Chapter I

Some anuran amphibians of Western Ghats and their distribution
Introduction

The Western Ghat region of India has been identified as one of the 25 mega biodiversity hot spots of the world (Myers et al., 2000). It harbors 121 species of amphibians of which 105 are auurans (Daniels, 2001). The study of amphibian biology in India has been considerably hindered by the lack of appropriate identification guides. There are many uncertainties in the taxonomic status of many species of the genus ranidae and philautus due to considerable amount of morphological resemblances amongst coexisting species (Inger, 1996, Daniels 1997). A serious and detailed study is essential to determine the correct identification of many of the Indian species (Biju, 2001).

Frogs and toads have evolved species specific vocalization. These calls are of primary importance in breeding biology. Calls are certainly the clues that a species uses in mate-choice. Advertisement calls are highly species specific and may be used to identify the species more precisely than the morphological characteristics (Schneider et al., 1993). Distribution of anurans may be easily studied in the species in which the calls have been recorded, by localising their advertisement calls instead of routine method of collecting and identifying. It will also help in quantitative assessment of the population density of any anuran in a chosen area (Kanamadi, 2001). Earlier taxonomic works indicate that, an important character like vocalization has not been fully utilized, either
in identification or in studying the geographical distribution of anurans in India. Hence, the present work was undertaken to survey and identify some anurans of Western Ghats on the basis of vocalization.

Materials and Methods

Field trips were conducted in some parts of Western Ghats and fringe areas during pre-monsoon and monsoon seasons to record anuran species between 1996 and 2001. Calling males were located based on the advertisement call, they were captured and their morphometric/ morphological peculiarities were noted. Only one or two specimens belonging to each species were collected and preserved in 8% formalin. Later in the laboratory the frogs were identified up to the species level by using taxonomic keys (Boulenger, 1882, 1890, 1920; Daniel, 1963, 1975; Daniel and Gekar 1989; Inger et al 1984; Dutta, 1992, 1997; Dutta and Arachchi 1996; Daniels, 1997a, b, c). Later they were confirmed by Zoological survey of India, Southern Regional Station, Chennai and Bombay Natural History Society, Mumbai.

Observations

In the present study 12 species of anurans belonging to the family microhylidae, ranidae and rhacophoridae were identified based on vocalization.
1. *Rana temporalis*: It is a medium sized frog; the largest specimen measures 56 mm in snout to vent (SV) length; head longer than broad, snout pointed when viewed laterally (figure. 1); narial openings are laterally placed and are nearer to the tip of the snout; tympanum distinct rounded or vertically oval; fingers free, long and slender; first finger is shorter than fourth, second shortest, third finger longest; tips of the toes and fingers dilated into distinct discs; toes almost fully webbed; dorsal side of head and back brown bronze with deep chocolate sides; a pale band along sides; legs cross banded with brown; ventral side pale yellow.

Habitat: The frog is found along with the margin of the water bodies like water pools, ponds, and water pockets in the green forests, in between dead leaves. Some of them are found on small rock pockets besides streams.

Distribution; Sagar (16° 37'N 76° 51'E), Shimoga (13° 56N 75°38'E), Agumbe (13° 32'N 74° 10'), Sringeri (13° 25'N 75°15'E), Kollur (13°53' N 74° 53'E) and Kemmannugundi( 13°13' N 75°15'E).

2. *Rana malabarica*: It is a common frog in the Western Ghats; the largest specimen measures 64 mm in SV length; adults can be easily recognized by their distinctive colour pattern (figure. 2); snout obtuse, projects slightly beyond the mouth; tympanum distinct and the diameter of the tympanum is slightly less or equal to the diameter of the eye; toes fully webbed; tips of the
fingers and toes swollen but not enlarged into discs; first finger is longer than the second; tibio-tarsal articulation reaches the tympanum or eye; heels overlap when the legs are folded at right angles to the body; skin smooth with distinct dorso-lateral glandular fold from above; body colouration is brick red to bright crimson from the tip of the snout to vent, distinctly separated from black of the sides; white marbling on sides and limbs.

Habitat: They are commonly found in forest litter deposits but during the breeding season they aggregate near the water bodies like water pools, paddy fields agricultural tanks.

Distribution: Distributed around Londa (15° 60' N 74° 53'E), Anashi (14° 48' N, 74° 11' E), Sirsi (14°34' N 74° 32' E), Sagar (16° 37' N 76° 51'E), Jog (14° 45' N 74° 53' E), Shimoga (13° 56N 75°38'E), Sringeri (13° 25' N 75°15'E), Agumbe (13° 32' N 74° 10'), Kollur (13°53'N 74° 53'E) and Kemmannugundi (13°13' N 75°15'E).

3. **Indirana beddomii**: It is a medium-sized frog, the largest specimen measures 32mm in SV length; head moderate, snout obtuse (figure. 3); Interorbital space as broad as the upper eyelid; fingers moderate; fingers and toes with well-developed discs; first finger equals to the second in length; tympanum two-third of eye; webbing on the toes extended to the lower half of fourth toe; tibio-tarsal articulation reaches the tip of the snout or little beyond;
heels strongly overlap when the limbs are folded at right angles to the body; skin olive black with dark spots and glandular folds; a strong supra-temporal fold from the eye to the shoulder; dark cross band between the eyes a black band along the canthus rostralis; limbs distinctly cross barred; ventral surface white.

Habitat: Commonly found on surface of wet rocks, inhabiting shallow water pools and pockets between grass or litter, under the canopy of dense vegetation. They are also found in litter deposits besides streams.

Distribution: Anashi (14° 48' N, 74° 11’ E), Agumbe(13° 32’N 74° 10’), Srigeri (13° 25’N 75°15’E), Kemmannugundi( 13°13’ N 75°15’E), Kollur (13°53’N 74° 53’E) and Amboli Ghat (15° 58’ N 74° 10’E).

4. *Limnonectes syhadrensis*: It is a small sized frog, the largest specimen measures 23mm in SV length; head longer than broad; snout obtusely pointed; hind limbs short; first finger hardly extends beyond the second; toes slightly webbed (less than *Limnonectes limnocharis*); the tibio-tatsal articulation reaches the tympanum or posterior border of the eye; a narrow mid dorsal line present; dorsal surface dark brown with broken longitudinal glandular skin; ventral surface white; thighs barred; in all specimens the lips are pale white without any dark vertical bars.
Habitat: Inhabit grass fields and paddy fields where there is shallow water, water pockets with submerged grass, small water pools.

Distribution: Anashi (14° 48' N, 74° 11' E), Sirsi (14°34' N 74° 32' E), Sagar (16° 37'N 76° 51'E), Jog (14° 45' N 74° 53' E), Shimoga (13° 56N 75°38'E), Agumbe(13° 32'N 74° 10'), Sringeri (13° 25'N 75°15'E) and Kollur (13°53'N 74° 53'E).

5. *Tomopterna rufescens*: Medium sized frog; the largest specimen measures 34 mm in SV length; head broader than long, with rounded snout (figure. 4); tympanum distinct; the diameter of the tympanum is about half the diameter of the eye; tibio-tarsal articulation reaches tympanum or eye; heels slightly overlapping when legs are folded at right angles to the body; first finger much longer than second, third equal to or slightly longer than first; toes feebly webbed; first phalanges of first and second toes free; sub articular tubercle of the finger are prominent; inner meta tarsal tubercle is large; skin with numerous warts above and two glandular ridges forming an inverted open 'V' between shoulders; body colour is brown above with dark spots and marbling; limbs barred.

Habitat: Inhabit at the margins of the streams between rocks and hilly terrain and also grass patches on elevated places. Frogs are also found in forests under stones and logs between decaying litter.
Distribution: Sagar (16° 37' N 76° 51' E), Jog (14° 45' N 74° 53' E), Agumbe (13° 32' N 74° 10'), Sringeri (13° 25' N 75° 15' E), Kollur (13° 53' N 74° 53' E) and Kemmannugundi (13° 13' N 75° 15' E).

6. *Rana curtipes*: A medium sized frog; the largest specimen measures 60 mm in SV length; head large; snout short (figure. 5), rounded with well marked canthus rostralis; nostrils nearer to the end of the snout than to the eye; tympanum distinct nearly as large as eye; fingers moderate; first finger extending beyond second; toes short, nearly entirely webbed; tips of the fingers and toes swollen or dilated in to very small discs; the tibio-tarsal articulation reaches the eye; the body colour is brown above with blackish dots, lateral folds, lighter limbs dark brown except the throat which is light brown.

Habitat: Commonly found on forest floor rich in decaying litter besides flowing water. They are also found at the edge of ponds, small water pockets.

Distribution: Londa (15° 60' N 74° 53' E), Anashi (14° 48' N, 74° 11' E), Sagar (16° 37' N 76° 51' E), Jog (14° 45' N 74° 53' E), Shimoga (13° 56' N 75° 38' E), Sringeri (13° 25' N 75° 15' E), Agubme (13° 32' N 74° 10'), Kollur (13° 53' N 74° 53' E) and Kemmannugundi (13° 13' N 75° 15' E).
7. *Kaloula pulchra*: Medium sized frog; the largest specimen measures 68 mm in SV length; snout rounded with indistinct canthus rostralis; inter orbital space is broader than the upper eyelid; fingers with well developed truncate discs; first finger shorter than the second; toes moderate, about one third webbed at the base, the tips are swollen; two meta tarsal tubercles present; tibio-tarsal articulation reaches the shoulder; colour pattern is distinct and consists of blackish brown and brick red areas (figure 6); a median blackish brown area bordered by two dorso-lateral bands of red and narrow inter orbital band of red; ventral surface grey.

Distribution: Dharwad (15° 27' N 75° 05'E), Sirsi (14° 34' N 74° 32'E), Sagar (16° 37' N 76° 51'E), Anasi (14° 48' N, 74° 11' E) and Londa (15° 60'N 74° 53'E).

8. *Ramanella montana*: Medium sized frog; the largest specimen measures 36 mm in SV length; snout short, blunt, post narial ridges well marked; fingers moderate, tips of the fingers dilated in to discs; toes webbed meta tarsal tubercle are two in number; tibio-tarsal articulation reaches to shoulder or between shoulder and eye; skin smooth; body colour brown with dark spots.

Habitat: Frogs are found in drainage canals, small water pools, puddles having loose soil besides ponds,
Distribution: Sagar (16° 37'N 76° 51'E), Jog (14° 45' N 74° 53' E), Shimoga (13° 56N 75°38'E), Sringeri (13° 25'N 75°15'E), and Kollur (13°53'N 74° 53'E).

9. *Rhacophorus malabaricus*: Large sized frog; the largest specimen measures 70mm in SV length; snout sub triangular; canthus rostralis distinct; loreal region slightly concave; nostrils equally distant from the eye and tip of the snout; Interorbital space is broad; tympanum is two-fifth of the diameter of the eye; fingers and toes webbed to the discs; The tibio-tarsal articulation reaches the eye or the nostril; heels overlap when the legs are folded at right angles to the body; skin finely granular above more coarsely below; body colour is green above (figure. 7), lower part whitish, web between fingers and toes pinkish. Habitat: Arboreal, found on big trees in evergreen forests, bamboo vegetation besides water bodies.

Distribution: Sagar (16° 37'N 76° 51'E), Agumbe (13° 32'N 74° 10'), Sringeri (13° 25'N 75°15'E), Anashi (14° 48' N, 74° 11' E) and Londa (15° 60'N 74° 53'E)

10. *Philautus variabilis*: Small sized frog; the largest specimen measures 26mm in SV length; head short; hind feet about two-third webbed; the webbing
extends to second tubercle on the side of the fourth toe and distal tubercle on
the fifth toe; a slight rudiment of webbing between fingers; tips of the fingers
expanded into discs; discs of the toes are narrower than that of those of the
fingers; the dorsal surface has small granules (figure. 8); a dark interorbital
band may be present; the colour of the dorsal surface ranges from light tan to
dark brown; however the frogs exhibit distinct colour patterns hence the name
variabilis; a more or less well defined barring pattern present on the legs and
feet.

Habitat: Common bush frog inhabits shrubs, small trees away from water.
Frogs are arboreal, rarely found on land.

Distribution: Widely distributed in many parts of Western Ghats which
includes the areas around Sirsi (14°34' N 74° 32' E), Sagar (16° 37'N 76°
51'E), Jog (14° 45' N 74° 53' E), Shimoga (13° 56N 75°38'E), Sringeri (13°
25'N 75°15'E), Kollur (13°53'N 74° 53'E) and Londa (15° 60'N 74° 53'E).
Fringe areas of Western Ghats including Dharwad (15° 27' N 75° 05'E) and
Belgaum (15° 52'N 74°34'E), and the areas around Miraj (16°49’N 74° 50'E)
and Sangli (16°52’N 74°36'E).

11. *Philautus leucorhinus*: Small sized frog; the largest specimen measures 27
mm in SV length; Head longer than broad; snout short pointed (figure. 9). nares
Explanation to figures

Figure 1 Shows adult *Rana temporalis* Note the distinctive colour pattern and distinct tympanum.

Figure 2 Shows adult *Rana malabarica* Note the supra temporal fold from the eye to shoulder.
Explanation to figures

Figure 3  Show adult *Indirana beddomi* Note the pointed snout  Distinct, tympanum  Fingers with discs

Figure 4  show adult *Tomopterna rufescens*  Note the skin with numerous warts  Limbs barred
Explanation to figures

Figure 5 Show adult *Rana curtipes* Note short rounded snout Tympanum distinct and nearly as large as eye

Figure 6 Shows adult *Kaloula pulchra* Note distinct colour pattern Snout rounded Fingers with well developed discs
Explanation to figures

Figure 7: Show adult Rhacophorus malabaricus. Note the sub triangular snout. Fingers and toes webbed to discs. Body colour green. Fingers and toes pinkish.

Figure 8: Shows adult Philautus variabilis. Note the tips of the fingers expanded into discs. Dorsal surface has small granules.
Explanation to figures

Figure 9 Shows adult *Philautus leucorhinus* Note the pointed snout Head longer than broad Tops of the digits with well developed discs

Figure 10 Shows adult *Philautus femoralis* Note Short and rounded snout Tympanum barely visible Digits with well developed discs Dorsal surface smooth
nearer to the tip of the snout than to the eye, canthus rostralis distinct, tympanum distinct, rounded or vertical, supra tympanic fold present, fingers with rudimentary webbing, first finger slightly shorter than the second, third finger longest, two palmar tubercles, tips of the digits with well developed discs with circummarginal grooves, subarticular tubercle on outer side of the first toe, dorsal side is smooth or slightly granular, ventral side is granular

Habitat  Found in bushes, shrubs and other small vegetation away from water

Frogs are also found in Banana plantations and holes and crevices of big trees

Distribution  Widely distributed in many parts of Western Ghats which includes the areas around Sirsi (14°34’ N 74° 32’ E), Sagar (16° 37’N 76° 51’E), Jog (14° 45’ N 74° 53’ E), Shimoga (13° 56N 75°38’E), Sringeri (13° 25’N 75°15’E), Kollur (13°53’N 74° 53’E), Anashi (14° 48’ N, 74° 11’ E), and Londa (15° 60’N 74° 53’E)

12 Philautus femorahs: Small sized frog, The largest specimen measures 24 mm in SV length, Snout relatively short and rounded ( figure 10), canthus rostralis moderate, loreal region oblique and slightly concave, nostrils nearer to the tips of the snout than to the eye, inter orbital space broader, upper eyelids relatively small, much narrower than inter orbital distance, tympanum barely visible, fingers free, a rudimentary webbing between the fingers, toes about three -fourth webbed with webbing extending to disc on fifth toe and to the
discs on the lateral sides of third and fourth toe, discs of fingers well developed, skin smooth dorsally, granular beneath, with granular throat

Habitat found in bushes, shrubs and small trees away from the water

Distribution Uncommon in Western Ghats Distributed around Agumbe(13° 32'N 74° 10'), Sringeri (13° 25'N 75°15'E) and Kollur(13°53'N 74° 53'E),

Discussion

Indian subcontinent with varieties of climate, vegetation and topography provides a great range of environments, which support a rich bio-diversity. The variations in geographical and ecological features within the subcontinent are responsible for uneven distribution of flora and fauna. Western Ghats are considered as richest in amphibian species in the whole of tropical Asia. This narrow biogeographic province is also remarkable for amphibian fauna unique to it and in that many species are endemic.

conducted based on the conventional method of collection and observation of anurans and hence these studies reveal the fauna of a limited geographical area. The geographic distribution of *Rana perezi* (Steinwarz and Schneider, 1991) and *Rana epeirotica* (Schneider and Haxhu, 1992) have been studied using calls as indicators of presence of species. In India, vocalization was first time used to locate and identify some frogs of Dharwad (Kanamadi and Hiremath 1990). In the present work, the distribution of some frogs is carried out in a larger geographical area in the Western Ghats. The species specific advertisement calls has led to locate *Rana malabarica, Rana temporalis, Rana curtipes, Indirana beddomi, Limnonectes syhadrensis, Tomopterna rufescens, Ramanella montana, Kaloula pulchara, Rhacophorus malabaricus, Philautus variabilis, Philautus leucorhinus* and *Philautus femoralis*.

The study reveals that *R. malabarica, L. syhadrensis, R. curtipes, P. variabilis* and *P. leucorhinus* are distributed in many parts of Western Ghats whereas *R. temporalis, P. femoralis, T. rufescens, R. malabaricus* are restricted to only the evergreen and semi evergreen forest belt. The taxonomic uncertainty prevails in the members of the group *ranidae* and *philautus*. The controversies regarding the *Limnonectes limnocharis* and *Limnonectes syhadrensis* exists because these species show some similarities in their morphology, and they coexist in some places. Hence, it is normally believed that *L. syhadrensis* is a sub species of *L. limnocharis*. The present study reveals...
that in many places they are sympatric and emit different types of advertisement calls, and can be easily differentiated by their calls. In the earlier studies, the distribution of *L. syhadrensis* was reported only from Maharastra, Goa (Inger and Dutta, 1984, Sekar, 1992, 1999, Dutta, 1992, 1997) and some parts of Karnataka (Darnels, 1991). The present work, for the first time, reports the distribution of the frog from many parts of Karnataka. The rhacophorid frog, *Philautus variabilis*, was reported from Kerala (Inger et al., 1984, Dutta, 1992, 1997, Daniels, 1997), Tamilnadu, (Dutta, 1992, 1997, Daniels, 1997, Karthikeyan, 2001), Andhra (Dutta, 1992, 1997) and in Karnataka, it was reported to occur only from Kemphole (Daniels, 1997). In the present survey, it is found that the frog is located in many parts of Western Ghats and its fringe areas of Karnataka and Maharastra.

It is observed that the members of the genus *Philautus, P. variabilis, P. leucorhinus* and *P. femoralis* show a unique distribution pattern. All the three species are sympatric around Agumbe, Sringeri and Kemmannugundi and in the rest of the Western Ghats, *P. variabilis* coexists with *P. leucorhinus* whereas in the fringe areas and near by places only *P. variabilis* is found. Further studies on bio-ecology of these frogs may help to reveal the reasons for such unique pattern of distribution.
The habitat selection is one of the important ecological requirements for successful breeding in frogs and toads. The richness of amphibian diversity in the study area reflects the availability of congenial habitat and microhabitat. The pattern of habitat selection in case of *R. malabarica, R. curtipes* and *R. temporalis* having a dense canopy cover and high density of trees helps to preserve moisture and humidity in the leaf litter even during the dry season. Small and shallow water pools on the rocks' surface in case of *I. beddomii*, streams between rocks and hilly terrain and grass patches on the elevated places in case of *T. rufescens* and shallow ground water pools in case of *L. syhadrensis* act as safe nurseries for the developing tadpoles.

The present study suggests that the vocalization is an important and reliable tool in identification of anuran species, which may be used in distribution studies.
Summary

1 This chapter deals with some anuran amphibians of Western Ghats. Species belonging to ranidae, microhylidae and rhacophoridae are located based on vocalization.

2 The species *Rana malabarica*, *Rana temporalis*, *Rana curtipes*, *Indirana beddomi*, *Limnonectes syhadrensis*, *Tomopterna rufescens*, *Ramanella montana*, *Kaloula pulchra*, *Rhacophorus malabaricus*, *Philautus variabilis*, *Philautus leucorhinus* and *Philautus femoralis* were located on the basis of vocalization and the distribution of these frogs was studied in different parts of Western Ghats based on calling.

3 *Rana malabarica*, *L syhadrensis*, *R curtipes*, *P variabilis* and *P leucorhinus* are distributed in many parts of Western Ghats whereas *R temporalis*, *P femoralis*, *T rufescens* and *R malabaricus* are restricted only to evergreen and semi evergreen forest belt.

4 The study suggests range extension of *L syhadrensis* and *P variabilis*.

5 It is suggested that vocalization is an important and reliable tool in identification of species and distribution studies on Indian anurans.