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RESEARCH ARTICLE

Morphometric study of the Indus Valley Toad *Duttaphrynus stomaticus* (Lutken, 1864) from Srinagar Garhwal region of Uttarakhand, Western Himalaya

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Abstract

Indus valley toad, *Duttaphrynus stomaticus*, is a widespread habitat generalist species of Indian subcontinent and South-East Asia. This study analyzes the degree of morphological differentiation among populations of the common toad *Duttaphrynus stomaticus* in the Srinagar Garhwal region of Uttarakhand, India. Thirty morphometric and some qualitative characters were analyzed. Variations in a number of morphometric and qualitative characters in samples were analyzed using descriptive statistics. High degree of female-biased sexual size dimorphism was observed. Morphological variation among the samples was more expressed in morphometric than in qualitative characters.

Introduction

BUFONIDAE is a large and geographically widespread taxon of neobatrachian frogs (Duellman and Trueb, 1986). Bufo contains more than half of the 350 bufonid species and is geographically ubiquitous; only two of the remaining 32 genera have more than 10 species and all have relatively restricted geographic ranges (Frost, 1985). More than half of the species within the family Bufonidae are contained within the genus Bufo. Bufo is a nearly cosmopolitan genus, with representatives in all six biogeographic regions (following Wallace 1876), which is the largest distribution of any amphibian genus. Evidence suggests, however, that Bufo is not monophyletic, and there are no synapomorphies uniting the genus (Graybeal and Cannatella 1995). The species *Duttaphrynus stomaticus* (Lutken, 1864), Common Indus valley toad (Fig.2), belongs to the genus Bufo within the family Bufonidae first discovered by Lutken in 1864 from Assam India, is widely distributed toad species in the Indian sub continental (Chanda, 2002; Daniel, 2002; Dutta, 1992). They burrowed easily in sandy or wet soil using their hind limbs to dig the soil. It has been reported from many habitats, including seasonal, deciduous forest, arid plains and scrubland, grassland, areas of human habitation, plantations, Dry deciduous forest areas also preferred but are seen near water bodies during the breeding season. Perusal of literature revealed scanty data available pertaining to its ecology and species diversity from Western Himalaya. Further, any data on this species is lacking. Hence, an attempt to fill this lacuna through a short term study encompassing diversity and morphometry of anurans was undertaken. The present study analyzes the morphometric sampling of *Duttaphrynus stomaticus* population in Srinagar Garhwal region of Uttarakhand, Western Himalaya. Data obtained on the morphometry of the species during the present study would contribute to the knowledge of the bio-ecological perspectives of the species.

Materials and Methods:

Study area: The present study was undertaken in Srinagar Garhwal, Uttarakhand (30.13°N 78.48°E). The region is part of the western Himalayan. Sampling was done at a height of 1819 feet to 2256feet (Fig.1). The field work was carried out in the study sites during the months of January to May of 2014 during late evening hours (6PM-11PM). Survey was carried out near water bodies and micro-habitats such as, on the floor, leaves, rocks, under leaf litter,

among dried leaves, under logs, under the soil, among weeds, near termite mounds etc. based on standard procedure (Daniel, 2005, Pichandi et al., 2013, Chowdhary et. al., 2014).

Morphometric measurements:

Randomly collected Bufo samples were measured in the selected site. Live toads were caught and thirty measurement characters (Islam et. al., 2008; Chowdhary et. al., 2014) were analyzed using digital Vernier caliper (Aerospace) to the nearest 0.1 mm accuracy (Table 1). Morphometric measurements of the samples (N=34; 16 males and 18 females) randomly collected during the survey were taken in the field conditions and animals were released after recording the observations. Care was taken to ensure no stress on the animals during the course of the measurements. Method of sampling is based on the methodology given by Pichandi et al. (2013). The data was used to analyze the correlation between the morphometric parameters of the randomly collected individuals. Along with the quantitative morphological measurements, some qualitative characters, including body color, dermal ridge, median stripe, snout shape, body shape, and thigh region coloration were also observed. Correlation analysis was done on pooled data of both males and females taking only 16 important morphometric parameters. Regression analysis was performed for three morphometric variables viz., Head length (HL) with Snout vent length (SVL) and Hind limb length (HLL) with Snout vent length (SVL) only.

Result and Discussions:

The descriptive statistics data for male and female along with the pooled correlation analysis of morphometric parameters are tabulated sequentially (Table 2 and 3). Regression plots for morphometric parameters viz., SVL and HL; SVL and HLL of *Duttaphrynus stomaticus* with fitted regression equation are also depicted (Fig. 4). Maximum SVL of the sample measured was found to be 49.13mm in male and 65.35mm in female. A significant positive correlation was obtained between the 16 important morphometric parameters considered at the 1 % level of significance (Table 3). Regression analysis was performed for three morphometric variables viz., Head length (HL) with Snout vent length(SVL) and Hind limb length (HLL) with Snout vent length(SVL) and fitted regression equation viz. Male: $y = 0.098x + 7.562$ ($R^2 = 0.918$); Female: $y = 0.088x + 7.956$ ($R^2 = 0.881$) and Male: $y = 1.224x - 7.449$ ($R^2 = 0.800$); Female: $y = 0.715x + 18.33$ ($R^2 = 0.827$), respectively were obtained for the species. Along with the quantitative morphological measurements, some qualitative characters, including body color, dermal ridge, median stripe, snout shape, body shape, and thigh region coloration were also observed.

Table1. Morphological parameters used in this study.

Abbreviation	Character
SVL	Snout-vent length
HL	Head length (from back of mandible to tip of snout).
HW	Head width (left side back of mandible to right side back of mandible)
STL	Snout-tympanum length (Tip of snout to front of tympanum)
MSL	Mouth angle-snout length (Tip of snout to end of mouth opening)
NS	Nostril- snout length (Distance from nostril to tip of snout)
SL	Snout length
NTL	NTL Nostril tympanum length (Distance between nostril and front of tympanum)
EN	Distance from front of eyes to nostril
TEL	Tympanum eye length (distance between end of eye to front of tympanum)
TD	Tympanum diameter (Maximum diameter)
MN	Distance from back of mandible to nostril
MFE	Distance from back of mandible to front of eye
MBE	Distance from back of mandible to back of eye
IN	Internarial space (Distance between 2 nostrils)
EL	Eye length (greatest diameter of the eye including upper eyelids)
IOD	Interorbital distance
UEW	Maximum width of upper eyelid
HAL	Hand length (from base of outer palmer tubercle to tip of third finger)
FAL	Fore arm length (from elbow to base of outer palmer tubercle)
LAL	Lower arm length
HLL	Hind limb length

THIGHL	Thigh length
TL	Tibia length
FOL	Foot length (from base of inner metatarsal tubercle to tip of fourth toe)
TFOL	Length of tarsus and foot (from base of tarsus to tip of fourth toe)
ThreeFL	Third finger length
OneFL	First finger length
FourTL	Fourth toe length
ITL	Inner toe length

Table2. Descriptive statistics of morphometric parameters of *Duttaphrynus stomaticus* (N=34) from Srinagar Garhwal region, Uttarakhand, India.

	Male ♂ (n= 16)				Female ♀ (n= 18)			
	Minimum (mm)	**Maximum (mm)**	**Mean (mm)**	**Standard Deviation (mm)**	**Minimum (mm)**	**Maximum (mm)**	**Mean (mm)**	**Standard Deviation (mm)**
SVL	34.86	49.13	39.8456	3.95887	34.86	65.35	46.8011	7.64464
HL	10.91	12.56	11.4787	0.40607	11.08	13.46	12.1122	0.72314
HW	8.78	16.19	12.7606	2.70204	11.63	17.80	16.2094	1.70144
STL	5.80	8.37	6.6675	0.63988	6.06	14.92	9.5939	2.40756
MSL	6.25	11.14	8.9681	1.42444	8.21	12.55	10.9017	1.24318
NS	0.21	1.82	0.6425	0.47023	0.41	2.99	1.6522	0.65947
SL	2.07	3.99	3.3344	0.46655	3.33	5.76	4.6211	0.75645
NTL	5.07	6.55	6.0250	0.35125	5.07	11.93	7.9406	1.80561
EN	2.01	2.89	2.5125	0.22591	2.41	4.67	3.3300	0.62873
TEL	0.06	0.46	0.1813	0.11135	0.14	1.98	0.6817	0.49977
TD	1.71	2.78	2.2175	0.39393	2.01	3.18	2.8222	0.32095
MN	7.54	9.48	8.8688	0.41344	8.78	13.97	10.7872	1.50152
MFE	5.15	8.29	7.1875	0.77800	6.50	10.01	7.8922	0.82812
MBE	2.03	3.06	2.3731	0.27373	2.25	5.87	3.7717	1.01643
IN	1.96	3.62	2.7513	0.48343	2.62	4.01	3.3294	0.37203
EL	2.99	5.03	4.0075	0.73084	3.51	5.99	4.8839	0.58211
IOD	2.40	4.63	3.1844	0.66498	2.62	4.79	4.0939	0.62217
UEW	2.01	4.01	2.9763	0.72148	2.28	4.21	3.6606	0.54755
HAL	5.03	7.98	7.1263	0.83718	6.84	12.06	9.7539	1.90099
FAL	1.51	10.20	6.9550	2.10968	1.51	12.82	9.7083	2.44717
LAL	3.04	7.43	3.9844	1.20959	3.09	7.43	5.6800	1.08418
HLL	30.66	47.51	41.3481	5.41730	41.93	60.56	51.8300	6.01584
THIGHL	10.50	16.01	12.5688	1.88526	11.47	18.74	15.5172	1.79181
TL	9.23	15.84	12.7094	2.07766	11.97	17.79	16.1339	1.85555
FOL	9.54	16.28	13.1994	1.69086	12.91	17.06	14.8889	1.22318
TFOL	12.40	22.87	17.5656	3.19291	17.12	24.36	22.0489	2.15116
ThreeFL	2.64	5.95	3.6956	0.76613	3.54	6.98	5.0994	0.93454
OneFL	1.81	4.03	2.9600	0.63879	2.16	4.09	3.2161	0.58760
FourTL	3.54	10.40	6.4119	2.36762	4.22	10.76	8.5994	1.96417
ITL	0.11	1.81	1.0106	0.51607	0.40	1.79	1.0972	0.29860

Table 3. Correlation coefficient (r) values for important morphometric parameters of *Duttaphrynus stomaticus* (N=34) from Srinagar Garhwal region, Uttarakhand, India.

	SVL	HL	HW	NS	SL	EN	TD	EL	IOD	HLL	THIGHL	FOL	3FL	1FL	4TL	ITL
SVL	1.000	0.965	0.843	0.958	0.950	0.905	0.895	0.905	0.824	0.865	0.887	0.908	0.959	0.909	0.890	0.910
HL		1.000	0.845	0.962	0.927	0.918	0.928	0.933	0.887	0.949	0.921	0.921	0.978	0.912	0.912	0.895
HW			1.000	0.868	0.947	0.962	0.905	0.956	0.833	0.831	0.959	0.927	0.866	0.969	0.974	0.929
NS				1.000	0.933	0.928	0.970	0.944	0.924	0.941	0.940	0.929	0.984	0.926	0.929	0.886
SL					1.000	0.971	0.914	0.961	0.832	0.860	0.936	0.969	0.940	0.972	0.948	0.970
EN						1.000	0.938	0.984	0.874	0.893	0.970	0.970	0.933	0.985	0.969	0.969
TD							1.000	0.964	0.972	0.960	0.960	0.933	0.968	0.933	0.952	0.873
EL								1.000	0.925	0.920	0.977	0.980	0.958	0.982	0.975	0.954
IOD									1.000	0.940	0.921	0.880	0.931	0.864	0.902	0.794
HLL										1.000	0.924	0.889	0.951	0.872	0.903	0.819
THIGHL											1.000	0.932	0.930	0.969	0.989	0.908
FOL												1.000	0.953	0.960	0.935	0.966
3FL													1.000	0.929	0.925	0.906
1FL														1.000	0.978	0.965
4TL															1.000	0.916
ITL																1.000

*Correlation Coefficient (r) is significant at the 0.01 level (2-tailed).

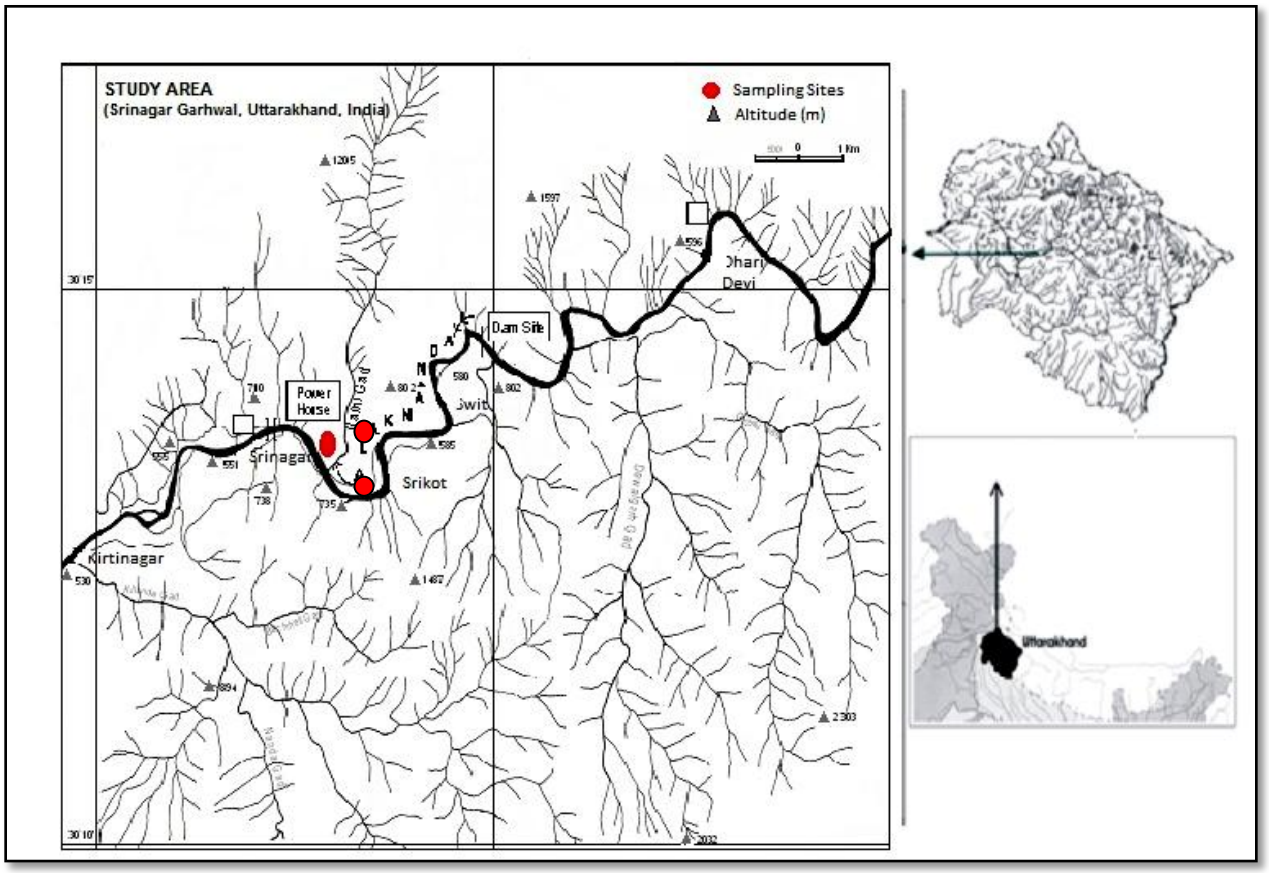

Fig. 1 Location map of study area

Fig. 2 *Duttaphrynus stomaticus* (Study Specimen)

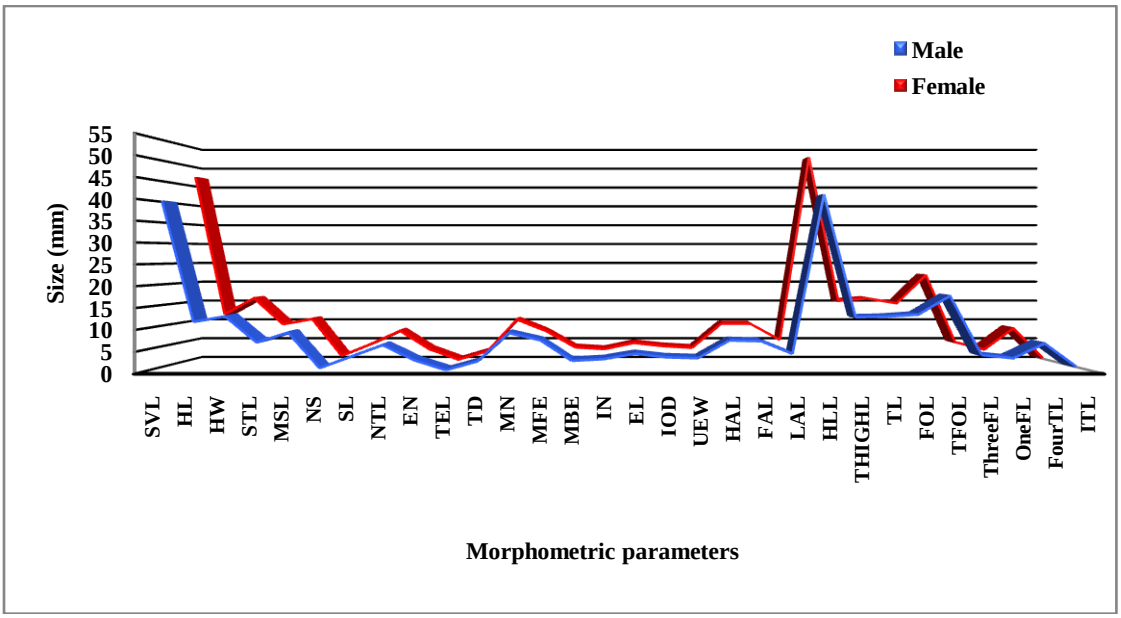

Fig. 3 Comparative Morphometric variation among male and female specimens of *Duttaphrynus stomaticus* recorded from studied area

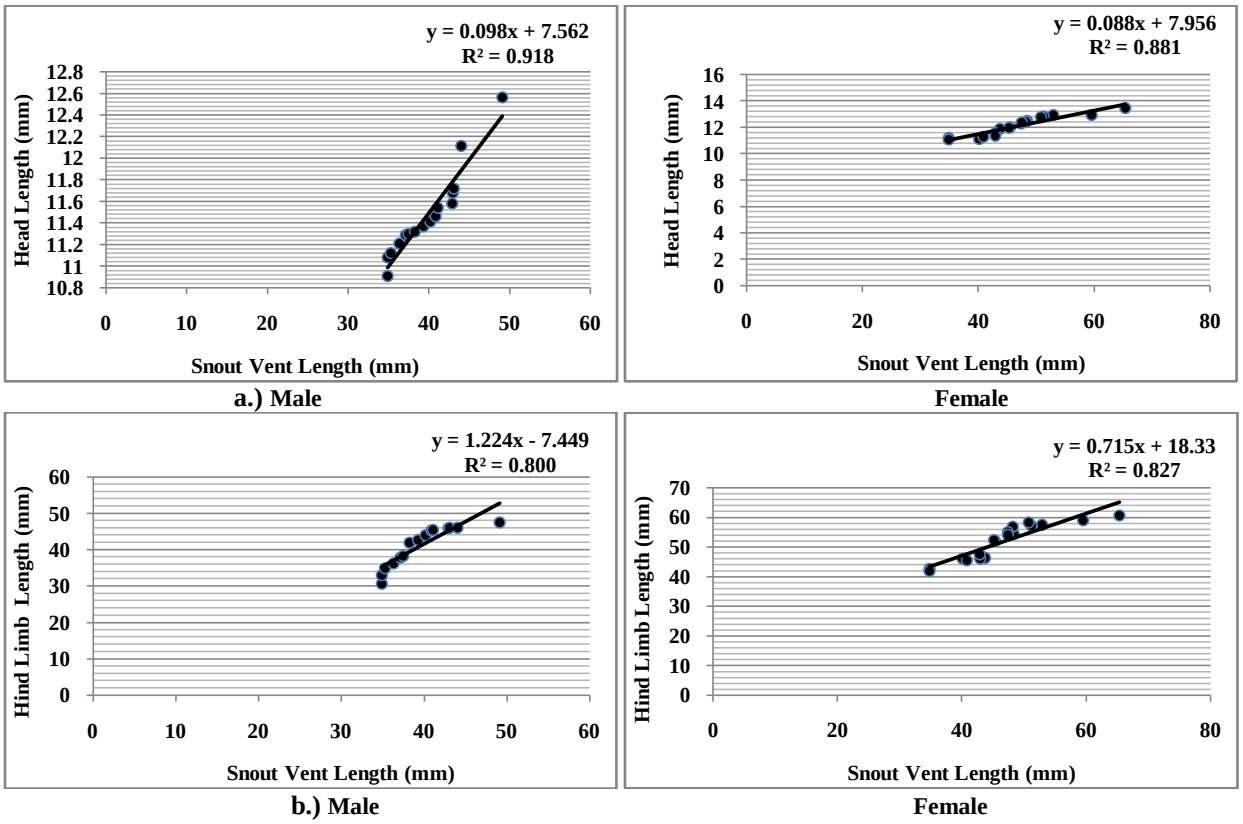

Fig. 4(a & b) Comparative Regression analysis plots for morphometric parameters of male and female of *Duttaphrynus stomaticus* with fitted regression equation

Morphological Characteristics:

Skin of skull near snout is co-ossified with skull. Tympanum distinct rounded and almost 2/3rd of maximum diameter of eye. Snout short, blunt at the tip. Nostril nearer tip of snout than anterior corner of eye. Interorbital space flat broader than upper eyelid. Head wider than long, without any cranial ridges. Fore limbs moderate. First finger slightly longer than second. Third finger longest and fourth shortest. The subarticular tubercles blunts, mixed with flat glands on palm. Palmer tubercles distinct, triangular and wider in front. Hind limbs stout and short. Tarsometatarsal articulation reaches upto posterior corner of eye. Toes moderate with two thirds webbing. Two moderate with metatarsal tubercles. Subarticular tubercles simple and small. Skin of upper surface, palm and soles covered with flat glands of various sizes. Parotoid flat, elliptical placed on scapular region on both sides.

Coloration:

Dorsum brownish or olive-gray sometimes marbled and uniformly speckled with dark brown patches. Ventrum white, belly and lower lip dull whitish but in breeding season coloration changes to yellow in both sexes. The male look brighter than female. Juveniles are light brown with dark marblings.

The morphological data is unique being a rare data to be produced in terms of the species morphometry in the region and future studies in this regard would facilitate further understanding of the impact of immediate ecological conditions on the anuran morphology. Snout vent length (SVL) and head length (HL) were the two variables that mostly contributed for significant differences related to morphometric traits, as observed for other groups (Castellano and Giacoma, 1998; Castellano et al., 1999; Babik & Rafinski, 2000; Castellano et al., 2000; Méndez et al., 2004, Rosso et al., 2004, Silva et al., 2008, Bahuguna and Bhutia, 2010, Pichandi et al., 2013, Chowdhary et. al., 2014). In this study, the body size of *D. stomaticus* was observed within the range recorded so far (Bahuguna and Bhutia, 2010).The study found a high degree of female-biased sexual size dimorphism, which is also known for other populations of the common Indus valley toad (Bahuguna and Bhutia, 2010).The most used explanation of the sexual dimorphism in the body size is the advantage that bigger females have in producing a greater number of eggs (Gibbons and McCarthy, 1986; Halliday and Verrel, 1986; Cvetković et al., 2007).

Although, the present findings contribute to the morphometric data for the population of the species from the region, the variation is attributed to the regional differences compared to the available literature. However, it is worth considering the data owing to its uniqueness viz., first time reporting from the study region contributing to the understanding of the ecological impacts on morphometry in future.

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