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TAXONOMIC STUDIES ON JUNGLE PALM SQUIRREL *FUNAMBULUS TRISTRIATUS* (WATERHOUSE) FROM NORTHERN WESTERN GHATS

S. S. TALMALE
Zoological Survey of India,
Central Zone Regional Centre,
168-169, Vijay Nagar, Jabalpur-482 002 (Madhya Pradesh)
E-mail : s_talmale@yahoo.co.in

INTRODUCTION :

In India, genus *Funambulus* is represented by five species. Jungle Palm squirrel, *Funambulus tristriatus* (Waterhouse, 1837) is a largest species of the genus classified under the family Scuridae of the order Rodentia. It shows distinct three light longitudinal stripes on the dorsal surface (Photo-1A). Underparts light or whitish. Face, forehead, back and haunches tinged with rusty red. Tail most often shorter than the Head and Body. The ingunal region, testis and mid-ventral line of the tail cadmium orange to Saturn red in colour (Photo-1B). Occipitonasal length of the skull exceeds 40 mm. Palate usually more than half of the occipitonasal length.

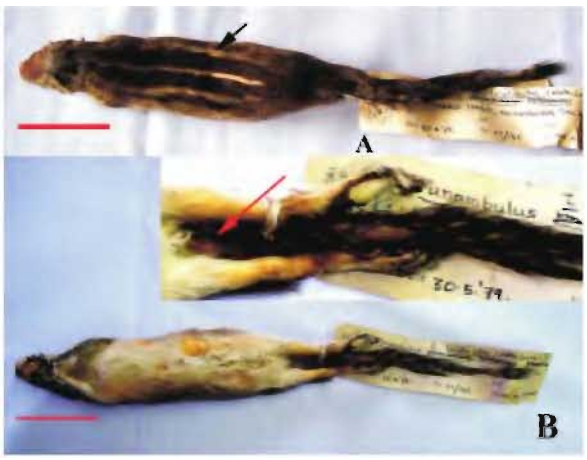
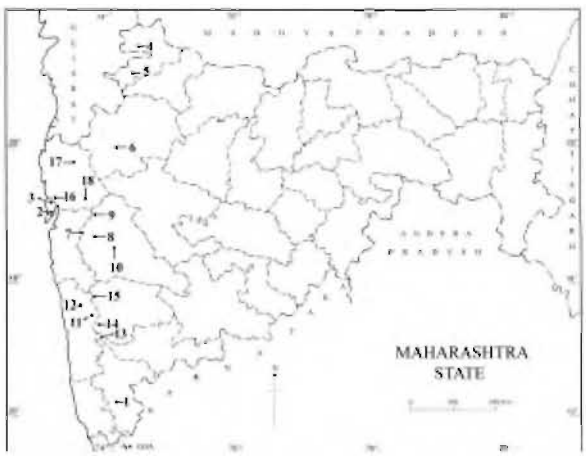


Photo-1 : *Funambulus tristriatus tristriatus* (Waterhouse) Female (ZSI.WRS. M/ 146) (Scale bar = 50 mm). A. Longitudinal three pale buff to brownish stripes (Marked by arrow) between the intermediate dark brown to black bands on the dorsal surface. B. Underparts whitish. Inguinal region & mid-ventral line of the tail cadmium orange to Saturn red in colour (Marked by arrow, Inset)

Funambulus tristriatus (Waterhouse), an endemic species to Western Ghats of India, is



Map 1 : Distribution of *Funambulus tristriatus tristriatus* (Waterhouse) in Maharashtra State. Records from Maharashtra State includes Kolhapur Dist. : Radhanagari Wildlife Sanctuary [1]; Mumbai Dist. : Ghatkopar [2]; Mumbai Suburban Dist. : SGNP, Borivali [3]; Nandurbar Dist. : Amlibari, Tal. Akkalkua [4], Kondanbari, near Visarwadi [5] (Extended Distribution); Nashik Dist. : Nashik [6]; Pune Dist. : Khandala [7], Karla [8], Bhimashankar [9], Pune [10]; Ratnagiri Dist. : Shirgaum [11], Khed [12]; Sangli Dist. : Chandoli Wildlife Sanctuary [13] ; Satara Dist. : Helwak [14], Ghatmatha [15]; Thane Dist. : Thane [16], Jawhar [17], Dehri, Murbad [18].

found upto Bombay in north and occurs in Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu in south (Agrawal, 1973; Corbet & Hill, 1992; Molur *et al.*, 2005). It is diurnal and semi-arboreal and occurs in Tropical Evergreen Forest, Moist Deciduous Forest and plantations like tea, cardamom and coffee (Molur *et al.*, 2005). They feed on paddy grains, male flowers of coconut, mucilage of cacao beans, fruits and other plant parts and insects like termites, black ants, beetles, insect larvae etc. (Bhat and Mathew, 1985). Present paper reports its occurrence in Nandurbar district of Maharashtra State in north (Map 1) which extends the range of earlier distribution. The article also offers comments on its subspecific status in northern part of Western Ghats.

MATERIAL AND METHODS

Present study is a part of the thesis submitted by the author to the Univeristy of Pune for the award of Ph.D. degree, 2007. It includes morphometric examination of voucher specimens collected from northern part of Western Ghats available in Zoological Survey of India, Kolkata (ZSI, Kolkata), Zoological Survey of India, Western Regional Centre, Pune (ZSI,WRC) and National Institute of Virology, Pune (NIV). External, Cranial and Dental measurements of each voucher specimen were taken by a vernier caliper with a dial graduation reading up to 0.1 mm. All measurements were taken in millimeter (mm).

Abbreviations used for measurements: Length of Head and Body (HB), Length of tail (Tl), Length of Hind-foot (HF), Length of Ear (E), Occipitonasal length (onl), Condylobasal length (cbl), Greatest zygomatic width (zw), Frontal width (fro), Length of tympanic bulla (bl), Nasal length (nas), Length of maxillary toothrow (mtr), Length of diastema (dia), Length of palate (pal), Length of the orbit (orb), Nasal width (nw), Mandibular length (ml).

Material Examined : Maharashtra : Mumbai Suburban Dist. : 1♀ , Ghatkopar, Salsette, 24.iv.1914, Coll. S. H. Prater, (ZSI, Kolkata, 14957), 1♂ , Ghatkopar, Salsette, 27.iv.1914, Coll. S. H. Prater, (ZSI, Kolkata, 14954); Nandurbar Dist. : 1 ♀, Amlibari Tal. Akkalkua, 24.xi.1985, Coll. M. S. Pradhan ZSI,WRC, M/462), 1♀, Kondaibari Ghat near Visarwadi, 19.xi.1985, Coll. M.S.Pradhan, ZSI,WRC, M/453); Pune Dist. : 2 unsexed, Katkarwadi, Pune, 04.ii.1955, Coll. B. S. Lamba (NIV, W183, 189, skin only), 1 unsexed, Katakarwadi, Pune, 08.ii.1955, Coll. B. S. Lamba, (NIV, W18, skin only), 1♂, Vithhalwadi, Pune, 13.vi.1963, Coll. S. Paradkar, (NIV, KRPS 24), 1♂, Vithhalwadi, Pune, 07.i.1966, Coll. S. Paradkar, (NIV, KRPS 2224), 1♂ ,1♀ , Karla village and around, 08.vi.1984, Coll. M. S. Pradhan, (ZSI,WRC, M/520, 521); 1♀, Karla, Pune-Bombay Road, 11.v.1988, Coll. M. S. Pradhan, (ZSI,WRC, M/510); 1♀, Hanuman Temple, Bhimashankar, 30.v.1979, Coll. A. S. Mahabal, (ZSI,WRC, M/146); Ratnagiri Dist. : 1♂ , Khia (Khed), 24.xii.1914, Coll. S. H. Prater, (ZSI, Kolkata,

Table -1: External, cranial and dental measurements (mm) of *Funambulus tristriatus tristriatus* (Waterhouse) studied from Maharashtra State. SD: Standard Deviation; N : Sample size

	Mean	Range	SD	N
HB	162.4	138.0 – 185.0	±15.81	15
Tl	138.07	118.0 – 157.0	±12.08	13
HF	37.21	32.0 – 40.4	±2.27	17
E	13.21	8.7 – 16.0	±2.05	14
onl	40.73	39.5 – 42.5	±1.01	15
cbl	37.50	36.0 – 39.0	±0.83	15
nas	12.36	10.1 – 13.2	±0.89	14
pal	20.73	20.0 – 21.7	±0.54	14
*mtr	7.62	7.2 – 8.0	±0.25	14
fro	13.79	12.0 – 15.2	±0.94	15
orb	12.00	11.1 – 13.0	±0.45	14
dia	9.86	9.3 – 11.1	±0.55	14
bl	7.35	6.7 – 8.0	±0.41	13
zw	22.97	21.3 – 24.1	±0.86	14
nw	5.2	4.7 – 5.4	±0.22	12
ml	23.2	22.2 – 24.1	±0.65	13

* Upper toothrow includes premolars and molars.

Table-2: Comparison of external, cranial and dental measurements (mm) of different races under *Funambulus tristriatus tristriatus* (Waterhouse) specimens studied by Ellerman (1961) and Agrawal and Chakraborty (1979b) with those of the specimens under present study. SD : Standard Deviation; N: Sample size.

		Ellerman, 1961 (Maharashtra specimens only)		Agrawal and Chakraborty (1979b)	Present study	
		Funambulus tristriatus tristriatus (numarius)	*Funambulus tristriatus tristriatus* (*thomasi*)	*Funambulus tristriatus tristriatus*	*Funambulus t. tristriatus* from Satara and Ratnagiri Dist. (Range of '*numarius*')	*Funambulus t. tristriatus* from Pune, Mumbai, Thane, Nandurbar Dist. (Range of '*thomasi*')
HB	Range	140 – 155	140 – 147	**97.0 – 187.0**	**150 – 158**	**127 – 185**
	Mean with SD	148.90 ± 4.57	143.5 ± 3.10	148.9 ± 23.99	154 ± 5.65	161.07 ± 18.72
	N	11	4	20	2	14
Tl	Range	124 – 157	120 – 148	**108.0 – 161.0**	**118 – 123**	**122 – 157**
	Mean with SD	137.72 ± 11.19	137 ± 14.46	137.1 ± 16.80	120.5 ± 3.53	139.66 ± 11.08
	N	11	4	20	2	12
HF	Range	26.0 – 36.0	35.0 – 38.0	**32.0 – 45.0**	**32.0 – 36.0**	**33.4 – 40.4**
	Mean with SD	31.36 ± 2.90	37.0 ± 1.41	36.57 ± 2.84	34.0 ± 2.82	37.27 ± 2.29
	N	11	4	20	2	15
E	Range	15.0 – 18.0	13.0 – 15.0	13.5 – 20.0	15.0 – 15.0	8.7 – 16.0
	Mean with SD	15.90 ± 1.13	13.75 ± 0.95	16.25 ± 1.5	15.0	12.91 ± 2.07
	N	11	4	20	2	12
onl	Range	39.6 – 41.6	40.2 – 41.5	**37.6 – 44.5**	**40.4 – 42.5**	**39.1 – 42.5**
	Mean with SD	40.92 ± 0.63	40.85 ± 0.91	41.44 ± 2.17	41.36 ± 1.05	40.57 ± 0.98
	N	9	2	14	3	12
cbl	Range	--	--	--	36.6 – 37.7	36.0 – 39.0
	Mean with SD	--	--	--	37.15 ± 0.77	37.56 ± 0.86
	N	--	--	--	2	12

Contd...

Conted. Table-2

nas	Range	11.4 – 13.1	11.8 – 13.1	10.8 – 14.2	10.1 – 12.8	11.3 – 13.7
	Mean with SD	12.41 ± 0.47	12.45 ± 0.91	12.71 ± 1.02	11.73 ± 1.43	12.53 ± 0.69
	N	9	2	14	3	11
pal	Range	20.0 – 21.2	20.4 – 20.9	**18.4 – 23.5**	**20.4 – 20.7**	**20.0 – 21.7**
	Mean with SD	20.74 ± 0.41	20.65 ± 0.35	21.19 ± 1.51	20.55 ± 0.21	20.76 ± 0.58
	N	9	2	14	2	12
mtr	Range	7.4 – 8.0	7.7 – 7.9	**7.3 – 8.8**	**7.5 – 8.0**	**7.2 – 8.0**
	Mean with SD	7.7 ± 0.19	7.8 ± 0.14	8.02 ± 0.49	7.75 ± 0.35	7.6 ± 0.24
	N	8	2	13	2	12
fro	Range	10.9 – 12.4	12.1 – 12.2	11.2 – 13.8	13.0 – 14.1	12.0 – 15.2
	Mean with SD	11.81 ± 0.44	12.15 ± 0.07	12.65 ± 0.79	13.53 ± 0.55	13.85 ± 1.03
	N	9	2	14	3	12
orb	Range	11.4 – 12.1	12.0 – 12.1	11.7 – 13.4	11.6 – 12.1	11.1 – 12.3
	Mean with SD	11.75 ± 0.26	12.05 ± 0.07	12.41 ± 0.52	11.85 ± 0.35	11.90 ± 0.35
	N	9	2	13	2	12
dia	Range	--	--	--	10.0 – 10.2	9.3 – 11.1
	Mean with SD	--	--	--	10.1 ± 0.14	9.85 ± 0.56
	N	--	--	--	2	12
bl	Range	--	--	--	7.0 – 7.3	6.7 – 8.0
	Mean with SD	--	--	--	7.15 ± 0.21	7.39 ± 0.43
	N	--	--	--	2	11
apf	Range	--	--	--	1.1 – 1.2	1.0 – 2.1
	Mean with SD	--	--	--	1.15 ± 0.07	1.36 ± 0.41
	N	--	--	--	2	11
zw	Range	--	--	--	22.5 – 24.1	21.3 – 24.1
	Mean with SD	--	--	--	23.2 ± 0.81	22.90 ± 0.90
	N	--	--	--	3	11
ml	Range	--	--	--	22.6 – 24.0	22.2 – 24.1
	Mean with SD	--	--	--	23.3 ± 0.98	23.18 ± 0.64
	N	--	--	--	2	11

14955); Satara Dist. : 1♂,1♀, Helwak, 09.xii.1914, Coll. S. H. Prater, (ZSI, Kolkata, 14958 (skull only), 14956); Thane Dist. : 1♀ , Dehari, Murbad, 17.iii.1984, Coll. M. S. Pradhan, (ZSI,WRC, M/391).

Material examined other than study area : Goa : 1♂, 1 Km. N. of Poinguinim, Canacona, 24.xii.1968, Coll. V. C. Agrawal, (ZSI, Kolkata, 18743); **Kerala :** 1♀, Valley, Travancore, South India, 30.viii.1915, Coll. S. N. Pillay, (ZSI, Kolkata, 14962); **Tamil Nadu :** 1♂, Sengartheri, Kalkkad Mundanthurai Reserve Forest, 19.vii.1997, Coll. D. Mudappa, (ZSI,WRC, M/840, Donated).

RESULT AND DISCUSSION

Wroughton (1916) described *Funambulus tristriatus numarius* from Helwak, Satara Dist. as a local race which is smaller in size than *F. tristriatus*. Later Wroughton and Davidson (1919) described *Funambulus thomasi* from Khandala, Pune Dist. However, both the taxa were synonymised in *F. t. tristriatus* by Ellerman (1961) due to overlapping of characters within these races. Agrawal and Chakraborty (1979a) also supported Ellerman's view. Later, Moore and Tate (1965) maintained *numarius* (including *thomasi*) as a distinct subspecies of *F. tristriatus*. Corbet and Hill (1992) and Thorington and Hoffman in Wilson and Reeder (2005) also followed the same view. Pradhan and Talmale (2009) retained it tentatively and also recommended detailed taxonomic studies of *numarius* for its validity. However, Alfred *et al.* (2002), Srinivasulu *et al.* (2004) accepted views of Ellerman (1961) and synonymised both *numarius* and *thomasi* under the nominate subspecies *F. t. tristritus*. Specimens collected from localities of *thomasi*, *numarius* and nominate subspecies of *F. tristriatus* were compared and studied in the present work. It will be seen from the comparative account that there is a considerable amount of overlapping in the morphological and osteological measurements (Table- 1 & 2 (marked bold) and also in colour forms of these subspecies. Moore and Tate (1965) recognized *numarius* but commented that " Shortridge obtained 35 specimens in Dharwar and Kanara which are clearly intermediates between [*numarius*] and *tristriatus*...". Therefore, it is strongly opined to accept the views of Ellerman (1961) and keep *numarius* and *thomasi* in *F. t. tristriatus*.

The specimen studied from Tamil Nadu (ZSI,WRC, M/840) having larger size with HB : 190mm, onl :44.1 mm, pl : 23.6 mm and mtr : 9.5 mm, matches with the measurements of *F. tristriatus wroughtoni* Ryley given by Ellerman (1961), which has been synonymised under *F. tristriatus tristriatus* by Corbet and Hill (1992) and Thorington and Hoffman in Wilson and Reeder (2005).

As per collection and literature record the species has been reported from different localities from Maharashtra State in the Western Ghats (Map 1). Collection record from Nandurbar District, Maharashtra (Map 1) indicates extension of range of distribution of this species beyond Mumbai and the northern Western Ghats.

As per IUCN CAMP, 2005 this species has been categorized under Near Threatened category (Molur et al, 2005), recent IUCN status shows Least Concern (Molur and Nameer, 2008) on the basis of its wide distribution, tolerance of a degree of habitat modification, presumed large population.

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