

Diversity of Anuran Fauna in Mangalore Taluk, Dakshina Kannada District, Karnataka, India

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The amphibian (caecilians, salamanders and anurans) fauna of India is very diverse and play a major role in ecosystem functioning, especially as consumers of pest

insects and their therapeutical value (Dinesh et al. 2009; Tseng et al. 2010). Semi-permeable skin, amniotic eggs and the biphasic life make them particularly vulnerable

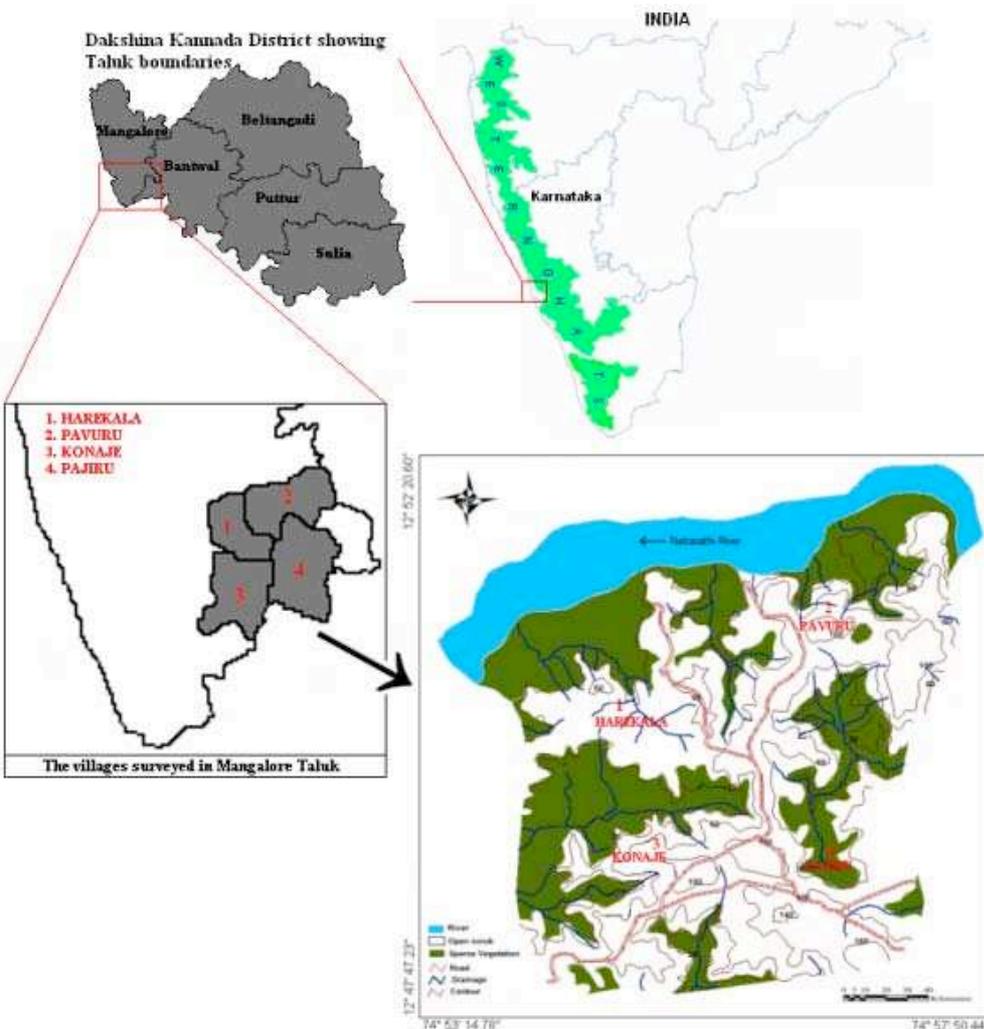


Image 1. *Duttaphrynus melanostictus*

to changes via contamination of their habitats. Frost (2011) recorded 5,966 anurans among 6,771 species of amphibians in the world and in India, a total of 295 anurans among 330 amphibians. The Western Ghats, biodiversity hotspot of India harbors as many as 157 species of amphibians which includes 134 anurans and 112 endemic species (Dinesh & Radhakrishnan 2011).

Numerous studies have documented anurans in the Karnataka portion of the Western Ghats (Uttangi 1989; Daniels 1992; Dutta & Ray 2000; Krishnamurthy & Hussain 2000; Manjunatha Reddy et al. 2001; Aravind 2002; Krishnamurthy 2003; Das & Kunte 2005; Dinesh et al. 2007; Seshadri et al. 2009; Molur & Molur 2010; Hegde & Bhat 2011; Purushotham & Tapley 2011; Gururaja & Ramachandra 2012; Hegde 2012; Rathod & Rathod 2013). However, the documentation of anurans from the Mangalore Taluk

Figure 1: The map showing open scrub and sparse vegetation, drainages, contour of the surveyed villages situated south of Netravathi river, Dakshina Kannada district, Karnataka, India.



the morphological features and the structure of advertisement calls (Kuramoto & Joshy 2001; Kuramoto et al. 2007), molecular and morphological studies on genus *Euphylietus* (Joshy et al. 2009), presence of deformities in the case of *Fejervarya rufescens* and *Indirana beddomii* (Nair & Kumar 2005, 2007) and sexual dimorphic features of fungoid frog *Hylarana malabarica* (Nair & Kumar 2010) from Konaje.

The presence of a good population of amphibians in a region is an indication of a healthy environment (Gururaja et al. 2008). In context, the present study aimed to document and compares the anuran diversity of four villages (Harekala, Pavuru, Pajiru and Konaje) in Mangalore Taluk, Dakshina Kannada District, Karnataka.

Material and Methods

Study area

The study area (14,370 acres) lies between 12°47'47"N to 12°52'20"N & 74°53'14"E to 74°57'50"E covers four villages (Harekala, Pavuru, Pajiru and Konaje) encompassing varied topography and forest cover (Fig. 1 and Table 1) situated south of Netravathi River in Mangalore Taluk, Dakshina Kannada District of Karnataka.. The altitude ranges from 20-160 m. The area receives an average rainfall ranging



Image 2. *Euphylietus aloysii*

from 22.76-99.44 cm during the monsoon (June to September) during March 2003 to December 2006. The temperature recorded varied from 17.8 to 37.1°C and humidity ranged from 25 to 100 %.

The study area consist predominately of an open and sparse scrub forest, paddy fields (food crop *Oryza sativa*), trees (*Hopea ponga*, *Terminalia*

Figure 3. Bray-Curtis similarity level based on richness of anuran species encountered in certain localities of four villages (Harekala, Pavuru, Pajiru and Konaje), Mangalore Taluk, Karnataka.

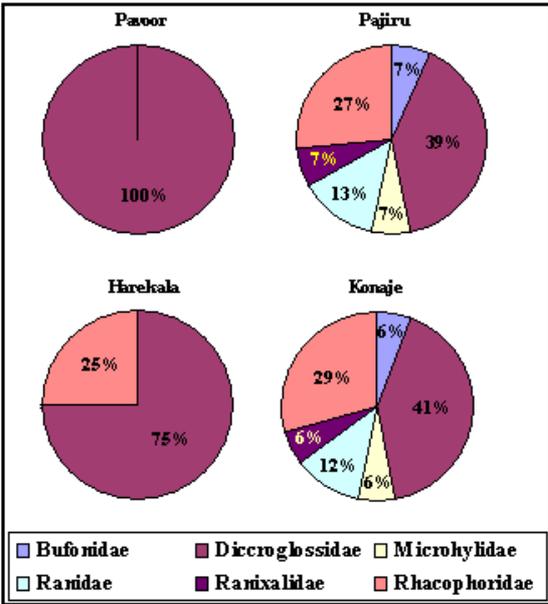
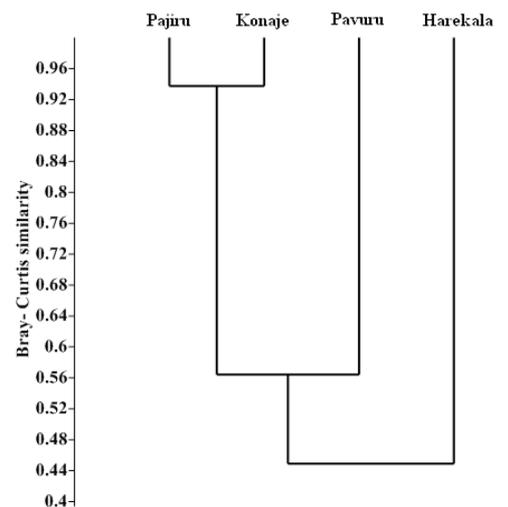


Figure 2. Percent distribution of representative families of sighted anurans from certain localities covering four villages in Mangalore Taluk, Karnataka. Dicroglossidae family is represented maximally in all the four villages viz: Harekala, Pavuru, Pajiru and Konaje.

in Dakshina Kannada District of the state is scanty. Existing literature documents the presence of the burrowing frog, *Sphaerotheca dobsonii* in Mangalore (Boulenger 1882). Research on anurans from certain localities (Kadri, Padil, Bajipe, Adyar and Karnoor) in Mangalore Taluk have documented

Image 3. *Fejervarya caperata*



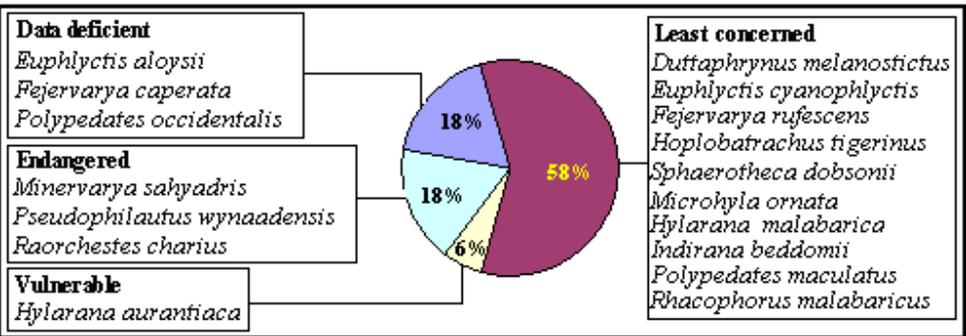


Figure 4: IUCN status of anurans recorded from certain localities of four villages viz: Harekala, Pavuru, Pajiru and Konaje, Mangalore Taluk, Karnataka.

Image 4. *Fejervarya rufescens*



paniculata, *Alstonia scholaris*, *Terminalia tomentosa*, *Syzygium caryophyllatum*, *Mimusops elengi*, cultivated endemic plants of Western Ghats (Shetty & Kaveriappa 2001), plantation crops (areca *Areca catechu*, coconut *Cocos nucifera*, cultivated plants such as — cashew *Anacardium occidentale*, mango *Mangifera indica*, banana *Musa paradisiaca*, acacia *Acacia auriculiformis*, eucalyptus *Eucalyptus globulus*, casuarina *Casuarina equisetifolia*), and natural/artificial water bodies.

Data collection and analysis

The sampling was done randomly particularly during the

rainy season at dawn and dusk. The anurans were detected based on visual encounter and through their auditory call. Certain parts of the study area could not be explored due to very steep slopes and thick vegetation. The anurans sighted at certain localities viz: Gramachavadi in Harekala Village; Pavuru and Inoli in Pavuru Village; Pajiru and Kambla Padavu in Pajiru Village; Adkare, Parande, Kodijal, Mulara, Mangalore University campus and Patteri in Konaje Village (Fig 1 & Table 2) were hand-picked or caught using aquatic nets. The collected individuals were photographed, identified using appropriate

identification keys (Boulenger 1890; Rao 1937; Daniel 1963a, 1963b, 1975; Daniel & Sekar 1989; Daniel 1997a, b, c; Chanda 2002; Daniels 2005) and were released after recording morphometric data viz: Snout-vent length (SVL - from tip of snout to posterior margin of vent); Head length (HL - distance from cranial ridge to snout tip); Head width (HW - widest part of the head); Snout length (SL - distance from anterior margin of the eye to snout tip); (NED - distance between anterior edge of eye and posterior edge of nostrils); Nostril to snout tip (NST - distance between anterior

Image 5. *Hoplobatrachus tigerinus*



Table 1. Bird's eye view of land use, cover pattern (%) and relative number / density (+ : lowest; ++: medium; +++: high and ++++: highest) of four villages (Harekala, Pavuru, Pajiru and Konaje) situated south of Netravathi river in Mangalore taluk, Dakshina Kannada district.

Bird's eye view of land use and cover area %	Harekala	Pavoor	Pajiru	Konaje
Barren / little vegetation	10	10	50	10
Paddy fields	20	15	20	10
Natural forest / Canopy cover	70	75	30	80
open scrub vegetation	++	++++	+	+++
sparse vegetation	+	+++	++	++++
Drainages	+	++++	++	+++
Natural water bodies	+++	++++	+	++
Artificial water bodies	+	+	+++	++++

Table 2: List of anuran species and diversity indices (Shannon-Wiener and Evenness) based on number of species and their representative families recorded from four villages in Mangalore taluk, Dakshina Kannada District.

FAMILY	SPECIES	PAVURU	HAREKALA	PAJIRU	KONAJE
Bufoidea	<i>Duttaphrynus melanostictus*</i>	x	x	√	√
Dicroglossidae	<i>Euphlyctis aloysii</i>	√	x	x	√
	<i>Euphlyctis cyanophlyctis</i>	√	√	√	√
	<i>Fejervarya caperata</i>	√	√	√	√
	<i>Fejervarya rufescens</i>	√	x	√	√
	<i>Hoplobatrachus tigerinus*</i>	√	√	√	√
	<i>Minervarya sahyadris</i>	√	x	√	√
	<i>Sphaerotheca dobsonii</i>	√	x	√	√
Microhylidae	<i>Microhyla ornata*</i>	x	x	√	√
Ranidae	<i>Hylarana aurantiaca*</i>	x	x	√	√
	<i>Hylarana malabarica</i>	x	x	√	√
Ranixalidae	<i>Indirana beddomii</i>	x	x	√	√
Rhacophoridae	<i>Polypedates maculatus*</i>	x	√	√	√
	<i>Polypedates occidentalis*</i>	x	x	√	√
	<i>Pseudophilautus wynaadensis*</i>	x	x	√	√
	<i>Raorchestes charius*</i>	x	x	x	√
	<i>Rhacophorus malabaricus*</i>	x	x	√	√
Total number of families		1	2	6	6
Total number of species		7	4	15	17
Shannon-Wiener index	No. of families	1.529	1.477
	No. of species	1.665	1.181	1.969	2.542
Evenness index	No. of families	0.7691	0.73
	No. of species	0.76	0.82	0.48	0.75

edge of snout and posterior edge of nostrils); Eye diameter (ED - maximum distance between rims of eye); Tympanum diameter (TD - maximum distance between rims of tympanum); Width of upper eyelid

(WUE- distance between margin to the base of eyelid); Inter-orbital width (IOW- shortest distance between eye sockets); Inter-narial width (INW - distance between

nostrils); Forelimb length (FLL - distance from shoulder joint to tip of longest finger); Hindlimb length (HLL - cloacae to tip of longest toe); Femur length (FEL - cloacae

Image 6. *Minervarya sahyadris*



Image 7. *Microhyla ornata*



Image 8. *Hylarana aurantiaca*



Image 9. *Hylarana malabarica*



to knee) and Tibia length (TIL - knee to heel) using digital calipers (Fisher Scientific) to the nearest 0.01 mm (Table 3).

Shannon-Wiener (Shannon & Weaver 1949) and evenness indices are used for comparing diversity between varied habitats (Clarke & Warwick 2001). The evenness index will be zero if the sample in consideration has only one species and would be maximal when all species of the sample in consideration have even abundance (Sagar & Singh 1999). The indices (Shannon-Wiener and Evenness) and Bray-Curtis similarity coefficient values were generated using PAST software (Hammer 2001).

Result and Discussion

The present study, the first report from certain localities covering four villages records the occurrence of 17 species of anurans (Images

1-14), placed under six families viz: Bufonidae, Dicroglossidae, Microhylidae, Ranidae, Ranixalidae and Rhacophoridae (Table 2 & Fig. 2). Nine species are recorded for the first time from the Mangalore Taluk (Table 2).

Family-wise distribution suggests the highest representation of Dicroglossidae in Pavuru and Harekala, whereas the Rhacophoridae (mainly arboreal) were represented mostly in Konaje and Pajiru. Species sighted represent one family in Pavuru, two in Harekala and six in Konaje and Pajiru (Fig. 2). Habitat-wise distribution suggest the occurrence of anurans representative of varied habitats (aquatic, semi-aquatic, terrestrial, burrowing, semi-arboreal and arboreal) in Pajiru and Konaje, while the aquatic, semi-aquatic and arboreal anurans were recorded from Harekala. On the other hand, only the aquatic, semi-aquatic and burrowing species were sighted in Pavuru (Table 2). The high species richness in Konaje and Pajiru

Image 10. *Indirana beddomeii*



Image 11. *Polypedates maculatus*

(Table 2) suggest the presence of suitable habitats (Table 1) and food availability compared to the other two villages (Harekala and Pavuru) that lie in close proximity to the Netravati river (Fig. 1). The lesser diversity of anuran species in Harekala and Pavuru villages may also be due to inundation during high tide which probably be resulting in non availability of food during inundation. However there could have been an under estimation of species at Pavuru and Harekala due to the steeper slopes and dense vegetation that could not be surveyed. The details of the morphometric data recorded is as detailed in Table -3.

Diversity indices in the present study suggest more or less similar richness / diversity of anurans in Konaje and Pajiru, the maximum being in Konaje (Table 2). The Bray-Curtis similarity index based on shared anuran species richness exhibits that Konaje and Pajiru

Table 3: Morphometric data* (mean ± standard deviation in mm) of anuran species recorded from four villages (Harekala, Pavuru, Pajiru and Konaje), Mangalore Taluk, Dakshina Kannada District.

Species	SVL	HL	HW	SL	NED	NST	WUE	IOW	INW	ED	TD	FL L	HLL	FEL	TIL
<i>Duttaphrynus melanostictus</i>	68.61 ± 4.98	16.14 ± 1.61	26.07 ± 1.54	4.79 ± 0.32	3.32 ± 0.25	0.96 ± 0.13	5.93 ± 0.27	5.04 ± 0.13	4 ± 0.00	6 ± 0.00	4 ± 0.00	45.29 ± 3.81	97.29 ± 11.87	29.64 ± 3.89	26.36 ± 2.95
<i>Euphlyctis alowsii</i>	33 ± 5.46	9.82 ± 2.12	11.64 ± 2.11	3.55 ± 0.47	2.41 ± 0.38	0.64 ± 0.23	2.55 ± 0.42	1.23 ± 0.26	1.91 ± 0.54	3.5 ± 0.00	3 ± 0.00	18.91 ± 3.30	53.64 ± 11.32	15.64 ± 2.94	14.18 ± 2.60
<i>Euphlyctis cyanophlyctis</i>	58.36 ± 3.22	17.64 ± 0.56	22.14 ± 1.11	5.29 ± 0.27	3.29 ± 0.27	1.5 ± 0.00	3.86 ± 0.24	2 ± 0.00	2.64 ± 0.24	5 ± 0.00	4.5 ± 0.00	34 ± 1.53	93.07 ± 4.48	28.36 ± 1.21	25.36 ± 1.21
<i>Fejervarya caperata</i>	32.09 ± 1.70	9.24 ± 1.01	10.78 ± 1.50	4.61 ± 0.37	2.43 ± 0.17	1.72 ± 0.25	2.70 ± 0.25	2.00 ± 0.00	2.70 ± 0.25	3.13 ± 0.68	1.78 ± 0.25	18.35 ± 1.19	55.70 ± 5.29	14.20 ± 1.47	16.98 ± 2.40
<i>Fejervarya rufescens</i>	38.14 ± 1.78	9.5 ± 0.73	13.47 ± 0.67	3.5 ± 0.62	1.97 ± 0.67	1.03 ± 0.21	3.03 ± 0.12	1.97 ± 0.12	2.72 ± 0.35	4.42 ± 0.43	1.92 ± 0.43	23.53 ± 5.28	60.72 ± 3.36	18.22 ± 1.00	18.78 ± 1.73
<i>Hoplobatrachus tigerinus</i>	94.58 ± 16.85	12.5 ± 2.26	33.42 ± 5.06	12.00 ± 1.82	-	-	-	2.92 ± 1.11	4.92 ± 0.74	8.92 ± 0.80	6.67 ± 0.82	54.33 ± 10.34	151.08 ± 23.53	45.5 ± 7.34	47.58 ± 7.49
<i>Minervarya sahyadris</i>	20.9 ± 0.77	5.3 ± 0.26	6.6 ± 0.52	2.00 ± 0.00	1.00 ± 0.00	0.7 ± 0.11	1.4 ± 0.21	1.7 ± 0.11	1.5 ± 0.00	2.00 ± 0.00	1.00 ± 0.00	10 ± 0.00	29.5 ± 1.29	8.3 ± 0.26	9.00 ± 0.00
<i>Sphaerotheca dobsonii</i>	62.5 ± 2.39	18.63 ± 2.20	24.75 ± 1.89	7.31 ± 1.65	4.31 ± 0.88	2.5 ± 0.93	5.63 ± 0.74	3.81 ± 0.59	4.38 ± 0.44	7.25 ± 0.71	3.63 ± 0.35	37.94 ± 2.74	85.75 ± 5.76	26.63 ± 2.56	23.25 ± 1.58
<i>Microhyla ornata</i>	20.11 ± 1.60	4.83 ± 0.90	6.11 ± 0.82	2.28 ± 0.36	1.72 ± 0.36	0.37 ± 0.09	1.00 ± 0.00	2.22 ± 0.51	1.86 ± 0.22	1.75 ± 0.25	-	11.33 ± 1.56	32 ± 2.19	8.67 ± 0.71	9.56 ± 0.68
<i>Hylarana aurantiaca</i>	39.75 ± 2.47	11.5 ± 2.12	10.25 ± 1.77	5.00 ± 0.00	4.00 ± 0.00	0.50 ± 0.00	2.75 ± 0.35	4.25 ± 0.35	3.75 ± 0.35	3.75 ± 0.35	2.75 ± 0.35	28 ± 2.83	68.5 ± 0.71	18.5 ± 0.71	21 ± 1.41
<i>Hylarana malabarica</i>	57.42 ± 5.37	16.58 ± 1.44	19.33 ± 1.23	5.92 ± 0.90	4.04 ± 0.72	1.17 ± 0.39	5.29 ± 0.26	4.25 ± 0.45	4.92 ± 0.42	5.79 ± 0.26	4.79 ± 0.26	35.75 ± 2.42	86.75 ± 7.12	23.25 ± 2.63	26.88 ± 2.30
<i>Indirana beddomii</i>	29 ± 4.71	9.88 ± 1.03	11.5 ± 1.00	4.38 ± 0.63	3.00 ± 0.82	0.88 ± 0.25	2.25 ± 0.29	2.75 ± 0.50	3.25 ± 0.50	3.25 ± 0.50	2.25 ± 0.50	16.38 ± 2.72	48.63 ± 6.26	14 ± 1.41	15.25 ± 1.71
<i>Polypedates maculatus</i>	66 ± 5.11	18.57 ± 1.74	22.21 ± 1.37	7.18 ± 0.72	5.14 ± 0.53	1.14 ± 0.31	5 ± 0.76	7.18 ± 0.89	4.64 ± 0.41	5.96 ± 0.60	4.64 ± 0.46	40.32 ± 3.32	106.29 ± 12.36	30.93 ± 3.38	33.29 ± 2.87
<i>Polypedates occidentalis</i>	58.17 ± 5.31	14.75 ± 2.40	18.5 ± 2.41	6.42 ± 0.58	4.25 ± 0.27	1.67 ± 0.41	5.25 ± 0.61	5.42 ± 0.49	4.25 ± 0.42	6.15 ± 0.37	4.3 ± 0.46	43.83 ± 9.85	98.75 ± 14.72	29.67 ± 3.88	31.92 ± 4.76
<i>Pseudophilautus wynaadensis</i>	22.13 ± 2.11	5.75 ± 0.45	8.63 ± 0.43	3.13 ± 0.23	2.13 ± 0.23	0.5 ± 0.00	1.63 ± 0.23	2.88 ± 0.23	2.25 ± 0.45	2.6 ± 0.18	1.05 ± 0.09	12.21 ± 2.78	37.21 ± 2.62	11.04 ± 0.72	11.83 ± 0.98
<i>Raorchestes charius**</i>	22	8	8.5	2.5	1.5	0.5	2	2	2	2.5	1	12	34	9.5	11
<i>Rhacophorus malabaricus**</i>	41.5	14.5	15.5	6.5	4.5	1.5	2	5	4	4	3	30	76.5	21	22.5

*Mean of six; ** only one sample. SVL - snout vent length; HL - distance from cranial ridge to snout tip; HW - Head width; SL - Snout length; NED - distance between anterior edge of eye and posterior edge of nostrils; NST- Nostril to snout tip; ED- Eye diameter; TD- Tympanum diameter; WUE- distance between margin to the base of eyelid; IOW- Inter orbital width; INW- Inter narial width; FL- Forelimb length; HLL- Hindlimb length; FEL- Femur length and TIL- Tibia length

share similarity at the level of 0.94 (Fig. 3). Whereas anuran species in Pavuru and Harekala share similarity with other two (Konaje and Pajiru) villages at the level of 0.58 and 0.44 respectively. This points that vegetation and specific requirements for the survival of anuran species in Konaje and Pajiru are almost similar and congenial to sustain the existence of diverse anurans.

The percent distribution based on IUCN status, the anurans recorded in the present study were categorized as 18% endangered, 6% vulnerable, 58% least concerned and 18% data deficient (Fig. 4).

Anuran species namely *Euphlyctis aloysii*, *Fejervarya caperata*, *Fejervarya rufescens*, *Minervarya sahyadris*, *Sphaerotheca dobsonii*, *Indirana beddomii*, *Polypedates maculatus*, *Polypedates occidentalis*, *Pseudophilautus wynaadensis*,

Image 12. *Polypedates occidentalis*



Image 13. *Pseudophilautus wynaadensis*



Raorchestes charius and *Rhacophorus malabaricus* reported earlier as endemic to Western Ghats (Dinesh & Radhakrishnan 2011) have been sighted and recorded in this study. However, a recent report documents two of these species i.e. *Sphaerotheca dobsonii* and *Polypedates maculatus* as not being endemic to the Western Ghats alone (Gururaja 2012). The record of these endemic anuran species in present study may possibly be due to close proximity of the study area to the Western Ghats and similar climatic conditions. Thus, there is a need to record distribution and create awareness pointing to the importance of the amphibians, in particular the anurans which play an important role in maintaining a stable environment.

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Image 14. *Raorchestes* sp.



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Image 17. *Rhacophorous malabaricus*



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