

Endemic and Threatened Amphibians from the Sacred Groves and Plateaus of Western Ghats in Maharashtra

Abstract

We studied the amphibian diversity and distribution with major emphasis on their endemism and conservation in the six sacred groves and six high altitude plateaus in the Western Ghats of Satara, Pune and Raigad districts of Maharashtra. Although these sites fall outside legal protected areas and are diminutive in size compared to a Sanctuary or National Park however they are patches of native biodiversity rich forests. Importance of such sites in terms of conservation of endemic species of Northern Western Ghats are discussed. These habitats are experiencing land use changes due to infrastructural and anthropogenic development. It is feared that fragmentation or degradation to these sites will cause local or irreversible extinction of endemic species. During our surveys we recorded seven endemic species from seven families of amphibians. Out of which one species is Endangered, two are Vulnerable, three are Data Deficient and one is Not Evaluated on IUCN redlist. This study unveils the fact that most of these points are functioning as refuge to the populations of endemic and threatened amphibians in Western Ghats and their conservation is important.

Introduction

Worldwide acclaimed biodiversity hotspot Western Ghats is the center of amphibian diversity and endemism (Biju 2001; Garg and Biju 2017). In vertebrates group, amphibians exhibit the highest level of endemism in Western Ghats of India. In Cretaceous period, a long topographical separation of Indian subcontinent may have given conditions for high endemism (Van Bocxlaer et al., 2012). The current Indian amphibian species count is ca 429 (Frost 2017) and 413 (Amphibia Web 2017). Several species are at the verge of extinction due to anthropogenic pressure (Biju et al., 2011). There have been many studies in the protected areas such as national parks and tiger reserves however there is a paucity of research data from legally unprotected and community conserved areas such as sacred forest or grasslands especially with respect to amphibian fauna. This study is an attempt to bridge this gap and to discover diversity of endemic amphibians in areas outside legal protection.

Key words:

Amphibians, endemic, Sacred groves, Maharashtra

Eggs of *Nyctibatrachus humayuni* from Maharashtra.
Photo Credit: Abhijit Das

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Since the British colonial era, western Maharashtra has been in focus for amphibian research. Novel species were described since 1888, for example *Indirana leithii* (Boulenger 1888) from Matheran and *Fejervarya syhadrensis* (Annandale 1919) from Satara and Pune districts. After independence, more species such as *Nyctibatrachus humayuni* (Bhaduri and Kripalani 1955) from Mahabaleswar (Satara District), *Indotyphlus battersbyi* (Taylor 1960) from Khandala, Poona District, *Xanthophryne koynayensis* (Soman 1963) from Koyna Satara district were discovered.

Recently, many herpetological searches in high rainfall areas such as Amboli forest (Sindhurg district), Koyna Wildlife Sanctuary (Satara district), Phansad Wildlife Sanctuary (Raigad district), Tahmini (Pune district) have revealed several novel species and highlights the previously considered underestimated diversity of amphibians in Maharashtra. For example, endemic anuran genus *Xanthophryne*; species *X. tigerina*, *Indirana chiravasi*, *Pseudophilautus amboli*, *Micrixalus uttaraghathi*, *Fejervarya cepfi*, *Gegeneophis danieli*, *Raorchestes ghatei*, *Indotyphlus maharashtraensis*, *Nyctibatrachus danieli*, *Indosylvirana caesari*, *Sphaerotheca pashchima* are

described in the last decade. Several researchers have worked on breeding behaviors, and found such as a new type of amplexus i.e. "Dorsal Straddle" with rare female call descript (Willaert et al. 2016; Gramapurohit et al. 2011) in endemic anuran *Nyctibatrachus humayuni*; reproductive biology of the endemic toad *Xanthophryne* (Gaitonde et al. 2016).

In the sense of tradition and religious duties, locals respect and protect their deity and their sacred groves (SGs). These groves are remnants of native forest covers so they contain high diversity and richness of species (Gadgil and Vartak 1976). The surrounding landscape influences the biodiversity thriving within the groves and any further disturbance may adversely affect the dwelling populations of endemic species and this may lead to local or permanent extinction of species in that area (Bhagwat et al., 2005). Sacred groves providing variety of habitats to locally restricted wild species as refuge so their protection should be on top priority (Ormsby and Bhagwat 2010).

The point endemism in amphibians has been seen on plateaus (PLs) in northern Western Ghats. It has been observed that plateaus acts as "islands" of biodiversity and

Xanthophryne tigerina is a critically endangered species.
Photo Credit: Abhijit Das



their local biological diversity is very unique than species found in plains. For example restricted distribution of *Xanthophryne tigrina* (Amboli plateaus), *X. koynaensis* and *Indotyphlus maharashtraensis* (Koyna plateaus) indicate extraordinary endemism for flora & fauna (Watve et al., 2013) in Northern Western Ghats. Presence of niches and micro habitats within forest patches and lateritic plateaus signify high amphibian conservation significance of these areas and they must be protected. This study adds more evidence to support this hypothesis.

Methods

Standard amphibian survey protocols were followed during the entire course of study. Stratified diurnal and nocturnal field surveys were conducted in mornings and evenings for two days per site for the inventory of endemic amphibians in the respective site using opportunistic sampling in the monsoon season from June to November in 2014. Survey time was approx. 6.00am-9.00am and 7.00pm- 10.00pm. Various habitat scanning methods were used such as actual sightings, presence of egg clutch, male anurans conspicuous advertisement calls, frogs' foam nest using search lights and head lamps at night. Previously published literature was reviewed to know the distribution and habitat of species. Variety of micro habitats such as leaf litter, rocky crevices, mud and small breeding pools for aquatic habitats, tree canopy for arboreal species were scanned. Digging the soil for fossorial animals such as *Ichthyophis* and *Indotyphlus*, upturning stones, scanning leaf litters; road kill sightings were also observed (Kamei et. al., 2009). Field protocols were followed such as using protective gum boots or shoes by field workers, head lamps and search lights were used for nocturnal surveys. First aid kit was always carried on the field (Gururaja and Ramachandra 2012). GPS readings of study sites were taken using GARMIN GPS 60. A final map using Arc GIS and Google Earth Pro was prepared.

Result

From our study we recorded seven endemic species which belong to seven families. Out of these seven Western Ghats endemics, six species *Fejervarya cepfi*, *Indirana leithii*, *Nyctibatrachus humayuni*, *Raorchestes ghatei*, *Indosylvirana caesari* and *Indotyphlus maharashtraensis* are endemic to Northern Western Ghats(*) i.e. they show restricted distribution with respect to north of Goa gap.

Figure 1: Map of Study sites and endemic species distribution

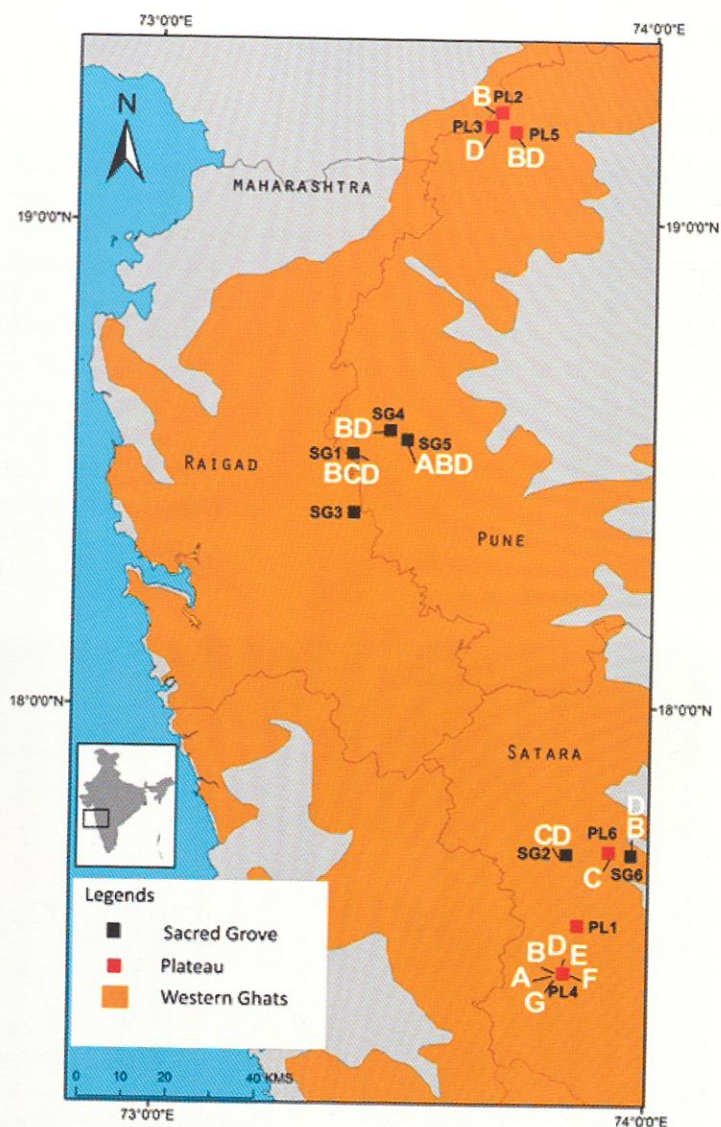


Table 1: Endemic species reported in this study:

Sgs					
S. no.	Species Common Name	Scientific Name	Family	Occurrence (as per IUCN)	Conservation Status (IUCN)
1	CEPF Burrowing Frog	<i>Fejervarya cepfi</i>	Dicroglossidae	N/A	Not evaluated
2	*Matherana Leaping Frog	<i>Indirana leithii</i>	Ranixalidae	Common	Vulnerable
3	*Bombay Night Frog	<i>Nyctibatrachus humayuni</i>	Nyctibatrachidae	Common	Vulnerable
4	*Ghate's Bush Frog	<i>Raorchestes ghatei</i>	Rhacophoridae	Common	Data Deficient
PLs					
5	*Maharashtra Golden Frog	<i>Indosylvirana caesari</i>	Ranidae	Common	Data deficient
6	*Humbarli Caecilian	<i>Indotyphlus maharashtraensis</i>	Indotyphlidae	Uncommon	Data deficient
7	Marbled Ramanella Frog	<i>Uperodon marmoratus</i>	Microhylidae	Common	Endangered

Note: *Species endemic to Norther Western Ghats

Raorchestes ghatei was the most commonly encountered endemic species during our study and was sighted and heard in most of the sites in the shrubs and small trees in the sacred forest as well as on the shrub cover on high altitude plateaus. Newly described *Fejervarya cepfi* was uncommon and was found only in two sites, in a sacred grove and a plateau each. *Indirana leithii* was also fairly sighted in many of the sites under leaf litter, rocky outcrops and on the adjacent roads to sites. *Indosylvirana caesari* was seen on the rocks in the downside streams emerging from

sloppy edges of the Vankasawadi plateaus. *Indotyphlus maharashtraensis* was caught after digging the moist soil near the herbaceous plantation of *Strobilanthes* sp., *Eriocaulon* sp. and *Utricularia* on Vankasawadi Plateau.

Three species were threatened on IUCN redlist. *Indirana leithii* and *Nyctibatrachus humayuni* are Vulnerable; and *Uperodon marmoratus* is Endangered in IUCN redlist. The endemic species recorded in this study is approx. 35% of the total endemics of Northern western Ghats in

Hydrophylax bahuvistara
Photo Credit: Abhijit Das



Table 2: Site details and codes

S.no.	Surveyed Sites	Site Code	District	Latitude	Longitude	Elevation (approx. meters)
1	Bapuchibuva Sacred Grove	SG1	Pune	18°31'14.04"N	73°23'36.43"E	712
2	Ghataidevi Sacred Grove	SG2	Satara	17°41'44.74"N	73°50'11.41"E	1150
3	Kondethar Sacred Grove	SG3	Raigad	18°23'54.80"N	73°23'47.82"E	539
4	Vadavdhar Sacred Grove	SG4	Pune	18°33'39.90"N	73°29'9.95"E	757
5	Valne Sacred Grove	SG5	Pune	18°32'58.13"N	73°30'11.69"E	735
6	Yavtेशwar Sacred Grove	SG6	Satara	17°41'27.79"N	73°57'9.47"E	1041
7	Chalakewadi Plateau	PL1	Satara	17°33'0.52"N	73°50'17.66"E	1143
8	Durgawadi Plateau	PL2	Pune	19°13'10.60"N	73°38'59.38"E	1157
9	Hatvij Plateau	PL3	Pune	19°12'33.62"N	73°38'45.32"E	1105
10	Vankasawadi Plateau	PL4	Satara	17°27'1.57"N	73°50'0.93"E	1085
11	Warsubai Plateau	PL5	Pune	19°11'22.88"N	73°42'48.49"E	1130
12	Yavtेशwar Plateau	PL6	Satara	17°42'3.91"N	73°55'19.24"E	1025

Table 3: Presence chart of endemic species in study sites

S. no.	Species	SG 1	SG 2	SG 3	SG 4	SG 5	SG 6	PL 1	PL 2	PL 3	PL 4	PL 5	PL 6
A	<i>Fejervarya cepfi</i>					Y					Y		
B	<i>Indirana leithii</i>	Y			Y	Y	Y		Y		Y	Y	
C	<i>Nyctibatrachus humayuni</i>	Y	Y										Y
D	<i>Raorchestes ghatēi</i>	Y	Y		Y	Y	Y			Y	Y	Y	
E	<i>Indosylvirana caesari</i>										Y		
F	<i>Indotyphlus maharashtraensis</i>										Y		
G	<i>Uperodon mormoratus</i>										Y		

Maharashtra. More detailed assessments are required in such sacred groves and plateaus as they will yield more endemic species thriving in legally unprotected areas and their conservation measures are needed to be addressed urgently since land use and land cover patterns are changing rapidly in these landscapes due to urbanization and developmental activities.

Species account

1) Matheran Leaping Frog *Indirana leithii* (Boulenger, 1888)

Diagnostic Characters: Medium-sized frog with snout vent length (SVL) 34mm; head longer than wide and snout lengthier than horizontal diameter of eye; snout rounded; pupil horizontal; tympanum

distinct, more than $\frac{3}{4}$ of eye; canthus rostralis indistinct in cross section; flank granular with warts; has truncated and Y shaped discs. Femoral glands are present in males. First finger shorter than second, webbing extensive. Semi-terrestrial tadpoles.

Distribution: Restricted to northern Western Ghats from Ahwa Dang in Gujarat to Gaganbawda in Maharashtra, records outside Western Ghats needs confirmation (Dahanukar et al. 2016). Recorded and found common in Bhimashankar, Matheran and Mahabaleshwar.

Local Observations: *I. leithii* was found and seen commonly in most of the sites. Individuals were seen in the moist leaf litter and wet rocks crevices in forest patches of sacred grove and plateaus in Mulshi, Junnar (Pune) and Patan Koyana (Satara). We



Figure : Matheran Leaping Frog
(*Indirana leithii*)

observed few dead (road killed) individuals on tar road adjacent to Vadavthar sacred groves after heavy showers in the night. On an occasion we observed *I. leithii* individuals moving out from the plastic and temple waste in Valne sacred grove (Pune district). They were more abundant in sacred grove forest areas than plateau grasslands (see table 3).

2) CEPF Burrowing Frog *Fejervarya cepfi* (Garg and Biju, 2017)

Diagnostic Characters

It's a medium sized frog (SVL 33 mm) with stout body. Snout subovoid in dorsal view

and obtuse in lateral view. Presence of rictal gland at labial region of the mouth; eye length shorter than snout length; tympanum diameter nearly half of eye length; thigh length shorter than shank length; prominent shovel-shaped inner metatarsal tubercle prominent and small outer metatarsal tubercle; webbing between toes small.

Distribution

Known to occur in Western Ghats in Maharashtra. Amboli (Sindhurg district) is the type locality. Also shows confirmed distribution record from Phansad Wildlife Sanctuary (Raigad district) and Koyna Wildlife Sanctuary in Satara district (Garg and Biju, 2017).

Figure : CEPF Burrowing Frog
(*Fejervarya cepfi*)



Local Observations

We recorded this species from Valane sacred grove (Pune) and Vankasawadi Plateau (Satara) in our study (see table 3). It was relatively less abundant as compared to its sympatric *F. syhadrensis*. On both occasion we found them on tar roads at night after light showers.

3) Bombay Night Frog *Nyctibatrachus humayuni* (Bhaduri and Kripalani, 1955)

Diagnostic Characters

N. humayuni is a medium sized frog (male 47mm, female 52mm), snout is rounded; tympanum is not visible; grey, brown to brick red and wrinkled dorsal skin with dorsolateral folds and glandular projections; well-developed ridge extending from the lip over the tip of the snout to between the nostrils, at which point it bifurcates, producing an inverted 'Y' and webbing is modest (Biju et. al. 2011).

Distribution

N. humayuni is known to occur and widely spread in the semi evergreen forests in Koyna Kaas, Mahabaleshwar and Bamnoli in Satara district; Khandala, Mulshi in Pune district; and Matheran in Raigad district.

Local Observations

We found this species from two sacred forest and two plateaus edges which had somewhat good overhanging vegetation with canopy especially in both sacred groves (see table 3). All the recorded sites had perennial rocky streams. It has been observed in Ghatai Devi sacred grove where the stream water was diverted for construction purpose to expand the temple premises may degrade the forest patch and subsequently impact the habitat of *N. humayuni*. It is the only anuran species in the world known to use a newly discovered mating position known as "dorsal straddle" and rare female calls of *N. humayuni* has been reported (Willaert et al. 2016). It is an endemic frog and Vulnerable on IUCN redlist. Its conservation measures are recommended to stop infrastructural



Figure : Bombay Night Frog
(*Nyctibatrachus humayuni*)

activities in the sacred groves and surrounding forest.

4) Ghate's Shrub Frog *Raorchestes ghatei* (Padhye, Sayyed, Jadhav, and Dahanukar, 2013)

Diagnostic characters

It is a shrub frog with size (25mm); snout

slightly projecting beyond mouth; tympanum small 1/3 of eye. Tongue deprived of pipila; nuptial pad is absent; a bony tubercle on humerus in males is present as sexual dimorphism character. Skin is granulated on dorsum; lateral groin is marbled with white blotches on brown; fingertip dilation has discs.

Distribution

It is a common and widely distributed species inhabit semi-evergreen forests and scrub patches in the Western Ghats of Maharashtra.

Local Observations

The only shrub frog species recorded in our study. Common in most of the sites. Males were heard calling from shrubs and undergrowth at height of 1-5 meters above ground at night. Some individuals (mostly females) were seen under rocks in day.

Figure : Ghate's Shrub Frog
(*Raorchestes ghatei*)



5) Maharashtra's Golden-backed Frog *Indosylvirana caesari* (Biju, Mahony, Wijayathilaka, Seneviranthne, and Meegaskumbura, 2014)

Diagnostic Characters

I. caesari is a medium sized frog with 50mm SVL). Head is small, extended; horizontal from dorsum; snout is pointed in dorsal and ventral and rounded in lateral view. canthus rostralis cross section is rounded; nostril oval; tympanum slightly smaller than of eye; Forelimbs shorter than the length of hands; fingers are long; pointed discs; moderate webbing present; Skin near snout and eyes shagreened; dorsum granular; dorsolateral fold present; rictal gland is distinct at corner of mouth; throat smooth; ventral belly shagreened.

Distribution

It's endemic to Western Ghats of Maharashtra. Recorded from Humbarli in Koyna, Bamnoli, Kaas, Mahabaleshwar (Satara district) and Amboli (Sindhudurg district) (Biju et al. 2014). It has been seen in streams of north Goa also.

Local Observations

During our study, this species was recorded only from Vankasawadi Plateau area in Patan (Satara district) in a sloppy downside hill stream at the edge of plateau. Three individuals (males) were seen on the lateritic rocks in the stream near monsoon ephemeral grown herbaceous vegetation of *Eriocaulon* sp. and *Utricularia* sp. on the upper side and rocky stream in the downside of the hill. This area is under severe anthropogenic pressure due to windmill farms and construction sites.



Figure : Maharashtra's Golden-backed Frog (*Indosylvirana caesari*)

6) Marbled Ramanella
***Uperodon marmorata* (Rao, 1937)**

Size approx. 35 mm. Blunt snouts with V shaped markings on snout. Warty dorsum. Fingers with wide triangular dilations. Less webbing in feet. Occur in north Western Ghats montane rain forests above 1,000 m and north Western Ghats moist deciduous forests below and can be seen on the forest floor, tree bases, holes and termite mounds. Nothing is known about its breeding

behavior, probably its eggs metamorphose into adults through larval development like other microhylids. Habitat loss is caused due to change in land use pattern for agriculture, plantation, tourism and development are amongst major threats to this anuran. In our surveys to Vankaswadi plateau, we have observed an individual in a small forest patch near road. Habitat fragmentation further drives this species towards extinction. It's an Endangered species on IUCN redlist and endemic to Western Ghats.

Figure : Marbled Ramanella (*Uperodon marmorata*)



7) Humbarli Caecilian
Indotyphlus maharashtraensis
(Giri, Wilkinson, and Gower,
2004)

Diagnostic Characters

Secondary annular grooves present; it has a depressed preanal strip anterior to disc surrounding vent. Small mid-ventral longitudinal incision in front of vent; V shaped scar on the posterior part of dorsal surface of head; Body shape cylindrical and dorsally compressed. Snout tip bluntly rounded; Eyes visible through skin;

Tentacles are short and globular and pointed at tip. Tentacles apertures are horseshoe shaped.

Distribution

Known to occur only from its type locality in Koyna (Satara district).

Local Observations

It was seen in the lateritic moist thin soil cover after digging on the high altitude plateau top of Vankasawadi in Patan post monsoon in September 2014. The surrounding habitat had sparsely grown *pleocaulus* sps., *Eriocaulon* sps. and *Utricularia* sps. herbaceous vegetation.



Figure : Humbarli Caecilian
(*Indotyphlus maharashtraensis*)

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