therefore, private animal collectors resort to wanton destruction of this economically important amphibian.

*Rana (Paa) tuberculata* Tilak and Ray, 1985  
(Plate XIV, XV & XVI)

*Rana (Paa) tuberculata* Tilak and Ray (1985), *Zool. Anz., Jena* 215 (3/4) : 231-239. (Type locality : Chakrata, district Dehradun).

**Diagnosis :** Hill stream dwelling frogs attaining a maximum size, 42 mm for males and 36 mm for females. Head wider than long. Snout longer than eye. Internarial distance greater than interorbital distance. Tympanum hidden under skin, almost half the diameter of eye. Tips of finger and toes rounded and swollen. Males with spiny tubercles on the dorsal aspect of first and second metacarpals, and females with large ova during breeding season.

**Holotype :** NRS/ZSI-A-1, adult male (36 mm) collected from origin of Kheel Gad, Road side west of Purari, 5 km west of Chakrata, District Dehradun, Uttar Pradesh, altitude-2000 mts. 7. V. 1978, Raj Tilak.

**Description :** Head wider than long, width being 1.17-1.23 times longer than length and contained 2.59-3.56 times in body length. Length of head contained 3.16-3.66 times in body length. Snout rounded and projects beyond mouth, length of snout contained 1.66-2.92 times in head length and 2.00-2.50 times in head width. Eye smaller than length of snout and contained 1.20-1.46 times in its length. Canthus rostralis rounded. Loreal region oblique and slightly concave. Internarial distance more than interorbital distance, former being 1.18-1.48 times in latter. Internarial distance contained 2.50-2.81 times in head length. Nostrils situated midway between eye and tip of snout. Each nostril oval in shape and

bears a small knoblike fleshy expansion at its hinder part. Interorbital distance contained 3.03–3.70 times in length of head. Distance between nostrils and eye contained 3.33–4.00 times in head length. Diameter of eye contained 2.30–2.52 times in head length. Width of upper eyelid equal to that of interorbital distance. Upper eyelid 1.21–1.48 times the diameter of eye. Tympanum 1.90–2.73 times the eye and 4.52–6.73 times in head length. Tympanum hidden under skin. After removal of skin, tympanum nearly rounded and its greatest diameter equals the distance between it and eye. Pineal ocellus absent. Vomerine teeth lie in two oblique series closer to each other and posteriorly, these patches extend beyond posterior border of choanae. Maxillary teeth well developed. Tongue wide, covering almost whole buccal floor and notched behind. Supra-tympanic fold prominent and extends from posterior border of eye to shoulder. A small insignificant dorsolateral fold visible only in anterior part between scapular region to eye on each side. A prominent transverse fold of skin present behind eyes.

Forelimbs of moderate size; its length contained 1.10–2.00 times in body length. Length of humerus contained 3.20–3.80 times, length of radio-ulna 3.15–4.25 times and length of hand 2.06–2.56 times in length of forelimb. Tips of fingers rounded, slightly swollen on lower surface, and a transverse groove on the upper surface between penultimate and last phalanx present. First finger almost equal to second and fourth. Third finger longer than all the fingers. Proximal sub-articular tubercles of fingers very prominent and slightly wider than long. Distal subarticular tubercles poorly developed. First and second metacarpals 2/3rd free, second and third 1/2 united through their length while third and fourth connected with each other throughout their length. Three metacarpal tubercles on palm, outermost

poorly developed, these tubercles longer than wide.

Hindlimb comparatively shorter than that of other species of subgenus *Rana (Paa)* Dubois (1975). Tibiotarsal articulation, when extended forward, reaches hinder margin of eye. Length of hind-limb contained 1.51–1.72 times in body length. Length of femur contained 3.43–3.87 times, length of tibia 3.33–3.51 times and length of foot 3.92–3.26 times in length of hind-limb. Tibial width contained 2.75–3.36 times in length of tibia, when folded at right angles to body, heels overlap each other very slightly. Tibial length shorter than distance from base of metatarsal tubercle to tip of fourth toe. Fourth toe longest and equal to nearly half of the distance between its tip and proximal end of tarsus. Tips of toes swollen and wider than subarticular tubercles. Circummarginal groove on tip of toe absent, but a groove present on upper surface in between penultimate and last phalanx, in same manner as in fingers. Outer metatarsal separated by web through 3/4th of its length. Webbing of toes not complete and deeply emarginate. A narrow fringe of web covers a part of distal end of first and second toes, whole of first and penultimate phalanges of third and fifth toes and distal three phalanges in fourth toe. A thin dermal fringe runs along border of first toe from its distal tip to metatarsal tubercle. Inner metatarsal tubercle prominent and longer than wide; its length contained 1.75–2.50 times in length of first toe. No outer metatarsal tubercle. Tarsal fold absent. A prominent dermal fold forming a transverse groove on the tibio-humerus and tibio-tarsal joints.

**Colouration :** An irregular dark brown cross band between the two eyelids on frontoparietal zone of head. Ground colouration of dorsal side of head grey, suffused with brown. Rest of body bears brown patches with elongated brown

marblings on dorsal side. Ventral side of body immaculate. In males, ventral aspect of lower jaw bears closely placed dark brown dots which impart this region a brown colouration. Edges of lower jaw bear dark brown bars. Fore-limbs and hind-limbs bear dark brown cross bands on dorsal aspect, and fingers and toes also possess cross bands very prominent on joints of phalanges. Colouration of body differs in individuals of different age groups and also differs with habitat where they live. But overall colouration of body of female deeper than that of male. Lighter ground colouration of male makes brown patches more prominent.

**Sexual Dimorphism :** Subgenus *Rana (Paa)* prominently based on secondary sexual characters of male. In the present species, male also shows significant differences from female in distribution of nuptial spines on first finger, horny black-tipped spinules throughout dorsal aspect, specially on tibio-tarsal region, dense concentration. Prominent anal glands with black tips present around vent; these glands very much swollen and distinct in male than in female.

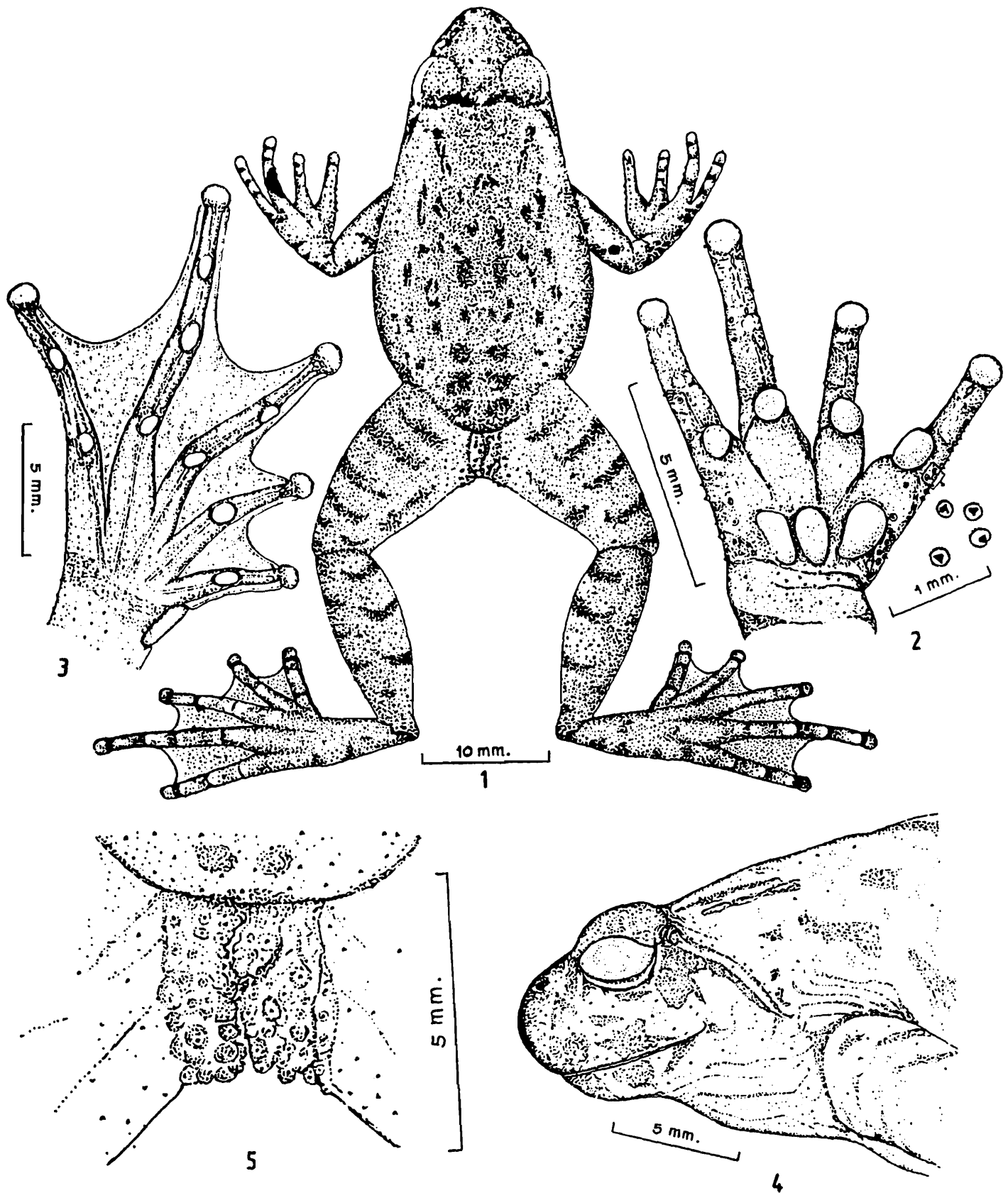
**Larval Morphology :** The tadpole of hindlimb stage (63 mm) possess oral disc studded with papillae except on anterior part of upper lip. Angles of jaw bear greatest concentration of papillae which extend towards upper lip, gradually reducing into a single row while posteriorly they extend along the border of the lower jaw in a double row. Beak black. It is bordered with small teeth. Number of horny labial teeth and their rows gradually increase from younger to older stages and reduce only when four-legged advanced stage shifts from water to land. Pupil black and rounded and iris golden. Only three rows of lower labial teeth of which two outer ones complete and inner one narrowly interrupted. Of the six (rarely 7) rows of upper labial teeth, outer single row

complete and inner five rows gradually and broadly interrupted. Under high-power microscope, each row composed of a large number of shovel-shaped teeth, arranged in a series. Each tooth in fact, of three spout-like pieces joined end to end in a series, terminal piece functional one with a row of 10-1 prominent serrations arranged along its rim. Second and third pieces lie concealed behind terminal piece. Proximal piece embedded in muscles. Spout of shovel-shaped terminal piece of tooth incurved and its movement controlled by muscles for efficient scrapping function. Second piece of tooth with row of serrations present in formative stage. Each piece of tooth formed of keratin and hence larval dentition keratodont. It appears that second and proximal pieces of tooth become functional in succession as soon as distal piece wears out and cast off. Details of this set up may be used for larval taxonomy. Spiracle on left side near posterior part of head. Anal opening placed at root of ventral caudal fin. Internarial distance slightly greater than interorbital distance. Nostrils, round openings without fleshy expansions on hinder part, unlike adult condition. Oral disc performs the function of suction due to presence of elongated papillae and also helps feeding. Tail muscular and by its powerful lateral jerks, maintains forward movement against water current of hill-streams.

**Etymology :** Specific name derives from its tubercular glands scattered throughout body mainly on anal region of both sexes.

**Relationships :** This species is very close to *Rana (Paa) blanfordi* Boulenger, which is one of twenty one species included in the subgenus *Rana (Paa)* (Dubois 1975) and is known to be distributed in Mussoorie Hills. While agreeing in many morphological features, *Rana (Paa) tuberculata* Tilak and Ray, differs from *Rana blanfordi* in the following characters :

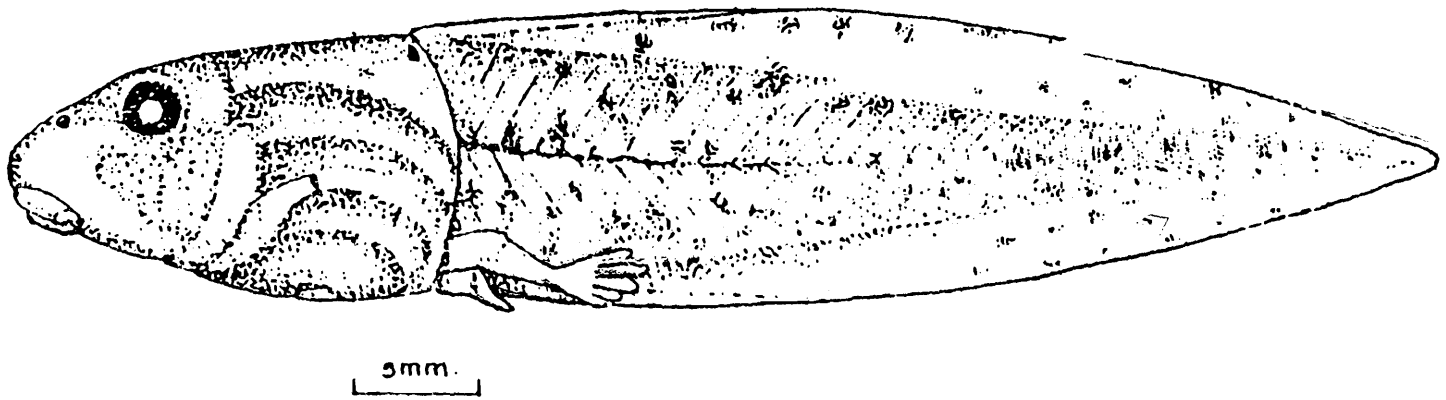
PLATE - XIV



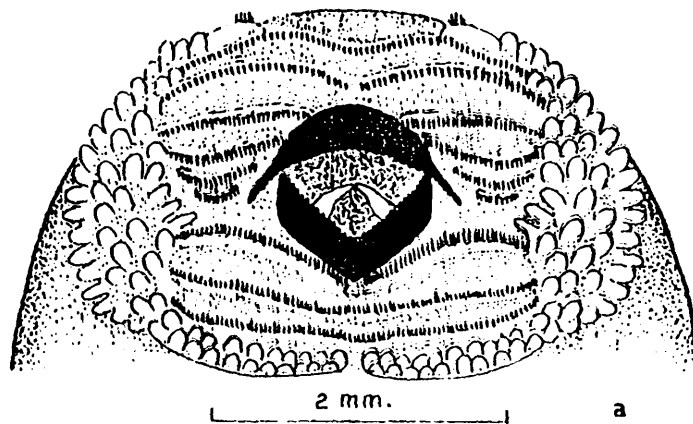
*Rana (Paa) tuberculata* Tilak & Roy

Fig. 1. Adult male (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. Head (Lateral view); 5. Anal region (Dorsal view)

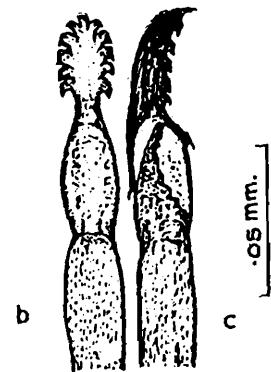
## PLATE - XV



1



a



b

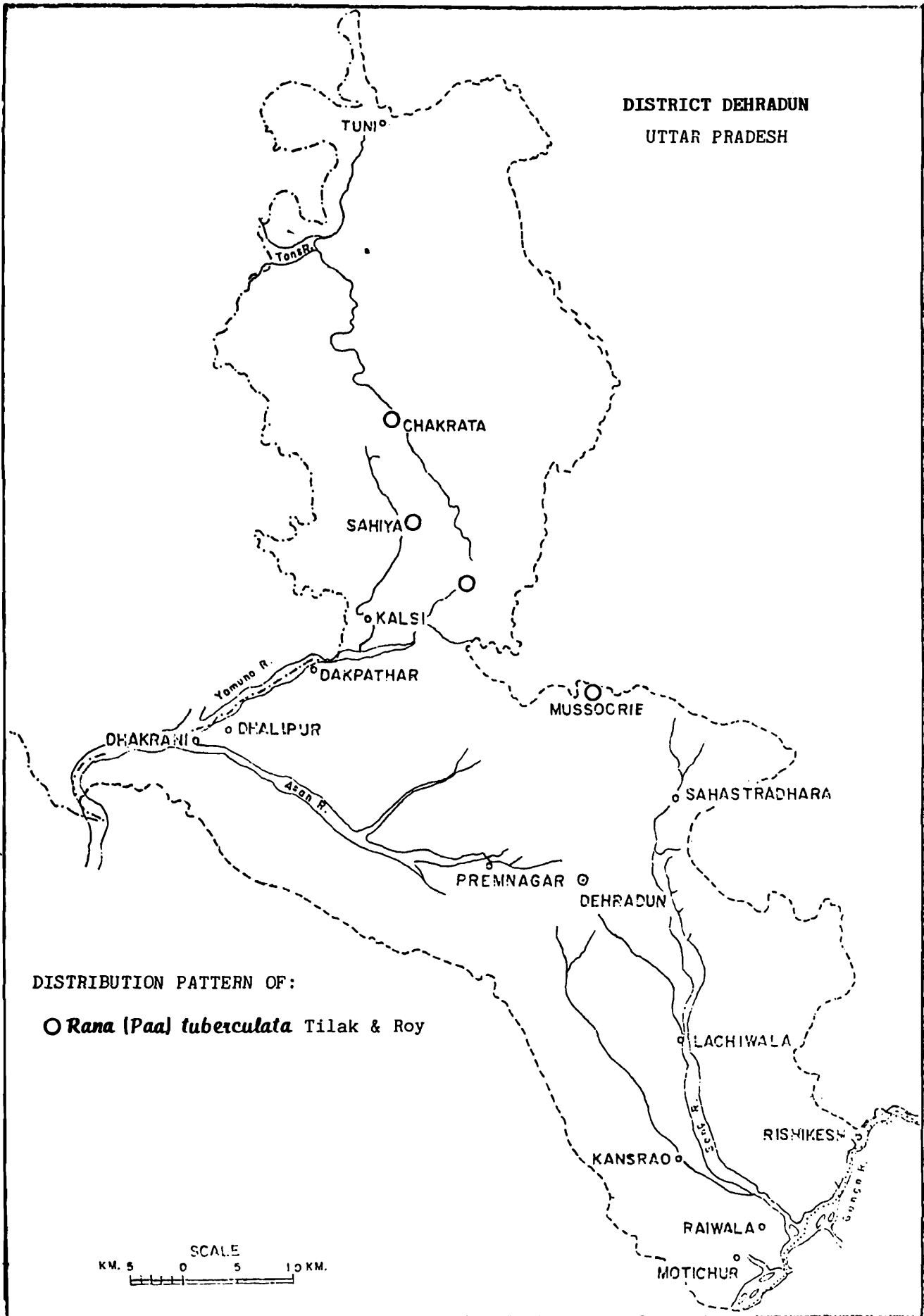
c

2

*Rana (Paa) tuberculata* Tilak & Roy

Fig. 1. 15 days' old Tadpole (Lateral view); 2a. Oral disc of same Tadpole (Ventral view);  
2b. Keratodont (Ventral view); 2c. Keratodont (Lateral view)

PLATE - XVI



1. First and second fingers almost equal.
2. Skin covered with spiny tubercles and males with secondary sexual characters.
3. Nostrils equidistant from eye and tip of snout.
4. Tympanum hidden.
5. Tibiotarsal articulation reaching hinder border of eye.
6. Toes not forming discs.

Further, it resembles *Rana (Paa) annandalii* Boulenger in having distribution of spinules uniformly throughout the dorsal aspect of body but differs markedly in length of hind-leg which is smaller and tibiotarsal articulation reaching only hinder part of eye. Moreover, the snout is greater than eye. The new species, *Rana (Paa) tuberculata*

agrees with *Rana (Paa) feae* Boulenger; *Rana (Paa) phrynoides* Boulenger and *Rana (Paa) sternostigmata* Murray in length of hind-leg in relation to body length but it clearly differs from all of them in following characters:

1. First finger equal to that of second finger.
2. Interorbital distance equal to upper-eyelid.
3. Tips of fingers and toes are swollen but not forming any disc.
4. Webbing between toes not complete.
5. Tarsal fold absent.

Dubois (1975) described *Rana (Paa) minica* from the neighbouring areas of Garhwal but this species differs markedly from the new species in body size, and in having longer hindleg and the tibiotarsal articulation extending beyond the tip of snout.

### Genus *Tomopterna* Dumeril and Bibron, 1841

- Tomopterna* Dumeril and Bibron (1841) *Erpet. Ge.*, 8 : 443 (Type species : *Tomopterna delandii*).  
*Sphaerotheca* Guenther (1858) *Cat. Batr. Sal. Birt. Mus.* : 7, 20.  
*Pyxicephalus* Tschudi (1839) *Mem. Soc. Sci. Nat. Neuchatal*, 2 : 442.

**Distinguishing Features :** Fingers completely free; toes incompletely webbed, metatarsals bounded by muscles. Vomerine teeth in two oblique series. Inner metatarsal tubercle shovel-shaped with sharp margins. Tongue large, free and notched behind.

**Distribution :** India : Throughout except altitude above 2200 mts. Elsewhere : Nepal, Pakistan, Bangladesh, Ceylon. Upper Burma.

### Known Indian Species :

1. *Tomopterna breviceps* (Schneider, 1799)
2. *Tomopterna dobsonii* (Boulenger, 1882)
3. *Tomopterna leucorhynchus* (Rao, 1937)
4. *Tomopterna parambikulamana* (Rao, 1937)
5. *Tomopterna rolandae* Dubois, 1983
6. *Tomopterna refescens* (Jerdon, 1854)

### *Tomopterna breviceps* (Schneider, 1799)

(Plate XVII & XVIII)

*Rana breviceps* Schneider, (1799) *Hist. Amph.* : 142; Peters (1863), *Mont. Berl. Ac.* : 76; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, : 32; Boulenger (1890), *Faun. Brit. India, Rept. and Batr.* : 451; Ferguson (1904), *J. Bombay nat Hist. Soc.*, 15 : 502; Bhaduri and Kripalani (1954), *J. Bombay nat. Hist.*

*Soc.*, **52** : 620-623; Swan and Leviton (1962), *Proc. Calif. Acad. Sci.* ser. 4, **32**(6) : 124; Mansukhani and Murthy (1964), *Rec. Zool. Surv. India.*, **62** (1-4) : 59; Hejmadi (1974), *Prak. Utkal. Univ. J. (Sci.)* : 91; Hejmadi et. al., (1979), *J. Zool. Soc. India.*, **31**(1 & 2) : 29; Pillai (1982), *Rec. Zool. Surv. India.*, **79** : 363-365; Tllak and Mehta (1983), *Res. Bull. (Sci.) Punjab Univ.*, **34**(3 & 4) : 161; Sarkar (1984), *Rec. Zool. Surv. India.*, **81** (3 & 4) : 231.

*Rana variegata* Gravenhorst (1829), *Delic. Mus. Vratisl. L* 33.

*Pyxicephalus fodiens* Jerdon (1854), *J. Asiat. Soc. Bengal.* : 534.

*Pyxicephalus pluvialis* Jerdon (1854), *J. Asiat. Soc. Bengal.* : 535.

*Sphaerotheca strigata* Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 20, pl. 2. fig. A. (Type locality : Madras).

*Tomopterna strigata* Guenther (1860), *Proc. Zool. Soc. London.* : 165.

*Pyxicephalus breviceps* : Guenther (1864), *Rept. Brit. India.* : 411-412; Theobald, (1868, *J. Asiat. Soc. Bengal.*, : 80; Anderson, (1871), *Proc. Zool. Soc. London.* : 200; Murray (1884), *Zool. Sind.* : 399.

*Rana (Tomopterna) breviceps* : Boulenger (1920), *Rec. Indian Mus.*, **20** : 103-104. Kirtisinghe (1957), *Amph. Ceylon.* : 24; Dubois (1974), *Bull. Mus. natn. Hist. Nat. Ser. 3r, n° 213 (Zool. 143)* : 385. Daniel (1975), *J. Bombay nat. Hist. Soc.*, **72**(2) : 520.

*Tomopterna breviceps* : Inger and Dutta (1987), *J. Bombay. nat. Hist. Soc.*, **83**(Suppl.) : 184.

**Material Examined** : 12 examples (80, 40), collected from different localities; Sahiya, Kalsi, Dhalipur, Sahaspur, Selakui, Jhajra, Dehradun around, and Mussoorie, Rajpur, Shastradhara and Shiwalik ranges in district Dehradun.

**Description** : Body rather short and stout. Head sloping anteriorly, broader than long, width of head 1.15 – 1.23 times of head length. Tip of snout rounded. Mouth subterminal, canthus rostralis obtuse, loreal region depressed. Nostrils more nearer the tip of the snout than anterior corner of eye. Length of snout shorter than eye, length of eye 1.14 – 1.20 times of snout length. Internarial distance slightly greater than interorbital width, which is 0.50 to 0.75 times in upper eyelid. Upper eyelid wider than interorbital width. Upper eyelid 1.20 to 1.50 times of interorbital width. Tympanum distinct, vertically oval. Diameter of eye 1.50 – 1.58 times of diameter of tympanum. There is a supratympanic fold commencing from posterior corner of eye upto shoulder. Vomerine teeth in two oblique groups, extending a little beyond hinder edge of choanae. Tongue free and deeply notched behind.

Fingers quite free, first longer than second. First finger 1.33 – 1.65 times length of second finger. Third finger as long as first or slightly longer. Fourth finger shortest. First finger with a large, round subarticular tubercle on palmar surface. Subarticular tubercles on second, third and fourth almost equal in dimension and quite prominent. Palmar tubercle elongated. Fore-limb stout and more closer to body and head.

Hind limbs robust and toes moderate. Subarticular tubercles prominent but smaller in dimension than those of fingers. Tips of toes obtuse. Toes with half web. Inner metatarsal tubercle shovel-shaped, compressed, placed obliquely at base of first toe. Length of first toe 1.50 to 1.66 times length of inner metatarsal tubercle, no outer tubercle. Outer metatarsals externally united by muscles. Hind limb short, tibiotarsal articulation reaching shoulder. Heels not meeting each other when folded at right angles to body. Tibia flabby with strong muscles. The length of tibia 2 to 3 times its width and much shorter than foot.

Skin of upper parts smooth with some scattered,

## PLATE - XVII

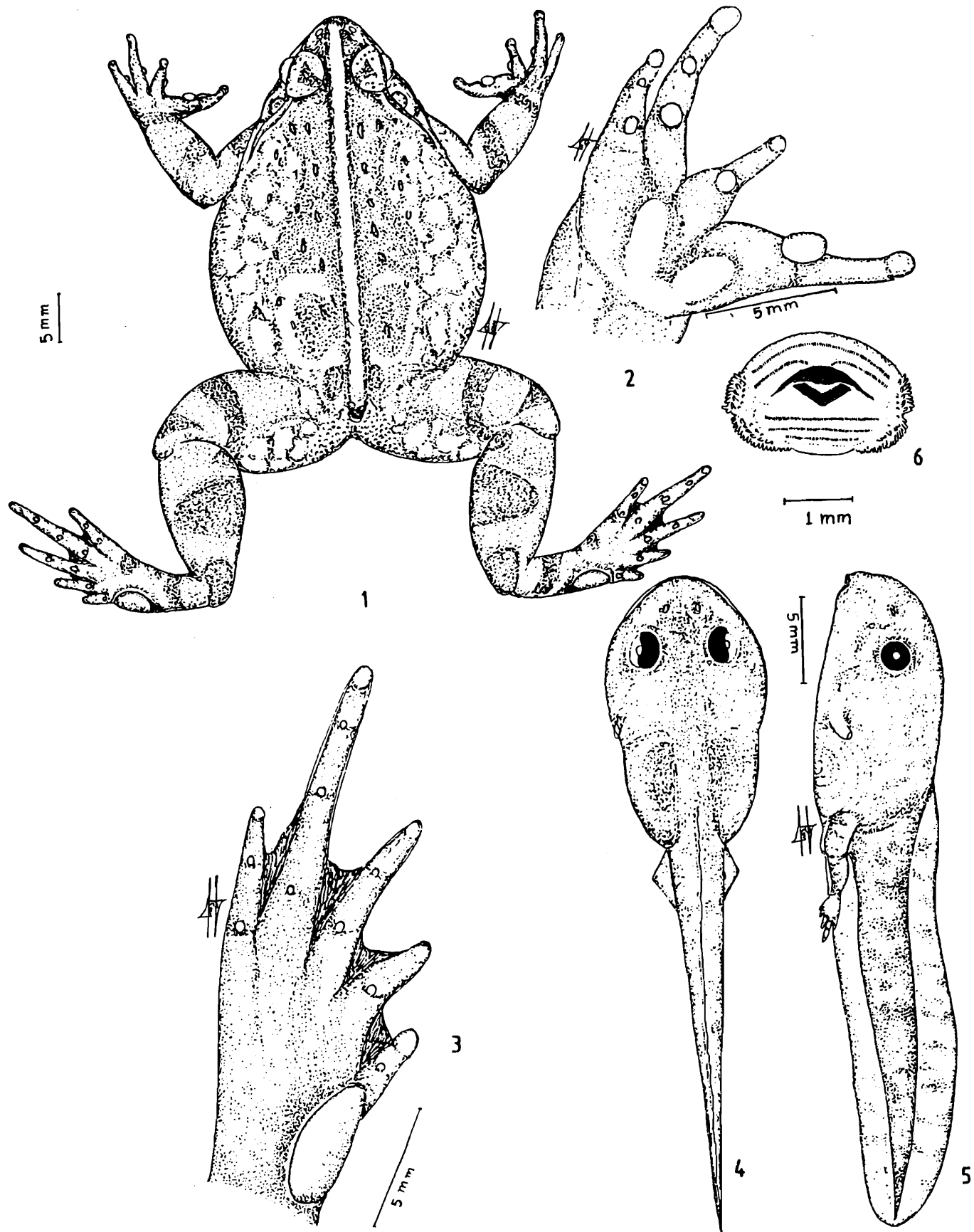
*Tomopterna breviceps* Schneider

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. 10 days' old Tadpole (Dorsal view); 5. 10 days' old Tadpole (Lateral view); 6. Oral disc of same Tadpole (Ventral view)

elongated tubercles. Belly and lower surface of thigh near anal region glandular.

**Osteological Characters :** Skull compact, zygomatic branch of squamosal very short. Nasal bones small, separated from each other and from frontoparietals; sphenethmoid largely exposed above, produced forward beyond nasals. Omosternal style forked at base. Precoracoids strong, straight. Terminal phalanges obtuse. The femur and tibia very stout bones. Inner metatarsal tubercle flat and compressed bone with a cartilaginous outer margin.

**Colouration :** There is a considerable colour variation within the same population. In some individuals, dorsum completely brick-red in colour without a vertebral streak of black colour. Canthal and tympanic zones are black in colour. The posterior aspect of limbs marbled with cream colour, ventrally immaculate. Some individuals yellowish brown, generally with a yellow vertebral streak. Dorsal side of body and limbs bear dark brown bold patches. Ventrally immaculate. Crown with two oblique brown streaks separated by yellow band beginning from upper eyelid and converging in posterior region. Males with a dark brown vocal sac.

**Sexual Dimorphism:** Male is smaller than female and also stouter with slender toes. Breeding male with external vocal sac which is formed by two lateral bladders, communicating in the middle with a cleft on each side of tongue for entry of air from mouth to sac. Throat of males dark brown to black.

**Larval Morphology :** Tadpoles of hind-limbed stage (32 days old); shape of body oval, total length being 3.20 to 3.23 times of head and body length and 1.55 to 1.60 times of tail length. Snout tip rounded, eyes dorsal. Interorbital distance as long as diameter of eye, or slightly less. Interorbital distance 1.40 – 1.43 times of internarial distance. Mouth subterminal, oral denticles surrounded by

small digitiform papillae on angle of jaws. Upper and lower rostradonts black and serrated on margin. Spiracle situated on left side forming a tubular outward opening. Vent median and placed on ventral aspect of body near junction of ventral caudal membrane and abdomen, opening little beyond the junction. Height of tail membrane almost equal to height of body.

Colouration of tail is well marked with blotches of brown pigments. Caudal membranes are less pigmented. Dorsally brown pigmented. The neural zone is dark pigmented than rest of body. Ventrally transparent except on belly which is dark pigmented. Hind limbs crossbarred, but webbing between toes restricted to the base.

**Distribution :** India : Andhra Pradesh, Gujarat, Kerala, Karnataka, Maharashtra, Rajasthan. Tamil Nadu, Uttar Pradesh (Allahabad and Agra), West Bengal, Bihar, Himachal Pradesh (Sirmour). Orissa, Madhya Pradesh.

Elsewhere : Sri Lanka, Nepal, Upper Burma.

**Habitat and Breeding Habit :** These burrowing frogs can only be detected during breeding season (June–July) at night. They conceal themselves under stones, wooden logs or even in soft soil mixed with leaf litter within dense forest. The males emit a peculiar mating call ‘awang’ – ‘awang’ – ‘awang’ during rainy nights near water pools. The call of males is the only clue to detect the presence of this frog. The females emit no sound, they usually come out late at night. Except during breeding season, these frogs are rarely seen. The adults usually burrow in soft soil in same manner as burrowing microhylid, *Uperodon systoma* does. They take advantage of shovel-shaped metatarsal tubercles and move effectively backward to enter their retreats.

They feed on terrestrial insects such as termites, ants, grass-hoppers and smaller winged insects. These burrowing frogs usually spawn in rain water pools just like other frogs of genus *Rana*.

The eggs are laid in a gelatinous matrix. The eggs are of 1.2 – 1.5 mm. in diameter, when laid. Number of eggs approximately 500 to 600 in a clutch, and after fertilization it take 40 to 45 days for developing into froglets. A natural habitat-like situation was created in the laboratory during their developmental studies. It is observed that metamorphosis is accomplished in a shorter period in natural habitat than in artificial enclosures.

**Remarks :** Rare anuran recorded from the area., stout and toad-like frog generally found in evening in association with common Indian toad'. It's strong shovel-shaped metatarsal tubercle is used

for digging, and sometimes the frog is found to dig soil in search of its food and shelter.

Boulenger (1920), included subgenus *Tomopterna* Dum. and Bib. of genus *Rana* Linn., and opined that these burrowing forms are allied to *Rana tigrina* (= *R. tigerina*)-*limnocharis* group. Inger and Dutta (1987) placed the species under genus *Tomopterna* Dum. and Bib. However this taxonomic treatment appears to be more appropriate because of morphological and ecological differences shown by members of genus *Tomopterna* in comparison with those of genus *Rana*.

### Genus *Bufo* Laurenti, 1768

- Bufo* Laurenti (1768), *Syn. Rept.*, : 25 ; Schneider (1799), *Hist. Amph.*, I : 111 ; Daudin (1803), *Hist. Rain.* : 71 ; Eagler (1828), *Syst. Amph.* : 206 ; Tschudi (1838), *Mem. Soc. Sci. Nat. Neuchate.*, II : 88 ; Dumeril and Bibron (1841), *Erpet. Gen. VIII* : 662 ; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 55 ; Cope (1865), *Nat. Hist. Rev.* : 102.
- Oxyrhychus* Spix (1824), *Spec. Nov. Test. Ran.* : 49.
- Otilophus* Tschudi (1838), *Mem. Soc. Sci. Nat. Neuchatal.*, II : 89 ; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 69.
- Phyne* (Oken), Fitzinger (1843), *Syst. Rept.* : 32.
- Chilophryne* Fitzinger (1843), *Syst. Rept.* : 32 ; Cope (1862), *Proc. Acad. Philad.* : 357.
- Phrynoïdis* Fitzinger (1843), *Syst. Rept.* : 32. Cope (1865), *Nat. Hist. Rev.* : 102.
- Peltaphryne* Fitzinger (1843), *Syst. Rept.* : 32 ; Cope (1862), *Proc. Acad. Philad.* : 357.
- Anaxyrus* Tschudi (1845), *Faun. Per. Herp.* : 78.
- Schismaderma* Smith (1849), *III. S. Afr. Rept. App.* : 28 ; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 138.
- Adenomus* Cope (1860), *Proc. Acad. Philad.* : 371.
- Epidalea* Cope (1865), *Nat. Hist. Rev.* : 102
- Otaspis* Cope (1868), *Proc. Acad. Philad.* : 312.

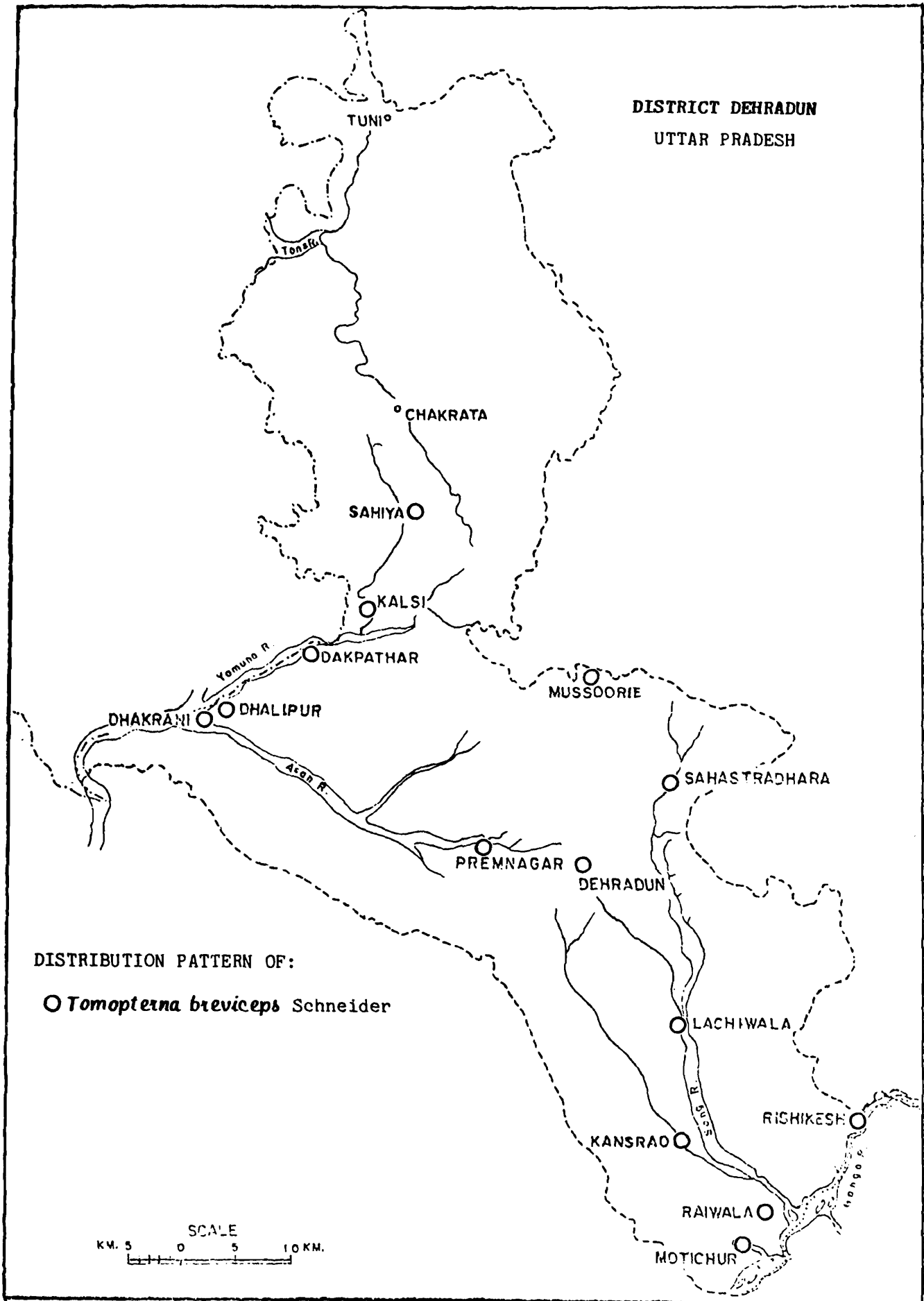
**Distinguishing Characters :** Pupil horizontal. Snout rounded, limbs short. No maxillary or vomerine teeth. Tongue elongate, ovate, and entire, free behind. Skin more or less warty or spinous. Nostrils lateral. Fingers free, toes half to 2/3rd webbed. Outer metatarsals united. The diapophyses

of sacral vertebra more or less diated. Terminal phalanges obtuse.

#### Known Indian Species :

1. *Bufo abatus* Ahl, 1925
2. *Bufo beddomii* Guenther, 1875

PLATE - XVIII



3. *Bufo brevirostris* Rao, 1937
4. *Bufo camortensis* Mansukhani and Sarkar, 1980
5. *Bufo fergusonii* Boulenger, 1892
6. *Bufo himalayanus* Guenther, 1864
7. *Bufo hololius* Guenther, 1875
8. *Bufo koynayensis* Soman, 1963
9. *Bufo latastii* Boulenger, 1882
10. *Bufo melanostictus* Schneider, 1799
11. *Bufo microtympnum* Boulenger, 1882
12. *Bufo parietalis* Boulenger, 1882
13. *Bufo silentvalleyensis* Pillai, 1981
14. *Bufo stomaticus* Lutken, 1863
15. *Bufo stuarti* Smith, 1929
16. *Bufo viridis* Laurenti, 1768

**Distribution :** Cosmopolitan, except New Guinea, Polynesia, Australia and Madagascar.

***Bufo himalayanus*** (Guenther, 1864)  
(Plate XIX, XX & XV)

*Bufo melanostictus* var. *himalayanus* Guenther (1864), *Rept. Brit. Indian.*, : 422.

*Bufo sikkimensis* (Part) Stoliczka (1872), *Proc. Asiat. Soc. Bengal.*, : 112.

*Bufo himalayanus* : Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*, : 305 ; Boulenger (1890) ; *Fuan. Brit. India. Rept. and Batr.*, : 505 ; Annandale (1906), *J. Asiat. Soc. Bengal.*, 2 : 290 ; Annandale (1912), *Rec. Indian Mus.*, 8 : 19 ; Daniel (1962), *J. Bombay nat. Hist. Soc.*, 59 : 667 ; Mertens (1969), *Stuttg. Beitr. Naturk.* 197 : 12 ; Inger (1972), *Bufo of Eurasia* in Blair : 102-118 ; (group of *Bufo melanostictus*) Dubois (1974), *Bull. Mus. natn. Hist. nat. ser. 3e n° 213 (Zool. 143)* : 343 ; Gorham (1974) *Checklist of world Amphibians up to 1 January 1970.*, : 80 ; Pillai and Chanda (1979), *Rec. Zool. Surv. India.*, 75 : 367 ; Sarkar and Sanyal (1985), *Rec. Zool. Surv. India.*, 82 (1-4) : 293 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Suppl.) : 136.

**Material Examined :** 9 adults (60 + 30), collected from Chakrata, Sahiya, Mussoorie (Jharipani), 14.III.85 & 25.IV.85, Coll. P. Ray.

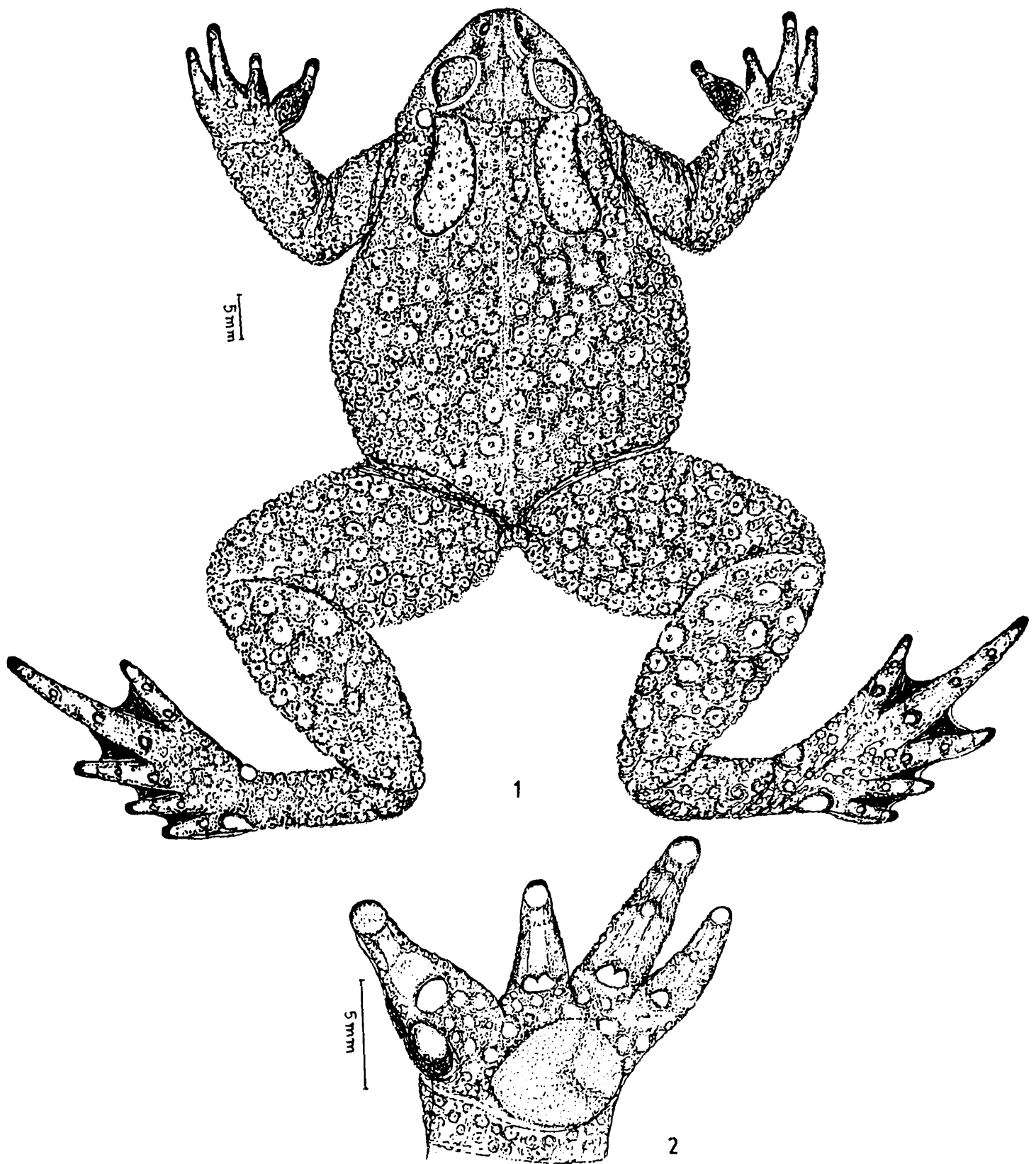
**Description :** Head much wider than long. Crown concave with low blunt supraorbital ridges without bony elevation on frontoparietal. Inter-orbital space broader than upper eyelid which is movable and at times of danger, it protects eye. Tympanum very small, covered with lateral part of parotoids. Parotoids elongated and cover scapular region, anterior end of parotoids wider than posterior narrow end. The shape of parotoids is distinct and their anterior ends lie near the posterior corner of eye. Head and body covered with flat glandules of different shapes and sizes. Snout short, tip blunt. Nostrils lie nearer tip of snout. The warty skin on the upper side of skull completely co-ossified

with nasals and frontoparietal bones. Supratympanic area glandular, large glands near the angle of jaws. Upper jaw expanded sidewise from level of lower jaw.

Fore-limbs moderate and flabby. First finger extending well beyond second finger. Third finger longest and fourth shortest. Subarticular tubercles prominent, one each on metacarpal and phalangeal joints of first and second finger. Two subarticular tubercles on third and fourth finger, proximal subarticular tubercles bilobular. Palmar tubercle flat and broader than long.

Hind limbs muscular and short. Tarsometatarsal articulation reaching upto axil in females and upto tympanum in males. The webbing between toes extensive, three phalanges of fourth toe devoid of

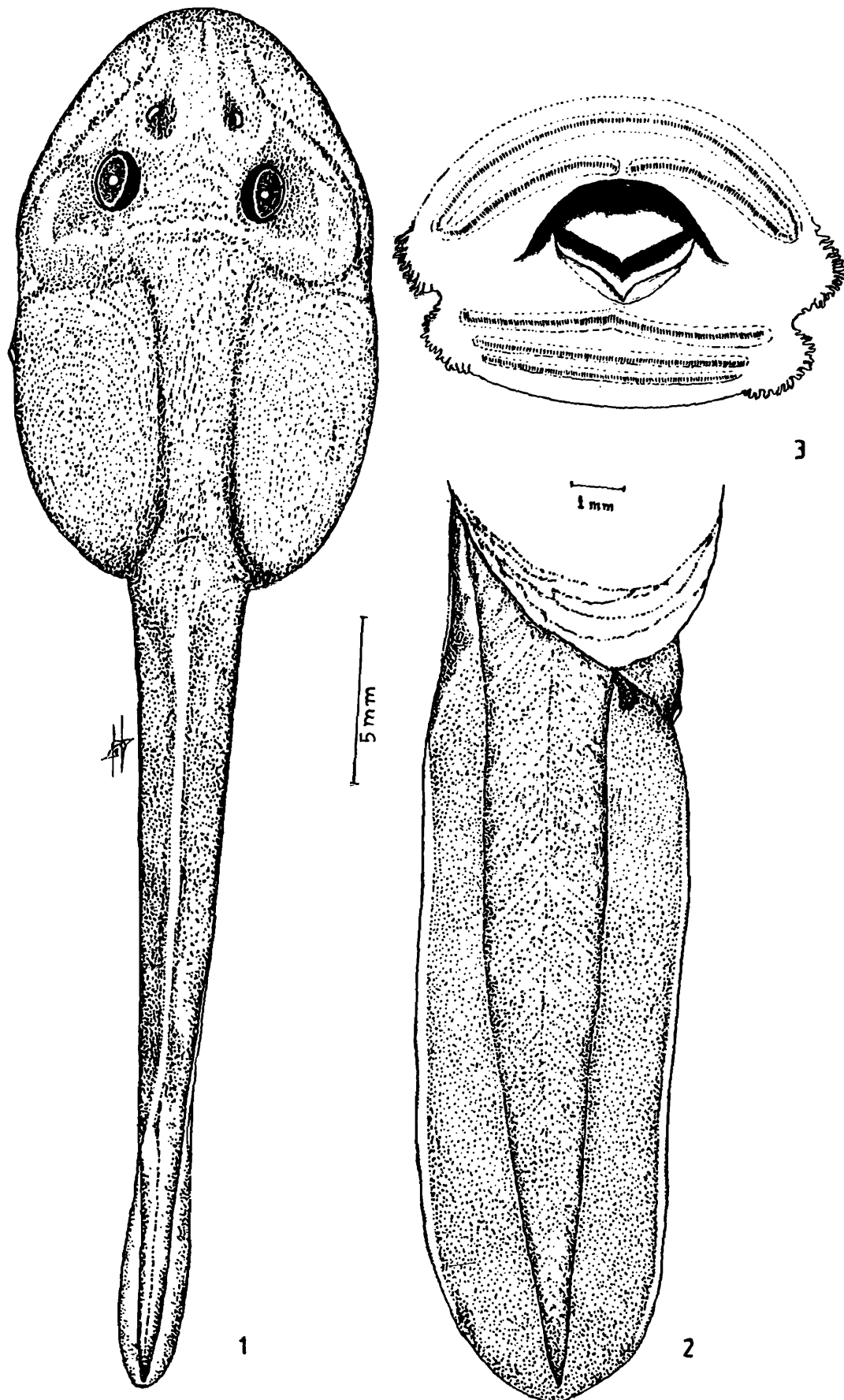
PLATE - XIX



*Bufo himalayanus* Guenther

Fig. 1. Adult male (Dorsal view); 2. Hand (Ventral view)

## PLATE - XX



*Bufo himalayanus* Guenther

Fig. 1. 10 days' old Tadpole (Dorsal view); 2. Tail of same tadpole (lateral view); 3. Oral disc of same Tadpole (Ventral view);

web, complete webbing in third and fifth toe. All toes with a fringe of dermal fold on each side apart from web. Almost all metatarsals are united by muscles. Web very thick. Subarticular tubercle well developed. Inner metatarsal tubercle elongated, anterior elevated and projected. Outer tubercle flat in females but elevated in males. Length of tibia 2.61-2.88 times of its maximum diameter.

Skin of dorsal side covered with elevated porous glands which differ in shape, size and texture. Some specimens show smooth texture of glands in breeding season. Some specimens collected from Mussoorie bear spinous glands whereas those collected near Chakrata and Sahiya are smooth. Large size specimen ( $\sigma$ , 165 mm) shows no significant spinous glands. The ventral aspect of all specimens is glandular and glands more or less uniform and closely set. Well cornified callosities present on inner side of first metacarpal in males during breeding season. The tips of fingers and toes are covered with a black cornified layer forming a black cap.

**Osteological Characters :** Compact skull, premaxilla rounded. Frontoparietals flat. Zygomatic arch expanded, two occipital condyles large. Procoelous vertebrae. The transverse process of sacral vertebra dilated. Coracoids and precoracoids divergent and connected by an arched cartilage. The epicoracoid, is almost free and overlapping corresponding cartilage of opposite side. The distance of head of ilium narrow. Terminal phalanges, triangular and curved inward.

**Colouration :** Dorsal side of body and limbs dark olive to grey. Ventral aspect immaculate. Large sized specimens look very dirty and ugly but adult males are slightly more glossy than females. The body colouration agrees well with large rocks near hill stream and this animal is able to camouflage effectively with surrounding. Ventral colouration blotched with olive and white. The toes and fingers are crossbarred.

**Sexual Dimorphism :** As a rule males are almost half size of females and small. During breeding

season male possess nuptial callosities on outer aspect of first and second fingers. The males have subgular vocal sacs. Hind limb is comparatively larger in size in males than in females.

**Larval Morphology :** The tadpoles easily distinguishable by dark brown to almost black colouration. Plenty in stagnant water pools near the hill streams. Usually fertilized ova takes about 45-50 days for metamorphosis into miniature toad. These tadpoles are usually seen from March to June. But they are also noticed during December

January ; they exhibit a phenomenon of overwintering. The typical black bufonid tadpoles 27-30 mm in hind-limb stage. Upper lip bears an outer uninterrupted and an inner slightly interrupted row of labial teeth. The lower lip is covered with three uninterrupted rows of labial teeth of which the inner one is slightly notched in middle. The edges of upper and lower lips are papillated. Rostrodonts bear black indistinct serrations on outer margin.

Total length of tadpole 2.25 - 2.28 times its head and body length and 1.80 - 1.86 times its tail length. The length of head and body 1.71 - 1.75 times its maximum width. Internarial distance 1.75 - 1.78 times in interorbital distance. The length of intestine is 3.92 - 4.00 times the total length of body and tail.

The food of tadpoles' comprises bottom debris in water and also the material scrapped from submerged rocks.

**Distribution :** India : Darjeeling, Meghalaya, Arunachal Pradesh (Namdhapa National Park), Uttar Pradesh (National).

Elsewhere : Nepal, Sikkim, Pakistan.

**Habitat and Habits :** These large sized toads are abundantly found above an altitude of approximately 2000 mts. They are usually found near large water bodies, mostly the hill streams. Large irrigation pools created by temporary

impoundment of hill streams act as ideal breeding places for hill dwelling amphibians of this region. These Himalayan toads make their appearance during March for purpose of breeding when they can be easily detected near water pools during night. The call of male is very loud and voluminous "Ghorrr'-'Ghorrr'-'Ghorrr'" in a long pitch. The male is much smaller in size (80 mm) in comparison to the female (165 mm). The amplexus is axial and very much cohesive ; they embrace so tightly the pairing couples cannot be separated easily. They move around in the water in amplexus. The female carries male on her back by swimming from one place to other and selects spawning site. The spawning behaviour is peculiar because female lays eggs in a double string ; this is different from that of toads in plains where string is single. The double string of eggs show both ovaries function simultaneously and release mature ova through cloaca with two strands of mucilage. It is further observed that each string houses a double row of black ova. The diameter of each string is nearly 8 mm and its length 20-30 mts. A portion of string measuring 40 cm was found to contain 40-45 eggs in two rows (diameter of egg -2mm). The mucilaginous string is transparent with black ova at the time it is laid but after a little while mucilaginous string turns opaque. The high rate

of fecundity indicates that species should have a dense population in the area but because of secretive habit of adults, they are normally seen in small numbers. They inhabit darker places in hills and take shelter in crevices which is beyond approach. The parotoids of this toad are large and secrete a pungent fluid which acts as a defensive mechanism for these sluggish creatures whose limb movement is not so powerful. They usually move by crawling although jumping for shorter distances also observed. Normally they are preyed upon by nocturnal snakes.

Stomach contents comprise large Caterpillars, Molluscs, Hemiptera, Orthoptera and Coleoptera.

**Remarks :** Boulenger (1882), while describing *B. himalayanus*, mentions "First finger not extending beyond second" but in figure on plate XX, first finger is longer than second. He (Boulenger, 1890) has subsequently also repeated same observation. In present study it has been observed that size of the first and second fingers is correctly shown in the plate xx of Boulenger (1882), while in description, he has erred. The present material agrees well with the figure of Boulenger (1882). The present material differs from the description by Boulenger (1882, 1890) and differences are shown in the table below :

*B. himalayanus* from district  
Dehradun

1. First finger well beyond the second.
2. Tympanum small but distinct.
3. Fourth toe half webbed but with almost a complete web between first & second & third and fourth & fifth toes.
4. Toes with two subarticular tubercles on third and fourth, and single subarticular tubercle on first, second & fifth.
5. There is a subgular vocal sac in males.
6. Tarsometatarsal articulation extends upto axil in females and upto tympanum in case of male.

*B. himalayanus* from Nepal,  
Sikkim and Darjeeling  
Described by Boulenger (1882, 1890)

1. First finger not extending beyond the second (reverse of his figure on plate xx, 1882).
2. Tympanum very small, rather indistinct.
3. Toes 1/2 to 2/3rd webbed.
4. Toes with simple subarticular tubercle (1882). Toes with single subarticular tubercle (1890).
5. Male without vocal sac.
6. Tarsometatarsal articulation reaches in front of eye, or the tip of snout.

Regarding subarticular tubercles on toes, there appears to be a printing mistake in the word 'simple' coined by Boulenger (1882). It is indeed 'single' as described by Boulenger (1890). This point seems to have escaped the notice of the amphibian specialists so far.

Guenther (1864) considered this species as an alpine race or a variety of *B. melanostictus*. In this connection, Annandale (1912), commented "I am inclined to agree with Dr. Guenther in regarding this form merely as an Alpine race of *B. melanostictus*. The greatest difficulty is often experienced in separating specimens and quite typical individuals of *B. melanostictus* are often found at considerable altitudes in the Himalaya. Almost every gradation between the two forms can be found."

As such, *B. melanostictus* and *B. himalayanus* are taxa confused with each other. But Boulenger (1882) recognised the species as a distinct taxon and referred it to the physiognomy of *B. vulgaris* which is distributed in Europe, Asia and N. W. Africa. In the present study of tadpoles, it is revealed that the species are quite distinct from *B. melanostictus* in size and display of flat glands throughout the body, small tympanum and pattern of webbing in between toes. The males are smaller than the females. The males of *B. himalayanus* are almost similar to those of *B. melanostictus* in size. But the absence of cranial ridges and smaller tympanum easily distinguishes the species from *B. melanostictus*.

### *Bufo melanostictus* Schneider, 1799

(Plate XXI & XXV)

*Bufo melanostictus* Schneider (1769), *Hist. Amph. I. Jena.*, p. 216 ; Gravenhorst (1829), *Del. Mus. Zool. Vart* : 57 ; Guenther 1860, *Proc. Zool. Soc. London.* : 165 ; Guenther (1861), *Proc. Zool. Soc. London* : 220 ; Guenther (1864), *Rept. Brit. India.* : 422 ; Stoliczka (1870), *Proc. Asiat. Soc Bengal.* : 155. Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, ed. 2 : 306 ; Boulenger (1890), *Faun. Brit. India* : 505-507. Sclater (1892b), *List Batr. Indian Mus.* : 27 ; Flower, (1896), *Proc Zool Soc. London.*, 911, pl. XLIV ; Boulenger (1907), *Rec Indian Mus. I* : 149 ; Stejneger (1907), *Bull. U. S. Nat Mus. LVIII* : 72, Van Kampen (1923), *Amph. Indo-Aust Archip.* 80 ; Swan and Leviton (1962), *Proc. Calif Acad Sci ser. 4.* 32 (6) : 107 ; Danlel (1963a), *J. Bombay. Nat. Hist. Soc.*, 60 : 435-437 ; Mansukhani and Murthy (1964), *Rec. Zool. Surv. India.*, 62 (1-4) : 58 ; Inger (1966), *Fieldiana Zool.*, 52 : 1-402 ; Inger (1972), *Univ. Texas. Press.*, : 102-118 ; Gorham (1974), *Check list of world Amphibians upto 1 January 1970.*, : 82 ; Dubois (1974), *Bull. Mus. Natn. Hist. Nat. paris. Ser. 3n° 213 (Zool. 143)* : 345 ; Hejmadi (1974), *Park. Utkal. Univ. Journ. Sci.*, 2 (1 & 2) : 91. Pillai and Chanda (1979), *Rec. Zool. Surv. India.*, 75: 387 ; Pillai and Chanda (1981), *Rec. Zool. Surv. India.*, 79 : 167 ; Mansukhani and Sarkar (1981), *Rec. zool. Surv. India.*, 79 (1 & 2) : 272 ; Tilak and Mehta (1983), *Res Bull. (Sci.) Punjab Univ.*, 34 : (3 & 4) : 162 ; Sarkar (1984), *Rec. Zool. Surv. India.*, 81 (3 & 4): 216 ; Sarkar and Sanyal (1985), *Rec. Zool. Surv. India.*, 82 (1-4) : 94 ; Chanda (1986), *J. Bengal Nat. Hist. Soc. N. S.*, 5 (2) : 142 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Suppl.) : 136.

*Bufo scalar* Daudin (1803), *Rain.*, : 94, pl. 34 ; Tschudi, (1838), *Mem. Soc. Sci. Neuchatel.*, 2 : 88 ; Dum and Bibron, (1841), *Erpet. Gen.*, : 699 ; Schlegel. (1837) *Abbild* : 4, Pl. 20.

*Bufo bengalensis* Daud, (1803), *Rain* : 96, pl. 35.

*Bufo isos* Lesson (1834), in. *Belang. Vov. Indian Or. Rept.* : 334 ; Dumeril and Bibron, (1841), *Erpet. Gen.* : 702.

*Bufo gymnauchen* Bleeker (1858), *Nat. tijdschr. Nedrel. Ind.*, XVI : 46. Van Kampen (1923), *Amph. Indo-Aust. Arch.* : 81.

*Bufo spinipes* Fitzinger (1861), *Siz. Akad. Wien.*, 42 : 415.

**Material Examined :** 79 examples (60+, 190), collected from different localities ranging from Shiwaliks to the lesser Himalaya up to 3000 mts. in different seasons from 1981 to 1986.

**Description :** Head with more or less elevated bony ridges, viz. canthal ridge along canthus rostralis ; a supraorbital ridge along inner edge of upper eyelid, which may be continued into preorbital and postorbital ridges and slightly backwards into a parietal ridge ; and a supratympanic ridge. Crown of head deeply concave. Snout shorter than upper eyelid. Interorbital space much broader than upper eyelid. Canthus rostralis angular. Loreal region slightly oblique, nearly flat. Nostrils nearer tip of snout than anterior corner of eye. Tympanum more than half diameter of eye, nearer to eye.

Forelimbs moderate. Finger-tips usually more cornified and black. First finger extending beyond second, but in smaller specimens, length of first and second finger almost equal. Third finger longest. Second finger slightly shorter than fourth. Metacarpal tubercles present, spinous, intermingled with spinous warts.

Hind limbs short. Tips of toes obtuse. First toe, smallest and fourth longest. Third toe longer than fifth. Toes about half webbed, three distal phalanges of fourth toe free of web. Two metatarsal tubercles distinct, outer oval and inner elongated slightly projected anteriorly. Subarticular tubercles small. Tarsometatarsal articulation reaching shoulder or near tympanum. The web in between toes thick.

Upper parts densely covered with more or less prominent, often spinous warts and tubercles of various sizes. A double series of round cornified large warts present on both side of vertebral line, commencing from cranio-vertebral joints to sacral zone. Parotoids moderate and elongated. The tubercles, the parotoids, the ridges on the head, the maxillary edges, and the tip of fingers and toes often with dark brown cornified substances. Granular beneath.

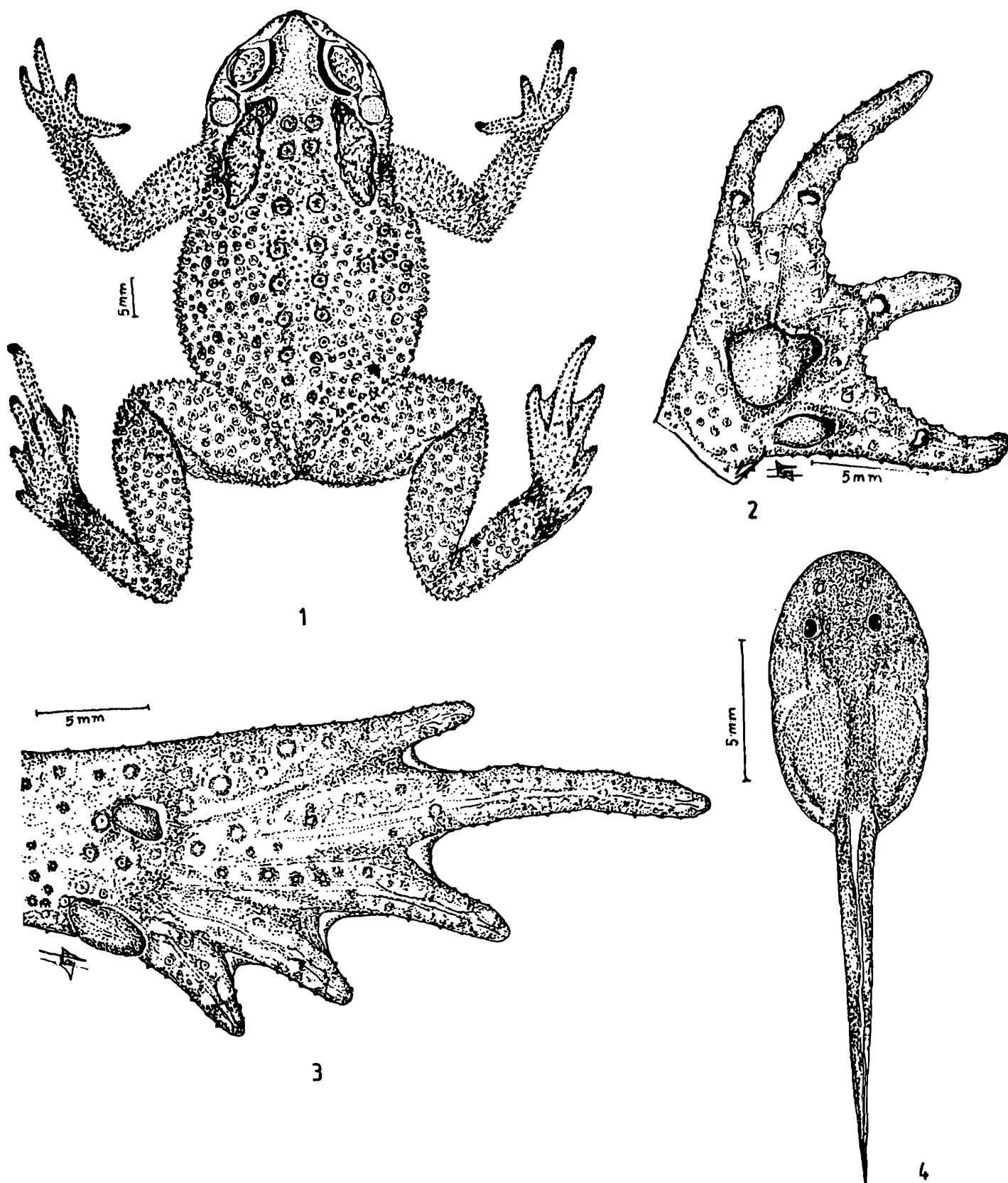
**Osteological Characters :** Skull dorsoventrally flattened and premaxillae rounded. Frontoparietals medially concave. Vertebrae procoelous. The transverse process of sacral vertebra dilated. Coracoids and precoracoeds divergent and connected by an arched cartilage, the epicoracoid, which is free, and overlapping corresponding cartilage of opposite side. Omosternum absent, xiphisternum with an expanded cartilage on the tip. The tips of terminal phalanges are obtuse.

**Colouration :** Usually dark brown above, sometimes limbs crossbarred, ventral surface immaculate or more or less spotted or with a network of brown colour. The tips of glands are tubercular, sometimes with black spines.

**Sexual Dimorphism :** Breeding males with a subgular vocal sac. The nuptial pads of two inner fingers become cornified and covered with black spinules. The tip of digits are covered with black caps. Males are smaller than females.

**Larval Morphology :** The fertilised ova usually takes 35 to 40 days for complete metamorphosis into small toads. Tadpoles are usually blackish, easily differentiated from ranid tadpoles in colouration. The hind limb stage (20-23 days old) shows some distinct characters by which it can be identified. Length of body about one and a half its width and about 3/4th length of tail. Tail 3 to 4 times as long as deep. The depth of caudal muscle about half the greatest total depth of tail. Nostrils much nearer to the eye than to the end of the snout. Eyes dorsally placed, interorbital distance usually twice the internarial distance. Spiraculum left sided, directed backwards, and visible from above and below. Vent median. Tail with broadly rounded tip. Mouth ventral, lips with papillae only at the corners. Labial teeth (keratodont) on the upper lip consists of outer uninterrupted and inner broadly interrupted. Lower labial teeth with three rows, inner two medially notched and with slight interruption, the outer one uninterrupted and almost equal to middle one.

PLATE - XXI



*Bufo melanostictus* Daudin

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. 10 days' old Tadpole (Dorsal view)

**Habitats and Habits :** This is one of the most common toads usually found in lower elevations (2500 mts.). In the Doon Valley, its population is sparse because of dominant species, *Bufo stomaticus*. Its population is normally observed near well cultivated zones or in the plains, although some examples from Mussoorie and Chakrata have been collected. These toads prefer holes, cracks and crevices as their shelter. During day time, they usually take shelter under rocks and even under wooden logs. They are very active at night. They feed on nocturnal insects of various sizes and kinds. At night, they are seen under street lights during summer. This toad adopts the feeding territory to which it restricts itself. Its activity is highly influenced by weather. Adults are mainly active at night, young becoming active during day as well. The hunting toad is guided primarily by vision ; the tactile sense is less important while smell and hearing seem to have no effect. Smaller prey is picked up with the tongue while larger prey is seized with the jaws. The forelegs are used to assist in swallowing of larger prey. It is observed that acceptance and refusal of prey is due to taste as well as tactile stimuli. There is no distinct prey preference ; acceptance and refusal are based upon experience. Toads are able to avoid unpalatable food after relatively short experience and can readily

differentiate between palatable and unpalatable food.

They are commonly seen near human habitation. They breed during June-August. The eggs are laid in water pools or even in stream within aquatic vegetation. Copulation is axillary. The eggs are black and laid in a muellaginous string. The string with single row of ova looks like a beaded necklace.

**Distribution :** India : Widely distributed in plains and also found at considerable altitudes (2500mts).

**Elsewhere :** Sri Lanka, Nepal, Bangladesh, Burma, and Malaya Archipelago.

**Remarks :** It is a common terrestrial, nocturnal toad distributed throughout Indian subcontinent upto an altitude of 2500mts. There is a marked size variation among specimens collected from various habitats ; normally specimens collected from plains are comparatively smaller and more slender than those inhabiting high altitudes. In Dehradun, the toad's population is more concentrated towards Shivalik foothills. These toads are widely used for biological studies in the laboratories. It is also interesting to note that these toads are very social and play a major role in checking populations of undersirable domestic insect pests.

***Bufo stomaticus* Luetken, 1863**  
(Plate XXII, XXIII, XXIV & XXV)

*Bufo stomaticus* Luetken (18630, *Vidensk. Meddr. dansk. naturh. Foren.*, **14** : 305 ; Guenther (1864), *Rept. Brit. India.* : 420 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, : 281 ; Boulenger (1891), *Ann. Mag. nat. Hist.*, ser. 6, 7 : 463 ; Slater (1892a), *proc. Zool. Soc. Lond.*, 347 ; Annandale (1908), *Rec. Indian Mus.*, **2** : 305 ; Annandale (1909), *Rec. Indian Mus.*, **3** : 283 ; Annandale and Rao (1918), *Rec. Indian Mus.*, **15** : 39 ; Hora and Chopra (1923), *Rec. Indian Mus.*, **25** : 369-376 ; Nieden (1923), *Das Tierreich* : **46** : 409 ; Rao (1923), *J. Bombay nat. Hist. Soc.*, **29** : 132 ; Smith (1929) (1929), *Rec. Indian Mus.*, **31** : 79 ; Daniel (1963a), *J. Bombay nat. Hist. Soc.*, **60** : 429 ; Mertens (1969), *Stuttg. Beitr. Naturk.*, **197** : 73 ; Inger (1972) *Bufo of Eurasia* In Blair : 358 ; Sarkar (1984), *Rec. Zool. Surv. India.*, **81** (3 & 4) : 217-219 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, **83** (Suppl.) : 138.

*Bufo Pantherinus* (non Dumeril and Bibron) : Anderson (1817a), *Proc. Zool. Soc. London* : 203.

*Bufo andersonii* Boulenger (1883), *Ann. Mag. Nat. Hist.*, ser. 5 (12) : 163 ; Boulenger (1890), *Fuan. Brit. India, Rept. and Batr.* : 504 ; Annandale (1909), *Rec. Indian Mus.*, **3** : 284 ; Mc Cann (1938), *J. Bombay nat. Hist. Soc.*, 40 : 426 ; Soman 1960, *J. Bombay nat. Hist. Soc.*, **57** : Mansukhani and Sarkar (1964), *Rec. Zool. Surv. India.*, **62** (1 & 2) : 58 ; Mansukhani and Murthy (1964), *Rec. Zool. Surv. India.*, **62** (1-4) : 52.

**Material Examined :** 78 examples (520+, 260) collected from different localities in Doon Valley and Shiwalik foot hills.

**Description :** Head wider than long, without any cranial ridges. Snout short, blunt at the tip. Nostrils nearer tip of snout than anterior corner of eye. Interorbital space flat broader than upper eyelid. Skin of skull near snout is co-ossified with skull. Tympanum distinct rounded and almost 2/3rd of maximum diameter of eye.

Fore limbs moderate. First finger slightly extending beyond second. Third finger longest and fourth shortest. The subarticular tubercles blunt, mixed with flat glands on palm. Palmer tubercle distinct, triangular and wider in front.

Hind limbs stout and short. Tarsometatarsal articulation reaches upto posterior corner of eye. Toes moderate with two-thirds webbing. Two moderate metatarsal tubercles. Subarticular tubercles simple and small.

Skin of upper surface, palm and soles covered with flat glands of various sizes. Parotoids flat, elliptical, placed on scapular region on both sides. Parotoids not so elevated as in *B. melanostictus*. The colouration varies with season and environment. In breeding season, some individuals show bright yellow mixed with brown patches. Ventrally immaculate. But most specimens bear dark olive colouration on dorsal side and are immaculate ventrally. Young individuals of this species indistinguishable from those of *B. melanostictus* because the bony ridges on the skull is not developed in younger specimens.

**Osteological Characters :** Same as given for *B. melanostictus*, except bony ridges on skull are less concave on medial aspect of frontoparietals.

**Colouration :** Dorsal aspect tends to display a hue of dark gery in life but after preservation colour transforms into brown or black. Ventral surface suffused with cream and brown but in breeding season colouration changes to yellow in both sexes. The males look brighter than females. Dorsum uniformly speckled with dark brown patches.

**Sexual Dimorphism :** Males smaller in size with subgular vocal sac. In breeding season, the nuptial callosities develop on outer aspect of first finger.

**Larval Morphology :** Hind limb stage tadpole (18-22mm) takes approximately 23-25 days for development from fertilization of ovum to this stage. The head and body moderately flat, and anteriorly elliptical. Nostrils large and situated nearer eye than tip of snout. Spiracle left sided. Mouth ventral. Angles of jaws papillated, upper jaw with outer uninterrupted and inner interrupted row of labial teeth. The lower lip with three rows of labial teeth, of which inner one slightly interrupted in middle. The upper and lower rostradents black and minutely serrated on outer margin. The tail less than twice as long as head and body. Lip blunt and rounded. Both caudal membranes almost equal in width, and less blotched than body. The upper membrane starts from posterior extremity of body and rises gradually. The dorsal surface of head and body densely covered with silvery white pigments intermingled with brown. The caudal region is mottled, with dark brown patches.

There are some morphological differences two allied species of *Bufo melanostictus* and *Bufo stomaticus*, which are distributed in same ecological niches. The differences are presented below :

12 days old tadpole of <i>B. stomaticus</i>	12 days old tadpole of <i>B. melanostictus</i>
1. Head and body club-shaped ; head wider than body.	1. Head and body globular ; head and body almost similar in dimension.
2. Eye diameter 1.38 times the interorbital width. Eyes large.	2. Eye diameter 2.12 times the interorbital width. Eyes small.
3. Maximum width of head 1.48 times the combined length of head and body (excluding tail).	3. Maximum width of head 1.75 times the combined length of head and body (excluding tail).
4. Internarial distance 1.77 times the interorbital width.	4. Internarial distance 1.31 times the interorbital distance.
5. Spiraculum a slightly elevated tube opening on the left side of the body.	5. Spiraculum slightly depressed opening on the left side of the body.
6. Intestinal coil with three loops.	6. Intestinal coil with two loops.
7. Lower jaw with three rows of labial teeth (keratodonts) ; inner row slightly interrupted in the middle, middle comparatively smaller than inner one. Outer one largest, crescent shaped and concave towards oral aperture. Upper jaw with outer uninterrupted row and inner one interrupted, quite apart from each other.	7. Lower, jaw with three rows of labial teeth (keratodonts) ; inner row uninterrupted, middle one as long as inner one. Outer one largest, notched in the middle. Upper jaw with outer uninterrupted row and inner one interrupted.
8. Head, body and tail light brown, eyes clearly demarcated. Tail membrane transparent with light pigmentation.	8. Head, body and tail muscle black ; eyes merge with body colour. Tail membranes densely pigmented.

Daniel (1963a) has detected two rows of teeth on the lower jaw of the tadpoles of *Bufo melanostictus* from western India. However, in the present material, lower jaw has three rows of labial teeth of which the outermost row is notched in the middle. The material under study is an authentic and reliable sample of this species because same has been reared in a well managed aquarium in laboratory. In order to understand the

significance for the differences in larval dentition, the adults of this species from two different localities in Dehradun and from western India should be thoroughly examined. Moreover, there is very little or no difference in the newly metamorphosed miniature toads of two species, *Bufo stomaticus* and *Bufo melanostictus*. After a good deal of observation it is confirmed that in spite of their similarity they differ in many respects as follows :

12 days old small toad of <i>B. stomaticus</i>	12 days old small toad of <i>B. melanostictus</i>
1. Small pinkish warts throughout the body.	1. Small spinules throughout the body.
2. Palmar tubercle triangular, broad distally.	2. Palmar tubercle elongated.
3. First finger longer than second.	3. First and second fingers almost equal.
4. Toes half webbed.	4. Toes one fourth webbed.
5. Colour lighter brown.	5. Blackish with cross bars on the limbs.

**Habitat and Breeding Habits :** This toad is usually found more in numbers in urban areas than in rural areas, probably, because of reason that its prey consisting mostly of insects is found in plenty around light posts which are always more in number in urban areas. They are found lurking in domestic areas even in dark corners of houses in search of insects, and they seem to be very social in behaviour. They sometimes climb up walls and also a certain height among trees in search of food. They are nocturnal and in breeding season, that is after onset of monsoon, males emit nuptial calls in a continuous pitch of 'RREONG-RREEONG-RREONG-RREONG-RREONG' to attract females. At midnight they stop their call which is indication that they have selected their males and commence the act of spawning. The spawn is laid in a string. It is observed that strings usually get attached with submerged grasses and then pair move around to release spawn in a manner of loose, unknit threads. The amplexus is axial and very cohesive. Though the males comparatively smaller in size they embrace very tightly and even if they are caught in pairs they never mind and may not be separated easily even later. Sometimes it is observed that some pairs lay their spawn at late night or during early morning.

During present study author observed a male of this species (*B. stomaticus*) in amplexus with a female of *Rana tigerina* in a rainwater pool in the month of June, 1985. It is interesting and throws some light on probable intergeneric hybridization in the group. Intergeneric hybrids have been produced experimentally in many other groups.

This curious phenomenon, which is worth pursuing, will be followed up further.

**Distribution :** India : Assam, Bihar, Himachal Pradesh, Karnataka, Jammu and Kashmir, Maharashtra, Orissa, West Bengal.

Elsewhere : Nepal, Sri Lanka, Arabia, Pakistan.

**Remarks :** The present material is referred to as belonging to species *Bufo stomaticus* Luetken (1863), because of general usage of this name by various experts such as Inger (1972), Dubois (1974) etc., who used this name for material from this region. However, a check-up of relevant literature (Boulenger, 1883, 1890) shows that those specimens which bear a tarsal fold are described as *Bufo andersonii* whereas the species *Bufo stomaticus* constitutes another complex of specimens without a tarsal fold. Inger (1972) and Dubois (1974) have merged *B. andersonii*, partly with *B. stomaticus*. It appears that Dubois (1974) was characterised the two disputed species on the basis of presence or absence of tarsal fold. The material under study there are specimens with or without tarsal fold, and therefore be referred to two distinct species viz., *B. stomaticus* without tarsal fold and *B. andersonii* with a tarsal fold. Since the present author does not have access to the entire material belonging to these species for comparison, the present material is for the time being referred to as *B. stomaticus* Luetken, till a thorough examination of material of species from all localities within range of its distribution is made. Taxonomic analysis in detail is beyond the scope of this work and is, therefore, not attempted.

#### Genus *Polypedates* Taschudi, 1838

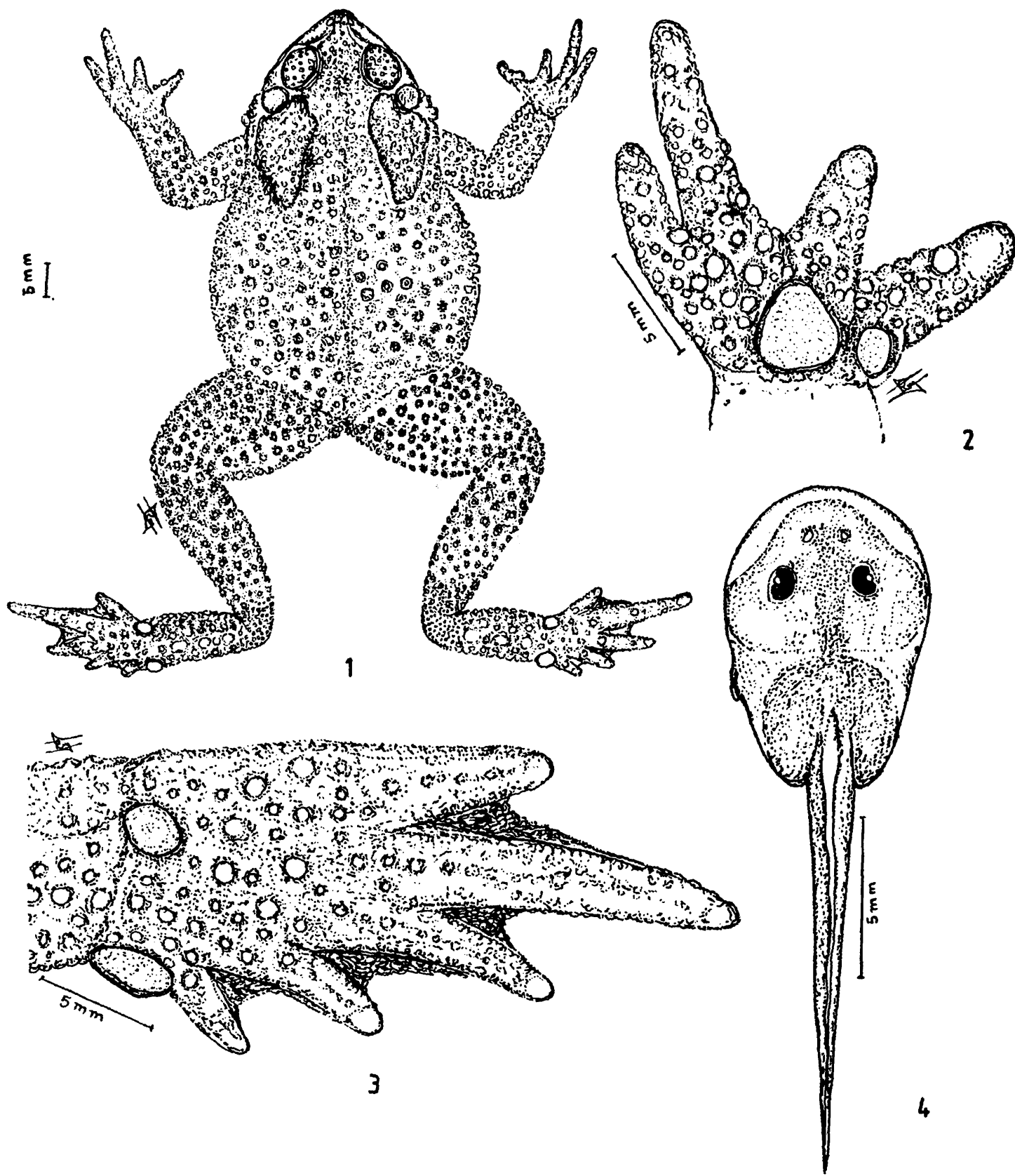
*Hyla* Boie (in Gravenhorst (1829), *Sumpt. Leop. Voss.* : 26 (part) ; Schleger (1837-1844), *Duss. Verl. Arnz. & Comp.* : 13 (part) ; Wiegmann (1832), *Handbuch der Zoologie.* : 260 (part) ; Daudin (1840), *Hist. nat. ran. gren. crap.* : 18 ; Barbour (1912), *Mem. Mus. Comp. Zool.*, : 127 ; Barbour (1920), *Copeia.*, 88 : 98.

*Brugeria* Taschudi (1838), *Mem. Soc. Sci. nat. Neuchatel.*, 2 : 34 (part).

*Polypedotes* (sic) Taschudi (1838), *Mem. Soc. Sci. nat. Neuchatel.*, 2 : 34 (part).

*Polypedates* Taschudi (1838), *Mem. Soc. Sci. nat. Neuchatel.*, 2 : 75, (Type species : *Polypedates leucomystax*)

PLATE - XXII



*Bufo stomaticus* Luetken

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. 10 days' old Tadpole (Dorsal view)

PLATE - XXIII

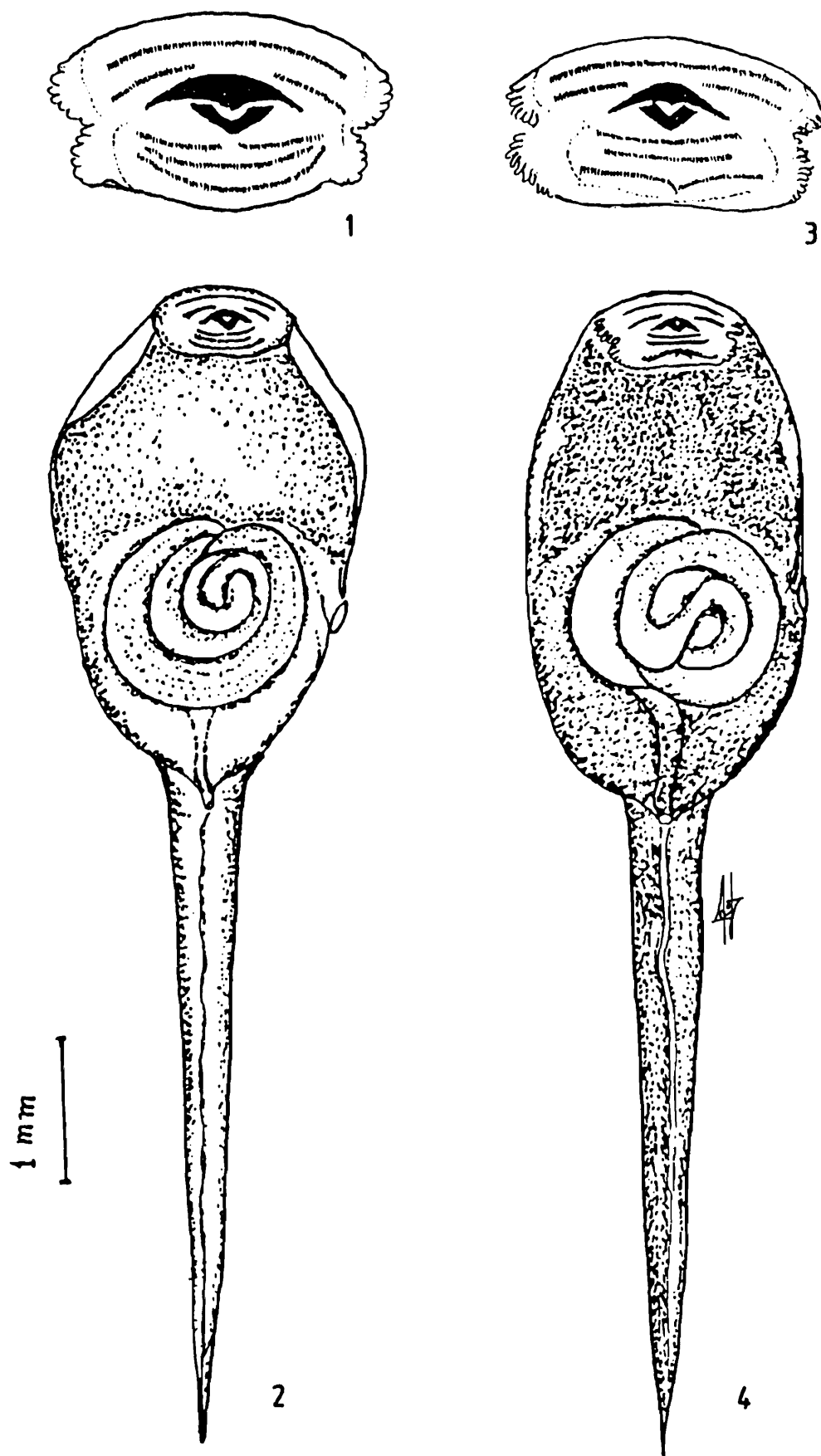


Fig. 1. Oral disc of 10 days' old *Bufo stomaticus* tadpole (Ventral view); 2. 10 days' old Tadpole of *B. stomaticus* (Ventral view); 3. Oral disc of 10 days' old *Bufo melanostictus* Tadpole (Ventral view); 4. 10 days' old Tadpole of *B. melanostictus* (Ventral view)

PLATE -XXIV



Fig. 1. Photograph of female *Bufo stomaticus* Luetken



Fig. 2. Photograph of unusual amplexus of *B. stomaticus* (♀) and *Rana tigerina* (♂)

PLATE - XXV



: Dumeril and Bibron (1841), *Erpet. Gen. Paris.*, VIII : 519 (part) ; Cantor (1847), *J. Asiat. Soc. Bengal.*, 26 (7) : 1063. Dumeril (1853), *Ann. Sci. Nat. Zool.*, 19 : 156 (part) ; Dumeril et al. (1854), *Lib. Ency. Ror. Paris.*, IX : 401 (part) ; Guenther (1864), *Rept. Brit. India.* : 427 (part) ; Guenther (1868), *Proc. Zool. Soc. London.* : 485 (part) ; Hoffmann (1873-1878), *leipzig and Heidelberg.* : 647 (part) ; Boettger (1879), *Abh. Senck. nat. Ges.* : 41 (part) ; Stejneger (1907), *Bull. U. S. nat. Mus.* 58 : 143 (part) ; Taylor (1921), *Manila Bureau of printing.* publ. No. 15 : 80 (part) Noble (1931), *The Biology of Amphibia.* : 525 (part) ; Okada (1931), *Tok. Imp. Exp. st.* : 202 (part) ; Liem (1970), *Fieldiana Zool.* 57 : 96-98.

*Trachyhyas* Fitzinger (1843), *Syst. Rept.* : 31 (part).

*Rhacophorus* Dumeril and Bibron (1841), *Erpet. Gen. Paris*, VIII : 530 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.*, : 73 (part) ; Thurston (1888) *Cat. Batr. Sal. and Apoda of South India.* : 29 (part) ; Boulenger (1890), *Fuan. Brit. India, Rept. and Batr.* : 470 (part) ; Boettger (1893), *Ber. Senck. naturf. Ges.* 6 : 14 (part) ; Gadow (1901), *Amp. Rept.* : 245 (part) ; Boulenger (1912), *Mal. Penin. Amp. Rept.* : 245 (part) ; Boulenger (1912), *Mal. Penin. Rept. Batr.* : 247 (part) ; Van Kampen (1923), *Amph. Indo Aust. Arch.* : 242 (part) ; Ahl (1927b), *Sitz. Ges. naturf. Freunde*, Berlin. : 35 (part) ; Smith (1927), *Proc. Zool. Soc. London.* : 123 (part) ; Smith (1930), *Bull. Raffles Mus.* No. 3 : 111 (part) ; Okada (1931), *Tok. Imp. Exp. St.* : 178 (part) ; Ahl (1931b), *Das. Tierreich.* : 51 (part) ; wolf (1936), *Bull. Raffles Mus.*, No. 12 : 147 (part) ; Bourret (1942), *Les Batr. de I. Indochine.*, : 408 (part) ; Liu (1950), *Fieldiana : Zool. Mem.*, 2 : 359 ; Inger (194a), *Fieldiana : Zool.* 33 : 370 ; Kirtisinghe (1957), *The Amphibia of Ceylon.* : 54 (part) ; Taylor (1962), *Univ. Kansas Sci. Bull.* 43 : 522 (part) ; Inger (1966), *Fieldiana : Zool.*, 52, 279 (part).

**Distinguishing Characters :** Species of the genus are moderately large. Skin of body and limbs smooth. Digital discs large. Fingers webbed at the base. Omosternum slightly formed at the base. Vomerine teeth always present, distal end of metacarpal distinctly dilated ; bony knob on distal metacarpal of third finger large. Terminal phalanges of fingers and toes 'Y' shaped. An intercalary ossicle between penultimate and terminal phalange present.

**Distribution :** India, Burma, Sri Lanka, Thailand, Indochina, Formosa South West and south China, Hainan, Malaya Peninsula, Sumatra, Borneo, Celebes, Java, Lesser Sunda Islands as far as Timor and the Philippine Islands.

**Known Indian Species :** *Polypedates maculatus* (Gray, 1834).

*Polypedates maculatus* (Gray, 1834)  
(Plate XXVI & XXVII)

*Hyla maculata* Gray (1834), *III. Ind. Zool.*, : 82.

*Buergeria maculate* : Taschudi (1938), *Classif. Batr.*, : 75

*Polypedates leucomystax* : Dumeril and Bibron (1841), *Erpet. Gen.*, VIII : 519 ; Kelaart (1852), *Prodr. Faun. Zevl.* (1) : 193.

*Polypedates maculatus* (Part) : Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 78 ; Guenther (1864), *Rept. Brit. India.*, : 428 ; Blanford (1870), *J. Asiat. Soc. Bengal.*, 39 : 376 ; Anderson (1871), *Proc. Zool. Soc. London.*, : 307 ; Stoliczka (1872), *Proc. Asiat. Soc. Bengal.*, : 106 ; Liem (1970), *Fieldiana : Zool.*, 57 : 96-98 ; Dubois (1974), *Bull. Mus. natn. Hist. nat. ser. 3e, n° 213 (Zool. 143)* : 385 ; Inger and Dutta (1984), *J. Bombay nat. Hist. Soc.*, 83 (Suppl) : 139.

*Polypedates biscutiger* Peters (1871), *Mon. Berl. Ac.*, : 649.

*Polypedates megacephalus* Hallow (1860), *Proc. Ac. Philad.*, : 48.

*Rhacophorus maculatus* (Part) : Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.* : 83 ; Boulenger (1889), *Proc. Zool. Soc. London.*, : 30 ; Boulenger (1890), *Faun. Brit. India. Rept. and Batr.*, : 475 ; Ferguson (1904), *J. Bombay nat. Hist. Soc.* 15 : 503 ; Annandale (1912), *Rec. Indian Mus.*, 8 : 14, 24 ; Annandale and Rao (1918), *Rec. Indian Mus.*, 15 : 35 ; Swan and Leviton (1962), *Proc. Calif. Acad. Sci. ser. 4*, 32(6) : 109 ; Sarkar (1984), *Rec. Zool. Surv. India.*, 81 (3 & 4) : 232 ; Sarkar and Sanyal (1984), *Rec. Zool. Surv. India.*, 82 (1 & 4) : 290.

*Rhacophorus (Rhacophorus) maculatus* : Ahl (1931b) *Das Tierreich* : 133.

*Rhacophorus leucomystax* : Pillai and Chanda (1979) *Rec. Zool. Surv. India.*, 79 : 167 (part).

*Rhacophorus leucomystax himalayensis* Annandale (1912). *Rec. Indian Mus.*, 8 :15 ; Sarkar and Sanyal (1985), *Rec. Zool. Surv. India.*, 82(1-4) : 289.

*Rhacophorus leucomystax maculatus* : Wolf (1936), *Bull. Raffles Mus.*, 12 : 142 ; Bourret (1942), *Les. Batr. de I, Indo-Chine.*, : 409 ; Kirtisinghee (1957), *The Amphibia of Ceylon.*, : 94.

**Material Examined** : 4 examples, (30 + 10) Motichur forest, District Dehradun, 19. VII. 86, P. Ray.

**Description** : Tip of snout obtusely pointed. Head slightly broader to almost equal in length. Length of snout 1.42 to 1.52 times diameter of eye. Canthus rostralis distinct, loreal region vertical and concave. Nostrils much nearer to tip of snout than anterior corner of eye. Interorbital distance slightly greater than upper eyelid. Tympanum distinct, its diameter 1.30 to 1.42 times diameter of eye. Tongue fairly large, wide, free and bifid behind. Vomerine teeth in two more or less oblique series between choanae and touching anterior margin of latter.

Fore limbs fairly stout, with moderately enlarged terminal discs of fingers. Fingers with a rudiment of web, more pronounced in between third and fourth fingers. A crest-like elevated fold of skin present on upper surface of all digits on joint of penultimate and distal phalanges serving as an indication of presence of intercalary ossicle. Discs of fingers rather large but smaller than tympanum. First and second fingers are almost equal in length. The width of disc of first finger less than other discs. Third finger, the longest. Fourth finger slightly longer than second finger. Ventral aspect of metacarpals bear glandular supernumerary

tubercles. Subarticular tubercles well developed and rounded. Palmer tubercle elongated.

Hind limb slender, well adapted for jumping. Toes with discs of similar nature but smaller in dimension. Web between fingers not extending upto discs. Two phalanges each of first, second and third digits are free of web except for a minor fringe. Three phalanges of fourth digit devoid of web. Only fifth toe is webbed upto base of disc. Outer metatarsals separated by web upto base. Elongated subarticular tubercles distinct and longer than wide. Inner metatarsal tubercle single but distinct. Length of tibia 4.10 to 4.23 times of its diameter. Tibiotarsal articulation extends upto tip of snout.

Skin smooth and finely granulated above head. Dorsal aspect of rest of body uniformly glossy. A fold above tympanum runs from posterior corner of eye and extends upto shoulder. Belly and lower surface of thigh coarsely glandular. Anal fold above the anus present.

**Osteological Characters** : Hyoid with elongated bony thyrohyal. The blade-shaped alary process lies on antero-lateral side of hyoid plate, without dilation. Anterior horn absent. Posterior lateral process long at least one third of thyrohyal. Diapophyses of sacral vertebra not dilated.

## PLATE - XXVI

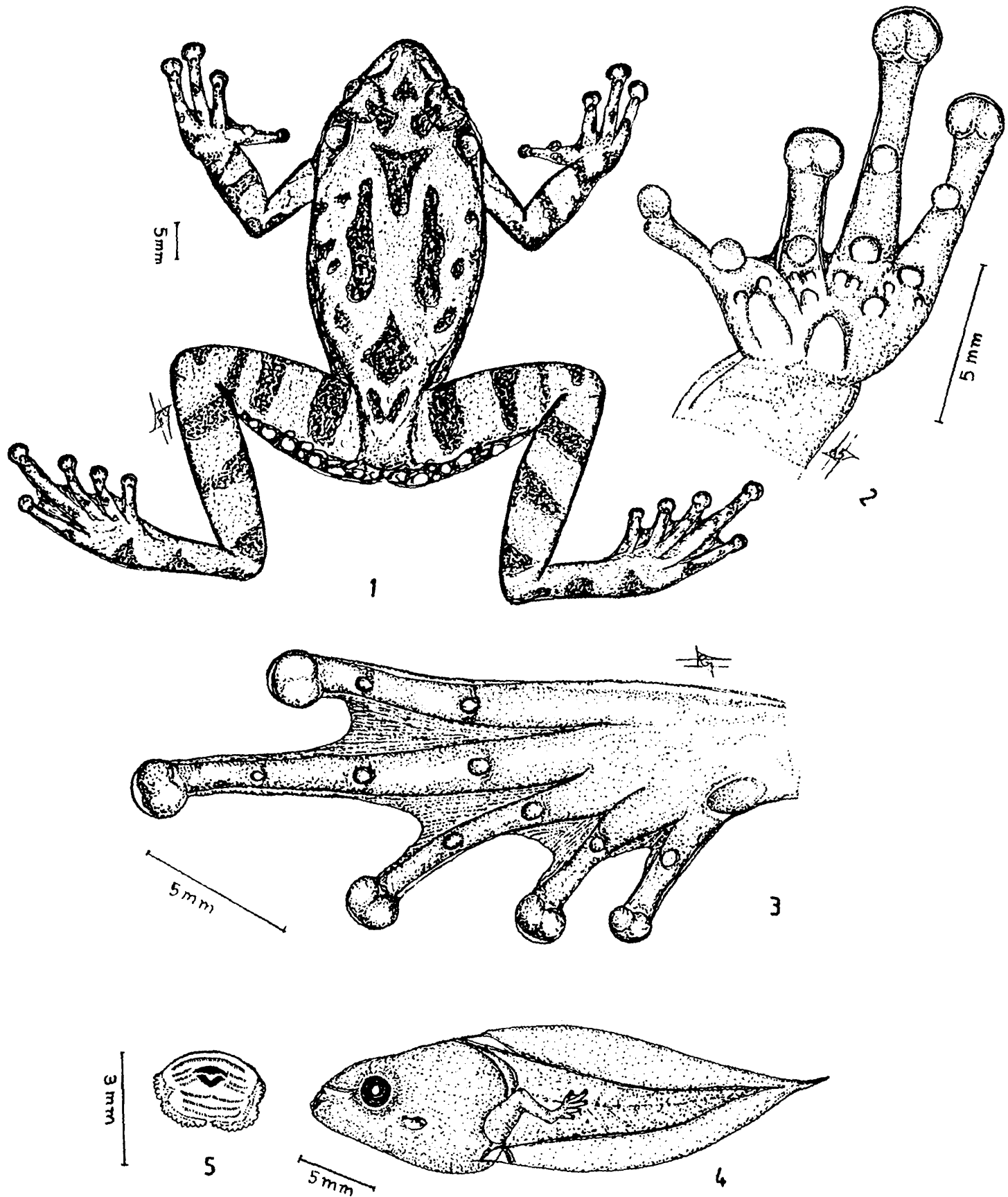
*Polypedates maculatus* Gray

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view); 4. 10 days' old Tadpole (Dorsal view); 5. Oral disc of same Tadpole (Ventral view)

Vertebral column procoelous, centrum cylindrical ventrally. Neuropophyses connecting the centrum and transverse process attached on dorsolateral portion of centrum.

The anterior portion of frontoparietal is wider than its posterior portion. Nasals squash-shaped and not in contact with each other, but they remain in contact with sphenethmoid. The sphenethmoid well exposed. Upper jaw toothed. The base of omosternum is slightly forked with a small round cartilaginous plate at the end. Xiphisternum with a long bony style. The coracoids are firmly united by a cartilaginous epicoracoid.

**Colouration :** Colouration variable, dorsum cream with dark brown patches. Usually a large hourglass-shaped mark on hinder part of Canthal streak continues to tympanic area and is coloured dark brown.

Canthal streak continues to the tympanic area and is coloured dark brown. Iris golden. The spots are very distinct in mature specimens. Limbs cross barred. Hinder side of thigh light brown with yellowish rounded spots.

**Sexual Dimorphism :** Males are smaller in size and with a vocal pouch on ventral aspect of throat which is connected with buccal cavity through two openings by the side of tongue in lower jaw. Breeding males show slight enlargement of first metacarpal region.

**Larval Morphology :** Hind limb stage tadpole measures 44 mm. Eyes lateral, spiraculum sinistral vent dextral at some distance above lower edge of subcaudal crest. Upper crest of tail slightly extending beyond its base towards anterior side of body. Mouth with labial teeth and rostradonts serrated on outer margin. Length of body 1.5 to 2 times its width ; tail 1.5 to 2 times length of body, 3 times as long as deep. The depth of muscular portion at its base more than half total depth. Nostrils nearer end of snout than to eye. Spiraculum sinistral visible from above, directed

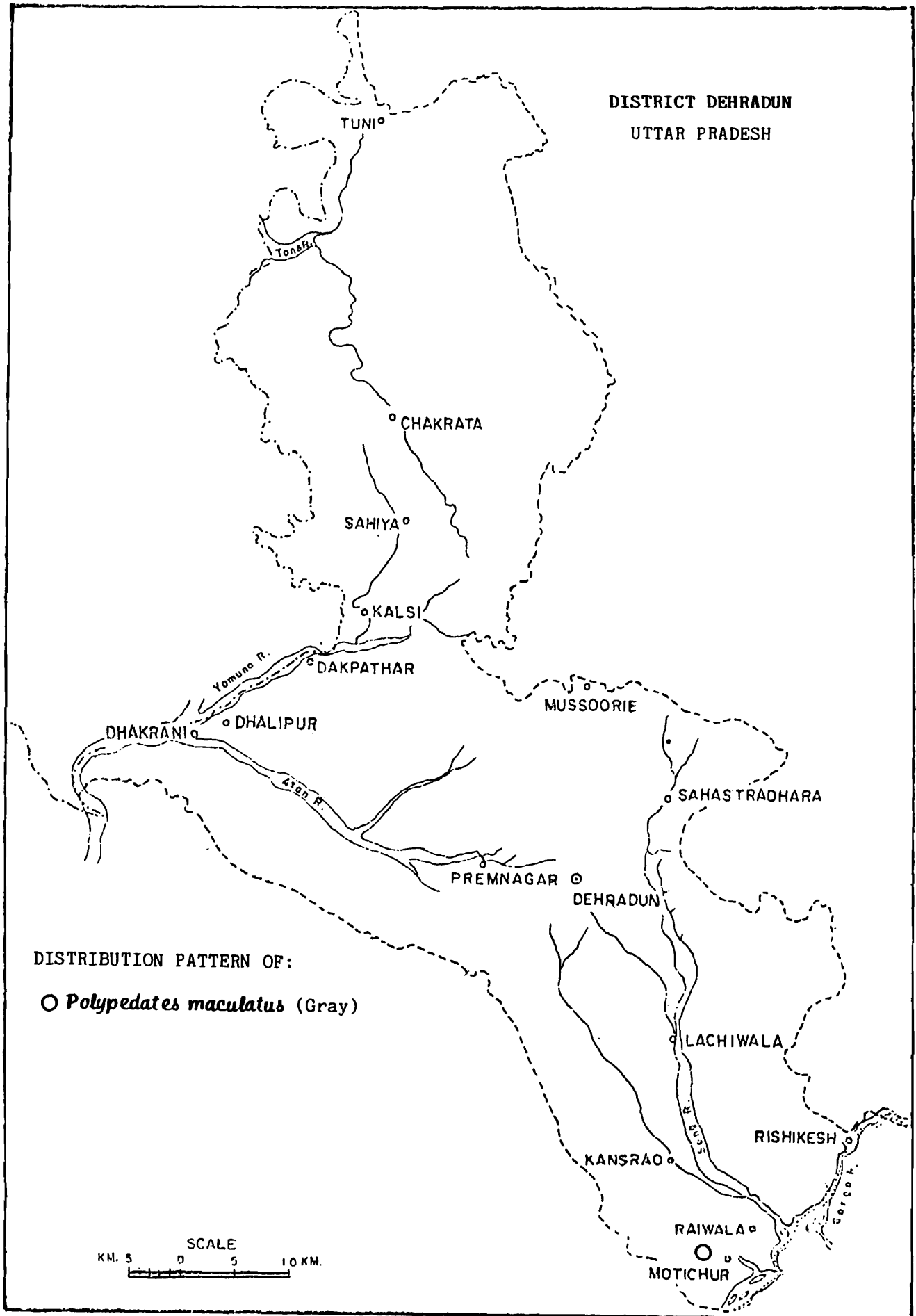
upwards and backwards, nearer vent than tip of snout. Tail acutely pointed, dorsal crest of about same size as ventral. Lips with papillae along sides and lower border, with a notch in centre of lower lip. Rostradonts well serrated on outer margin. Upper lip with one uninterrupted and three interrupted rows of labial teeth and lower lip with two uninterrupted rows and one row of slightly interrupted teeth in middle.

Brown or yellowish, irregularly mottled with dark brown pigments. Crests colourless.

**Habitat and Breeding Habits :** These agile tree frogs are seldom detected because of their secretive habitat and colouration matching with surroundings. During breeding season, they come out from their hideouts at night. During day, they conceal themselves in tree holes. It is noticed that tree holes are usually moist. In breeding season, males attract females by their specific loud metallic sound 'Thok' 'Thok' -'Thok'- 'Thok' breaking the stillness after a rainy night. The metallic sound indicates their presence in dense forest and it is perhaps only clue to detect these delicate and rare tree frogs. When rainwater pools preserve sufficient nutrient-rich water with small plants around, frogs lay their spawn in a frothy mass on leaves hanging on surface of water. The fertilised ova get metamorphosed within cellular compartments of mucoid frothy mass till gilled larvae emerge and fall in water below. By their larval movements correlated with drops of rain, metamorphosed tadpoles drop into nutrient-rich water and continue their aquatic larval life. It takes them about 35 to 40 days to develop into small four- legged froglets depending on atmospheric temperature, food and other such factors. The developed hind-limb larval stages can be easily sorted out from different tadpoles within same aquatic environment.

**Distribution :** All over India except Haryana, Punjab & Rajasthan. Present collection record shows that they are only found below an altitude of 700 mts in foothills of Shiwalik ranges.

PLATE - XXVII



**Remarks :** This species is very rare in study area. After a thorough search only a few specimens have been collected so far. These tree frogs commonly hide in the tree holes which are partly moist. They are strictly nocturnal and their body colouration so camouflaging it is difficult to locate them at night.

Apparently genus *Polypedates* is derived from an early rhacophorid stock, but it differs from *Rhacophorus* in several characters.

### Genus *Microhyla* Taschudi, 1838

*Engystoma* (part) Fitzinger (1826), *N. Class Rept.*, : 65 ; Guenther (1858), *Cat. Batr. sal. Brit. Mus.*, : Cope (1867) *J. Acad. Philad.*, (2), VI : 194 ; Boulenger (1882), *Cat. Batr. Sal. s. Ecaudata. Brit. Mus.*, ed. 2 : 160 ; Mir. Ribeiro (1920). *Rev. Mus. Paulista. XII.*, : 281; Mir. Ribeiro (1926). *Arch. Mus. Nae. Rio de Janeiro, XXVII.*, : 182 ; Nieden (1926), *Das Tierreich.*, Anura II. : 63 ; Dumeril and Bibron (1841). *Erpet. Gen. VIII.*, : 738 ; Cope, (1889), *Bull. U. S. Nat. Mus.*, XXXIV : 385.

*Engistoma* Peracca (1904), *Bol. Mus. torino. XIX.*, 465 : 23.

*Hysaplesia* (Part) Boie (1826), in Ferussae. *Bull. Sci. Nat.*, IX : 239.

*Hylaplesia* (Part) Boie (1827), in Schlegel, *Isis.*, XX : 294.

*Stenocephalus* (non Latereille, 1825) Taschudi, (1838). *Mem. Soc. Sci. Neuchatel.*, II, 1839., : 86.

*Microhyla* Taschudi (1838), *Mem. Soc. Sci. Neuchatel.*, II. 1839 : 28, 71 (Type species *Hylaplesia achatina* Boie (nom. nud.) = *Microhyla achatina* Tschudi ; Boulenger (1882), *Cat. Batr. sal. Brit. Mus.*, ed. : 163 ; Boulenger (1890), *Faun. Brit. India. Rept. & Batr.*, : 491 ; Sarasin (1910), *Zool. Jahrb. (suppl.)*, 12 (i) : 18 ; Vogt, (1911), *Sitzber. Ges. Natf. Fr. Berlin.*, : 183 ; Boulenger (1912), *Faun. Malay Penin Rept. & Batr.*, : 258 ; Smith (1917), *J. Nat. Hist. Soc. Siam.*, 2 : 229 ; Rao (1918), *Rec. Indian Mus.*, 15 : 41 ; Prasad (1918), *Rec. Indian Mus.*, 15 : 101 ; Barbour (1920), *Occ. Paaper Mus. Zool. Michigan LXXVII* : 2 ; Robinson and Kloss (1920), *J. F. M. S. Mus.*, 8 : 305 ; Van Kampen (1923), *Amph. Indo-Austr. Arch.*, : 152 ; Nieden (1926), *Das Tierreich, Anura* II : 27 ; Parker (1928), *Ann. Mag. Nat. Hist.*, (10) II : 473 ; Smith (1930), *Bull. Rafles Mus.*, (III) : 125 ; Pope (1931), *Bull. Amer. Mus. Nat. Hist.*, LXI : 591 ; Noble (1931) *Biol. Amph.*, : 537; Parker (1934), *A monograph of the frogs of the family Microhylidae* : 123-124.

*Gastrophryne* Fitzinger (1843), *Syst. Rept.* : 22 (Type species *Engystoma carolinense*, Holbrook) ; Stejneger (1910), *Proc. Biol. Soc. Washington.*, XXIII : 166 ; Parker (1927), *Occ. Paper Mus. Zool. Michigan CLXXXVII* : 5 ; Noble (1931) *Biol. Amph.*, : 537.

*Siphneus* Fitzinger (1843), *Syst. Rept.*, : 33 (Type species *Engystoma ornatum*, Dum. and Bibr.).

*Dendromanes* Gistel (1848), *Naturg. Thierr.*, : 11 (austitute name for *Microhyla*).

*Deplopelma* (Part) Guenther (1858), *Cat. Batr. Sal. Brit. Mus.*, : 50.

*Scaptophryne* Fitzineger (1861), *Sitzber. Ak. Wiss. Wien.*, XLII : 641 (Type species *Scaptophryne labyrinthica* Fitzinger *Engystoma pulchrum* Hallowell).

*Copea* Steindaechner (1864) *Verh. Zool. bot. Ges. Wien.*, : 286 (Type species *Copea fulva*. Steindachner = *Engystoma rubrum*, Jerdon).

*Callula* (Part) Cope (1867), *J. Acad. Philad.* (2), VI : 192.

*Systema* (non Wagler) Cope (1867), *J. Acad. Philad.* (2), VI : 193. (Part).

*Ranina* (non Lamarck) David (1872), *Nouv. Arch. Mus. Paris.*, VII : 416.

*Biol. Centr. Amer. Rept. & Batr.*, : 210 (Type species *Glossostoma aterrimum* Guenther). ;

*Eupemphix* (non Steindachner) Boulenger (1903) *Ann. Mag. Nat. Hist.*, (7) XII : 552.

*Dasylops*, Mir. Ribeiro (1924), *Biol. Mus. Nae. Rio Di Janeiro.*, IV : 255 (Type species *Dasylops schirchii*, Mir Ribeiro) ; Noble (1931), *Biol. Amph.* : 538.

**Distinguishing Features :** Pupil circular, tongue elliptical, entire and free behind. A dermal ridge across palate between choanae, and another in front of pharynx. Tympanum hidden, Fingers free. Toes blunt more or less dilated, sometimes, with a feeble web. Coracoids united by a simple epicoracoid cartilage, precoracoid none, no omosternum, sternum cartilaginous. Diapophyses of sacral vertebra dilated. Vertebral column diplasiocoelous. Terminal phalanges simple, or 'T' shaped.

**Distribution :** India : From Cape to Himalayan foot hills.

Elsewhere : East Indies, China, Ceylon, Burma, Nepal.

#### Known Indian Species :

1. *Microhyla berdmorei* (Blyth, 1856)
2. *Microhyla chakrapani* (Pillai, 1977)
3. *Microhyla inornata* (Boulenger, 1890)
4. *Microhyla ornata* (Dumeril and Bibron, 1841)
5. *Microhyla rubra* (Jerdon, 1854)

#### *Microhyla ornata* (Dumeril & Bibron, 1841) (Plate XXVIII & XXIX)

*Engystoma ornatum* Dumeril and Bibron (1841), *Erpet. Gen. VIII* : 745 (Type locality : Malabar Coast, India) ; Cope, (1867), *J. Acad. Philadelphia.*, (2) VI : 194.

*Siphneus ornatum* : Fitzinger (1843), *Syst. Rept.*, : 33.

*Diplopelma ornatum* : Guenther (1858), *Cat. Batr. Sal. Brit. Mus.*, : 50. ; Guenther (1864), *Rept. Brit. India.*, : 417 ; Theobald, (1868), *Cat. Rept. Mus. Asiat. Soc. Bengal.*, : 82 (Part).

*Microhyla ornata* : Boulenger (1882), *Cat. Batr. Sal. Brit Mus.*, ed. 2 : 165 ; boettger (1885), *Ber. Off. Ver. Nat.*, : 98, 162, Anderson (1889), *J. Linn. Soc. London.*, XXI : 350 ; Boulenger (1890) *Fauna Brit. India, Rept. and Batr.*, : 491 ; Boettger (1892), *Ber. Off. Ver. Naty.*, : 98, 102 ; Sclater, (1892), *Batr. Ind. Mus.*, : 22 ; Flower (1899) *Proc. Zool. Soc. London.*, : 901 pl. LX, fig 1 ; Laidlaw (1900), *Proc. Zool. Soc. London.*, : 887 ; Boettger (1901), *Ber. Senck. Nat. Ges.*, : 52 ; Boulenger (1903), *Fasc. Malay. Zool.*, I : 133 ; Butler (1904). *J. Bombay nat. Hist. Soc. XV* : 387 ; Ferguson (1904), *J. Bombay nat. Hist. Soc. XV* : 506 ; Walterstorff (1906), *Abh. Mus. Magdeburg. I* (3) : 131 ; Sarasin (1910), *Zool. Jahrb., Syst.*, XII : 131, 134 ; Boulenger, (1912), *Fauna Malaya. Penins. Rept. and Batr.*, : 260 ; Vogt (1913), *Sitzber. Ges. Natf. Fr. Berlin.*, : 222, 227 ; Smith (1916), *J. Nat. Hist. Soc. Siam.*, II : 160 ; Smith (1917), *J. Nat. Hist. Soc. Siam.*, II : 268 ; Anderson (1917). *Vet. Ak. Handl. Stockholm. LV*, 4 : 17 ; Rao (1917). *Rec. Indian Mus.*, XII : 281 ; Mell (1922), *Arch. Naturg.*, LXXXVIII, 10 : 130 ; Vogt (1922). *Arch. Naturg. LXXXVIII*, 10 : 145 ; Smith (1923), *J. Nat. Hist. Soc. Siam.*, II : 212 ; Parker (1928), *Ann. Mag. Nat. Hist.*, (10) II : 493 ; Gee and Boring (1929), *Peking Soc. Nat. Hist. Bull.*, IV, 2 : 26 ; Cochran, (1930), *Bull. U.S. Nat. Mus.*, LXXVII, II : 7 ; Smith (1930), *Bull. Rafles. Mus. III* : 129 ; Pope (1931), *Bull. Amer. Mus. Nat. Hist.*, LXI, 8 : 597 ; Mc Cann (1932), *J. Bombay nat. Hist. Soc. XXXVI* : 176 ; Parker (1934) *A monograph of the frogs of the family Microhylidae* : 139-141 ; LIU (1950), *Fieldiana, Zool. Mem. II*

: 312 ; Acharji and Kripalani (1951), *Rec. Indian Mus.*, 49 : 178 ; Swan and Leviton (1962), *Proc. Calif. Acad. Sci.*, XXXII (6) : 108 ; Daniel (1963), *J. Bombay nat. Hist. Soc.* 60 (2) : 690-702 ; Gorham (1974), *Check list of World Amphibians upto 1 January 1970.*, 126 ; Dubois (1974), *Bull. Mus. Natn. Hist. Nat. Paris.*, Ser 3e n° 213 (143) : 352 ; Hejmadi (1977), *Park. Utk. Univ. J. (Sc)* 11 : 92 ; Hejmadi et al. (1980), *J. Zool. Soc. India.*, 32 (1 & 2) : 43-48 ; Pillai and Chanda (1981), *Rec. Zool. Surv. India.*, 31 (3 & 4) : 220 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (suppl.) : 136.

*Engystoma carnaticum* Jerdon (1854), *J. Asiat. Soc. Bengal.*, XXII : 534 (Type locality Carnatic) : Mason (1860), *Burma*, ed. 2 : 325.

*Diplopelma carnaticum*, Stoliczka (1870), *J. Asiat. Soc. Bengal.*, XXXIX : 154 ; Anderson (1879), *Zool. Yunnan* : 841.

*Engystoma malabaricum* Jerdon (1854), *J. Asiat. Soc. Bengal.*, XXII : 534 (Type locality Malabar).

*Microhyla fissipes*, Boulenger (1884), *Ann. Mag. Nat. Hist.* (5), XIII : 397 (Type locality Taiwan-fu, S. Formosa) ; Boettger (1887), *Ber. Off. Ver. Nat.*, : 162 (Part) ; Werner (1903), *Abh. Bayer. Akad. Wiss.* II, 22 : 369 ; Stejneger (1907), *Bull. U.S. Nat. Mus.*, LVIII : 88 ; Vogt (1914), *Sitzber. Ges. Natf. Fr. Berlin.*, : 101 ; Mell (1922), *Arch. Naturg.* LXXXVIII (10) : 130 ; Stejneger (1925), *Proc. U.S. Nat. Mus.*, LXVI : 12 ; Nieden (1926), *Das Tirreich*, Anura II : 35 ; Okada (1931), *Tailless Batr. Jap. Emp.*, : 71 (Part).

*Microhyla eremita* Barbour (1920), *Occ. papers Mus. Zool. Michigan*, LXXXVI : 3 (Type locality Nanking) ; Stejneger (1925), *Proc. nat. Mus.*, LXVI : 11 ; Schmidt (1927), *Bull. Amer. Mus. Nat. Hist.* LIV : 562 ; Fang and Chang (1931), *Contr. Biol. Lab. Sci. Soc. China, Zool.*, VII (2) : 87.

**Distribution** : India : Throughout from Cape to the Himalayan foot hills.

Eleswhere : China, (South of Sze-chwan and Kiangau), Formosa, Tonkin, Hainan, Burma, Siam, Annam, Cochin-China, Malaya Peninsula, Nepal, Sri Lanka.

**Material Examined** : 37 examples (240, 130), from Sahiya, Kalsi, Dhalipur, Dakpathar, Sahaspur, Selakui, Jhajra, Premnagar, Dehradun city and around, Lachhiwala, Motichur, Risikesh, Bhatta-fall near Mussoorie, Rajpur and Sahastradhara.

Collections were made during 1983-1987 of different seasons by different faunistic tour parties of NRS/ZSI, Dehradun (U. P.).

**Description** : Smallest ornamental frog known in India. Head narrower than body and longer than wide. Snout obtusely pointed, projecting beyond lower jaw. Maximum diameter of eye equals length of snout. Nostrils nearer tip of snout than anterior

corner of eye. Interorbital distance slightly greater than internarial distance and greater than width of upper eye lid. Canthus rostralis obtuse, straight. Loreal region vertical. Tympanum hidden under skin. Tongue oval, entire. Jaws toothless.

Forelegs short and slender. First finger much shorter than second. Third the longest. Fourth slightly longer than second, subarticular tubercles well developed. Two elongated palmer tubercles. Terminal portion of all fingers swollen into a small round knob on ventral aspect.

Hind legs comparatively robust than fore legs. Tip of toes similar to those of fingers. Toes with rudiment of web at the base, subarticular tubercles distinct. Two metatarsal tubercles, inner one elongated, outer small and round. Diameter of tibia 3 to 3.5 times in its length. Heels overlapping when legs folded at right angles to body. Tibiotarsal articulation extends up to posterior corner of eye.

Small round tubercles on dorsal and lateral aspect of body. Limbs covered with small white

tipped tubercular glands. Ventral aspect smooth. Posterior aspect of thigh nearer anal region covered with densely set tubercles.

**Osteological Characters :** Skull triangular, prevomer divided, palatine absent, nasals untied. Frontoparietals broad at base, ethmoid not exposed. Vertebral column diplasiocoelous. The transverse processes of sacral vertebra are dilated, transverse process of eighth and ninth vertebra anteriorly directed. Condylar socket of atlas well expanded laterally. In the pectoral girdle, clavicle, precoracoid and omosternum absent. Terminal phalanges with slight dilation at the tip.

**Colouration :** In life, colouration of this tiny frog is brilliant. A reddish brown well defined dark streak commences behind eyes and extends from shoulder to flank. The characteristic colour pattern, a dorsomedian dark patch, begins at about mid-level of eyes, narrows slightly on the occiput, then widens a little finally spreading on to the sacral region. The small tubercles throughout dorsal region of body and limbs (red in life) white spotted in preserved condition. Limbs cross barred. Anterior aspect of thigh and anal region darker. Lower surface cream coloured in life but transformed into white after preservation. Some specimens show well blotched throat and chest.

**Sexual Dimorphism :** Males quite smaller and slimmer than females and with a subgular vocal sac during breeding season but always with a transverse fold of skin on throat even in nonbreeding season. The male emits an amazingly high pitch sound which seems unbelievable for so small a creature. The ventral aspect of males is densely pigmented, whereas females exhibit scattered pigmentation.

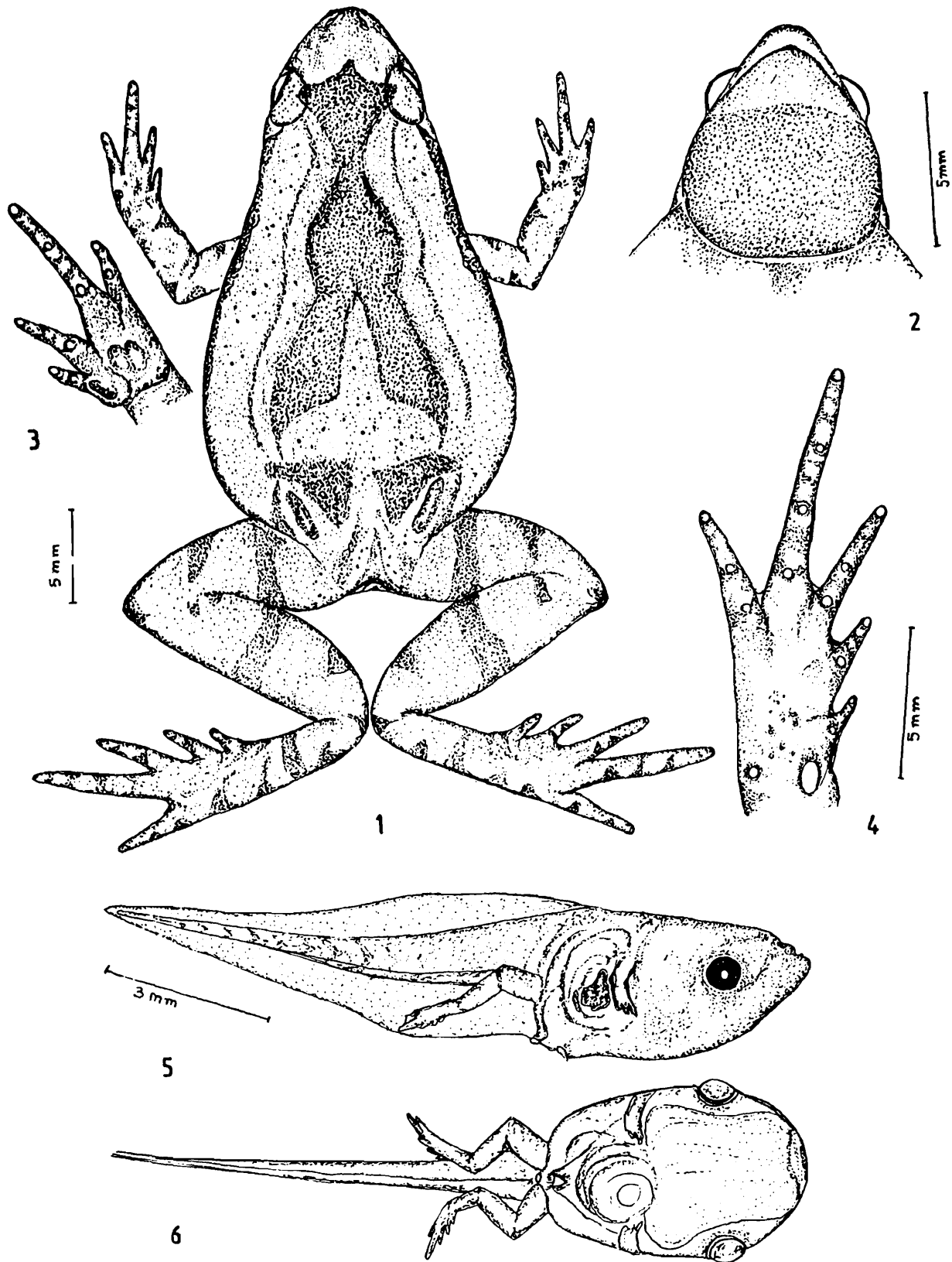
**Larval Morphology :** The specific transparent tadpoles with hindlimbs emerge after 26 to 30 days depending on maintenance of culture. The head and body are flattened anteriorly. Entire head and body transparent by which internal organs can be easily seen. The opening of mouth is

funnel-shaped in keeping with frog's feeding habits. Mouth dorsoterminal with 'U' shaped infralabial flange. Eyes lateral. Interocular distance more than four times of internarial distance. Head and body 1.50 to 1.58 times the tail length. Tail membranes very delicate and thin, acutely pointed at tip ; when floating in water, only tip of tail flickers like a flagellum. On the dorsomedial aspect above intestine, two air sacs clearly visible (in life) ; it seems probable they act as hydrostatic organ during their pelagic life. The spiracular opening is situated just in front of vent and is midventral in position with a rounded ventral margin. Anal tube median.

**Habitat and Breeding Habits :** These microhylid frogs are nocturnal in habit. They conceal themselves under logs, stones, or leaf litter and are also seen under bark of tree and crevices of rocky river bed. They are very much active during breeding season when they are found near water pools. It is also observed that they can change their colour to a certain extent depending on their habitat. They feed on small ants and termites which are perhaps their favourite prey. They are sometimes collected from nearby termite mounds. Their tongue is quite adapted for picking up fast moving terrestrial insects that is one of the reason of their presence near an ant hill or a termite mound. The tadpoles are also found in pools fed with rain water in the forests.

**Remarks :** This tiny frog is commonly found among the grass and under dry leaves covering moist soil. The breeding season starts at Dehradun from May to July, although spawning coincides with first pre-monsoon shower. The spawn are laid in stagnant rain water pools near forested zone but within city it is observed that they lay their spawn in road side temporary pools where the pools are surrounded by grassy vegetation even in cemented garden tanks. The peculiar spawn with a gelatinous matrix, floating on surface of water, is easily recognisable by its circular film of mucous embedded with 200 to 300 eggs. The eggs are cream coloured when laid but become darker as the process of development progresses further.

PLATE - XXVIII



*Microhyla ornata* Dum. & Bibr.

**Fig.** 1. Adult female (Dorsal view); 2. Throat of male (Ventral view); 3. Hand (Ventral view); 4. Foot (Ventral view); 5. 30 days' old Tadpole (Lateral view); 6. 30 days' old Tadpole (Ventral view)

PLATE - XXIX



Genus *Uperodon* Dumeril and Bibron, 1841

*Rana* (Part) Schneider (1799), *Hist. Amph.*, I : 144.

*Bombinator* (Part) Merrem (1820), *Versuch. Syst. Amph.* : 178.

*Engystoma* (Part) Cuvier (1829), *Regne Animal*, ed. 2 (II) : 112.

*Systema* (non Wagler) Tschudi (1838), *Mem. Soc. Sci. Neuchater*, II. 1839:86 ; Cope (1867), *J. Acad. Philad.*, (2), VI, : 193.

*Uperodon* Dumeril and Bibron (1841), *Erpet. Gen.*, VIII : 746 (Type species : *Engystoma marmoratum* Cuvier *Rana Systema* Schneider) ; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 48 ; Parker (1934), *A monograph of the frogs of the family Microhylidae*, London : 73-74.

*Hyperodon* (emend.) Jerdon (1854), *J. Asiat. Soc. Bengal*. XXVI : 533.

*Cacopus* Guenther (1864), *Rept. Brit. India* : 415 (Substitute name for *Uperodon* Dum. and Bibr.,) ; Boulenger (1882), *Cat. Batr. Sal. Brit. Mus.*, ed. 2, : 173 ; Boulenger (1890), *Fauna Brit. India, Rept. and Bat.* : 495 ; Nieden (1926), *Das Tierreich*, Anura, II : 19 ; Noble (1931), *Biol. Amph.* : 532.

*Pachybatrachus* Keferstein (1868), *Arch. f. Naturg.*, XXXIV : 273 ; (Type species : *Pachybatrachus petersi* Keferstein *Rana systema* Schneider).

**Distinguishing Features** : Pupil circular. Tongue subcircular, entire and attached on buccal floor. Choanae large and oval. Two small bony prominences close together, between and on a level with hinder edge of choanae, a small papilla on hind margin of each choana. A denticulated dermal ridge, across the palate in front of pharynx preceded by a shorter curved one. Tympanum hidden. Digits not dilated at tip. Fingers free, toes with rudimentary web at base.

Prevomer entire or divided. Clavicles, procoracoids and omosternum absent. Xiphisternum a large cartilagenous plate. Diapophyses of sacral vertebra rather strongly dilated. Vertebral column diplasiocoelus Terminal phalanges simple.

**Known Indian Species :**

1. *Uperodon globulosum* (Guenther, 1864)
2. *Uperodon systema* (Schneider, 1799)

*Uperodon systema* Schneider, 1799

(Plate XXX, XXXI &amp; XXXII)

*Rana systema* Schneider, (1799), *Hist. Amph.* I, : 144 (Type locality "Eastern India") ; Shaw (1802), *Gen. Zoology*, III : 174 ; Peters (1863), *Mon. Ak. Berlin.* : 82.

*Bombinator systema* : Merrem (1820) *Syst. Amph.* : 178.

*Cacopus systema* : Guenther (1864), *Rept. Brit. India.* : 414 ; Theobald 1868, *J. Asiat. Soc. Bengal. (Cat. Rept. Mus. Asiatic Soc.)* : 82 ; Boulenger, (1882), *Cat. Batr. Sal. s. Ecaudata Brit. Mus.* ed. 2. : 174 ; Thurston (1888), *Cat. Batr. Sal. South India.* : 43, pl. IX ; Boulenger (1890), *Fauna Brit. India, Rept. and Batr.* : 496, fig. 186 ; Boettger (1892), *Kat. Batr. Senck. Nat. Ges.* : 25 ; Sclater (1892), *Batr. Indian. Mus.* : 24 ; Ferguson (1904), *J. Bombay nat. Hist. Soc.* XV, : 507, pl. B. figs ; Rao (1918), *Rec. Indian Mus.* XV : 45 ; Nieden (1926), *Das Tierreich*, Anura II : 19, figs. 14-15.

*Uperodon systema* : Parker (1931), *Archiv. Zool. Ital.*, XVI : 1243, fig. 3 ; Parker (1934), *A monograph of the*

frogs of the family Microhylidae. : 74-75 ; Mahendra (1939), *J. Bombay nat. Hist. Soc.*, 41 (1) : 180-181 ; Daniel (1936), *J. Bombay nat. Hist. Soc.*, 60 (3) : 690-702 ; Hejmedi (1974), *Park. Utk. Univ. J. (Sci.)*, II (1-2) : 95 ; Gorham (1974), *Checklist of world Amphibians upto 1 January 1970.*, : 127 ; Hejmedi et al. (1979), *J. zool. Soc. India.*, 31 (1-2) : 65-72 ; Tilak and Mehta (1983), *Res. Bull. Punjab Univ. (Sci.)*, 34 (3-5) : 157-165 ; Inger and Dutta (1987), *J. Bombay nat. Hist. Soc.*, 83 (Sup.) : 187.

*Engystoma marmoratum* Cuvier (1829), *Regne Animal.*, ed. II : 112 (Type locality "India") ; Guerin (1829), *Icon. Gen. Rept.* pl. 27, fig. 3.

*Uperodon marmoratum* : Dumeril and Bibron (1841), *Erpet. Gen.*, VIII, 749 ; Guenther (1858), *Cat. Batr. Sal. Brit. Mus.* : 49.

*Hyperodon marmoratum* : Jerdon (1854), *J. Asiat. Soc. Bengal.* XXII : 533.

*Systema marmoratum* : Steindachner (1867), *Reise Novara Amph.* : 36 ; Cope (1867), *J. Acad. Philadelphia* (2), VI : 194.

*Systema breviceps* (Part) Tschudi (1838), *Mem. Soc. Sci. Neuchatel.*, II : 1839 : 86.

*Systema leschenaulti* (n. n.) Tschudi (1838), *Mem. Soc. Neuchate.*, II. 1839 : 86.

*Cacopus globulosus* (Part) Guenther (1864), *Rept. Brit. India.* : 416 ; Pearson (1910), *Spolia zeylanica*, VII : 110.

*Pachybatrachus petersii* Keferstein (1868), *Arch. Naturg.*, 274, pl. VI, figs. 8-10 (Type locality "New South Wales").

**Material Examined** : 9 examples (6♂, 3♀), collected from Sahiya, Kalsi, Jhajra, Lachhiwala, (date of collection 18.V.84, 5. VII. 85, 15.VII.86, and 21.VII.86, respectively.) Coll. P. Ray.

**Description** : Head small, snout rounded ; snout length equal to the length of eye. Canthus rostralis indistinct. Loreal region oblique, slightly elevated. Nostrils nearer to tip of snout than anterior corner of eye. Interorbital space 1.75-2.00 times width of upper eyelid. Tympanum hidden. Tongue oval, entire free behind. Choanae very large, with a movable dermal flap, which can close the narial passage. Two small bony prominences, close together, between and on level with hinder edge of choanae, a small papilla on hinder margin of each choana, a narrow denticulated ridge across sphenoidal region ; another very broad, in front of pharynx. Shape of body globular.

Forearm stout. Fingers free, tips simple not dilated. First finger shorter than second which almost equal to fourth. Third finger longest. Subarticular tubercles indistinct.

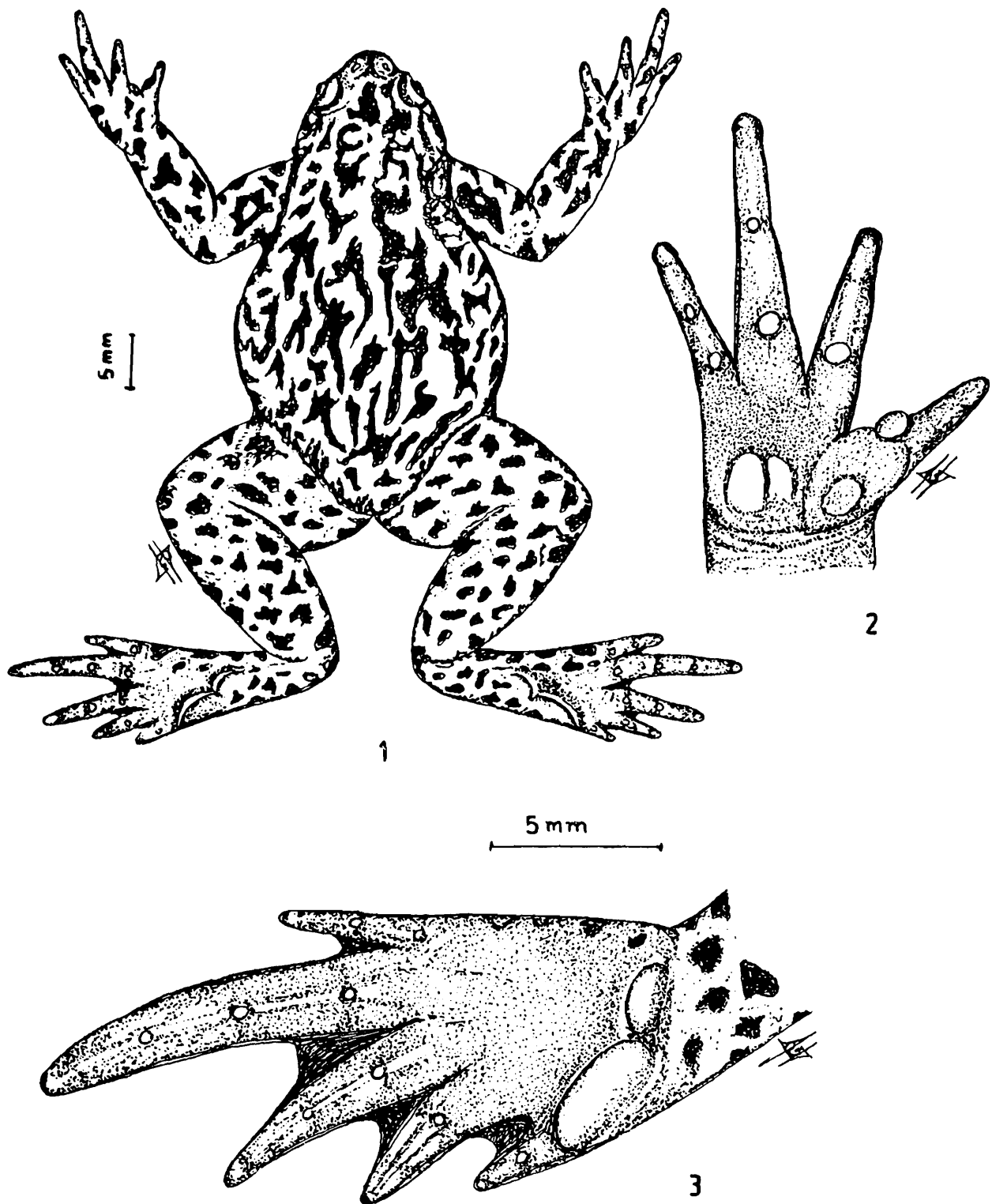
Thigh and shank highly muscular and robust. Two metatarsal tubercles, inner small, horizontally placed and outer, large and obliquely placed, shovel shaped and adapted for fossorial living. Toes webbed at base. Subarticular tubercles like those of fingers. Toe tip simple. First toe smallest and fourth longest.

Skin smooth dorsally except glandular anal region. A fold from posterior corner of eye to shoulder, ventral surface smooth.

**Osteological Characters** : Thyrohyals distinct bony rod, no anterior alary process. Skull with distinct anterior slope. Frontoparietals wide. Nasals separated from each other. Sphenethmoid exposed. Clavicles, precoracoid and omosternum absent ; xiphisternum round cartilaginous plate. Coracoids well developed. Hind leg with bony shovel shaped inner metatarsal bone. Distal end of astragalus with a small additional cartilage.

**Colouration** : Dark brown marbled ; the colouration forming a conspicuous reticulum on the dorsal aspect of body ; limbs are also of same colour. Ventrally immaculate.

PLATE - XXX



*Uperodon systoma* Schneider

Fig. 1. Adult female (Dorsal view); 2. Hand (Ventral view); 3. Foot (Ventral view);

**Sexual Dimorphism :** The males are smaller in size and with a dark brown inflated vocal sac on ventral aspect of lower jaw.

**Larval Morphology :** After hatching of 35 to 40 days tadpoles show well-developed hind limbs with five toes and characteristic two inner metatarsal tubercles. At this stage, head and body squarish, one and a half as long as broad. Nostrils nearer the orbit than tip of snout. Eyes lateral. Interorbital distance 4.5 to 5.0 times internarial distance. Mouth dorsoterminal. Spiraculum median, opening through a transparent tube just above vent. Tail acutely pointed 3.5 to 4.0 times as long as deep, and 1.5 to 1.75 times as long as head and body. Caudal membranes moderately deep. Dorsal caudal membrane starts from base of tail. Caudal membranes well blotched. Head and body well blotched with brown and cream colour. Ventrally transparent with little pigmentation at anterior side.

**Distribution :** India : Himachal Pradesh (Sirmour), Karnataka, Kerala, Orissa, Andhra Pradesh, Tamil Nadu, Uttar Pradesh (Agra, Allahabad, Saharanpur, Dehradun), West Bengal.

Elsewhere : Ceylon (Sri Lanka).

**Habitat And Breeding Habits :** These rare microhylid frogs inhabit thickly wooded tracts of district Dehradun. They come out of their burrows for a short period only in rainy season near water holes in forested areas. Moreover, they are nocturnal in habit, and hence come out only at night for feeding and breeding purposes. They are well adapted for fossorial habit which ensures them protection in forested zone from predators such as snakes and birds. They feed on termites, ants and similar terrestrial insects. The breeding season starts from June/July and males emit a very loud sound to attract females, and only then they can be detected near water pools at night. The tadpoles are surface feeders and feed on plankton in rainwater pools. It is seen that they

usually lay their spawn in fresh rainwater pools nearer forested zone. The tadpoles frequently produce air bubbles on surface of water and they also inhale some amount of air as their floating device.

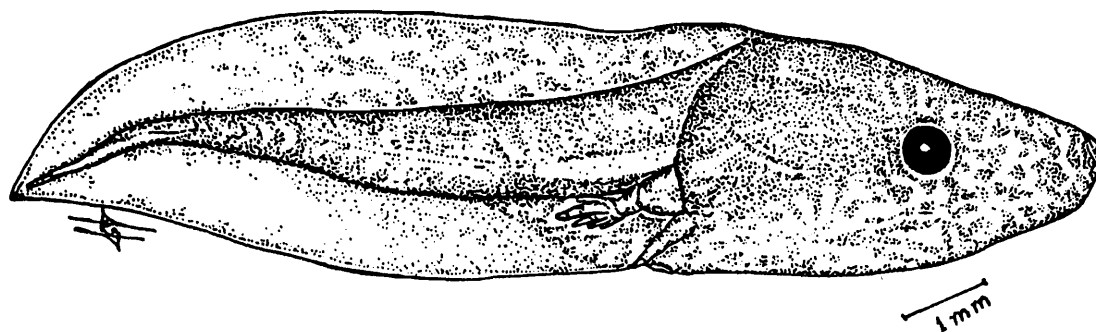
**Remarks :** This microhylid frog, commonly called as Marbled Balloon Frog, has so far been recorded from Agra, Allahabad, Saharanpur (Uttar Pradesh), Sirmour (Himachal Pradesh). The present record extends its range to the Himalayan foot hills along Shiwalik ranges.

## DISCUSSION AND CONCLUSION

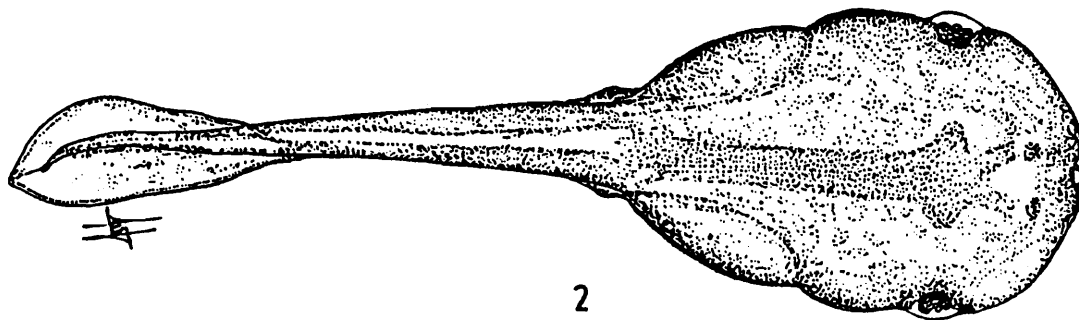
**Zoo Geographical Remarks :** As there are few amphibians known in fossilised state, there is no direct evidence available to understand the past distribution of amphibians either in space or in time, but from their present geographical distribution, a few conjectures can be made. It seems probable that south-eastern Asia is one of the major centres of origin for amphibians from which they could have spread southwards to New Guinea, Westwards and south westwards to Africa and Madagascar, and eastwards to Central and South America.

In India, the distribution of amphibians is very uneven. The highest concentration of species and genera are in the northeast and the Western Ghats of west peninsular India. Of the total known population of amphibian species, about 60% are endemic to the western ghats and to the northeastern India. In the present study, however, it is interesting to note that some endemic species (which are reported as new to science) along with a dense population of frogs and toads are found in district Dehradun. Although Indian amphibian fauna has a number of endemic genera and species, it does share some species with the neighbouring countries like Burma (33 anurans, 1 salamander), Sri Lanka (21 species of anurans), Nepal (16 anurans, 1 salamander), China (21 anurans). However, more information on the geographic

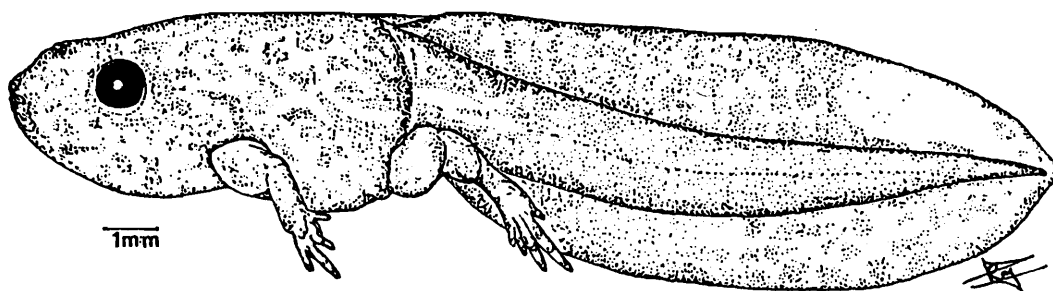
PLATE -XXXI



1



2



3

*Uperodon systoma* Schneider

**Fig. 1.** 15 days' old Tadpole (Lateral view); 2. The same Tadpole (Dorsal view); 3. 35 days' old Tadpole (Lateral view)

distribution of different amphibian species in India and elsewhere needs further studies based on large scale exploration and collection.

Swan and Leviton (1962) concluded that the Himalayan amphibian fauna have close affinities with those of adjoining countries ; the amphibian fauna of eastern part is much related to Burma, Thailand, South-China and adjoining regions, while that of Western Himalaya have relationships with the fauna of Nepal, Tibet and Pakistan along with other Indian regions.

In the present investigation, of the sixteen recorded species from district Dehradun, there are 3 species new to science (*Rana (Paa) tuberculata* Tilak & Ray, *Amolops chakrataensis* sp. nov., *Amolops jaunsari* sp. nov.) and three species recorded for the first time from Uttar Pradesh (*Bufo himalayanus* Guenther, *Bufo stomaticus* Luetken, *Amolops afghanus* Guenther) northern India. It is also interesting to note that among sixteen species studied, 12 species have already been reported from Nepal Himalaya (Dubois 1974), but *Uperodon systoma*, Schneider, two new species of *Amolops* and *Rana (Paa) tuberculata* Tilak and Ray, are only localised in the Indian subcontinent.

**Endemicity and Habitat Condition :** The term 'endemicity' is coined to represent the restricted distribution of a taxon to a particular area or region. Endemicity among amphibians is not uncommon because it requires certain specific habitats required for survival and propagation of the species. In the district Dehradun, there are sixteen species of anurans recorded from different habitats (Table 6) and most of them are restricted to a particular area with specific only and that is why they are endemic to the area.

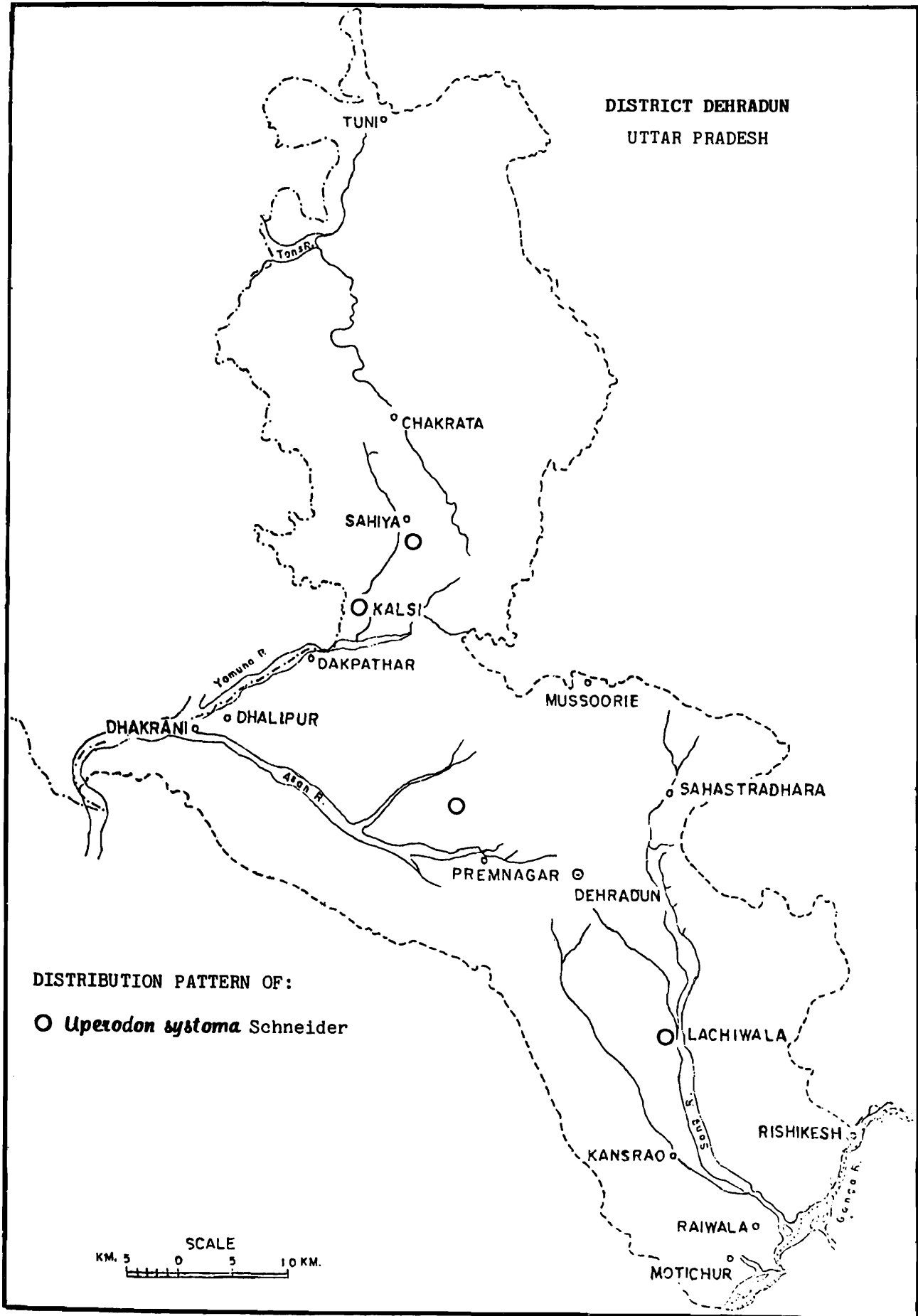
All the sixteen species discussed in present work have selective habitats and altitudinal distribution. For instance *Amolops* species were recorded mostly at or above 1500 mts and sometimes at 3000 mts. In this district *Rana*

species are, of course mostly distributed from lower altitudes i.e., 300 mts. to 1700 mts, except for *Rana (Paa) tuberculata* which is mostly localised alongwith *Amolops* species. The altitudinal distribution pattern of species of *Bufo* is interesting in all respects. The Himalayan Toad, *Bufo himalayanus* is mostly localised, being found between 1500mts - 2500mts whereas toads *Bufo melanostictus* and *Bufo stomaticus* prefer to live within the ranges of 300-1500mts. The common toad, *Bufo melanostictus* is often found to ascend upto 3250mts. The only species of *Microhyla* (*M. ornata*) is distributed from foothills to an altitude of 1500mts. The tree frog *Polypedates maculatus*, however, lives below 700mts. along with *Rana cyanophlyctis*, *Rana limnocharis*, *Rana tigerina* and *Rana crassa*. The distributional pattern of *Uperodon systoma*, is peculiar and interesting. Though the species is previously recorded from plains of different parts of India, yet, the species from collected 1200mts. along with *Tomopterna breviceps*. Thus, it is obvious that altitude and other associated physiographic factors have a major role to play in distributional pattern of amphibian fauna in this district.

Moreover, the habitat preference and associated ecological factors restrict the geographic distribution of amphibian fauna thus preventing further evolution of taxa in this group.

The habitat of amphibians is highly varied because of fact that certain major requirements must be met for their survival. These requirements vary from species to species, some amphibians have a very restricted distribution while others seem to be able to tolerate a wide variety of conditions, thriving in many different types of climates. Based on their habitat and other environmental factors, the amphibians can broadly be described as pond dwellers, river and stream dwellers, swamp and ditch dwellers, forest and field dwellers, burrowers, tree dwellers and so on. Among the different habitat factors, perhaps, temperature and humidity are the two most important factors that govern amphibian

PLATE -XXXII



distribution pattern. As such, amphibians cannot live in a place where subsoil is permanently frozen or in hot regions where the humidity is low. Another important factor is the type and amount of water that must exist to meet their requirements. Water must be fresh and as such, they cannot live in the sea, though a few can slightly tolerate salinity to a certain extent. Amphibians are highly sensitive to Sulphur, Borax, Gypsum and some heavy metals.

It is also interesting to understand that most of the amphibians have weather predicting capacity and thus can maintain periodicity of breeding behaviour and hibernation phenomena. They seem to have capacity to sense weather conditions. They probably possess atmospheric pressure registering device and are sensitive to the onset of monsoon when breeding males of different species start "calling" their mates a few hours before rainfall and get themselves ready for breeding.

The variety of climates, vegetation and topography in India, provide a wide choice of environments which lead to a wider distribution of amphibian fauna. According to the recent study by Inger and Dutta (1987), more than 181 species of amphibians were reported from various parts of India. Of all the known amphibian species of India about 90% Indian amphibians are anurans (frogs and toads) whereas the salamanders are known by one species and caecillians 15 species.

The sixteen species reported here belong to such distinct habitat types as mentioned in Table 6. Tree Frog, *Polypedates maculatus* is only arboreal among them. It possesses a number of adaptive characters for specialised habitat. The most obvious of these adaptations are the toe-pads, which are rounded and also secrete a sticky mucoid substance that increases the adhesive powers of the frog to the climbing surface. It has also long legs and slender body. They are also able to change their colour (from green to grey to brown and all shades in between). The tree-dwelling species do not have to leave their arboreal

habitat for the purposes of breeding and egg-laying. They make foam-nests on leaves overhanging water. The eggs are laid in cellular compartments filled with fluid in foam nest. As larvae hatch out and attain the gilled stage, they drop into water below and complete their further course of development. Normally, this species take shelter and hibernate into the tree-holes.

Many species of amphibians spend a good part of their life hiding, either in water under detritus, or on land under leaf-litter, rocks or logs of wood. Others, such as many of the microhylids and toads, dig shallow burrows in soil, hiding in day or in periods of extreme aridity and heat and emerging only at dusk or at night for foraging. But there are some amphibians who spend almost entire life underground emerging only during the rains. The Marbled Frog, *uperodon systoma* is one of them while species *Tomopterna breviceps* and *Rana crassa* exhibit a temporary burrowing habit only. The adaptative modifications acquired by these species are depicted in the shape of body, the eyes, and other sensory organs, the mouth, the skin and even in the breeding biology. The most characteristic features are the compact skull a narrow mouth, hidden tympanum, the relatively smooth skin, and a very retractile tongue. On the other hand, the ornate frog, *Microhyla ornata* shows adaptation to live under loose soil or leaf litter. A number of swamp and ditch-dwelling frogs recorded from this region are *Rana-cyanophlyctis*, water-edge dwelling *Rana limnocharis*, and the edible frog, *Rana tigerina* which is partial to moist holes and bushes close to the water. A number of toads also are seen inhabiting the ditches or swampy areas but only during the breeding season. In general, they have webbed feet for swimming, an enlarged tympanum, and power of jumping. (*Bufo himalayanus*, *Bufo melanostictus*, *Bufo stomaticus*) recorded from this region, mostly terrestrial and specially collected from forest floor. In general, they prefer darker places and wet situations where the type of cover such as rocks, leaves, leaf moulds and logs are always readily available. These land-dwellers have

characteristic warts on body and they resort to a crawling type of movement on land rather than jumping to long distances. All the species of genus *Amolops* (*Amolops Afghanus*, *Amolops chakrataensis*, *Amolops formosus*, *Amolops Jaunsari*) show perfect adaptation for their hill stream dwelling habit. They display marked characteristic variation in respect of eggs larvae, and adults. The eggs are comparatively larger, unpigmented and mostly laid under stones or near stagnant water pockets in hill stream. The tadpoles have a typical cascade-shaped head and body, thick muscular tail, as also the large sucktorial abdominal discs with which they adhere to the rocks under strong current of water. The adult stream-dwelling forms exhibit a number of adaptations such as enlarged digital discs, almost extensive webbing between toes, and streamlined body with long legs. The male tuberculated frog *Rana (Paa) tuberculata* shows characteristic secondary sexual character with spiny tubercles

on first and second fingers and female with large ova. The tadpoles of this species bear an extensive caudal membrane.

**Overwintering Phenomenon :** The hill-stream dwelling high altitude forms exhibit a phenomenon of overwintering. In the course of current study, larval stages of different species were collected and complete life history of different species has been studied from fertilised ova to fourlegged stage. The tadpoles of hill stream dwelling species (*Amolops afghanus*) in higher altitude ranging between 1000-3000 mts, do not complete their development in one season during summer and following autumn unlike many species of frogs in the plains. The developmental stages of these species show a very slow rate of development and as such, they are unable to attain four-legged stage to invade terrestrial habitat. This is probably connected with temperature of water which is low in hills and higher in plains. The slow-growing tadpoles live in water during entire winter season

**Table 6.** Habitat and distribution pattern of amphibian species, recorded in the present investigation

<i>Species</i>	<i>Habitat</i>	<i>Altitudinal Distribution Pattern</i>
<i>Amolops afghanus</i> (Guenther, 1858)	Stream dweller	1500-3000 M
<i>Amolops chakrataensis</i> sp. nov.	stream dweller	2700 M
<i>Amolops formosus</i> (Guenther, 1875)	Stream dweller	2500 M
<i>Amolops jaunsari</i> sp. nov.	Stream dweller	1700 M
<i>Bufo himalayanus</i> (Guenther, 1864)	Forest and field dweller	1500-3000 M
<i>Bufo melanostictus</i> Schneider, 1899	Forest and field dweller	300 2500 M
<i>Bufo stomaticus</i> Luetken, 1863	Forest and field dweller	300 2000 M
<i>Microhyla ornata</i> (Dum, & Bibr. 1841)	Forest and field dweller	300 1500 M
<i>Polypedates maculatus</i> (Gray, 1832)	Tree dweller	below 700 M
<i>Rana (Paa) tuberculata</i> Tilak & Roy, 1985)	Stream dweller	1000 2500 M
<i>Rana crassa</i> Jerdon, 1853	Burrower	300 1000 M
<i>Rana cyanophlyctis</i> Schneider, 1799	Pond and ditch dweller	300 1500 M
<i>Rana limnocharis</i> Boie (in Grav.), 1829	Swamp and ditch dweller	300 1500 M
<i>Rana tigerina</i> Daudin, 1802	Swamp and ditch dweller	300 1500 M
<i>Tomopterna breviceps</i> Schneider, 1799	Burrower	300 1500 M
<i>Uperodon systoma</i> Schneider, 1799	Burrower	300 1500 M

and in following spring, when temperature of water rises, they start attaining further stages of development and finally with onset of summer froglets leave water and enter their terrestrial habitat for further growth as an adult. The metamorphosis of developing tadpoles get arrested under extreme cold conditions during winter and activated only when temperature of water rises. This phenomenon of tiding over the winter months is peculiar to frogs inhabiting high altitudes and phenomenon is known as 'overwintering'. In general, adults of almost all species of amphibians hibernate during winter which is an unfavourable period for spending a normal life. Probably larval forms of high altitude amphibians follow a similar pattern of life history and undergo phenomenon of overwintering. This phenomenon appears to be a device developed by these taxa in order to survive and to be the fittest among different taxa of amphibians. The attainment of this innovation among high altitude living amphibians should be a character of their adaptive radiation in contrast to other species of amphibians. This highly evolved characteristic of such species is also indicated in their morphology.

**Conclusion :** The systematic study of amphibian fauna of Uttar Pradesh has never been attempted though physiographic and climatic features of this region is very much congenial for amphibian growth and development. In the present investigation, an attempt has been made to survey amphibian fauna of district Dehradun from different altitudes varying from 300 to 3300 mts. The study area covers three climatic zones : tropical foot hills, subtropical and temperate climatic zones. During the survey (1983-1987), a total of 1497 specimens were collected and studied in laboratory. The species *Rana cyanophlyctis*, *Rana limnocharis*, *Bufo melanostictus* and *Bufo stomaticus* occupy the highest frequency. These species are mostly distributed, from 300mts to 1500mts altitude. The current investigation reports on external and internal features of both adults

and larvae of sixteen species recorded from district Dehradun. These taxa are grouped into four families and seven genera. Three of these taxa are new to science. Of the sixteen species described only nine species were reported previously from various localities of Uttar Pradesh (Table 3).

The study reveals the area harbours both Pan-Oriental and Palearctic amphibian faunal elements. Most of the species have specific altitudinal distributional pattern and habitat preferences.

The eggs of several species were collected from selective habitats and studied. The developmental features of tadpoles were studied in laboratory in specially designed rearing tanks.

The larval morphology of amphibians studied here has been found to be important from the point of view of taxonomy. The detailed structure of individual oral teeth of larvae provides characters which could be specific and helpful in species identification.

The comprehensive and illustrative key provided will be useful for ready identification of all the sixteen species reported. Lastly the three frogs described as new to science have been thoroughly checked to the minutest detail before confirming them as new species. Further, the three new species are found to be distinctive, differing in several features from the forms closely allied to them.

#### ACKNOWLEDGEMENTS

I am gratefully indebted to the Director, Zoological Survey of India, Calcutta for providing necessary permission and facilities to continue the research work and consultation of literatures type, named and un-named collections present in the ZSI both at Head Quarters and Regional Stations.

Grateful thanks are due to the Director, National Museum of Natural History, New Delhi for extending necessary help during the course of incorporating referee's comments in the revised

manuscript and got re-typed and re-submitted for acceptance.

I also take this opportunity to express my indebtedness to Dr. G.S.Arora, Officer-in-Charge (Retd.) and Dr. Arun Kumar, Officer-in-Charge, Northern Regional Station, Dehra Dun for their constant encouragement and help.

I also express my sincere debt of gratitude to Dr. Raj Tilak for his guidance, critical review and facilities extended for accomplishment of this work.

Sincere thanks are also due to my friend Dr. S.C.Santra, Head of Ecological Studies, Kalyani

University, for his help in preparation of final manuscript and also identifying the plant species recorded from study area.

Thanks are also due to all my colleagues at Northern Regional Station, Zoological Survey of India, Dehra Dun who helped me in field work and in all respects to bring out the paper in the present shape.

Last but not the least, I appreciate my family for accepting all the troubles and responsibilities during weekends and holidays for completion of my research work.

## REFERENCES

- Abdulali, H. and Daniel, J. C. (1956) Notes on *Bufo stomaticus* Luetken in Bombay. *J. Bombay nat. Hist. Soc.*, **53** : 716-717.
- Abdulali, H. (1982) Some field notes on the newly described toad, *Bufo camortensis* Mansukhani and Sarkar. *J. Bombay nat. Hist. Soc.*, **79** (2) : 430.
- Abdulali, H. (1985) On the export of frog legs from India. *J. Bombay nat. Hist. Soc.*, **82** : 347-375.
- Acharji, M. N. and Kripalani, M. B. (1951) On a collection of Reptilia and Batrachia from the Kangra and Kulu Valleys, Western Himalaya. *Rec. Indian Mus.*, **49** : 175-184, fig.
- Agarwal, S. K. and Niazi, I. A. (1977) Normal table of developmental stages of the Indian bull frog *Rana tigerina*. *Proc. Nat. Acad. Sci. India Sec. B*, **2** : 79-92.
- Ahmad, N. (1946) On a small collection of vertebrates from high altitude in Kashmir State. *J. Royal Asiat. Soc. Bengal, (Scim)* **11** : 119-121.
- Anderson, J. (1871) A list of the Reptilian accession to the Indian Museum, Calcutta, from 1865 to 1870, with a description of some new species *J. Asiat. Soc. Bengal*, **40** : 12-39.
- Anderson, J. (1895) On a collection of Reptiles and Batrachia made by Colonel Yerbury at Aden and its neighbourhood. *Proc. Zool. Soc. London*, 635-663, pl. xxxvi-xxxvii.
- Anderson, J. (1901) A list of the Reptiles and Batrachians obtained by Mr. Blayney Percival in Southern Arabia. *Proc. Zool. Soc. London*, **2** : 137-152, pl. xiv-xv.
- Anderson, L. G. (1939) Batrachians from Burma collected by Dr. R. Malaise, and from Bolivia and Ecuador collected by Dr. C. Hammerlund. *Ark. Zool. Stockholm*, **30A**, n° 23 : 1-24.
- Anderson, S. C. (1963) Amphibians and reptiles from Iran. *Proc. Calif. Acad. Sci.*, ser. 4, **31** : 417-498, fig., tab.
- Annandale, N. (1905) On abnormal ranid larvae from north-eastern India. *Proc. Zool. Soc. London*, **6** : 58-61.
- Annandale, N. (1906) Notes on the freshwater fauna of India VIII, Some Himalayan Tadpoles. *J. Asiat. Soc. Bengal*, **2** : 289-292.
- Annandale, N. (1907) The distribution of *Bufo andersoni*. *Rec. Indian Mus.*, **1** : 171-172.
- Annandale, N. (1908) Notes on some Batrachia recently added to the collection of the Indian Museum. *Rec. Indian Mus.*, **2** : 304-305.
- Annandale, N. (1908b) Description of the tadpole off *Rana pleskii* with notes on allied forms. *Rec. Indian Mus.*, **2** : 345-346.
- Annandale, N. (1909) Notes on Indian Batrachia. *Rec. Indian Mus.*, **3** : 282-286.
- Annandale, N. (1910) An undescribed Burmese frog allied to *Rana tigrina*. *Rec. Indian Mus.*, **5** : 79.
- Annandale, N. (1910b) Description of a South Indian frog allied to *Rana corrugata* of Ceylon. *Rec. Indian Mus.*, **5** : 191.
- Annandale, N. (1912) Zoological Results of the Abor Expedition 1911-1912. I. Batrachia. *Rec. Indian Mus.*, **8** : 7-36, 3 pl.
- Annandale, N. (1913) Some new and interesting Batrachia and Lizards from India, Ceylon and Borneo. *Rec. Indian Mus.*, **9** : 301-307. pl. xv.

- Annandale, N. (1915) Herpetological notes descriptions. *Rec. Indian Mus.*, **11** : 345-346.
- Annandale, N. (1917a) Zoological results of a tour in the Far East. Batrachia. *Mem. Asiat. Soc. Bengal*, **6** : 119-156, pl. v-vi.
- Annandale, N. (1917b) The occurrence of *Rana pleskii* Guenther in Kashmir. *Rec. Indian Mus.*, **13** : 417-418.
- Annandale, N. (1918a) Further notes on *Rana tigrina* and allied forms. In Boulenger, G. A., et N. Annandale, *Rec. Indian Mus.*, **15** : 59-65 figs.
- Annandale, N. (1918b) Tadpoles from South India. *Rec. Indian Mus.*, **15** : 17-23.
- Annandale, N. and Rao, C. R. N. (1918) The tadpoles of the families Ranidae and Bufonidae found in the plains of India. *Rec. Indian Mus.*, **15** : 25-40, pl. ii.
- Annandale, N. (1919a) The fauna of certain small streams in the Bombay Presidency. *Rec. Indian Mus.*, **16** : 109-161, pl. i. vi.
- Annandale, N. (1919b) Some frogs of streams in the Bombay Presidency. *Rec. Indian Mus.*, **16** : 121-125.
- Annandale, N. (1919c) The tadpoles of *Nyctibatrachus* and *Ixalus variabilis* a correction. *Rec. Indian Mus.*, **16** : 303.
- Annandale, N. (1922) Parallel evolution in the Fish and Tadpoles of mountain streams. *Rec. Indian Mus.*, **24** : 505.
- Ahl, E., (1931) Anura III Polypedatidae. In *Das Tierreich. De. Gruyter, Berlin and Leipzig* xvi., 477 pp.
- Bardhan, N. R. and Bhaduri, J. L. (1956) Calcutta male toad, *Bufo melanostictus* as test animal in the diagnosis of pregnancy of Bangalore cattle. *Indian J. Dairy Sci.*, **9** : 9-16.
- Behura, B. K. (1965) Odisara Benga (in Oriya), *Zoological Society of Orissa Publication*. Utkal University, Bhubaneswar.
- Bhaduri, J. L. (1933) A note on the occurrence of *Rana hexadactyla* Lesson in Bengal. *J. Bombay nat. Hist. Soc.*, **36** : 514-516.
- Bhaduri, J. L. (1935) The anatomy of the adhesive apparatus in tadpoles *Rana afghana* (Guenther), with special reference to adaptive modifications. *Trans. Roy. Edin.*, **58** : 339.
- Bhaduri, J. L. (1944) A note on *Rana crassa* Jerdon, with extension of its range. *J. Bombay nat. Hist. Soc.*, **44** : 481-484.
- Bhaduri, J. L. (1945) Notes on a rare and interesting narrow mouthed frog, *Uperodon globulosum* (Guenther). *J. Bombay nat. Hist. Soc.*, **45** : 251-254.
- Bhaduri, J. L. and Kripalani, M. (1954) Notes on the frog *Rana breviceps* Schneider. *J. Bombay nat. Hist. Soc.*, **52** : 620-623.
- Bhaduri, J. L. and Daniel, J. C. (1956) The tadpoles of *Uperodon globulosum* (Guenther). *J. Bombay nat. Hist. Soc.*, **53** : 713-716.
- Bhaduri, J. L. and Kripalani, M. B. (1955) *Nyctibatrachus humayuni*, a new frog from the western ghats, Bombay. *J. Bombay nat. Hist. Soc.*, **52** (4) : 850-857.
- Bhora, P.; Tak, N. ; Bhargava, R. N. and Rathore, N. S. (1983) Frogs of Indian desert with illustrated key to their field identification. *Trans. Indian Soc. Desert Technol.*, **8**(2) : 113-118.

- Blyth, E. (1854) Notices and descriptions of various Reptiles, new or little known. *J. Asiat. Soc. Bengal*, **23** : 287-302.
- Boulenger, G. A. (1882) *Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum*. London, Taylor and Francis, xvi, 503 p., 30 pls.
- Boulenger, G. A. (1883) Description of new species of Reptiles and Batrachians in the British Museum. *Ann. Mag. Nat. Hist.*, ser. 5, **12** : 161-167, pl. v.
- Boulenger, G. A. (1887) On a rare Himalayan toad, *Copophryne sikkimensis* Blyth. *Ann. Mag. Nat. Hist.*, ser. 5, **19** : 405-407.
- Boulenger, G. A. (1888) Descriptions of two new Indian species of *Rana*. *Ann. Mag. Hist.*, ser. 6 (2) : 506-508.
- Boulenger, G. A. (1890) *The fauna of British India, including Ceylon and Burma, Reptilia and Batrachia*. London, xviii, 541 p.
- Boulenger, G. A. (1891) Note on *Lycodon atropurpureus* Cantor, and *Bufo stomaticus* Lutken. *Ann. Mag. Nat. Hist.* ser. 6, **7** : 462-463.
- Boulenger, G. A. (1904) Description of a frog from Ceylon hitherto confounded with *Rana limnocharis*, *Spolia zeylanica*, **2** : 73-74.
- Boulenger, G. A. (1905) On the habitat of *Rana blanfordii*. *Ann. Mag. Nat. Hist.*, ser. 7, **16** : 640.
- Boulenger, G. A. ; Annandale, N. ; Wall, F. and Regan, C. T. (1907) Reports on a collection of Batrachia, Reptiles and fish from Nepal and the Western Himalayas, *Rec. Indian Mus.*, **1** : 149-158, p. vi.
- Boulenger, G. A. and Annandale, N. (1918) Further observations of *Rana tigrina*. *Rec. Indian Mus.*, **15** : 51-67.
- Boulenger, G. A. (1919) On *Aelurophryne mammata* Guenther an addition to the batrachian fauna of Kashmir. *Rec. Indian Mus.*, **16** : 469-470.
- Boulenger, G. A. (1920) A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. *Rec. Indian Mus.*, **20** : 1-126.
- Bourret, R. (1942) *Les Batraciens de l' Indo-chine, Institute Ocenographique, de l' Indo-chine*, Hanoi, x-547. 4 pls. 196 figs.
- Chanda, S. K. and Talukdar, S. K. (1973) Preliminary observations on the foam nest and early development of a frog of *Rhacophorus* sp. (Amphibia : Rhacophoridae). *J. Assam Sci. Soc.*, **16** (2) : 208-209.
- Chanda, S. K. (1986) On a collection of Anuran amphibians from Darjeeling and Sikkim Himalayas, with description of a new species of *Rana* (Ranidae). *J. Bengal Nat. Hist. Soc.* New ser. **5** (2) : 140-151.
- Charan, D. (1972a) The pelvic musculature of *Rana tigrina* Daudin. *Annals Zool.*, Agra, **7**(4) : 81-92., figs.8.
- Charan, D. (1972b) Structure of the tail in the tail-stub and semi-adult stages *Rana tigrina* Daudin. *Annals Zool.*, Agra, **8**(1) : 9-21.
- Charan, D. (1973) The pelvic region of *Rana tigrina* Daudin and *Bufo andersonii* Boulenger. *Annals Zool.* Agra, **9**(1) : 1-40, 2 figs, 20 pls.
- Cope, F. D. (1866) Sketch of the the primary groups of Batrachia Salientia. *Nat. Hist. Rev.* (1865) : 97-120.
- Crump, M. L. (1974) Reproductive strategies in a tropical anuran community. *Misc. Publ. Mus. Nat. Hist. Univ. Kansas* 61.

- Daniel, J. C. (1962) Notes on some Amphibians of the Darjeeling area, West Bengal. *J. Bombay nat. Hist. Soc.*, **59** : 666-668, pls. i-iv.
- Daniel, J. C. (1963a) Field guide to the amphibians of Western India. Part I. *J. Bombay nat. Hist. Soc.*, **60** : 415-438.
- Daniel, J. C. (1963b) Field guide to the amphibians of Western India, Part II. *J. Bombay nat. Hist. Soc.*, **60**(3) : 690-702.
- Daniel, J. C. (1974) Amphibia In : *Gazetteer of India. Maharashtra State Gazetteers. general series Fauna*, Bombay.
- Daniel, J. C. (1975) Field guide to the amphibians of Western India. Part III. *J. Bombay nat. Hist. Soc.* **72** : 506-522.
- Dubois, A. (1974) Diagnoses de trois especes nouvelles d' Amphibiens du Nepal. *Bull. Soc. Zool. France.*, **98** : 495-497.
- Dubois, A. (1975) Un nouveau complexe d' especes Jumelles distingues par le chant le grenouilles du Nepal voisines de *Rana limnocharis* Boie (Amphibiens, Anoures). *C. r. Acad. Sci. Paris*, **281** : 1717-1720.
- Dubois, A. (1978) A new species of *Scutigera* Theobald 1868 from the western Himalayas (Anura : Pelobatidae). *Senckenbergiana Biol.* **59** (3/4) : 163-172.
- Dubois, A. and Khan, M. S. (1979) A new species of frog (Genus *Rana* subgenus *Paa* from Northern Pakistan (Amphibia, Anura). *J. Herpetology.*, **13**(4) : 403-410.
- Dubois, A. (1981) Liste des genres et sous-genres nominaux de Ranoidea (Amphibiens: Anoures) du monde, avec identification de leur espece-typus : Consequences nomenclaturales. *Monit. Zool. Ital.* (Suppl.) n. s., **15** : 225-284.
- Dubois, A. (1983) Note preliminaire sur le groupe de *Rana (Tomopterna) breviceps* Schneider, 1799 (Amphibiens, Anoures), avec diagnose d' une sous espice nouvelle de Ceylon. *Alytes*, **2**(4) : 163-170.
- Dubois, A. (1985) Diagnose prliminaire d'un nouveau genre de Ranoidea (Amphibiens, Anoures) du sud de l' Inde. *Alytes*, **4** : 113-118.
- Duda, P. L. and Sahi, D. N. (1977) An upto date checklist of herpetiles of Jammu and Kashmir. *Univ. Rev.*, **6** : 1-7. Univ. of Jammu, Pacca Danga Jammu, India.
- Dutta, S. K. and Hejmadi, P. M. (1981) Breeding and life history of the India bull frog, *Rana tigrina* (Daudin) *Prakruti Utkal. Univ. J. Sci.*, **13**(1-2) : 51-59.
- Dutta, S. K. (1985) Replacement names for two Indian species of *Philautus* (Anura : Rhacophoridae). *J. Bombay nat. Hist. Soc.*, **82** (1) : 219-220.
- Dutta, S. K. (1985) Notes on the correct spelling of the Indian Bull frog, *Rana tigrina* Daudin. *J. Bombay nat. Hist. Soc.* **82**(1) : 220-221.
- Emerson, B. S. (1976) Burrowing in Frogs. *J. Morph.*, **149** : 437-458.
- Ferguson, H. S. (1904) A list of Travancore batrachia. *J. Bombay nat. Hist. Soc.*, **15** (3) : 499-509.
- Fitzinger, L. J. (1861) Die Ausbeute der osterreichischen Naturforscher an Saugethieren and Reptilien Wahrend der Weltumregelung Sr. Majestat Fregatte Novara, Sitzungsber. math. Naturwin Classe Kaiserl. *Akad. Wiss. Wien.*, **42** : 383-416.
- Flower, S. S. (1896) Notes on a collection of Reptiles and Batrachians made in the Malay Peninsula in 1895-96 ; with a list of the species recorded from that region. *Proc. Zool. Soc. London.* ; 856-914, xlv-xlvi.

- Gorham, S. W. (1974) *Checklist of world amphibians up to 1 January 1970. New Brunswick Museum. St. John, New Brunswick.*
- Gosner, K. L. (1960) A simplified table for staging anuran embryos and larvae with notes on identification. *Herpetologica*, **16** : 183-190.
- Gruber, U. (1981) Notes on the herpetofauna of Kashmir and Ladakh, *British J. Herpet.*, **6(5)** : 145-150.
- Guenther, A. 1858) *Catalogue of the Batrachia Salientia in the collection of the British Museum.* London, ; xxi-160, pls. 12.
- Holtmann, H. (1985) Funktionsmorphologische untersuchungen zum aquatischen Nahrungserwerb von *Rana cyanophlyctis*, Thesis, pp. 53.
- Hora, S. L. and Chopra, B. (1923) Reptilia and Batrachia of the Salt Range, Punjab. *Rec. Indian Mus.*, **25** : 369-376.
- Inger, R. F. (1966) The systematics and zoogeography of the Amphibia of Borneo. *Fieldiana Zool.*, **52** : 1-402.
- Inger R. F. (1972) *Bufo* of Eurasia, In : Evolution in the genus *Bufo* W. F. Blair (ed.) Univ. Texas Press Austin Texas. p. 102-118.
- Inger, R. F. and Frogner, K. J. (1979) New species of narrow-mouth frogs (genus *Microhyla*) from Borneo. *Sarawak Mus. J.*, **27** : 311-324.
- Inger R. F. (1980) Relative abundances of frogs and lizards in forests of South-east Asia. *Biotropica*, **12** : 14-22.
- Inger, R. F. and Gritis, P. (1983) Variation of Bornean frogs of the *Amolops jerboa* species group, with description of two new species, *Fieldiana Zool.*, (n. s.) No. 19, 13 pp.
- Inger, R. F. ; Shaffer, H. B. ; Koshy, M. and Bakde, R. (1984) A report on a collection of amphibians and reptiles from the Ponmudi, Kerala, South India. *J. Bombay nat. Hist. Soc.*, **81.**, 406-427.
- Inger, R. F. and Dutta, S. K. (1987) An overview of the amphibian fauna of India. *J. Bombay nat. Hist. Soc.*, **83(suppl.)** : 135-146.
- Jayaram, K. C. (1974) Ecology and distribution of freshwater fishes, amphibia, and reptiles In : *Ecology and biogeography in India*, pp. 517-584.
- Jana, R. K. and Mondal, A. K. (1981) On the hybridization of *Rana tigerina* Daudin and *Rana crassa* Jerdon. *Proceedings natn. Acad. Sci. India (B)*, **51(1)** : 1-3.
- Joshee, A. K. (1968) Food habits of the Bull frog *Rana tigrina* Daudin. *J. Bombay nat. Hist. Soc.*, **65** : 498.
- Kampen, V. (1923) *The amphibia of the Indo-Australian Archipelago.* Leiden.
- Khan, M. S. (1968) Amphibian fauna of district Jhang with note on habits. *Pakistan J. Sci.*, **20(56)** : 227-233.
- Khan, M. S. (1972) The 'commonest toad' of West Pakistan and a note of *Bufo melanostictus* Schneider. *Biologia, Lahore*, **18(2)** : 131-133.
- Khan, M. S. (1973) Food of tiger frog, *Rana tigrina* Daudin. *Biologia, Lahore*, **19(1-2)** : 93-107, 4 figs, 3 tabs.
- Khan, M. S. (1976) An annotated checklist and key to the amphibians of Pakistan. *Biologia Lahore*, **22** : 201-210.
- Khan, M. S. (1979) On a collection of amphibians from northern Punjab and Azad Kashmir, with ecological notes. *Biologia Lahore* **25(1-2)** : 37-50.

- Khan, M. S. (1985) An interesting collection of amphibians and reptiles from Cholistan desert, Punjab. Pakistan. *J. Bombay nat. Hist. Soc.*, **82**(1) : 144-148.
- Khaleque, K. A. (1956) Pregnancy tests on the male toad *Bufo melanostictus* at Dacca (East Pakistan). *J. Trop. Med. Hyg.*, **59** : 78-82.
- Kirtisinghe, P. (1958) *The Amphibia of Ceylon*, Colombo (Privately Published), pp. xiv-112.
- Kripalani, M. (1952) On Indian tadpoles with a suctorial disc. *Rec. Indian Mus.*, **50** : 359-366. pl. viii.
- Kripalani, M. (1953) On two remarkable tadpoles from the Darjeeling District. *Everyday Sci.* Hoshiarpur., **2** : 57-61.
- Kripalani, M. (1961) Zoological results of the Indian Cho-Oyu Expedition (1958) in Nepal. Part 5. Amphibia. *Rec. Indian Mus.*, **59** : 214-244. pl. xiv.
- Kuramoto, M. (1973) *Rana limnocharis* of Kyushu and the south-western Islands. *Acta. Herpet. Jap.*, **4**(1-4) : 14.
- Leviton, A. E. and Anderson, S. C. (1970) the Amphibians and Reptiles of Afghanistan a checklist and key to the Herpetofauna. *Proc. Calif. Acad. Sci.*, ser 4, **38** : 163-206.
- Leviton, A. E. ; Myers, G. S. and Swan, L. W. (1956) Zoological results of the California Himalayan Expedition to Makalu, Eastern Nepal. I. Amphibians and Reptiles. *Occ. Pap. Nat. Hist. Mus.* Stanford Univ., **1** : 11-18.
- Liem, S. S. (1970) The morphology, systematics and evolution of the old world Tree frogs. (*Rhacophoridae* and *Hyperoliidae*) *Fieldiana Zool.*, **57** : vii-145.
- Liu, C. C. (1950) Amphibians of Western China. *Fieldiana Zool. Mem.*, **2** : 1-400.
- Mahendra, B. C. (1937) The vertebral column of the Anura : its bearing on the classification. *Curr. Sci. Bangalore*, **6**(1) : 13-16.
- Mahendra, B. C. (1939) Extension of the range of the microhylid frog (*Uperodon systoma* Schneider.) *J. Bombay nat. Hist. Soc.*, **41**(1) :
- Mahendra, B. C. (1939) The zoogeography of India in the light of herpetological studies. *Sci. Cult.*, **4**(7) : 11.
- Mansukhani, M. R. and Murthy, T. S. N. (1964) Fauna of Rajasthan, India Part 6, Amphibia. (1984), *Rec. Zool. Surv. India*, **62**(1 & 2) : 51-60, pls. 2.
- Mansukhani, M. R. and Sarkar, A. K. (1980) On a new species of toad from Camorta, Andaman and Nicobar, India, *Bull. Zool. Surv. India*, **3**(1 & 2) : 97-101.
- Mansukhani, M. R. and Sarkar, A. K. (1981) Notes on some amphibian collections from Tripura, India. (1984), *Rec. Zool. Surv. India*, **79**(1-2) : 267-273.
- Matsui, M. (1986) Three new species of Amolops from Borneo (Amphibia, Anura, Ranidae)., *Copeia.* : 623-630.
- Mathur, L. P. and Sharma, M. L. (1938) Observations on the abnormalities in the common Indian Frog, *Rana tigrina* Daudin. *Proc. Indian Acad. Sci.*, **8B**(3) : 182-187.
- McCann, C. (1938) The Reptiles and Amphibia of Cutch state., *J. Bombay nat. Hist. Soc.*, **40** : 425-427.
- McCann, C. (1943) A "Bushman's holiday" in the Abu hills., *J. Bombay nat. Hist. Soc.*, **43** : 206-217.
- Merrem, B. (1820) Tentamen systematics Amphibiorum., *Marburg.* : 174.

- Minton, S. A. (1966) A contribution to the herpetology of West Pakistan. *Bull. Am. Mus. nat. Hist.*, **134** : 51-58.
- Mohanty-Hejmadi, P. (1977) The amphibian fauna of Orissa. *Prak. Utkal. Univ. J. Sci.*, **11** : 89-97.
- Mohanty-Hejmadi, P. and Dutta, S. K. (1976) Addendum to the amphibian fauna of Orissa. *Prak. Utkal. Univ. J. Sci.*, **13**(1-2) [1981] ; 135-136.
- Mohanty-Hejmadi, P. (1977) Care and maintenance of Indian Frogs : Juveniles and adults. *Prak. Utkal. Univ. j. Sci.*, **11** : 75-79.
- Mohanty-Hejmadi, P. ; Dutta, S. K. and Khan, I. (1980) Life history of Indian frogs III : the ornate frog *Microhyla ornata*. *J. Zool. Soc. India*, **32**(1 & 2) : 43-48.
- Mohanty-Hejmadi, P. and Acharya, B. K. (1982) Observations on food habits of six species of Indian frogs. *J. Bombay nat. Hist. Soc.*, **79**(1) : 120-124.
- Mukerji, D. D. (1933) Some observations on the burrowing toad *Cacopus globulosum* guenther. *J. & Proc. Asiat. Soc. Bengal*, **27**(1) : 97-100. pl. 1.
- Murthy, T. S. N. and Rao, K. V. R. (1973) The common Indian pond frog : *Rana cyanophlyctis* Schneider an alternative specimen for laboratory studies. *Current Sci.*, **42**(1) : 33-34.
- Myers, G. S. Leviton, A. E. (1962) Generic classification of the high altitude Pelobatid toads of Asia (*Scutigera*, *Aelurophryne* and *Oreolalax*). *Copeia* : 287-291.
- Naik, Y. M. and Patel, R. K. (1987) Record of the fungoid frog *Rana malabarica* (Bibron) in Navsari (Gujarat state). *J. Bombay nat. Hist. Soc.*, **83**(2) : 672.
- Nicholls, G. E. (1915) Some notes upon the anatomy of *Rana tigrina*. *Proc. Zool. London.* : 603-609.
- Nieden, F. (1923) Amphibia. Anura I. Subordo Aglossa and Phaneroglossa, Sectio 1. Acrifera. *Das Tierreich*, 46 Lieferung, xxxii, 584.
- Nieden, F. (1926) Amphibia. Anura II. *Das Tierreich*.
- Noble, G. K. (1931) *The biology of the Amphibia* McGraw Hill, New York.
- Paranjapee, S. Y. and Mulherkar, L. (1979) On the survey of the amphibian fauna in and around Poona. *J. Univ. Poona Sc. &tech. Sec.*, **52** : 423-434.
- Parker, H. W. (1934) *A monograph of the frogs of the family Microhylidae*. The British Museum, London., 208 pp.
- Pillai, R. S. and Chanda, S. K. (1973) *Philautus shillongensis*, a new frog. (Ranidae) from Meghalaya, India. *Proc. Indian Acad. Sci. (B)* ; **78** : 30-36.
- Pillai, R. S. and Yazdani, G. M. (1973) *Bufoides* a new genus for the rock toad, *Ansonia meghalayana* Yazdani and Chanda, with notes on its ecology and breeding habits. *J. Zool. Soc. India*, **25**(1 & 2) : 65-70.
- Pillai, R. S. and Chanda, S. K. (1976) The distribution pattern of Amphibia in North East India. *J. Assam Sci. Soc.*, **19** (53) : 4.
- Pillai, R. S. and Chanda, S. K. (1977) *Rana danieli* and *Rana mawphlangensis*, two new frogs (Ranidae) from Khasi hills, India. *J. Bombay nat. Hist. Soc.*, **74**(1) : 136-140.
- Pillai, Ram and Chanda, S. K. (1979) Amphibian fauna of Khasi hills, Meghalaya. *Rec. Zool. Surv. India*. **75** : 383-395.

- Pillai, R. S. and Chanda, S. K. (1981) Amphibian fauna of Garo hills, Meghalaya with description of a new species of *Rana*. *Rec. Zool. Surv. India*, **79**(1-2) : 159-168.
- Pillai, R. S. (1981) Two new species of Amphibia from Silent Valley, South India. *Bull. Zool. Surv. India*, **3**(3) : 153-158.
- Pillai, R. S. and Pattabiraman, R. (1981) A new species of torrent toad (genus : *Ansonia*) from Silent Valley, South India. *Proc. Indian Acad. Sci.*, **90**(B) : 203-208.
- Pillai, R. S. (1982) Notes on *Rana dobsonii* Boulenger. *Rec. Zool. Surv. India*, **79**(3-4) : 363-365.
- Ramaswami, L. S. (1937) Some aspects of the anatomy of Anura (Amphibia)-a review. *Proc. Indian Acad. Sci.*, **10** : 41-80.
- Rao, C. R. N. (1920) Some South Indian Batrachians. *J. Bombay nat. Hist. Soc.*, **27** : 119-127, pls. i-ii.
- Rao, C. R. N. (1922) Notes on Batrachia. *J. Bombay nat. Hist. Soc.*, **28** : 439-447.
- Rao, C. R. N. (1937) On some new forms of Batrachia from South India. *Proc. Indian Acad. Sci.*, **6**(B) : 387-426.
- Roonwal, M. L. and Kripalani, M. B. (1961) A new frog, *Philautus cherrapunjiae* (Family Ranidae) from Assam, India, with field observations on its behaviour and metamorphosis. *Rec. Indian Mus.*, **59**(1 & 2) : 325-333.
- Sarkar, A. K. (1984) Taxonomic and ecological studies on the amphibians of Calcutta and its environs. *Rec. Zool. Surv. India*, **81**(3 & 4) : 215-236.
- Sarkar, A. K. and Sanyal, D. P. (1985) Amphibia. *Rec. Zool. Surv. India*, **82**(1-4) : 285-295.
- Schneider, J. G. (1799) *Historiae Amphibiorum naturalis et literariae. Fasc. I. Jenae*, xiii-370.
- Sclater, W. L. (1892a) On some specimens of Frogs in the Indian Museum, Calcutta, with description of several new species. *Proc. Zool. Soc. London* : 341-348. pl. xxiv.
- Sclater, W. L. (1892b) *List of the Batrachia in the Indian Museum. London.*, viii-43.
- Sekar, A. G. (1987) A note on the breeding habits of Jerdon's *Ramanella*, *Ramanella montana* (Jerdon, 1854). *J. Bombay nat. Hist. Soc.*, **84**(1) : 231-232.
- Silva, P. H. D. H. (1955) A list of Amphibia recorded from Ceylon with a report on the Amphibia in the Colombo Museum. *Spolia zeylan*, **27** : 243-250.
- Smith, M. A. (1924) Descriptions of Indian and Indo-Chinese tadpoles. *Rec. Indian Mus.*, **26** : 137-143.
- Smith, M. A. (1929) On a collection of Amphibians and Reptiles from the upper Reaches of the Brahmaputra. *Rec. Indian Mus.*, **31** : 77-80.
- Smith, M. A. (1940) The Amphibians and Reptiles obtained by Mr. Ronald Kaulback in Upper Burma. *Rec. Indian Mus.*, **42** : 465-486.
- Smith, M. S. (1951) On a collection of Amphibians and Reptiles from Nepal. *Ann. Mag. nat. Hist.*, ser. 12, **4** : 726-728.
- Smith, M. A. and Battersby, J. C. (1953) On a collection of Amphibians and Reptiles from Nepal. *Ann. Mag. nat. Hist.*, ser. 12, **6** : 702-704.
- Soman, P. W. (1960) A note on Amphibians of Kutch. *J. Bombay nat. Hist. Soc.*, **57** : 226-227.
- Stejneger, L. (1907) Herpetology of Japan and adjacent territory. *United states. Nat. Mus.*, Smithsonian Inst., **58** : 139-142.

- Stejneger, L. (1910) The amphibian generic name *Engystoma* untenable. *Proc. Biol. Soc. Washington*, **23** : 165-167.
- Stoliczka, F. (1870) Observations on some Indian and Malaysian amphibia and reptilia. *J. Asiat. Soc. Bengal* **39**(2) : 134-157.
- Stoliczka, F. (1872a) Observations on Indian Batrachia. *Proc. Asiat. Soc. Bengal*, : 101-113.
- Stoliczka, F. (1872b) Notes on some new species of Reptilia and Amphibia; collected by Dr. W. Waagen in North-Western Punjab. *Proc. Asiat. Soc. Bengal*, : 124-131.
- Swan, L. W. and Leviton, A. E. (1962) The herpetology of Nepal : a history, checklist, and zoogeographical analysis of the herpetofauna. *Proc. Calif. Acad. Sci.*, ser. 4, **32** : 103-147.
- Taylor, E. H. (1962) The amphibian fauna of Thailand. *Univ. Kansas Sci. Bull.*, **43** : 265-599.
- Taylor, E. H. (1964) A new species of caecilian from India. (Amphibia, Gymnophiona) *Senckenbergiana Biol.*, **45** : 227-231.
- Theobald, W. (1868) Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal. *J. Asiat. Soc. Bengal*, extra no. : iii-88.
- Theobald, W. (1873) Note regarding certain type specimens of Batrachia in the Asiatic Society Museum. *Proc. Asiat. Soc. Bengal*, 110-112.
- Thurston, E. (1888) *Batrachia. Salientia and Apoda of South India*. Madras : 1-54 : 13 pls.
- Tilak, R. and Husain, A. (1977) Extension of the range of distribution of a Microhylid frog *Uperdon systema* (Schneider). *J. Bombay nat. Hist. Soc.*, **73**(1) : 407.
- Tilak, R. and Mehta, H. S. (1983) On a collection of Amphibians of the Sirmour District (H. P.). *Re. Bull. (Sci.) Punjab Univ.*, **34**(3-4) : 157-166.
- Tilak, R. and Ray, P. (1985) Description of a new species of the subgenus *Rana* (*Paa*) Dubois from Chakrata Hills, District Dehradun Uttar Pradesh, India (Ranidae : Anura). *Zool. Anz. Jena* **215** (3 & 4) : 231-239.
- Van dijk, D. E. (1966) Systematic and field keys to the families, genera and described species of Southern African anuran tadpoles. *Ann. Natal Mus.*, **18**(2) : 231-286.
- Venkateswarlu, T. and Murthy, T. S. N. (1973) Fauna of Bihar State (India). 2. Amphibia. *Indian J. Zoot.*, **13**(2) : 129-130.
- Vogel, Z. (1965) *Reptiles and amphibians : Their care and behaviour*. The Viking Press, Inc. New York. : 228.
- Yazdani, G. M. and Chanda, S. K. (1971) A new toad *Ansonia meghalayana* (family Bufonidae) from Meghalaya (Assam), India with observations on its breeding on *Pandanus furcatus* Roxb. *J. Assam Sci. Soc.*, **14** : 76-80.
- Wadekar, U.L. (1963) The diet of the Indian Bull frog (*Rana tigrina* Daudin). *J. Bombay nat. Hist. Soc.*, **60**(1) : 263-268.
- Waltner, R. C. (1974) Geographical and altitudinal distribution of amphibians and reptiles in the Himalayas Part I. *Cheetal*, **16**(1) : 17-25.
- Wolf, S. (1936) Revisim der untergattung Rhacophorus. *Bull. Raffles Mus.*, No., No. **12** : 137-217, 8 figs.
- Zoological Institute of Sichuan (1977). Key to the Amphibia of China, Chengdu, Sichuan.