Chapter - 4

OBSERVATIONS

The amphibian fauna of Himachal Pradesh has been studied under two aspects;

(i) Systematics
(ii) Bionomics

(i) Systematics
The study is based on collections made during the past ten years by various parties of the Zoological Survey of India, Solan from 1969 - 1979 in which the author invariably took part. The osteological studies on all species could not be carried out due to the non-availability of enough material.
(ii) **Bionomics**

(a) **Food and feeding**

Food and feeding habits of four species of *Bufo*, viz. *Bufo melanostictus*, *Bufo himalayanus*, *Bufo stomaticus* and *Bufo viridis* are presented in this thesis.

(b) **Breeding**

The studies had to be restricted to four species, viz. *Bufo himalayanus*, *Bufo viridis*, *Amolops afghanus* and *Rana (Paa) minica* because of the paucity of the material.
Family : Bufonidae
Genus : Bufo Laurenti, 1768
Group : Bufo stomaticus, Inger, 1972

1. Bufo stomaticus Lutken, 1863
(Marbled toad)
(Figs. 11-14, 75-77, 123-124, 143 and 159-160)


Number of specimens examined : 20


Date of collection: 10.viii.72, 14.vii.75, 26.ii.76, 15.vii.76, 12.x.77, 8.viii.78, 17.viii.78, 27.viii.78, 29.viii.78

Description

A. General

Dirty white to greyish toad; a whitish tubercle at the angles of lower and upper jaws; bony ridges on head absent, head slightly wider than long; snout obtusely pointed, nostrils nearer the anterior part of snout; eyes large, prominent, interorbital width narrow; tympanum large and circular; first finger longer than second; hind limbs short, tarsal fold absent, toes two-third webbed; premaxillaries slightly overlapped by nasals; zygomatic process of squamosal hook-like, directed posterior in otic region; posterior border of frontoparietal almost touching foramen magnum; suprascapula nearly two times wider than scapula; clavicles held almost at an angle of 30° each.
B. Morphology (Figs. 11-14 and 75-77)

**Head:** Head 1.1 to 1.25 times broader than long, nearly one-third in body length, bony ridges absent; snout obtusely pointed, 0.4 to 0.45 in head length, nostrils nearer the anterior part of snout; eyes large, 0.45 to 0.5 in the length of head, interorbital width 0.6 to 0.7 in the height of upper eyelid; tympanum circular, 0.65 to 0.7 in ocular diameter; a long; whitish tubercle of variable length present at angles of lower and upper jaws; tongue pyriform; teeth absent.

**Parotoid glands:** A pair of bean-shaped glands just behind the eyes on either side, broad anteriorly and narrow posteriorly, 1.78 - 2.35 times longer than broad, dorsal surface with spiny tubercles.

**Fore limbs:** Each nearly 0.5 in the length of hind limb; first finger always longer than second, tips of fingers sometimes black, subarticular tubercles on fingers weakly developed, black nuptial excrescences on the two inner fingers of male; two metacarpal tubercles at the base of palm, inner smaller than outer, 0.25 in the latter; many tiny tubercles in the palm, which dominate subarticular tubercles of the fingers.

**Hind limbs:** Each limb 1.24 to 1.36 times of the total length; femur equals to tibia in length; tarsal fold absent; toes two-third webbed, tips of toes blunt and black.
subarticular tubercles of toes weakly developed and not distinguishable from tiny tubercles of the pes; two metatarsal tubercles, inner longer than outer, inner free distally.

**Colour**: Dirty white to greyish above, pale yellow to whitish below; when grey, dark grey regular patches interspersed with white patches thus former colour dominates, a vertebral dull white streak from snout to vent. Dorsal surface of skin with tiny tubercles, the latter with blunt spines; ventral surface rugose and rough.

C. **Osteology** (Figs. 123 — 124 and 143)

**Skull**: Premaxillaries slightly overlapped by nasals; quadratojugal moderately long; zygomatic process of squamosal hook-like, directed posteriad in otic region, squamosal process articulating with quadrate short; medial tips of palatines of two sides curved ventrally, approximating each other towards medial line; a long pterygoid ray articulates with parasphenoid; nasals short, 0.25 in head length, wider than long, blunt anteriorly, outer borders not elevated; rhomboidal sphenethmoid dorsally; width of frontoparietal 0.35 in width of head, sutural line of frontoparietals well marked, outer borders not elevated, posterior border almost approaching foramen magnum; anterior border of parasphenoid two-third deep in the orbit; exoccipital blunt and rounded posteriorly; prootics with slight depressions, anterior edges not elevated.
Pectoral girdle: Suprascapula nearly two times wider than scapula; scapula short slightly constricted in the middle, takes one-third part in the formation of glenoid cavity; clavicles rod-like, each held at an angle of about 30° and feebly curved upward at its articulation with scapula; anteromedial side of coracoid articulating with clavicle having much of cartilage in it; xiphisternum broad, plate-like.

D. Tadpoles (Figs. 159 - 160)

Dorsal surface of head and body dark grey or black with white dots, ventral surface dark grey.

Body: Snout rounded, 0.2 in the snout-vent length, nostrils midway between eye and anterior part of snout; spiracle in the posterior half with openings directed backwards; mouth narrower than length of snout; the upper jaw with two rows of labial teeth, the outer and upper uninterrupted while inner interrupted slightly in the middle, lower jaw with three uninterrupted rows of labial teeth, thus dental formula is $1 \frac{2}{3} : 1$; the jaws enclosing horny beak composed of two halves, upper completely covers the inner, inner surface of the two halves of the beak are serrated; inner lateral sides of lips with pointed papillae.

Tail: Tail pale greyish with fine black pigments, tail 1.4 - 1.5 times longer than body length, nearly 3 times longer than its width, dorsal and ventral profiles colourless.
with few scattered black pigments; rounded posteriorly; maximum width in the posterior half.

E. Distribution

Himachal Pradesh (up to 1500 m), Panjab, Haryana, Rajasthan and western India.

Elsewhere: Ceylon, western Pakistan and Nepal.
2. *Bufo andersonii* Boulenger, 1883
(Figs. 15-18, 78-80, 125-126 and 144)


1975. Bufo andersonii, Khera, Ph.D. thesis Panjab University, Chandigarh

**Number of specimens examined:** 20

**Locality**: Paonta Saheb, Kangra, Dehragopipur, Chamba, Nahan.

**Date of collection**: 16.vii.75, 4.iii.76, 8.iii.76, 16.viii.78, 22.iii.80.

**Description**

A. **General**

Dark brownish toad; head slightly broader than long; snout short and obtusely pointed; nostrils in the anterior part of snout; interorbital width more than height of upper eyelid; tympanum oval; paratoid glands 1.5 times longer than broad; tarsal fold distinct; inner and outer metatarsal tubercles small; premaxillaries not overlapped by nasals; zygomatic process of squamosal short; medial tips of palatines widely apart; posterior border of frontoparietal falls sufficiently short in reaching
foramen magnum; suprascapula shorter than scapula.

B. Morphology (Figs. 15-18 and 78-80)

**Head**: Head 1.35 to 1.4 times broader than long, slightly less than one-third of body length; bony ridges absent; snout obtusely pointed, 0.4 in the head length, nostrils almost at the tip of the snout; eyes large, 0.45 in the length of the head, interorbital width more than the height of upper eyelid; tympanum oval and beak-like dorsally.

**Paratoid glands**: Paired bean-shaped glands, situated dorsally on either side just behind the eyes with intervention of the tympanum, 1.5 times longer than broad, dorsal surface smooth.

**Fore limbs**: Each fore limb 0.45 in the length of hind limb; tips of fingers obtuse; first finger longer than second; subarticular tubercles of fingers weakly developed and interspersed between tiny tubercles of palm; two metacarpal tubercles at the base of the palm, inner metacarpal tubercle one-fifth in length than those of outer and nearly at the base of first finger, sometimes also cornified; breeding male with black nuptial excrescences on the two inner fingers; a lateral fold from the side of the jaws terminating at the hind limbs.

**Hind limbs**: Each hind limb 1.25 times longer than the body length; femur equals in length to tibia; tarsal
fold slightly distinct; inner and outer metatarsal tubercles small, prominent; tips of toes black and blunt; toes two-third webbed.

**Colour**: Dorsally brown to grey with few tubercles having black blunt spines, ventrally pale yellow to whitish, skin sometimes smooth with very few tubercles, ventral surface rough.

C. **Osteology** (Figs. 125 - 126 and 144)

**Skull**: Premaxillaries not overlapped by nasals; quadratojugal medium sized; zygomatic process of squamosal short not extending beyond border of pterygoid, squamosal process articulating with pterygoid short; medial tips of palatines straight and widely apart from each other; pterygoid ray articulating with parasphenoid long; nasals short, 0.2 in head length, obtusely pointed anteriorly; sphenethmoid triangular when seen dorsally; frontoparietal 0.32 in the width of head, sutural line of articulation of two frontoparietals of either side distinct, outer border of frontoparietal straight, posterior border of frontoparietal falls sufficiently short of foramen magnum; anterior border of parasphenoid two-third deep into the length of orbit; exocoipitals blunt and rounded posteriorly; prootics with shallow depression dorsally, anterior edge flat.

**Pectoral girdle**: Suprascapula shorter in width than scapula, 0.6 in the scapular width; scapula broad, slender
and rod-like, takes nearly one-third part in the formation of glenoid cavity; clavicles short and feeble, held at an angle of $30^\circ$; coracoid much wider distally, its anteromedial part articulates with clavicle; with only traces of cartilage in it; xiphistemum small, squarish structure and pointed posteriorly.

**Remarks**: It is the commonest toad intermingled with the populations of *Bufo stomaticus*; however, it can be differentiated from the latter by comparatively less tuberculations; interorbital width more than upper eyelid and a slightly developed tarsal fold.

**D. Distribution**

Himachal Pradesh (up to 1600 m), Rajasthan, Madhya Pradesh and Uttar Pradesh.

**Elsewhere**: Sind and Muscat in Arabia.
3. *Bufo viridis* Laurenti, 1768
(Figs. 19-22, 81-83, 127-128, 145 and 161-162)


**Number of specimens examined**: 20

**Locality**: Tapri, Shongtong, Kalpa, Chango.

**Date of collection**: 25.viii.76, 7.viii.78, 17.viii.78, 5.viii.79.
Description

A. General
Greenish toad; head slightly broader than long, nearly one-fourth in the body length, without bony ridges; snout blunt, nostrils nearer the snout than eye; eyes large, interorbital width narrower than height of upper eyelid; tympanum small; paratoid glands elliptical; fore limb half in length of hind limb; hind limb slightly longer than total length; quadratojugal moderately long; zygomatic process of squamosal extending into the orbital region; nasal: 0.25 in head length, inclined anteriorly; suprascapula wider than scapula; clavicles rod-like and almost held at an angle of 25°.

B. Morphology (Figs. 19-22 and 81-83)

Head: Head 1.1 to 1.2 times broader than long, 0.25 to 0.3 in total length, without bony ridges; snout blunt, 0.4 in head length, nostrils nearer the anterior part of snout than eye; eyes large, 0.45 to 0.5 in the head length, ocular diameter more than length of snout, interorbital space narrower than height of upper eyelid; tympanum small, distinct, 0.25 to 0.3 in the ocular diameter.

Paratoid glands: Paratoid glands are a pair of elliptical masses on either side just behind the eye, smooth, 1.5 times longer than broad.

Fore limbs: Each fore limb 0.5 in the length of hind limb; first finger longer than second and equals to ocular
diameter; tips of fingers obtuse, subarticular tubercles of fingers weakly developed and confluent with tiny tubercles of the palmar region; male with black nuptial excrescences on the two inner fingers and slightly extending to third finger; two metacarpal tubercles at the base of palm, inner 0.5 in the length of outer.

**Hind limbs:** Hind limb 1.25 to 1.35 times longer than the total length from snout to vent; femur equals tibia in length; tarsal fold absent; tips of toes blunt, toes nearly half webbed, subarticular tubercles of toes weekly developed, except the fourth toe, all other toes with single subarticular tubercle, the former with two subarticular tubercles; two metatarsal tubercles at the base of pes, inner stronger and twice in the length of outer; in addition, pes with silvery white tubercles of variable sizes and shapes.

**Colour:** Dorsally olive green with black and white regular patches, ventrally pale yellow to whitish, males with light grey colour and small tubercles, females brightly coloured. During breeding season, undersurface of the throat pink.

C. **Osteology** (Figs. 127-128 and 145)

**Head:** Premaxillaries not overlapped by nasals; quadratojugal moderately long; zygomatic process of squamosal extending deep into the orbital region, squamosal
process articulating with quadrate long; medial tips of palatines curved, approximating each other towards medial line; pterygoid ray articulating with parasphenoid short; vomer depressed; nasals 0.25 in head length, wider than long, inclined and rounded anteriorly, sphenethmoid pentagonal dorsally; frontoparietal comparatively narrow and 0.28 in the width of head, outer border flat, posterior border falls sufficiently short in reaching foramen magnum; anterior border of parasphenoid sinks two-fifth deep in the length of orbit, posterior border of exoccipital blunt and rounded; prootic with shallow depression dorsally, anterior edges straight.

Pectoral girdle: Suprascapula 1.5 times broader than long; scapula takes two-third part in the formation of glenoid cavity, clavicles rod-like and each held at an angle of 25°; coracoid articulating with clavicle with much of cartilage in it; metasternum short; xiphisternum broad anteriorly and pointed posteriorly, xiphisternum and metasternum of equal length.

D. Tadpoles (Figs. 161-162)

The detailed structure given in part dealing with bionomics.

E. Distribution

Himachal Pradesh (2000 - 3100 m), Kashmir.

Elsewhere: Europe, Rhine and Rome, N. Africa, Western and Central Asia, Mangolia and Tibet.
Group: *Bufo melanostictus*, Inger, 1972

4. *Bufo himalayanus* Gunther, 1864
   (Figs. 23, 26, 34-36, 129-130, 146 and 163-164)

   var. *himalayanus*


   Ser., 5, 20: 407-408.


   Ser., 12, 4: 726-728.

   Ser. 12, 6: 702-704.


Number of specimens examined: 20

Locality: Kulu, Chamba, Solan, Changi, Dalhousie, Rajgarh, Nohradhar, Tapri.


Description

A. General

Dirty white to greyish toad; bony ridges on head prominent but not cornified, head much wider than long, rounded anteriorly; snout obtusely pointed, nearly one-third in head length, smaller than eye; nostrils in the anterior part of snout; eyes large, interorbital width more than that of height of upper eyelid; tympanum very small; paratoid gland twice long than broad; premaxillaries not overlapped by nasals; frontoparietal 0.4 in width of head; clavicles held approximately at an angle of 30°.
B. **Morphology** (Figs. 23-26 and 84-36)

**Head**: Head 1.5 times broader than long, 0.25 to 0.3 in the body length, crown with elevated bony ridges, the latter not cornified; snout pointed, 0.3 to 0.35 in the head length, nostrils in the anterior half of the snout; eyes large, 0.4 in the head length, ocular diameter more than length of snout, interorbital width double the height of upper eyelid; tympanum very small and sometimes hidden below fold of paratoid gland; tongue long, pyriform.

**Paratoid glands**: A pair of kidney-shaped glands situated on either side behind the eyes; 2 to 2.6 times longer than broad; dorsal surface with spiny tubercles.

**Fore limbs**: Fore limb short, 0.4 to 0.45 in the length of hind limb; first finger slightly longer than second and shorter than third, tips of fingers obtuse and sometimes black, subarticular tubercles of fingers weakly developed; several tiny tubercles in the palmar region; two metacarpal tubercles at the base of the palm, inner almost at the base of first finger and smaller than outer, sometimes cornified; nuptial excrescences on the two inner fingers of male.

**Hind limbs**: Each hind limb short, 1.3 to 1.4 times longer than the body length; femur and tibia almost equal in length; tarsal fold absent, toes two-third webbed.
with blunt tips; two metatarsal tubercles of moderate size present; inner 1.5 to 2 times longer than outer, former free in the anterior half.

**Colour**: Colour varies from dirty white to greyish dorsally, ventrally pale yellow, dorsal surface with spiny tubercles and warts, ventral surface rough, female brightly coloured with fewer porous warts.

C. **Osteology** (Figs. 129-130 and 146)

**Skull**: Premaxillaries not overlapped by nasals; quadratojugal short; zygomatic process of squamosal slightly wide and extending into orbital region, squamosal process articulating with quadrato long; medial tips of palatines straight, approximate each other towards medial line; pterygoid ray articulating with parasphenoid long; nasal longer than broad, 0.3 in the head length, pointed anteriorly and depressed medially with outer borders elevated; sphenethmoid triangular dorsally; frontoparietal wide, 0.4 in the width of head, outer borders elevated, posterior border almost reaching foramen magnum; parasphenoid sinks half deep into the length of orbit; posterior border of exoccipitals produced into a spiny processes; prootic with deep and wide depression dorsally with its anterior border slightly elevated.

**Pectoral girdle**: Suprascapula slightly wider than scapula; scapula takes half part in the formation
of glenoid cavity; clavicles rod-like and held almost at an angle of 30° each; coracoid articulating with clavicles with much of cartilage in it; metasternum short; xiphisterum almost slender posteriorly.

D. Tadpoles (Figs. 163 - 164)
The detailed structure dealt in bionomics part.

E. Distribution
Himachal Pradesh (1500 - 3000 m), Sikkim, Himalayas.

Elsewhere: Nepal.
5. Bufo melanostictus Schneider, 1799
(Common Indian toad)
(Figs. 27-30, 87-89, 131-132, 147
and 165-166)


Brit. Mus. Lond.,: 1-530.


Lond., 1896 : 911.

2 : 289-292.

1923. Bufo melanostictus, Nieden Das Tierreich Anura,
Berlin : 116.


**Number of specimens examined**: 20

**Locality**: Paonta Saheb, Banethi, Solan, Chamba, Sundernagar, Nahan, Bilaspur, Shillie.

Description

A. General

Pale yellow to brownish toad; head broader than long with bony cornified black ridges; snout pointed, shorter than ocular diameter, nostrils at tip of snout; eyes large, interorbital width more than height of upper eyelid; tympanum large and circular; paratoid glands long, kidney-shaped; toes nearly two-third webbed; premaxillaries overlapped by nasals; zygomatic process of squamosal long; nasals long; anterior border of parasphenoid two-third deep in the length of orbit; suprascapula equals scapula in width; clavicles rod-like and held almost at an angle of 40° each.

B. Morphology (Figs. 27-30 and 87-89)

Head: Head 1.2 to 1.3 times broader than long, 0.25 to 0.3 in the total length, prominent cornified black bony ridges; snout pointed, short, 0.25 to 0.3 in head length; nostrils nearer the anterior part of snout than eyes; eyes large, 0.4 to 0.45 in the head length, ocular diameter more than length of snout, interorbital space wider than height of upper eyelid, a pair of black cornified tubercles at the articulation of head and vertebral column; the crown of head with spiny tubercles.

Paratoid glands: A pair of kidney-shaped glands, 2 to 3 times longer than broad, commencing from posterior.
border of eye to the middle of body.

**Fore limbs**: Each fore limb short, 0.4 in the length of hind limb; first finger longer than second, tips of fingers obtuse, cornified, black, subarticular tubercles on the fingers not prominent, several tiny tubercles in palm; two metacarpal tubercles at the base of the palm, inner smaller than the outer, cornified, black, male with black nuptial excrescences on the two inner fingers during breeding seasons.

**Hind limbs**: Each hind limb 1.4 to 1.5 times longer than that of total body length; femur equals tibia in length; tarsal fold absent; tips of toes blunt, black, toes two-third webbed; subarticular tubercles of toes weakly developed; two cornified metatarsal tubercles well developed, inner longer and stouter than outer.

**Colour**: Colour varies from pale yellow, greyish to black dorsally, ventral surface pale yellow to greyish; skin heavily tuberculated dorsally with spiny porous warts, ventral surface rough with small spiny tubercles.

C. **Osteology** (Figs. 131-132 and 147)

**Head**: Premaxillaries overlapped by nasals; quadratojugal short; zygomatic process of squamosal long, thin, extending into the orbital region; squamosal process articulating with quadrate very long and longest among all the species of Bufo, forms a raised platform of squamosal; medial tips of palatines straight, approximating
each other towards medial line; nasals longer than wide, 0.3 in the head length, pointed anteriorly, depressed medially and inclined anteriorly, outer border elevated; sphenethmoid triangular dorsally; frontoparietals fairly wide, 0.4 in the width of head, their outer borders elevated and posterior borders sufficiently falling short in reaching foramen magnum, thus not touching the latter; anterior border of parasphenoid extending two-third deep in the length of orbit; posterior border of exoccipitals produced into spines; prootics with deep depression dorsally, anterior edges elevated.

**Pectoral girdle:** Suprascapula equals scapula in width; scapula included about half in the glenoid cavity; clavicles rod-like and each held at an angle of about 40°; coracoid broad at distal ends with small constriction in the middle; metasternum short; xiphisternum slightly wide posteriorly.

**D. Tadpoles:** Dorsal surface appears to be black but when closely examined, it is dark brown dorsally and light brown ventrally.

**Body:** Snout blunt and rounded, 0.2 in snout-vent length; nostrils nearer the eye than snout; eyes small, 0.1 to 0.15 in the snout-vent length; spiracle on the left side and near the posterior half, spiracular tube directed
posteriors; width of mouth less than snout length, mouth slightly aterimal, jaws with two rows of upper lower and three rows of labial teeth, the outer row of upper labial teeth uninterrupted while lower about one-third interrupted in the middle, the jaws enclosing a horn beak composed of two halves i.e., upper and lower, their inner ends are serrated, upper half of beak completely covers lower; lower jaw with three uninterrupted rows of teeth, dental formula $1 \frac{1}{3}$; lateral sides of lips with pointed papillae.

Tail: Tail 3 to 3.5 times longer than broad, 1.5 to 1.6 times longer than snout-vent length, rounded distally, dorsal and ventral profiles start just from the vent, tail with slightly dark brown pigments, but the ventral profile with slightly less scattered pigments.

Distribution: Himachal Pradesh (up to 1550 m), Sikkim, Himalayas up to 1600 m, western India, Rajasthan.

Elsewhere: Ceylon, southern China, Malaya, Penninsula and Archipelago.
Family: Microhylidae
Genus: Uperodon, Dum. and Bibr.

6. Uperodon systoma (Schneider, 1799)
(Marbled toad)
(Figs. 31-34, 90-92 and 148)

1799. Rana systoma Schneider, Historiae Amphibiaraum
naturalis et literariae, Jenae: 144.


1829. Engystomum marmoratum Cuvier, Regne Animal ed. 2: 112

(part)
Neuchatel, 2: '86

1841. Uperodon marmoratus Duméril and Bibron, Erpet.
Gen., 8: 749.

22: 533

1858. Uperodon marmoratus, Günther, Cat. Batr. Sal.
Brit. Mus., 149.


1867. Systoma marmoratum Cope, J. Acad. Philadelphia,
(2) 6: 194.


**Number of specimens examined** : 20

**Locality** : Paonta Saheb.

**Date of collection** : 28.vii.75, 30.vii.80.

**Description**

A. **General**

Smooth, shiny, toad-like form; head slightly broader than long; snout, broadly pointed and shorter than ocular diameter; interorbital width twice the height of upper eyelid; a suprateemporal fold form eye to shoulder, bifurcating posteriorly; first finger smaller than second, subarticular tubercles of fingers well developed; subarticular tubercles of toes moderately developed; inner and outer metatarsal tubercles well developed and
blade-like, outer metatarsal tubercle smaller than inner; suprascapula shorter in width than scapula, scapula broad, long at the suprascapular articulation; clavicles, omosternum and episternum absent.

B. Morphology (Figs. 31-34 and 90-92)

Head: Head 1.1 to 1.2 times wider than long, 0.2 to 0.25 in the body length; snout rounded projecting beyond mouth, 0.4 in head length, nostrils nearer the anterior part of snout; eyes large, 0.5 to 0.55 in head length, interorbital width twice the height of upper eyelid; males with vocal sacs; a strong supratemporal fold from posterior part of eye to shoulder, bifurcating posteriorly, one part terminating towards lower jaw, other to shoulders; tympanum indistinct.

Fore limbs: Each fore limb 0.5 in the length of hind limb; first finger smaller than second and longer than fourth; tips of fingers obtuse; subarticular tubercles of fingers prominent; two metacarpal tubercles at the base of the palm, inner nearly double in length than outer with a prominent streak in the middle.

Hind limbs: Each hind limb 1.4 to 1.5 times longer than body length; femur slightly longer than tibia; tarsal fold well developed; subarticular tubercles of toes also well developed; toes slightly webbed; two metatarsal tubercles prominent, inner long and sword-like
and equals first toe in length, outer metatarsal tubercle also blade-like, 0.3 in the length of inner.

**Colour:** Black regular patches on pale yellow or dirty white background, ventral surface pale yellow to whitish; smooth dorsally; ventral surface slightly rough.

**Remarks:** When captured, secretes a sticky mucous which is milky white with pungent odour. Some juvenile were collected from stomachs of *Bufo stomaticus*.

C. **Osteology** (Fig. 148)

**Pectoral girdle:** Suprascapula 0.8 in the width of scapula; scapula broad and long at the articulation of coracoid, scapula takes 0.75 in the formation of glenoid cavity; precoracoid distinctively fused with coracoid and acts as articulating link between coracoid and scapula; clavicles, omosternum and episternum absent; coracoid wide at the articulations, two coracoids of adjacent sides held with little of cartilage, metasternum short; equals xiphisternum xiphisternum in length, wide and rounded posteriorly.

**Distribution:** Himachal Pradesh (300 m), Bengal, Orissa, Madhya Pradesh, Gujrat, maharashtra, Mysore.

**Elsewhere:** Ceylon.
Genus *Microhyla* Tschudi, 1839

7. *Microhyla ornata* (Dumeril and Bibron, 1891)

(The black-throated frog)

(Figs. 35-38, 93-95, 149 and 167-168)

1841. *Enyctatoma ornatum* Dumeril and Bibron, Erpet. Genl.,


	Beng., 22: 534.

	Mus.,: 50.

	London, : 165.

	Ser., 5, 3: 39.

1890. *Microhyla ornata*, Boulenger, Fauna Brit. India, Rept.and B
	London : 491.

	Michigan, 76: 3.

1926. *Microhyla fissipes*, Nieden, Das Tierreich Anura, 2:35

	2, 10 : 437.


Number of specimens examined: 20

Locality: Paonta Saheb, Solan, Nalagarh, Nurpur, Nahan, Ronhat.


Description

A. General

Small-sized frogs; pink with specific black streak dorsally; head slightly broader than long; snout rounded and projecting beyond mouth; nostrils almost at the tip of the snout; eyes large, ocular diameter more than length of snout; tympanum indistinct; first finger smallest; subarticular tubercles of fingers prominent; two metacarpal tubercles well developed; inner metatarsal tubercle prominent; precoracoid not distinct; coracoid thin in the middle and broad distally; metasternum short; xiphisternum knob-like.

B. Morphology (Figs. 35-38 and 93-95)

Head: Head 1.1 to 1.2 times broader than long, 0.2-0.25 in the length of body; snout rounded and projecting beyond jaws, shorter than ocular diameter; 0.3 in head length; eyes large, nearly 0.5 in the head length, interorbital width twice the height of upper eye lid; tympanum indistinct.
Fore limbs: Each fore limb short, 0.4 in the length of hind limb; first finger smallest; tips of fingers blunt; subarticular tubercles prominent; two metacarpal tubercles at the base of palm prominent and of equal length.

Hind limb: Each hind limb 1.5 to 1.6 times longer than body length; tibia slightly longer than femur; tarsal fold well developed; tips of toes blunt, web rudimentary; subarticular tubercles of toes prominent; inner metatarsal tubercle prominent and blade-like while outer only a swollen mass.

Colour: Pink with black streak, narrow anteriorly and wide posteriorly on the dorsal surface; ventral surface whitish to yellowish; hind limbs with black cross bars; male with black throat during breeding season; skin smooth dorsally; ventral surface rough.

Remarks: It is a small, toad-like form differentiated by short head and oval tongue. The frog remains hidden in bushes and comes out at night for feeding, this microhylid makes long jumps as if flying.

C. Osteology (Fig. 149)

Pectoral girdle: Suprascapula broader than scapula, the latter longer at its articulating ends; scapula included more than half in the formation of glenoid cavity; precoracoid indistinct; clavicles omosternum and episternum
absent; coracoid thin in the middle and broad distally, coracoid held at an angle of $40^\circ$, the two coracoids of adjacent sides held together with a small cartilage in the middle; metasternum short; xiphisternum broad.

D. **Tadpole** (Figs. 167-168)

Tadpoles transparent with specific black streak.

**Body**: Body of tadpole as long as tail; eyes small on lateral sides; colour black; snout nearly 0.2 in the body length, nostrils at tip of snout; mouth terminal without labial teeth; maximum width in the optic region, tapering posteriorly; posterior part of the body laterally compressed, spiracle median and on the ventral surface.

**Tail**: Tail as long as broad, dorsal profile less wide than ventral profile, maximum width of tail in the anterior half, tail pointed at its distal tip.

E. **Distribution**: Himachal Pradesh (up to 1550 m), western India, Assam, Punjab.

**Elsewhere**: Pakistan, Ceylon, South East Asia, South China, Formosa, Malaya, Peninsula.
Family: Rhacophoridae

Genus: Polypedates Tschudi, 1839

8. Polypedates maculatus (Gray, 1834)
(The Chunam frog)
(Figs. 39-42, 96-98 and 150)


**Number of specimens examined**: one

**Locality**: Chail.

**Date of collection**: 25.vii.76

**Description**

A. **General**

Dark brown; body broad anteriorly and tapering posteriorly, snout long, pointed, nostrils almost at tip of snout, snout as long as ocular diameter; a strong
supratemporal fold from eye to shoulder; tympanum two-third in ocular diameter; first finger smaller than second, tips of fingers with discs broader than long; fingers with rudimentary web, toes tips with discs smaller than those of fingers.

B. **Morphology** (Figs. 38-42)

**Head:** Head as long as broad, one-third in total length; snout long and pointed, nostrils at tip of snout; eyes 0.4 in head length, ocular diameter less than length of snout, interorbital width 0.25 times more than height of upper eyelid; tympanum circular and two-third in the ocular diameter; a strong supratemporal fold from the eye to shoulder and continues into the lateral fold of the body.

**Fore limbs:** Each fore limb 0.4 in the length of hind limb; first finger smaller than second, tips of fingers with discs broader than long and more than half in the ocular diameter; subarticular tubercles of fingers moderately developed, first two fingers with one subarticular tubercle each, while third and fourth fingers with two subarticular tubercles each; fingers with rudimentary web; two metacarpal tubercles at the base of palm, one at the base of first finger sharing in the formation of pad of first finger.

**Body:** Broad anteriorly and narrows down posteriorly in pelvic region, a lateral fold continues posteriorly up to hind limbs.
Hind limbs: Each hind limb 1.6 times longer than body length; tibia longer than femur; tarsal fold distinct; toe tips with discs smaller than those of fingers; first and second toe with one subarticular tubercle, while third and fifth with two subarticular tubercles each, fourth toe with three subarticular tubercles, subarticular tubercles of toes weakly developed as compared to those of fingers; toes two-third webbed; inner metatarsal tubercle small and outer metatarsal tubercle absent.

Colour: Dark brown above with pink and yellow ventrally; hind limbs with dark cross bars on the dorsal surface. Head with tiny tubercles, dorsal surface smooth, ventral surface rough and rugose.

Osteology (Fig. 150)

Pectoral girdle: Suprascapula 0.6 in the scapular width; scapula wide bar-like, long at the articulations of clavicles and suprascapula, about half takes part in the formation of glenoid cavity; omosternum longer than clavicle's length, entire, with knobbed episternum; clavicles thin, straight, rod-like and dilated at the scapular articulation; coracoid straight, coracoids of two adjacent sides held with a little of cartilage, firminsternia type; metasternum equals length of omosternum; xiphisternum slightly rounded posteriorly.

Family: Ranidae
Genus: *Rana* Linnaeus, 1758

Group: *Dicroalossus* Günther, 1860

(i) *Rana* (*Dicroalossus*) *hexadactyla*, Boulemer, 1913.

9. *Rana* (*Dicroalossus*) *cyanophlyctis*

*cyanophlyctis* Schneider, 1799


Number of specimens examined: 20

Locality: Bilaspur, Paonta Saheb, Shahpur, Solan, Sarhan.

Date of collection: 19.viii.72, 17.vii.75, 28.iv.76, 8.vii.76, 20.v.77.

Description

General
Dark brown to olive greenish frog; head as long as wide, arrow-shaped; snout obtusely pointed, nostrils equidistant from eyes and the anterior part of the snout; eyes large, interorbital width smaller than height of upper eye lid; tympanum circular, two-third in ocular diameter; first finger nearly equals or smaller in length, fingers pointed at tips, subarticular tubercles of fingers weakly developed; hind limbs long; tips of toes blunt, toes completely webbed, inner metatarsal tubercle digitiform.

Morphology (Figs. 43-46, 99-101)

Head: Head as long as broad, arrow-shaped, nearly one-third in total length of animal; snout obtusely pointed and 0.4 in the head length, nostrils equidistant from eye and anterior part of snout; eyes large, bulging, each equals to length of snout, interorbital width 0.6 in the height of upper eyelid; tympanum 0.6 in the diameter of eye, circular, bordered dorsally by supratemporal fold; a row of small tubercles from ventral surface of tympanum, bifurcating,
immediately, one part terminating towards lower jaw while second terminates laterally.

**Fore limbs**: Each fore limb short, 0.35 to 0.4 in the length of hind limbs; fingers slender and pointed at tips, first finger nearly equals to second or slightly smaller; subarticular tubercles of fingers weakly developed, first and second finger with one subarticular tubercle each, while third and fourth fingers with two subarticular tubercles each; demarcation of fingers extending deep into the palmar region; metacarpal tubercles of palm not prominent.

**Hind limbs**: Each hind limb long, 1.7 times longer than the body length; tarsal fold slightly demarcated; femur equals tibia in length; toe tips swollen and rounded, toes completely webbed; subarticular tubercles of toes weakly developed, first, second and third toes with one subarticular tubercle each while the fourth and fifth with two subarticular tubercles each and fifth has a fold of skin; outer metatarsal tubercle absent, inner one developed though small and digitiform and held with a web in aquatic forms.

**Colour**: Colour of the skin varies from grey, black, brown with some black patches dorsally, ventral surface whitish with black spots. Skin smooth or slightly tuberculated above, ventral surface smooth.

**Remarks**: This frog is commonly found up to 1500 m
in almost all biotopes and is available throughout the year. Commonly found along banks of ponds and ditches enjoying sunbath, when approached, immediately skips into the water, inner metatarsal tubercle slightly strong and not webbed in terrestrial forms.

Osteology (Figs. 133-134 and 151)

Head: Pre-maxillaries not overlapped by nasals; quadratojugal short; zygomatic process of squamosal moderately developed and extending into orbit, squamosal process articulating with quadrate feebly long, held at an angle of 30°; medial tips of palatines of two sides slightly curved downwards and slightly apart from each other; vomerine teeth in oblique rows; pterygoid ray articulating with parasphenoid short while other articulating with quadrate long; nasal broader than long, anteriorly produced into spine, two spines of nasals fit into the ascending process of premaxillaries; nasals short, 0.15 in length of head; sphenethmoid rhomboidal when seen dorsally; width of frontoparietal 0.25 in width of head, posterior border almost approaching the anterior extremity of foramen magnum, sutural line of articulation not distinct; anterior border of parasphenoid sinks half deep in the orbit; two horizontal limbs of parasphenoid produced into blunt spiny processes posteriorly; exoccipital with well developed occipital condyles; prootic wide and 0.4 in width of head, posteriorly produced into spine, slight depression dorsally.
Pectoral girdle: Suprascapula 1.5 times wider than width of scapula; scapula slightly projected at the articulation of clavicles, takes one-third part in the formation of glenoid cavity; clavicles slightly long, thin, splint-like, horizontal, dilated at the articulation of coracoids and scapula; precoracoid thin, nearly half the length of clavicles, omosternum forked at the base; episternum slightly knobbed; coracoids wider at articulation ends and constricted in the middle, anterior medial border of coracoid touching inner border of clavicle; metasternum equals episternum in length; xiphisternum squarish with pointed ends posteriorly.

Tadpoles (Figs. 169 and 170)

Dorsal surface whitish with scattered black patches and spots, ventral surface yellowish with black spots near belly.

Body: Snout obtusely pointed, 0.25 in the snout-vent length, nostrils nearer the eye than anterior part of the snout; eyes bulging, circular, dorsally situated, ocular diameter nearly half the length of snout, interorbital width equals distance from eye to nostrils, spiracle on the left side, opening of spiracle laterally directed, equidistant from tip of snout to vent or slightly near the latter; width of mouth nearly half the length of snout, inner lateral side of lip with pointed papillae, upper jaw with
one uninterrupted row of labial teeth and lower jaw with two uninterrupted rows of teeth, enclosed between the jaws, a wide horny beak with inner surfaces serrated.

**Tail** : Tail 1.5 to 1.75 times longer than snout-vent length, 2 to 3 times longer than broad, abruptly pointed at tip, maximum width of tail in the anterior half, dorsal and ventral profiles of tail with thin and transparent skin.

**Distribution** : Himachal Pradesh (up to 1550 m), commonly found in other parts of country.

**Elsewhere** : South Arabia, Baluchistan, Afghanistan, Ceylon.
(ii) Rana (Dicroglossus) tigerina and

limnocharis, Boulenger, 1918

Sub group Rana (Dicroglossus) limnocharis, Annandale, 1917

10. Rana (Dicroglossus) limnocharis syhadrensis, Annandale, 1919

(Figs. 51-54, 105-107, 137-138, 153)


Number of specimens examined : 20

Locality : Hamirpur, Paonta Saheb, Shahpur, Kangra, Dehragopipur, Manali.

Date of collection : 25.iv.75, 18.vii.75, 26.ii.76, 9.iii.76, 12.iii.76, 26.xi.30.
Description

A. General
Light grey to brownish, small-sized frog; head as long as wide or slightly longer, arrow-shaped; snout obtusely pointed and projecting beyond lower jaw, nostrils nearer the snout; eyes large, equal to length of snout, interorbital width equals to height of upper eyelid; tympanum distinct, nearly half in the ocular diameter; a strong supratemporal fold from eye to shoulder; first finger longer than second, subarticular tubercles of fingers prominent; three metacarpal tubercles at the base of palm; hind limbs short; tibia slightly longer than femur; toes half webbed.

B. Morphology (Figs. 51-54 and 105-107)

Head: Head slightly longer than broad, arrow-shaped, less than one-third in the total length; snout slightly projecting beyond mouth, long, 0.45-0.5 in the head length, rounded or obtusely pointed, nostrils nearer the anterior end of snout than eyes; eyes large, nearly equal to length of snout, interorbital width nearly equals to height of upper eyelid; tympanum distinct, 0.5 in the ocular diameter; a strong supratemporal fold bordering the tympanum and starting from posterior part of eye and terminating at shoulder.
Fore limbs: Each fore limb short, 0.4 in the length of hind limb; first finger longer than second but smaller than third, tips of fingers pointed; subarticular tubercles of fingers prominent, first two fingers with one subarticular tubercle each, third and fourth fingers with two subarticular tubercles; three metacarpal tubercles at the base of palm, outer and inner metacarpal tubercles elongated.

Hind limbs: Each limb 1.25 times longer than body length; tibia longer than femur; tarsal fold present; tips of toes pointed, toes half webbed, subarticular tubercles of toes well developed, elongated, first and second toe with one subarticular tubercle each, while third, fourth and fifth toes with two subarticular tubercles each, sometimes fourth toe with three subarticular tubercles; inner metatarsal tubercle small, spade-like and webbed and not separated throughout its length, outer metatarsal tubercle small and rounded.

Colour: Dorsal surface light grey, light pink or brown, sometimes white or yellow with vertebral streak; ventrally white or yellowish, gular region black in the males during breeding season; skin smooth dorsally as well as ventrally.

Remarks: Small-sized frog, usually seen in the fields, along the banks of rivers in stones, immediately
slips down into water when disturbed.

6. **Osteology** (Figs. 137-138 and 153)

**Head**: Premaxillaries not overlapped by nasals; quadratojugal long; zygomatic process of squamosal moderately long, lying over pterygoid, squamosal process articulating with quadrate at an angle of about 30°; medial tips of palatines slightly curved and widely apart from each other; vomer of adjacent sides widely apart and with teeth; pterygoid ray articulating with quadrate long, the other one articulating with parasphenoid short; nasals broader than long, anteriorly produced into two blunt, horn-like processes, nasals short, less than 0.1 in the length of head; prefrontal sunk deep into its nasal; sphenethmoid small, squarish, visible dorsally; frontoparietal narrow anteriorly and broad posteriorly, 0.3 wide in width of skull, posterior border almost approaches the anterior extremity of foramen magnum; anterior border of parasphenoid two-third deep in the orbit; exoccipitals of two sides produced into spiny processes posteriorly, occipital condyles small; prootic nearly one-third in width of skull, with slight depression dorsally.

**Pectoral girdle**: Suprascapula 1.5 times wider than scapular width; scapula wider than long, projected anteriorly at the articulation of clavicle and takes one-third part in the formation of glenoid cavity;
clavicles long, horizontal bars, medially held with a piece of cartilage; omosternal style forked at the base, omosternum equals in length with metasternum; episternum squarish with anterior and posterior ends pointed; coracoid wide at articulating ends and constricted in the middle, anterior medial border of coracoid touching clavicle, two coracoids held with small amount of cartilage; metasternum broad anteriorly and slightly narrow posteriorly; xiphisternum wide and rounded posteriorly.

D. **Distribution**: Himachal Pradesh (200 - 2000 m), Western India, Rajasthan, Sikkim.

Elsewhere: East Asia, Japan, China, Ceylon, Malaya, Peninsula and Archipelago, Philippines, Borneo.
Sub group *Rana* (Dicroglossus) *tigerina*, Annandale, 1917

11. *Rana* (Dicroglossus) *tigerina* *tigerina* Daudin, 1802
   (Figs. 47-50, 102-104, 135-136 and 152)


Number of specimens examined : 12

Locality : Paonta Saheb, Dehraogipur, Nahan, Parwanoo.

Date of collection : 17.vii.75, 8.iii.76, 28.iv.79, 16.iii.31.

Description

A. General

Green or brown with yellow or black spots, a yellow vertebral streak from snout to vent; head as long as
broad, arrow-shaped, one-third in total length; snout long, projecting beyond mouth, nostrils nearer the anterior part of snout than eyes; ocular diameter less than length of snout, interorbital width narrower than height of upper eyelid; fingers obtuse, subarticular tubercles prominent; tarsal fold distinct, inner metatarsal tubercles well developed; zygomatic process of squamosal long and extends in the otic region, squamosal process articulating with quadrate at an angle of 30°; vomers widely apart; omosternum forked at the base.

Morphology (Figs. 47-50 and 102-104)

Head: Head as long as broad, one-third in total length, arrow-shaped; snout long, 0.45 in the head length, snout projecting beyond jaws, nostrils equidistant from anterior part of snout and eye; eyes bulging, pupil circular, ocular diameter 0.35 in the head length, interorbital width two-third in the height of upper eyelid; tympanum circular, 0.75 in the ocular diameter; a strong supra-temporal fold from eye to shoulder.

Fore limbs: Each fore limb short, 0.35 in the length of hind limb; first finger longer than second and almost equals to third; finger tips obtuse or slightly swollen; subarticular tubercles of fingers prominent, first and second fingers with one subarticular tubercle each while third and fourth fingers with two subarticular
tubercles each; dermal folds of skin start from posterior border of subarticular tubercles and continue into palmar region; two metacarpal tubercles at the base of the palm but not clearly demarcated, inner metacarpal tubercle forms the pad of first finger.

**Hind limbs**: Each hind limb long, 1.35 times longer than total length; femur and tibia almost equal in length; tarsal fold distinctly present; tips of toes blunt, subarticular tubercles of toes well developed, first and second toe with one subarticular tubercle each, third and fifth toe with two subarticular tubercles each, fourth toe with three subarticular tubercles; toes completely webbed but do not extend to tips; a well developed shovel-shaped inner metatarsal tubercle present, no outer metatarsal tubercle.

**Colour**: Green, light brown with yellow or black regular patches; a distinct white or yellow vertebral streak; ventral surface whitish and lower surface of throat black; skin rough and porous dorsally, smooth ventrally.

C. **Osteology** (Figs. 135-136 and 152)

**Head**: Premaxillaries not overlapped by nasals; ascending process of premaxillaries slanting; quadratojugal long; zygomatic process of squamosal long and extends in the otic region, squamosal process articulating with quadrate at an angle of 30°, with a moderately long bar;
medial tips of palatines slightly curved and close to each other; vomers widely apart with vomerine teeth; pterygoid ray articulating with quadrate long and the other one articulating with parasphenoid short; nasal longer than broad, sutural line of two nasals grooved, anterior processes of nasals blunt and articulating with ascending processes of premaxillaries, with small amount of cartilage, nasal 0.25 in length of head; sphenethmoid small, triangular, visible dorsally; frontoparietal narrow anteriorly and wider posteriorly and articulating with a plate of parasphenoid, half deep into the orbit; exoccipital of two sides forms a raised plate; prootic with slight depression near its articulation with frontoparietal.

Pectoral girdle: Suprascapula equals in width to scapula; scapula short at articulation of clavicles and long at articulation with suprascapular articulation, half of scapula included in the formation of glenoid cavity; clavicles horizontal, held together with small piece of cartilage; omosternum forked at the base, omosternum smaller than length of clavicle; episternum small and rounded; coracoid broad distally and constricted in the middle, coracoids of adjacent sides held with a small amount of cartilage; metasternum shorter than omosternum; xiphisternum broad and rounded posteriorly.

E. Distribution: Himachal Pradesh (up to 600 m) Assam, base of the Himalayas. Elsewhere: Ceylon, Burmá and Southern Yunnan.
Group: **Tomopterna**, Dumeril and Bibron, 1841

12. **Rana (Tomopterna) breviceps**, Schneider, 1799

(Common burrowing-frogs)

(Figs. 55-58, 108-110, 139-140 and 152)

1799. **Rana breviceps** Schneider, *Historiae Amphibiarum naturalis et literaria*, Jenae: 1: 140.


Number of specimens examined: 16

Locality: Dehragopipur, Banethi, Solan, Nurpur, Paonta Saheb.

Date of collection: 9.iii.76, 16.vii.76, 22.vii.76, 10.viii.78, 30.viii.30.

Description

A. General

A toad-like form; dark brown to white in colour; head slightly broader than long; snout rounded, nostrils equidistant from eyes and anterior part of snout; ocular diameter equals to length of snout, interorbital width narrower than height of upper eyelid; tympanum circular, more than half the diameter of the eye; a strong supratemporal fold from eye to shoulder; first finger longer than second and equals third, subarticular tubercles of fingers prominent; inner metatarsal tubercle blade-like.

Morphology (Figs. 55-58 and 108-110)

Head: Head 1.1 to 1.25 times broader than long, nearly one-third in total length; snout rounded and 0.45 in the head length, nostrils equidistant from eyes and anterior part of snout; eyes prominent, ocular diameter equals to length of snout, pupil circular, interorbital width narrower than height of upper eyelid and internasal distance; tympanum distinct, circular, more than half the
diameter of the eye; a strong supratemporal fold from eye to shoulder, bifurcating posteriorly, tongue bifid, teeth present on the upper jaw as well as on vomer, vomerine teeth in strong oblique serifs between the choanae.

**Fore limbs**: Each fore limb short, 0.4 in the length of hind limb, first finger considerably longer than second and equals to third; subarticular tubercles of fingers prominent and oval, each finger with single subarticular tubercle; two metacarpal tubercles at the base of the palm, identical in shape and size.

**Hind limbs**: Each hind limb 1.4 times longer than total body length; femur slightly longer than tibia; tarsal fold indistinct; tips of toes blunt, subarticular tubercles of toes slightly less developed than those of fingers, all the toes with single subarticular tubercle except fourth which has two subarticular tubercles; toes slightly more than half webbed; inner metatarsal tubercle well developed, strongly compressed, blade-like, inserted obliquely at the base of first toe and longer than the latter, outer metatarsal tubercle absent.

**Colour**: Uniform pink to brown dorsally, with a yellow vertebral streak from snout to vent, pale yellow to whitish ventrally, gular region often black in breeding season in male, skin porous and rough dorsally and smooth ventrally.
Remarks: They are nocturnal in habit, seen in breeding season which corresponds to rainy season of this area from middle of June to middle of August. They do not live in water but prefer humid areas with stony ground. The blade-like inner metatarsal tubercle helps in digging and burrowing.

C. Osteology (Figs. 139-140 and 154)

Head: Premaxillaries slightly overlapped by nasals; quadratojugal short; zygomatic process of squamosal short, squamosal process articulating with quadrate moderately developed and held almost at an angle of 60°; medial tips of palatines of either side meet each other; pterygoid ray articulating with parasphenoid short; nasals long, 0.3 in the head length, longer than broad, slightly depressed in the middle, raised on the platform so formed by the ascending process of the premaxillaries; sphenethmoid not visible dorsally, frontoparietal narrow anteriorly and wider posteriorly, posteriorly 0.25 in the width of skull, sutural line of demarcation not well marked, posterior border falls much short of foramen magnum; anterior border of parasphenoid sinks one-third deep in the orbit; a spinous process of parasphenoid on either side; prootics produced into spines posteriorly, a slight depression in the prootic of each side.

Pectoral girdle: Suprascapula 1.5 times broader than scapula, the latter rod-like, pointed anteriorly at
its articulation with clavicle, only a small portion takes part in the formation of glenoid cavity; clavicles short, rod-like and almost lie horizontally to main axis; omosternum long, equals length of clavicle; episternum broad anteriorly; anteromedial sides of coracoid long and almost touching clavicle of respective side, coracoid broad distally and constricted in the middle, coracoid of adjacent sides held at an angle of 40°; metasternum slightly shorter than omosternum; xiphisternum broad and rounded posteriorly.

**Distribution**: Himachal Pradesh (up to 1550 m), Southern India, Rajasthan, Western Ghats.

**Elsewhere**: Ceylon, Upper Burma, Nepal.
Genus: Amolons Cope, 1865

13. Amolons afghanus, Gunther, 1858

(Figs. 59-62, 111-113, 155, 171 and 172)


1865 Amolons afghanus Cope, Nat. Hist. Rev.,
1865 : 97-120.


1890. Rana latopalmata, Boulenger, Fauna Brit India,

1912. Rana afghana, Annandale, Rec. Indian Mus.,

1912. Ixalus argus Annandale, Rec. Indian Mus.,

1920. Rana (Hylorana) latopalmata, Boulenger, Rec. Indian

Hist., 59 : 147-347.

1929. Rana afghana, Smith, Rec. Indian Mus.,
41 : 77-80.

1940. Rana afghana, Smith, Rec. Indian Mus.,
42 : 465-486.


**Number of specimens examined**: 20

**Locality**: Palampur, Sadhupul Chail, Renuka, Nohradhar, Ronhat.


**Description**

**A. General**

Head as long as broad; snout rounded and projecting beyond jaws, nostrils nearer the eye than snout; tympanum
very small, a granular area behind tympanum; fingers with discs, discs broader than long; first finger smaller than second; toes with discs smaller than those of fingers; inner metatarsal tubercle weakly developed; scapula broader than suprascapula; omosternum half the length of clavicle, clavicles long, rod-like.

B. **Morphology** (Figs. 59-62 and 111-113)

**Head**: Head as long as broad, 0.4 in the total length; snout rounded and projecting beyond jaws, 0.45 in the head length, nostrils equidistant from eye and anterior part of snout or sometimes slightly nearer the latter; eyes large and ocular diameter equals length of snout, interorbital width more than height of upper eyelid and less than internasal distance; tympanum very small and sometimes indistinct; a well marked supratemporal fold from eye to shoulder; a glandular area just behind tympanum.

**Fore limbs**: Each fore limb 0.5 in the length of hind limb; fingers moderately long with discs at tips, discs broader than long, nearly half in the ocular diameter; subarticular tubercles of fingers moderately developed; first, second and fourth fingers with one subarticular tubercle each, third with two subarticular tubercles; first finger smaller than second, third finger longer than snout; base of first finger with pad in male; two metacarpal tubercles at the base of palm, inner metacarpal
tubercle confluent with pad of first finger, outer metacarpal tubercle small and looks like a swollen mass.

**Hind limbs**: Each hind limb long, more than twice the length of body; femur equals in length to tibia; tarsal fold well developed; tips of toes with small discs smaller than those of fingers, grooved; toes completely webbed with a notch; subarticular tubercles of toes weakly developed, first and second toe with single subarticular tubercle each, third, fourth and fifth with two subarticular tubercles each; inner metatarsal tubercle small and at the base of fifth toe, outer metatarsal tubercle absent.

**Colour**: Dorsal surface grey, limbs with light brown colour, with dark cross bars or bands, ventral surface pale yellow to whitish, skin smooth above and below.

**Remarks**: These frogs show a great resemblance to tree frogs, the adults can only be collected during breeding seasons, near the banks of streams, but the tadpoles can be collected from the beds of torrential streams.

**Osteology (Fig. 155)**

**Pectoral girdle**: Suprascapula narrower at the articulation of scapula and broad at the articulation of vertebral column; scapula broader than suprascapula, plate-like and slightly curved in the middle, about half
of it takes part in the formation of glenoid cavity; clavicles long, rod-like, pointed medially, twice in length of scapula; omosternum small, not forked at the base; episternum small and rounded; coracoids long and distal ends broad, two coracoids of adjacent sides held with much of cartilage in it, anterior border of coracoid not touching clavicle of respective side; metasternum longer than omosternum; xiphisternum slightly rounded posteriorly and broader than episternum.

D. Tadpoles: (Figs. 171-172)
Detailed structure discussed in binomics.

Distribution: Himachal Pradesh (600 to 2500 m)
eastern Himalayas, Assam and Sikkim.

Elsewhere: Nepal.
Group: *Rana liebigii*, Annandale, 1917
Subgroup: *Paa*, Dubois, 1975

14. *Rana (Paa) minica*, Dubois, 1975
(Figs. 53–66, 114, 116, 141, 142, 156 and 173–174)


Number of specimens examined: 10

Locality: Solan, Renuka, Nohradhar, Theog.

Date of collection: 15.vii.76, 30.v.78, 20.iv.31, 23.viii.81.

Description

General

Toad-like form, light brown to dark brown; head broader than long, nearly one-third in total length; snout pointed, long, projecting, less than ocular diameter, nostrils nearer the eye than anterior part of snout; interorbital width wider than height of upper eyelid; tympanum indistinct; a supratemporal fold present; fore limbs short, first finger equals to second, subarticular tubercles of fingers well developed, tips of fingers with discs, metacarpal tubercles of palm weakly developed; hind limbs long, tarsal fold
well developed, inner metatarsal tubercle small and at the base of first toe.

**Morphology (Figs. 63-64, 114-116)**

**Head**: Head slightly broader than long or nearly equal, 0.3 in the total length; snout long, 0.5 in the head length, projecting anteriorly, nostrils nearer the eye than snout; eyes bulging, ocular diameter less than length of snout, interorbital width 1.25 times as long as height of upper eyelid; tympanum indistinct; a prominent supratemporal fold across the eyes to shoulder on each side.

**Fore limbs**: Each fore limb small, 0.3 in the length of hind limbs; first finger larger than second and length of snout, tips of fingers with small discs without grooves, subarticular tubercles of fingers well developed, first, second and fourth finger with one subarticular tubercle each, while third with two subarticular tubercles; metacarpal tubercles of palm weakly developed. First finger with cornified, black serrations in males in breeding season.

**Hind limbs**: Each hind limb long, 1.7 times longer than total length; tibia equals femur in length, tarsal fold present; tips of toes with smaller discs than those of fingers, subarticular tubercles of toes slightly prominent, first, second, third and fifth with one subarticular tubercle each while fourth toe with two
subarticular tubercles, toes two-third webbed, inner metatarsal tubercle small at the base of first toe and not separated throughout its length.

**Colour**: Dorsal surface dark brown or light brown with dark patches, while ventral surface white, throat pink in breeding males; skin smooth with small tubercles, ventral surface smooth.

**Remarks**: Commonest species of hills next to *Rana (Dicroglossus) c. cynaphlyctis*, but remains hidden under stones in water bodies.

**Osteology** (Figs. 141-142 and 156)

**Head**: Premaxillaries not overlapped by nasals, ascending processes of premaxillaries short, thin and inclined, premaxillaries of either side pointed at the line of articulation; quadratojugal short; zygomatic process of squamosal short and held over anterior pterygoidal ray, squamosal process articulating with quadrate short, held at an angle of about 45°; medial tips of palatines slightly apart; vomers of two sides widely apart, vomerine teeth in two oblique series; nasals 0.2 in head length, anteriorly produced into two horn-like projections where ascending processes of premaxillaries articulate; sphenethmoid squarish structure when seen dorsally; frontoparietals narrow anteriorly and slightly
broader posteriorly, 0.2 in the width of cranium, posterior border almost approaches the foramen magnum; anterior border of parasphenoid more than half deep in the orbit; occipital condyle small; prootic wide at the articulation of frontoparietal to match the broader part of the frontoparietal and slightly pointed laterally, prootic with slight depression dorsally, posteriorly produced into spine-like processes; pterygoid ray articulating with horizontal limb of parasphenoid very short.

**Pectoral girdle:** Suprascapula twice in width of scapula; scapula short and nearly 0.5 in the width of scapula, takes part in the formation of glenoid cavity; clavicle slender, rod-like, held horizontally, slightly dilated at the articulation of scapula; omosternum not forked; episternum triangular; coracoid broad distally and narrow medially, anteriomedial ends of coracoid touching clavicle of respective side; metasternum shorter than omosternum in length; *xiphisternum broad.*

**Tadpoles (Figs. 173-174)**

The detailed structure of tadpole discussed in **bionomics.**

**Distribution:** Himachal Pradesh (600 - 2500 m), eastern Himalayas.

**Elsewhere:** Nepal.
Group: Rana liebigii, Annandale, 1917

15. Rana liebigii, Günther, 1860
(Figs. 67-70, 117-119 and 157)


1860 : 143-175.

1861 : 213-227.


1870 : 83.

40 : 21.


1873. Rana liebigii, Theobald, J. Asiat. Soc. Beng.,
1873 : 1-38.


1890. Rana liebigii, Boulenger, Fauna Brit. India,
1892 : 341-348.

2 : 289-292.

1912. Rana liebigii, Annandale, Rec. Indian Mus.,
6 : 21.

6 : 136.

1920. Rana liebigii, Boulenger, Rec. Indian Mus.,
20 : 78.

4 : 726-728.


(3) 213, Zool. 143 : 341-411.

(3) 324, Zool. 231 : 1093-1125.

Number of specimens examined : one

Locality : Saproon, Solan.

Date of collection : 29.vii.76
Description

A. General

Head broader than long; snout rounded and projecting, nostrils nearer the eyes than snout; eyes small, ocular diameter equals length of snout; tympanum indistinct; fore limbs short, first finger slightly longer than second, subarticular tubercles of fingers prominent; dermal folds of skin on three inner fingers, three metacarpal tubercles at the base of the palm; tarsal fold distinct; subarticular tubercles of toes slightly less developed than those of fingers, inner metatarsal tubercle small; clavicles strong and rod-like, omosternum entire, episternum rounded and broad anteriorly; xiphisternum bifid.

B. Morphology (Figs. 67-70, 117-119)

Head: Head 1.1 to 1.2 times broader than long, one-third of total body length; snout rounded and projecting beyond jaws, 0.4 in the head length, nostrils nearer the eye than snout; eyes small; ocular diameter less than length of snout, 0.3 in the head length, interorbital space narrower than height of upper eyelid and still narrower than internasal distance; tympanum indistinct; a strong supratemporal fold from eyes to shoulders.

Fore limbs: Fore limbs short, each fore limb 0.35 in the length of hind limb; first finger slightly longer than
second; tips of fingers swollen and with small discs; subarticular tubercles on the fingers prominent; first and second fingers with single subarticular tubercle each, third and fourth with two subarticular tubercles each; dermal folds on three inner fingers starting from inner borders of subarticular tubercles and terminating in the palmar region; three metacarpal tubercles at the base of the palm, inner metacarpal tubercle longer than the outer two.

Hind limbs: Each hind limb 1.7 times longer than body length, femur equals tibia in length, tarsal fold distinctly present; toes nearly 4/5 webbed; tips of toes blunt and with discs devoid of grooves; subarticular tubercles of toes weakly developed as compared to those of fingers, first two toes with single subarticular tubercle each, while third, fourth and fifth toes with two subarticular tubercles each; inner metatarsal tubercle one-third the length of first toe; outer metatarsal tubercle absent.

Colour: Grey and white dorsally, pale yellow ventrally, skin porous and rough dorsally, while ventral surface slightly smooth.

C. Osteology

Pectoral girdle (Fig. 157)
Suprascapula slightly wider than scapula, broad
wing-like at the articulation of vertebral column; scapula long broad, only one-third takes part in the formation of glenoid cavity; clavicles strong, horizontally held; omosternum broad and rounded posteriorly; episternum knob-like; coracoids broad distally and constricted in the middle, anterior medial ends touching clavicle of respective side, coracoids of adjacent sides held together with a little cartilage; metasternum equals xiphisternum; xiphisternum broad and rounded with small constriction in the middle.

**Distribution**: Himachal Pradesh (about 1500 m), Sikkim.

Elsewhere: Nepal.
16. *Rana (Paa) vicinia*, Stoliczka, 1872
   (Figs. 71-74, 120-122 and 158)


Number of specimen examined : one

Locality : Nohradhar.

Date of collection : 25.vi.60.

Description

A. General

Green to dark grey; head slightly broader than long, nearly one-third in total length; snout long projecting beyond jaws, nostrils nearer the eye than anterior part of snout; eyes smaller than snout length;
tympanum indistinct; a lateral fold from eye to shoulder; tongue bifid, fore limbs less than one-third in the length of hind limbs; first finger smaller than second, subarticular tubercles of fingers well developed; hind limbs long; subarticular tubercles of toes slightly less developed than those of fingers; inner metatarsal tubercle less than half in the length of first toe; tarsal fold distinct; scapular width more than suprascapula; clavicles straight; omosternum entire.

B. Morphology (Figs. 71-74 and 120-122)

**Head**: Head 1.1 - 1.2 times broader than long, nearly one-third in the total length; snout long, obtusely pointed, 0.55 in the head length, nostrils nearer the eye than anterior part of snout; internasal distance more than interorbital width; eyes large; ocular diameter less than length of snout; interorbital width nearly equal to height of upper eyelid; tympanum indistinct; a supratemporal fold from eye to shoulder.

**Fore limbs**: Each fore limb short 0.35 in the length of hind limb; first finger smaller than second; subarticular tubercles of fingers prominent; first and second finger with one subarticular tubercles each, while third and fourth finger with two subarticular tubercles each; tips of fingers blunt and swollen; three metacarpal tubercles at the base of the palm, inner and outer of almost equal size.
Hind limbs: Each hind limb nearly twice the length of body; tibia slightly longer than femur; tarsal fold distinct; tips of toes blunt and swollen; subarticular tubercles of toes slightly less developed than those of fingers; first and second toe with one subarticular tubercle each, third and fifth toe with two subarticular tubercles each, while fourth toe with three subarticular tubercles; toes almost fully webbed with a slight notch; inner metatarsal tubercle nearly one-third in the length of first toe, outer metatarsal tubercle absent.

Remarks: Very much confused with *Rana* (*Paa*) liebigii but differentiated by the absence of dorsolateral folds and head less broad with snout obtusely pointed instead of rounded.

C. Osteology (Fig. 158)

Suprascapula 0.7 in the width of scapula; scapula broad and constricted in the middle; clavicle long and rod-like; omosternum small with broad, rounded episternum; coracoid straight, coracoids of adjacent sides held with much of cartilage in the middle; metasternum equals length of omosternum; xiphisternum less than width of episternum and forked.

Distribution: Himachal Pradesh (2500 m), Assam. Elsewhere: Nepal.
(ii) **Bionomics**

(a) **Food and feeding**

The food and feeding habits of the toads of Himachal Pradesh were studied at different altitudes from 300 - 3500 m. It is a known fact that the members of the class Amphibia, at least the adults, are primarily carnivorous (Reeder, 1964). The food of these toads depends upon the availability of prey in the habitat and there is a correlation between the abundance of toads and the ground fauna. These animals have been found to concentrate in or near the forests, nurseries and household kitchens where plenty of food was available. In the present work, the food and feeding behaviour of four species of *Bufo*, viz. *Bufo melanostictus, Bufo stomaticus, Bufo himalayanus* and *Bufo viridis* were studied. The former two species are inhabitants of altitude from 300 - 1500 m whereas the latter two are representatives of altitude ranging from 1500 - 3500 m. The toads were found to feed only upon the living prey. Degree of selectivity of food items was observed to depend upon the availability of food items. The abundance of insect fauna was found to be related with the onset of premonsoons and monsoons. The area was characterized by premonsoon showers in May while monsoons occurred in the middle of June and lasted till the end of August. The food and feeding habits of the toads were studied by making direct
observations in the field coupled with laboratory observations only during the active feeding period i.e., April to September. *Bufo melanostictus* and *Bufo stomaticus* were seen coming out of their hibernation by end of March or early April. The emergence in one season was still earlier by a few days with the onset of rains. High altitude forms like *Bufo himalay anus* and *Bufo viridis* emerged in April irrespective of comparatively low temperature as compared to low-land forms. At Nohradhar and Haripurdhar (2200 - 2500 m), the emergence of *Bufo himalay anus* was delayed by more than 22 - 25 days as compared to other localities. In high altitude forms, feeding activity was for shorter duration. The food and feeding studies were made in two steps, viz. (i) Mode of capture (ii) Analysis of gut contents.

(i) **Mode of capture**

The physiological state of the animal was found to be one of the major factors in capturing the prey. Amongst the species studied, *Bufo melanostictus* is the most active toad which could capture its prey by making sufficiently long and high jumps. *Bufo stomaticus* is slightly less active than the former species. *Bufo melanostictus*, due to its large gape of mouth, captured larger preys. Amongst the high altitude species, *Bufo viridis* is more active than *Bufo himalay anus* because the former species was observed to have preference for flying
insects. *Bufo himalayanus* is a sluggish toad, capturing its prey with very little effort. However, under forced conditions, it may go hunting. On the ground, the angle of posture in natural position differed in different species, viz. *Bufo melanostictus* 30°, *Bufo stomaticus* 60°, *Bufo himalayanus* 30° and *Bufo viridis* 45°. These figures reveal that the more active the toad, the higher is the angle. As soon as the toads sighted the prey, they watched its movements vigilantly and if the prey was within their approach, they slightly leaned their head towards it. Leaning of head was followed by protrusion and subsequent retraction of the tongue. During this process, much of the weight of body was on the fore limbs. This process was very common in *Bufo himalayanus* waiting for prey along water channels. When the prey was slightly higher, *Bufo melanostictus* was observed to make jumps of 10-15 cm in height and during this act, the weight of the body was on hind legs. The toads were generally found to make desired number of long jumps to approach the prey. The last jump of its approach towards the prey was followed by protrusion and subsequent retraction of the tongue. This process was over when the hind limbs touched the ground. The prey was retained in the mouth to ensure its paralysis or till it showed some retarded movements. It was then forced into the gullet by movements of the muscles of the lower jaw.
Sometimes *Bufo stomaticus* and *Bufo melanostictus* were observed feeding on a group of insects by the swirling action of tongue in anticlock-wise direction.

(i) **Analysis of gut contents**: The results of stomach analysis of various species are given in the following pages.

**Bufo stomaticus**

The stomach contents of 378 specimens from various localities showed the occurrence of a large number of invertebrates and a few vertebrates. Fig. 211 shows the percentage frequency occurrence of each food item. The degree of fullness of stomachs in different months is shown in Table 1. The occurrence of various food items in relation to size of toads is shown in Table 2.

A. **Invertebrates**

1. **Annelida** (found in 95 specimens (25.1%)). The occurrence of dissociated items of earthworms was recorded from Renuka, Nurpur, Paonta Sahib and Bilaspur. Earthworms were more abundant in lower size groups than larger size groups. The occurrence increased with rainy season and particularly on rainy days.

2. **Arthropoda**: The various representatives of the group are as follows:

   (a) **Myriapoda** (found in 180 specimens (47.6%))

   Only the broken parts occurred in the stomach contents. Maximum consumption was in April and May.
The larger toads had maximum contents. Variation in the frequency occurrence was due to locality.

(b) **Arachnida (Areneae)** (found in 136 specimens (35.9%))
The occurrence of spiders of family Areneidae was more common in large size groups than small sized toads. Variation in the percentage volume of this group was as a result of different localities.

(c) **Insecta**: This group of arthropods formed a major part of food consumed in all seasons.

(i) **Coleoptera** (found in 210 specimens (55.5%)). The common beetles of families Carabidae, Scarabidae and Coccinellidae were of common occurrence. The genera *Pherosoponhus, Anomala, Haltica* and *Brahmina* were recorded. The larger group of toads fed more on these insects and their abundance was recorded in pre-hibernation and post-hibernation periods.

(ii) **Hymenoptera** (found in 135 specimens (35.7%))
*Pollistes, Camponotus, Formica* and *Apis* were the main constituents of this group. During April and May, *Pollistes* and *Apis* dominated while after the break of rainy season, *Camponotus* and *Formica* were in abundance. The uptake of this group of insects was very common in larger-sized groups as compared to small-sized groups. Record of these insects in the stomach was higher in the pre- and post-breeding seasons.
(i) **Lepidoptera** (found in 196 specimens(51.35%))
The majority of caterpillar larvae occurred in April and May. Medium-sized toads preferred these insects.

(iv) **Dermoptera** (found in 56 specimens(14.8%))
The occurrence of *Forficula* was more common in smaller-sized toads. The percentage occurrence varied with respect to locality.

(v) **Isoptera** (found in 92 specimens(24.3%))
The occurrence of *Microtermes* was common in small-sized toads and the percentage occurrence decreased with larger-sized toads. It was also observed that isopterans were taken in groups at any one time.

(vi) **Orthoptera** (found in 182 specimens(48.1%))
The orthopterans also formed a major group of insects constituted by *Gryllotalpa*, *Gryllis*, *Mantid* and *Periplaneta*. The consumption of this group was at its peak during the premonsoons and fell in large-sized toads.

(vii) **Hemiptera** (found in 147 specimens(38.3%))
The common water scorpion of genus *Napa* and water bug, *Dysdercus*, were recorded from the stomachs. The occurrence was more frequent in the large-sized toads than small-sized ones.

(viii) **Diptera** (found in 46 specimens(12.16%))
Dipterans were represented by a group of house flies of the genus *Musca*. 
The specimens captured during the monsoons were with adults of genus *Ephemera*. The occurrence of ephemeropterans was higher in large-sized toads.

3. **Mollusca** (found in 145 specimens (38.3%))
The commonly occurring genera were *Planorbis* and *Bensonia* during and after the rainy season. The occurrence increased in larger groups.

**B. Vertebrates**: The vertebrates, usually juveniles of frogs and toads also formed a part of the diet of these toads. Feeding on vertebrates was resorted to due to the non-availability of invertebrate food.

(a) **Amphibia** (found in 22 specimens (5.32%))
The occurrence of the amphibians, viz. *Uperodon systoma* and *Bufo* was recorded from the larger-sized toads.

(b) **Reptilia** (found in 5 specimens (1.32%))
Only a very few large-sized toads were found with pieces of small snakes, 3-5 mm thick.

*Bufo melanostictus*

The gut contents of 309 toads from different localities were examined which revealed more of invertebrate diet and very little vertebrate diet. Small stones were invariably recorded in the stomachs. Sometimes dry leaves,
pine needles and other substrate material were also recorded along with main food items. Degree of feeding is shown in Table 3 and food in different size groups in Table 4. The percentage occurrence of different groups is represented in Fig. 212.

A. Invertebrates

1. **Annelida** (found in 30 specimens (9.7%))
   Small pieces of semi-digested earthworms were recorded in a few specimens and the maximum percentage occurrence was observed in the rainy seasons. The occurrence was higher in small size-groups than in larger ones.

2. **Arthropoda**: Arthropods formed a major portion of the diet and were represented by the following groups:
   - (a) **Myriapoda** (found in 106 specimens (34.3%))
     Myriapods occurred only in pieces in the stomach. Intake of *Myriapoda* was maximum in larger-sized groups in the month of April and May when there was scarcity of other insects.
   - (b) **Arachnida** (Araneae) (found in 128 specimens (41.42%))
     Spiders of the family Araneidae were recorded in stomachs and more frequently in medium-sized toads. The occurrence varied with locality.
   - (c) **Insects**: Insects were represented by the following orders:
     - (i) **Coleoptera** (found in 235 specimens (76.5%))
       Coleopterans were invariably recorded though their volume
varied. They formed the chief part of the diet of toad. Their occurrence was higher in pre-hibernation and post-hibernation. They were represented by the genera *Pheros'poohus, Haltica, Tenebris, Platymarcelis* and *Brahmina*. The intake was more in larger-sized toads, the size of prey varying from 4–25 mm.

(ii) **Hymenoptera** (found in 182 specimens(58.3%))

The occurrence of common ants belonging to the genus *Formica* was fairly common. The intake of other hymenoptera, viz. *Camponotus* and *Polistes* were also recorded. Their occurrence was higher during premonsoons and postmonsoons.

(iii) **Lepidoptera** (found in 146 specimens(47.2%))

The occurrence of lepidopteran larvae was more common in rainy season in the large-sized toads. Only some moths could be recorded in semi-digested state.

(iv) **Dermaptera** (found in 109 specimens(35.2%))

*Forficula* was commonly recorded in non-digested form. The occurrence was common in large-sized toads. The quantity varied with locality.

(v) **Orthoptera** (found in 247 specimens(79.9%))

It was the most commonly occurring group, irrespective of size-group represented by household insects, like *Grylids, Periplaneta* and *Gryllotalpa* and sometimes *Mantids*. The occurrence of this group of insects was more common before the monsoons and particularly just
after the emergence from hibernation of toads.

(vi) Hemiptera (found in 136 specimens (44.0%))
The occurrence of water scorpion, Ranatra and water bugs, Belosterna and Dysdercus, was common in over one-third of specimens examined. The intake was common in the large-sized toads than small-sized toads and the consumption was higher in rainy season.

(vii) Ephemeroptera (found in 108 specimens (34.95%))
The larvae and the adults of genus Ephemera were recorded from the stomachs. They were more common in larger toads. The toads were observed to sit and wait for them under street lights.

3. Mollusca (found in 94 specimens (30.42%))
Two species of molluscs could be recognised. The specimens from lower elevation were represented by Planorbis while those from high elevations were represented by Bensonia. The occurrence was more common in small-sized group, particularly during rainy season.

B. Vertebrates: The occurrence was often represented by two groups:

(a) Amphibia (found in 32 specimens (10.35%))
Only the juveniles of genus Bufo were recorded from the gut contents of larger-sized toads during rainy days.
(b) Reptilia (found in 6 specimens (1.94%))

Semi-digested pieces of small thin snakes of 3-5 mm were recorded in a very few specimens in rainy season.

Bufo himalayanus

The stomach contents of 234 specimens were examined from various localities. Only invertebrates were recorded. Small stones, dry pine leaves and some debris also constituted a part of food consumed. The percentage occurrence of different food items is shown in Fig. 213 and the degree of feeding in different parts of the year is shown in Table 5. Feeding of different food items in relation to the size of the toads is shown in Table 6. The following phyla of invertebrates were recorded:

1. Annelida (found in 178 specimens (76.6%))

Only semi-digested pieces of Lumbricidae could be identified. The occurrence was higher in younger and smaller toads than in larger toads. The annelids were found during June and July.

2. Arthropoda: This group of insects formed the major part of the diet of the toads irrespective of the locality and size. The following types were represented:

(a) Myriapoda (found in 88 specimens 37.6%)

Unidentified fragments of myriapods were recorded from the stomachs. Large-sized toads commonly consumed this food particularly in premonsoons just after their hibernation period.
(b) **Arachnida (Hapaleae)** (found in 70 specimens (29.9%)) Nearly one-third specimens were found with spiders of genus *Zilla* in their stomachs irrespective of the size of the toads. The quantity consumed varied with the locality.

(c) **Insects**: Different orders of this group were as follows:

1. **Coleoptera** (found in 181 specimens (77.35%)) Majority of specimens of toads were found with coleopterans in the stomachs; very large beetles of shiny appearance, viz. *Xylotrupus*, curculionid beetles of genus *Meloides* and genus *Brahmina* occurred. In some specimens, *Coccinella* was also recorded. The size varied from 5-30 mm. The occurrence was higher in larger groups in the months of April-May and August-September.

2. **Hymenoptera** (found in 136 specimens (58.1%)) Only common ants belonging to genera *Formica* and *Camponotus* were recorded in abundance. The intake was comparatively higher in larger groups after the first rainfall in May, and also in September.

3. **Lepidoptera** (found in 110 specimens (47.0%)) Only the caterpillars were recorded from stomachs. The occurrence was more common in larger-sized groups than in smaller-sized groups. The frequency of occurrence was higher in premonsoons.
(iv) **Dermaptera** (found in 89 specimens (38.03%))

Though these insects were in fragments but some parts revealed the occurrence of *Forficula trispinosa* and *Nala* sp. The intake of these insects was higher in April and May and particularly so in larger forms.

(v) **Orthoptera** (found in 108 specimens (46.15%))

The occurrence of small sized grasshopper, *Schistocerca* and cockroach, *Periplaneta* was more frequent, irrespective of the size groups.

(vi) **Hemiptera** (found in 104 specimens (45.2%))

*Nepa* and *Ranatra* were the common water scorpions found in the stomachs particularly in the months of June and July. The occurrence was irrespective of the size.

(vii) **Ephemeroptera** (found in 136 specimens (58.1%))

The toads fed on the larvae along the water channels and on adults under street lights. Genus *Ephemera* was recorded. The toads of usually small-sized group were observed with these flying insects in their stomachs.

3. **Mollusca** (found in 70 specimens (29.9%))

The occurrence of *Bensonia* could only be recorded in rainy seasons.

*Bufo viridis*

The gut contents of 233 toads from districts Simla and Kinnaur were examined. Only the invertebrates were found in stomachs. In some cases, some substrate
was also found associated with food. The percentage occurrence of various groups is shown in Fig. 214. The feeding of different food items in relation to size is shown in Table 6 and the degree of fullness in various months of the year is shown in Table 8.

**Invertebrates**

1. **Annelida** (found in 168 specimens (72.1%))
   
   Only the small semi-digested pieces representing family Lumbricidae were recorded. The occurrence was higher in June-July than in other months and more common in large-sized groups than in small-sized groups. The variation in the volume depended on the availability of insect fauna.

2. **Arthropoda**: The following groups were represented:
   
   (a) **Myriapoda** (found in 140 specimens (60.08%))
   
   Fragments of myriapods were found in semi-digested state. The intake was very common in small-sized groups than in large-sized groups. The quantity varied with locality.

   (b) **Arachnida** (Araneae) (found in 135 specimens (57.93%)) The occurrence of spiders of family Araneidae was common. The intake was irrespective of the size of the toad and higher in months of April-May.

   (c) **Insecta**: This group alone formed more than half of the total food consumed and toads did prefer
flying insects. Insects of the following orders were represented:

(i) **Coleoptera** (found in 166 specimens (71.24%))

Majority of the beetles belonged to genera Haltica, Xylotrupus, Anomala, Platymarcelis and Brahmina, usually not exceeding 10 mm in length. Aquatic beetle, Dysticus was also recorded in some stomachs. The occurrence was more abundant in larger groups of toads and was particularly higher in months of April-May and in September.

(ii) **Hymenoptera** (found in 118 specimens (50.06%))

Occurrence of common ants, viz. Formica and Camponotus was in half of the specimens examined. In some specimens, it was the only consumed food and particularly after the premonsoon showers. The intake was irrespective of the size of the toad.

(iii) **Lepidoptera** (found in 96 specimens (41.20%))

Semi-digested caterpillars were found, more particularly in large-sized toads, after the premonsoons.

(iv) **Dermaptera** (found in 78 specimens (33.37%))

The genera Forficula and Nala occurred in large-sized groups of toads, more frequently during the monsoons.

(v) **Orthoptera** (found in 98 specimens (42.06%))

Only the juveniles of grasshopper, adults of Mantid and some specimens of Gryllus were recorded. The occurrence was abundant in smaller-sized groups than in larger-sized
groups. The consumption of these insects was higher before the monsoons.

(vi) **Hemiptera** (found in 136 specimens (58.36%))
Water scorpion, *Ranatra* was found.

(vii) **Ephemeroptera** (found in 108 specimens (46.35%))
Larvae in fragmented form were more frequent. Adults were observed in June-July. The group was more abundant in larger-sized toads.

3. **Mollusca** (found in 98 specimens (42.06%))
Molluscs were commonly found in the stomachs particularly in the rainy seasons, in larger-sized toads. The genus *Bensonia* was recorded.

**Temperature in relation to feeding**

Usually the feeding activity was observed from April-September in high altitude species, viz. *Bufo viridis* and *Bufo himalayanus*, whereas in low altitude forms, viz. *Bufo melanostictus* and *Bufo stomaticus*, the feeding activity was from end of March to September. From September, the (lowering) of temperature was observed as shown in Fig. 215.

In colder nights from August-September, a reduction in hunting time period was observed, consequently the toads underwent hibernation and the feeding was reduced. Hunting time period of high elevated forms was comparatively of shorter duration than those of slightly low land forms.
Feeding in relation to breeding

Majority of bufonids under report, viz. *Bufo himalay anus*, *Bufo melanostictus* and *Bufo atomaticus* were found breeding from April-July. During breeding, the species showed slackness in feeding but at the same time, the feeding was not stopped altogether. In *Bufo viridis*, breeding activity was found to initiate by the end of June and hence, fed actively in the pre-breeding season. But during active breeding period, the urge for breeding was more than feeding.
(b) Breeding and developmental biology

The reproductive cycle and breeding behaviour in the anurans under report present a great deal of variation in commensurate with the change in the environment, viz. food, light, temperature and humidity etc. All these factors effect conjointly and the absence of any one of these can become a limiting factor. Adequate nutrition has been considered to be a prerequisite for reproduction in specially Bufo viridis. Similarly, increased photoperiod and moderately high temperature were found to go hand in hand.

It was observed that some species of anurans have a long breeding period, i.e., April-August as was recorded in some members of Ranidae, viz. Rana (Dicroglossus) cyanophlyctis cyanophlyctis, Rana (Dicroglossus) limnocharis erythrecsis and Rana (Paa) minica, and also Microhyla ornata. There are some forms in which the breeding period was slightly shorter than three months as in a few members of Bufonidae, viz. Bufo melanostictus and Bufo stomatius. There are still other forms where the breeding period hardly exceeded two months, viz. Rana (Tomopterna) brevica, Unerodon systena, Bufo himalayanaus and B. viridis. In all the species under report, the breeding activity was observed to be delayed for a period of 15-60 days with the increase of altitude from 300-2500 m.
In high altitude forms like *Bufo himalay anus* and *B. viridis*, the breeding period in the same locality was found to differ to avoid overlapping but at the same time, spawning season of other forms like *Bufo himalay anus*, *Rana (Paa) minica*, and *Amolops afgahanus* was observed to coincide very much with one another. In low altitude forms of *Bufo*, viz. *Bufo stomaticus* and *B. melanostictus*, one of the species was found to migrate to nearby localities to avoid overlapping of sites due to same breeding period.

The breeding frogs, toads, and micryhyllids could be located and recognised by their specific male calls. During the present course of studies, the breeding behaviours of four species of anurans were investigated i.e., two members of Ranidae, viz. *Rana (Paa) minica* and *Amolops afgahanus* and two representatives of Bufonidae, viz. *Bufo himalay anus* and *B. viridis*. The developmental stages of their tadpoles were also studied. All the observations were made in the field but in *Rana (Paa) minica*, results were also compared with the laboratory reared tadpoles.

*Rana (Paa) minica*

The breeding activity usually started in early April at 600 m while it was delayed by 10-15 days in higher elevations of 700-2500 m. The peak breeding activity was observed in June. During breeding season, the male call "croak" was recognised as keek - keek - kik - keek - kik. The undersurfaces of the throat in both the sexes were pink during breeding season.
Mating: Mating was observed after a number of male calls, which began soon after the sunset. Male was found to approach the breeding site earlier than female. A male call was enough for the female to locate its partner. The female was observed to move to the breeding site from a distance of about 300 m, it approached the breeding site and then slipped into the water. As soon as the male noticed the female, he followed her and caught hold of her by pressing on her back first with his right fore limb and then made a firm grasp of the female. In amplexus, the fore limbs of the male were immediately behind the fore limbs of female and the hind limbs were superimposed over the hind limbs. It was observed that male could enjoy the ride on female for 1-2 hours if not disturbed. After this act, they separated and were seen moving in different directions.

It was observed that when a male had selected a partner, the other males never approached the same female. On the contrary, when pairing started, more females generally gathered around the pair.

Spawning (Fig. 176): The spawn was usually laid in the late evenings in shallow ditches interspersed with the vegetation near hill streams. Each spawn was a small globular mass, 3-5 mm thick and in the form of white jelly enclosing about 100-150 eggs. The spawn was laid in 5-7 batches. After 12-16 hours of egg laying and fertilization, it acquired a ring-shaped structure which was transformed
into swollen mass of eggs after 24-36 hours and the ringed form lost its shape. The swelling of the egg masses continued up to 60-72 hours when the eggs became somewhat elongated and were transformed into young embryos. All the eggs hatched within 106 hours. Morphometric measurements of different stages are given in Table 9.

First stage (Figs. 177a, 177b) (7 days): The tail is twice the snout-vent length. Mouth is slightly terminal with fringed lips at the margins. The upper jaw is with six rows of labial teeth; the outer is uninterrupted while inner five rows are interrupted in the middle. The lower jaw is with three uninterrupted rows of teeth, thus dental formula is 1+5. The upper and lower jaws enclose a horny beak composed of two halves with inner surfaces serrated. The upper half of the beak is semilunar in shape while the lower with 'V'-shaped structure. There is a left spiracle on the posterior half of the body with the opening directed upwards. Dorsal profile of the tail gradually increases in size and becomes maximum wide in the middle, tapering posteriorly. The intestine is three times the total length of the tadpole. The tadpole is usually found at the bottom of the streams.

At this stage, the movements of the tadpoles are brought about by the tail fins. It clings to the substrate with the fringed lips and pointed papillae. The movements of the upper and lower jaws help in browsing the material with the help of dentitional rows while the inward flow of water is
Table 9

Morphometric measurements

of developing stages of

Rana (Rana) minima

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brought about by the movements of upper lip. The inner surfaces of the beaks serve to cut the food particles.

**Second stage (Figs. 178a, 178b) (10-12 days):** At this stage, the tadpole is longer than first stage and the growth is comparatively more in snout-vent length. Diameter of the eye is double than that of first stage. The lips also increased in size with their outer margins highly fringed. A rudiment of hind limbs has appeared.

**Third stage (Figs. 179a, 179b) (12-15 days):** At this stage, there is further increase in the length of tadpole. A few characteristic metamorphic changes, viz. deep sinking of beak, prominent eyes, enlargement of the hind limbs and the appearance of rudiments of the fore limb are observed. This stage of the tadpole is an active stage when the tadpole can swim more efficiently with the pedalling of hind limbs which also serve in adhesion during feeding.

**Fourth stage (Figs. 180a, 180b) (15-17 days):** At this stage, the tadpole is found to show some retrogressive metamorphic changes, viz. phagocytosis of tail and the reduction in the length of intestine i.e., 2.5 times the total length of the tadpole. Snout becomes prominent with reduction of lips and consequently, the diminishing in the dentitional rows. The cornification of the two halves of the beak start shedding. Rudiments of the fore limbs were seen through the transparent skin and there was closure of the spiracle.
Fifth stage (Figs. 181a, 181b) (17-20 days): This stage of the tadpole is considered to be the most advanced stage when the shape of the mouth considerably changed. The upper and lower halves of the beak sink deep with the disappearance of dentitional rows. Right and left fore limbs are fully formed. The intestine at this stage is only 2 times the total length of the tadpole. There is a shortening of the tail. It is a transitional stage when the bony beak is transformed into cleft of the mouth.

Sixth stage (Figs. 182a, 182b) (20-25 days): This is a transitory stage between the tadpole and the juvenile characterised by the presence of tail remains. The mouth becomes terminal but the cleft of the mouth is not deep. At this stage, the tongue cannot be propelled out. Fore limbs and hind limbs are fully formed.

Seventh stage (Figs. 183a, 183b, 184, 185) (25-30 days): This is a juvenile stage when the tadpole has just completed its metamorphosis. Snout, eyes, tympanum, fore limbs and hind limbs are fully developed. The tail is completely absorbed. The intestine is twice the total length of the juvenile.

*Amolops afghanus*

This is a typical torrential hill-stream species occurring at 600-2500 m. The breeding activity of this
species started in early April at low elevations. The peak of the breeding activity was attained in the months of May and June and breeding continued up to August. The adults were nearly 30 mm in length. The males were observed to be smaller than the females. The individuals of this species could only be located in the field with the help of their vocal calls which could be identified from a distance. The species was recognised with a peculiar call, viz. kik - i - kik - kil - i - i - kik.

Mating : In the evening, male came out of its crevices and sat along the water pools and croaked. With the initiation of the first croak, the assemblage of males at various small water pools was noticed. This was a low pitched croak as compared to other species. At the call of one male, 3-4 females were observed to approach the breeding site. Each female was found to locate the breeding site within 5-20 minutes. The female which approached first was found to slip into a small water pool with slow-running water, having a depth of about 15-30 cms. The mating call of the male did not stop although the male could probably see the female slipping into water. The other females were also found to follow the first. Male also made its way into the water and approached the female which reached first at the breeding site, slowly mounting her back with the help of his left fore limb. The amplexus was observed for more than one hour. During
Table 10

* Morphometric measurements of developing stages of *Angliola afghanus*

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this act of courtship, the fore limbs of male were behind the fore limbs of the female and hind limbs of the male over the hind limbs of the female. It was after an hour that the male left the first female and by jumping, mounted the second female which perchance was at an approachable distance. The first female was found to move after spawning. In the second mounting, the amplexus was also observed for one hour. Both the partners were seen moving in different directions.

**Spawn**: The freshly laid spawn was found to be a jelly-like mass comprising 200-250 eggs in the globular form, having a diameter of 5-7 mm. It was found to lose its shape as soon as disturbed. The spawn was laid under the stones which provided a running, though slow, current of water. The ecology of the area is shown in Fig. 186. All the eggs were found to hatch after 72-96 hours. The hatched embryos were kept in empty tins providing a continuous flow of water in natural streams. The following distinct developmental stages were studied, the morphometric measurements of which are given in Table 10.

**First stage** (Figs. 187a, 187b) (5-7 days): The snout is rounded with small eyes and a spiracle on the left side. There is a powerful sucker at the chest which is 0.8 in the snout-vent length of the tadpole. The mouth is bordered by fleshy lips fringed on the lateral sides with pointed papillae. The upper jaw is with two uninterrupted and five
interrupted rows of labial teeth. The lower jaw is with three uninterrupted rows of teeth. Enclosed between the upper and lower jaws, there is a horny, cornified, black beak composed of two halves i.e., upper and lower. The inner surfaces of the beak are serrated. The upper part of the beak is arched while the lower half is 'V'-shaped. The upper and lower surfaces are distinctly visible. Tail is 2-2.25 times the snout-vent length. Dorsal profile of the tail commences from midway of the tail with maximum width in the posterior three-fourth part and abruptly tapering posteriorly. The ventral profile has its origin slightly away from the origin of dorsal profile.

The tadpoles were found to feed on algal slime attached to stones in the current of water. They were found adhering to stones with the help of a powerful sucker. The pointed papillae on the lateral sides of lips serve to cling to the surface while rows of labial teeth serve to browse algal slime. The cut food is forced into the mouth along with water current created by the movements of upper jaw. The food is cut into small pieces with the help of serrated beak before taking it. Intestine is 2.5 times longer than the total length of the tadpole.

Second stage (Figs. 188a, 188b) (1-12 days): This stage of the tadpole is longer than first stage. The snout-vent length is 0.4 in the total length of the tadpole.
Few changes are observed in it, viz. overall increase in length, increase in length of sucker and intestine. Rudiments of hind limbs are also observed.

Third stage (Figs. 189a, 189b) (15-17 days): The tadpole is still longer than first two stages. Eyes are prominent. The tail length increases more as compared to snout-vent. At this stage, the sucker measures 0.6 in the snout-vent length. The ventral projections of the sucker start growing. The upper and lower halves of the beak sink deep and its upper part completely covers the lower. Dentitional rows of labial teeth start diminishing, well developed hind limbs are also present at this stage. Rudiments of the fore limbs are also visible through the transparent skin. The tadpole is active due to the appearance of hind limbs and can swim more efficiently due to their pedalling action. It is able to feed in still more rapid flow of water.

Fourth stage (Figs. 190a, 190b) (20-22 days): At this stage, the snout-vent length of the tadpole is found to increase more than that of the previous stages and is 0.4 in the total length of the tadpole. The upper and lower halves of the beak have sunk deep with the shedding of cornifications. The dentitional rows are observed to be diminishing. The snout acquires a pointed shape with eyes bulging prominently. The ventral projections of sucker are found to grow at the level of ventral surface.
The intestine is twice the total length of the tadpole.

**Fifth stage (Figs. 191a, 191b) (27-30 days):** This is juvenile or subadult stage. The tadpole has shed its tail. Snout gets obtusely pointed with well developed eyes along the upper eyelids. Due to small cleft of the mouth, it was still feeding on planktonic material. The tongue cannot be propelled out. Only the remains of the sucker are left. Fore-and hind-limbs are fully developed. The intestine, at this stage, is twice as long as the total length of the animal.

*Bufo viridis*

The toad exists at high altitude areas ranging from 1500-3500 m. The breeding activity was observed from late June to early August. During the breeding season, the croak of the male could be easily recognised. Peak breeding activity was observed in the month of July. A delay in the breeding activity was observed for 5-10 days with the increase in altitude to 3500 m. The male and female developed pink colouration on the undersurface of the throat during the breeding season. The females were slightly longer and brightly coloured than males. The dorsal surface of the female is smooth and beautifully coloured, whereas that of the male was slightly tuberculated and rough. The male croak with Terru - terru - terru, low pitched, differed slightly from *Bufo himalayanus*, the croak lasting for short period.
Mating: In the evening, with the approach of darkness, the toad came out of its burrows and started moving towards small water channels with its peculiar vocal call. The toad seemed to prefer small water channels with muddy bottom, 10-15 cm deep for breeding. The assemblage at the breeding ground was found to be initiated with the male call. At the breeding site, four males and seven females were observed. The croaking call of the male did not come to an end till pairing took place. All the females slowly moved into the water channel. It was only one male which immediately followed the females and could mount one of them. Later on, with a gap of 10-15 minutes, the other two males also slipped into the water and formed pairs. The fourth male moved without pairing. The remaining females were also seen to move in another pool of water. During pairing fore limbs of male were behind the fore limbs of female and hind limbs of the male were above hind limbs of the female dipping only the hind part in water. The amphixus was sufficiently strong and the male could ride female for more than two and half hours.

Spawn: The spawn was laid preferably under water channels of big boulders or around the vegetation. Ecology of the area is shown in Fig. 192. The spawn was a mucilagenous thread twined in the vegetation in clockwise manner about one metre in length enclosing 300-400 small black eggs. They looked like beads twined
in thread. After about 24 hours, the spawn started sinking in water and after 96-108 hours, hatching took place. Newly hatched embryos were motionless but started their small movements after 5-6 hours of hatching. These hatched embryos changed into young tadpoles after 84 hours which could actively swim for feeding. The following developmental stages were studied; morphometric measurements are shown in Table 11.

First stage (Figs. 193a, 193b) (7 days): This stage is observed after seven days of hatching. In the tadpole, mouth is terminal and nostrils are nearer the eye than anterior part of snout. The tail is 1.5 times the snout-vent length. The spiracle is on the posterior half of the body on the left side. Mouth is as wide as the length of snout. There are thin, fleshy lips bordering the mouth. The lips are fringed on the lateral sides and their inner surfaces are with pointed papillae. The upper jaw bears two rows of labial teeth, the outer upper row is uninterrupted while the lower is narrowly interrupted. The lower jaw bears three uninterrupted rows of labial teeth. Enclosed between the jaws, there is a horny beak composed of two halves i.e., upper and lower. The inner surfaces of the beak are serrated. The upper half completely covers the lower. Maximum width of the tail is in the posterior three-fourth part and terminal end of the tail is rounded. The intestine is twice the length of the tadpole. The tadpoles were found to feed on leaves and dead organic
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matter. They clinged to the substrate with the help of pointed papillae while the rows of teeth served to browse the material. The movement of the upper lip together with upper jaw directs the inward flow of water. The beak serves to cut the food particles into finer pieces.

**Second stage** (Figs. 194a, 194b) (10-12 days) : The tadpole is longer than that of the first stage. The mouth is 1.25 times wider as compared to first stage. The rudiments of hind limbs are seen.

**Third stage** (Figs. 195a, 195b) (14-15 days) : The tadpole is still longer than first two stages and the enlargement is conspicuous in the snout-vent region and the ocular diameter has increased. The mouth has also slightly shifted to terminal position with deep sinking. The rudiment of left fore limb is visible through the transparent skin. The hind limbs are small in length but still help in swimming.

**Fourth stage** (Figs. 196a, 196b) (18-20 days) : The fleshy lips of the mouth disappear and the dentition diminishes. The border of the mouth has thick lips. The left fore limb appears first with consequent closure of the spiracle. There is a further elongation of hind limbs at this stage. The tail shows retrogression in the terminal part. The intestine is 1.2 times longer than the total length of the tadpole.
Fifth stage (Figs. 197a, 197b) (22-24 days): This is considered to be the most advanced stage of the tadpole and in favourable conditions, it lasts for 5-6 days. Mouth is terminal with small gap. The fore- and hind-limbs are well developed. The tadpole can swim with the help of fore- and hind-limbs. It could neither feed efficiently on dead organic matter nor on terrestrial fauna as tongue could not be propelled out. The length of the tongue decreases. The intestine, at this stage, can be differentiated into various parts and is only 1.5 times longer than total length.

Sixth stage (Figs. 198a, 198b) (27-30 days): This is a semiadult stage. The toad can be recognised with the help of rudimentary tail. Limbs along with fingers, toes and web are fully developed. The arch of the mouth is sufficiently deep allowing the propulsion of tongue.

*Bufo himalayanus*

The toad inhabits the areas of high altitude ranging from an altitude of 1500 to 3500 m. Breeding of this toad starts from April in low altitude and in early May at high elevations. Peak breeding activity is attained in the month of May. During the breeding season, the colour of the undersurface of belly and head becomes pink in both the sexes. The low pitched vocal call of
the male can easily be recognised as Ter - ter - ter - ter, continuously for a few seconds.

**Mating**: (Fig. 199) At the dusk, the male was found to move towards water pools and channels where the current of water was slow. The vocal call began with the emergence of the toad from its burrow at night. In one locality, the toads selected hot water springs, where the water was luke warm. As soon as the toad was found to approach the breeding site, the call became more rapid. Females were found to locate the male from a distance of 100 m with the help of its vocal call, though pitch of the call was low. Two males reached the breeding sites; three females were observed to follow the males at the breeding sites. The small pool was oval in shape with depth of 50-60 cm. The ecology of the area is depicted in Fig. 200. The females slipped into the water pool and males followed them immediately. Both the males approached the females and one male was found to mount the female by jumping while the second male could also slip over the other female. The females were found to be 1.5-2.0 times longer than the males. Fore limbs of male were behind the fore limbs of female while the hind limbs of male were around the belly of female. This act of copulation lasted for more than two hours.

**Spawn**: The spawn was laid along the corners of the pools where the pool was not very deep. Sometimes the
spawn was also laid in small pools where it was twined around sticks. There were 400-450 eggs in the spawn, the latter measured 1.25 m length, the eggs acquired a cylindrical form. After 104 hours, some movements in the embryos were noticed. The embryos acquired the shape of tadpoles after 120 hours. The following developmental stages were studied, morphometric measurements are shown in Table 12.

First stage (Figs. 201a, 201b) (96 hours after hatching): The snout-vent length measures 0.4 in the total length of the tadpole. The mouth is bordered by fleshy lips. The upper jaw is with two rows of labial teeth. The outer row of upper labial teeth is uninterrupted while the inner one is interrupted widely in the middle. The lower jaw is with three uninterrupted rows of teeth. Thus the dental formula can be given as $1\times1$ $\frac{3}{2}$. The upper and lower jaws enclose a horny beak composed of two halves, viz. upper and lower, with inner surfaces serrated. Spiracle is on left side in the posterior half of the snout-vent. Tail is 1.5 times longer than snout-vent length and maximum width of the tail is in the posterior half, with the rounded terminal ends. The intestine is twice the total length of the tadpole. Just posterior to the mouth, a false or rudimentary sucker is present. While feeding, the tadpole clings to the dead organic matter with the help of pointed papillae on the lateral side of the lips. The movements of the upper and lower jaws help in
Morphometric measurements of developing stages of *Bufo himalayanus*

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browsing the dead organic matter. The movement of the upper lip along with the upper jaw, directs the inward flow of water. The serrated inner ends of the beak serve to cut the food particles into finer pieces. A rudimentary sucker was more prominent particularly when the tadpoles were examined immediately after the rains; obviously, the current was rapid at that stage.

**Second stage** (Figs. 202a, 202b) (8-9 days): This stage was attained after eight days of hatching. Tail is 1.75 times longer than snout-vent length. The eyes are more prominent with an increase in diameter. The width of the mouth is also more due to shifting of its aterinal position. There are more pointed papillae on the inner surface of the lateral sides. Hind limbs, though small in length, have also appeared.

**Third stage** (Figs. 203a, 203b) (12-14 days): There is still enlargement in the length of the tadpole. The width of mouth further increases and the beak sinks deeper. Rudiments of the left fore limbs are seen through the transparent skin. At this stage, hind limbs enlarge further. The intestine is twice than the total length of the tadpole which increases correspondingly with the increase in length of the tadpole. The tadpole was very active.

**Fourth stage** (Fig. 204) (15-16 days): There is a complete shifting of the mouth to its aterinal position
Snout and eyes become prominent. There is a reduction in the length of the tail. Both the fore limbs appear with the consequent closure of the spiracle. The denticional rows start disappearing. The horn beak has no cornification. The tail shows retrogression. Shortening and distinction of intestine are also observed.

Fifth stage (Figs. 205a, 205b) (21-23 days): The tadpole due to the terminal mouth and small cleft, could feed only on planktonic material. The intestine is 1.5 times longer than the total length of the tadpole.

Sixth stage (Figs. 206a, 206b) (25-27 days): This is a juvenile stage when only remains of the tail are recorded. At this stage, the subadult toad is found along the banks and under small stones coming out for feeding in the day time. The cleft of the mouth increases to allow some propulsion of the tongue. This juvenile could feed on aquatic coleopterans, hemipterans and small formicid ants.

Photoperiod in relation to breeding and development

From January up to July, there was a continuous increase in day-light hours from 600 to 900 minutes and vice-versa in the other parts of the year as shown in Fig. 217. The initiation of breeding activity was observed usually from April and sometimes from the end of March, when the day-length reached 720-740 minutes. The
developmental activity in case of Rana (Paa) minica was regained (as observed in laboratory) after the end of February i.e., 710 minutes of daylight and the retarded development was observed from months of September to December when photoperiod decreased from 730 to 600 minutes.

**Temperature in relation to breeding and development**

Temperature was considered to be one of the important factors in the initiation of breeding activity. The breeding of amphibians in low-land forms was found to be initiated earlier than in high elevated forms. A comparison of temperature at low-land (300m) and high elevated areas (200m) is given in Figs 216 and 217. A temperature range of 25-30°C was considered to be suitable for breeding. Usually the breeding activity was observed during the dusk hours when the temperature was 5-10°C lower than the day temperature but in rainy season, the breeding activity was also observed during the day which could be considered equivalent to slight lowering of temperature. The development of amphibians was retarded from September onwards, when there was a continuous decrease in minimum and maximum temperatures especially in high elevated areas. The metamorphic activity was regained from the end of February-March when the ambient temperature in high-land forms nearly touched 25-28°C.

**Rainfall in relation to breeding**

It was observed that rainfall played a dominant role
in initiating the breeding activity in low altitude forms. In high altitude forms of *Bufo*, the rainfall was not necessary to initiate breeding and it did accelerate the process. In some cases, a slight rainfall was helpful to activate breeding as for example in *Rana* (*Dicroglossus*) s. *evanochlytis*, *R.* (*Dicroglossus*) *limnocharis syphadensis*, *R.* (*Dicroglossus*) t. *tigerina* and *Microhyla ornata* whereas in others like *Rana* (*Tomopterna*) *brevicops* and *Uperodon systema*, heavy rainfall was observed to arouse breeding activity. In *Bufo atomaticus* and *B. melanostictus*, rainfall in April certainly enhanced the breeding activity but at the same time if there was no rainfall till the end of April, these toads bred in small water channels.