Bull. zool. Surv. India, 4 (1) : 95—101, 1981

A FIELD STUDY OF SUBSPECIFIC VARIATION IN TAIL FORM AND CARRIAGE IN THE RHESUS MACAQUE, *MACACA MULATTA* (PRIMATES), IN SOUTH ASIA

M. L. ROONWAL* AND P. C. TAK†

ABSTRACT

(1) In the common subspecies, *Macaca mulatta mulatta* (Zimmermann) (North India to farther east), the tail is moderately hairy, tapers towards the tip and ends in a weak tuft. In the relaxed state (standing, walking) it is pendant, except in the most dominant or alpha male in which it is carried vertically up with a small, outward, terminal loop. (2) In the Himalayan subspecies, *M. m. villosa* True, the tail is uniformly thick, sharply truncated at the end, densely hairy and without a terminal tuft. In the relaxed state all individuals, except in those of certain categories (e. g., alpha males, etc.), the tail is bent down almost at a right angle (7-shaped). (3) In the giant rhesus of Chitral, *M. m. mcmahoni* Pocock, the tail form is as in *villosa* but with longer hairs, and the mode of carriage is not known. (4) The tail length is 35.7 — 62.5 per cent of head-and-body, the average being longer in subspecies *vilosa* (49.4) than in *mulatta* (44.6). (5) Tail length in males increases directly with that of head-and-body, but the percentage proportion decreases. (6) Variations in other cercopithecids are discussed. Subspecific variations in tail are found also in the pig-tailed macaque (*Macaca nemestrina*) and in the Hanuman langur (*Presbytis entellus*).

INTRODUCTION

The rhesus macaque, *Macaca mulatta* (Zimmermann) (Cercopithecidae, Cercopithecinae), is widespread in South Asia, from eastern Afghanistan and northwestern Pakistan, via North India (south to the R. Godavari), Nepal, Bhutan and Burma, east to Thailand, Vietnam and southern China. It has a short, more or less hairy tail which is about half the length of the head-and-body. Four subspecies** are recognised (Pocock, 1932 ; Roonwal and Mohnot, 1977 ; Roberts, 1977) as follows (three of them are high altitude ones which have a restricted distribution) :— (1) *M. m. mcmahoni* Pocock. NE Afganistan and NW Pakistan (Chitral and Dir). (2) *M. m. villosa* True. The Western Himalayas, e.g., NW Pakistan (Kaghan and Neelam Valleys, and Murree Hills) and NW India (southern Kashmir, upper Punjab, Himachal Pradesh, and the Kumaun Hills in Uttar Pradesh) (3) *M. m. vestita* Milne-Edwards. South Tibet (Tengri Nor). (4) *M. m. mulatta* (Zimmermann). Is very widespread and occupies the rest of the species range.

Nothing is known of tail differences in the

* Desert Regional Station, Zoological Survey of India, Paota B Road, 3rd Street, Jodhpur.

† Northern Regional Station, Zoological Survey of India, 13 Subhas Road, Dehra Dun.

** Hill (1974) has synonymised subspecies *vestita* with *mulatta* and added three more subspecies (from China). But Hill's taxonomic conclusions are so unreliable (as already discussed by Fooden, 1976) that we are unable to accept them until the genus is revised more competently.

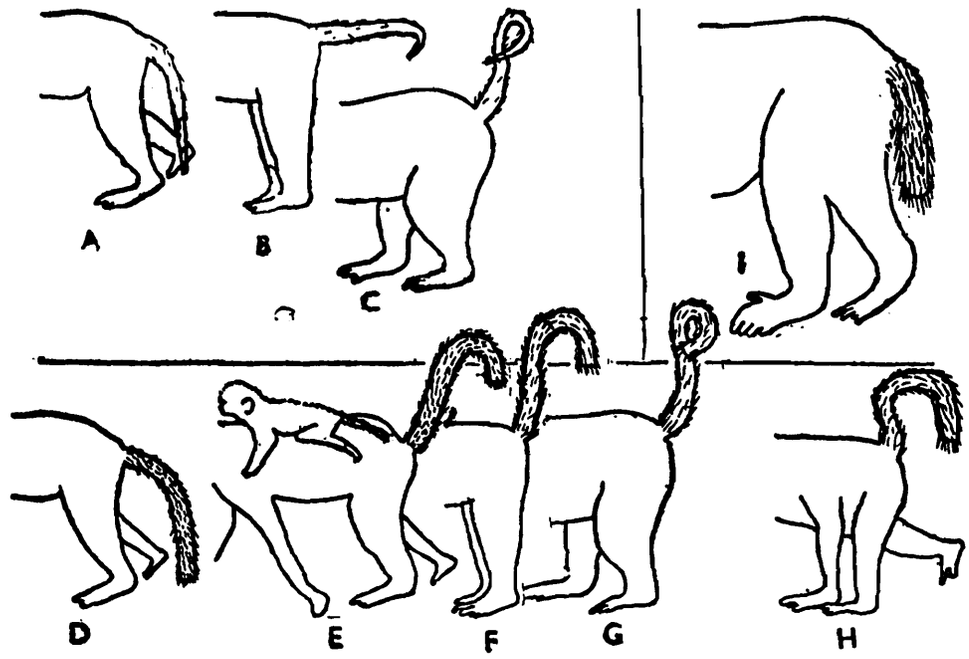

Fig. 1. Subspecific variations in relaxed tail carriage (standing, walking) in *Macaca mulatta* (A—C) *M. m. mulatta* (Rajasthan) : A. Female, with pendant tail. This mode characterises all adults except the alpha male. B. Female giving threat : Tail raised to subhorizontal, with the extreme tip curved downward. C. Alpha male : tail vertically up, with the distal end forming a small, outward, closed loop. (D—H) *M. m. villosa* (Kumaun Hills, except H) : D. Female (not carrying infant) and non-alpha males ; tail bent down at an angle (cf. A). E. Female carrying infant on back ; tail raised, with the distal end arched, F. Non-alpha male in the temporary absence of alpha (tail almost as in E). G. Alpha male (as in C). H. (Pakistan, ex Roberts : said to be normal for all : may be a local variant). I. *M. m. mcmahoni* (Chitral, ex Pocock, 1932 ; tail carriage depicted arbitrarily from museum specimen).

various subspecies. In the present paper we establish, on the basis of field observations, the existence and extent of such differences.

Material and Methods

The subspecies studied were *Macaca mulatta mulatta* and *M. m. villosa*. Field observations were made in the following locations : — (1) *M. m. mulatta* in the North Indian plains, especially Rajasthan and Uttar Pradesh. (2) *M. m. villosa* in the Kumaun Hills (NW Uttar Pradesh) in southern Kashmir (c. 22 km SE of Srinagar)' and in Kulu District (Hima-Pradesh).

Results

1. *Tail form and carriage*

In the common or plains snbspecies, *M. m. mulatta* (Table 1), the tail is on the whole rather thin and moderately hairy and is grey. It is thicker at the base and gradually tapers towards the tip, ending in a weak tuft. In the normal or relaxed state (standing and walking) it is wholely pendant (Fig. 1A), except in the most dominant or alpha male (Sade, 1971 ; Ojha, 1974 ; Roonwal, 1976, 1977) in which it is held vertically up, with a tiny, 'closed', backwardly directed, terminal loop (Fig. 1C). The loop involves about one-third of the distal part of the tail, and the tip has a tendency to cross the tail and point forward, though this may not happen in all cases. Ojha noted that in the temporary absence of the alpha male, the beta male raises the tail somewhat in the manner of

TABLE 1.—Tail form and carriage in adults of *Macaca mulatta*.

M. m. mulatta	*M. m. villosa*	*M. m. mcmahoni*
(A) *Tail form and structure*		
1. Tail thinner, tapering apically : apex rounded, not sharply cut. Only moderately hairy, with a weak terminal tuft. Colour greyish.	1. Tail thicker, uniformly thick throughout ; apex blunt aud sharply cut (as in a fox-terrier). Thickly hairy, with long hairs ; no terminal tuft. Colour olive brown.	1. Tail as in *M. m. villosa*.
(B) *Tail carriage in the relaxed state (standing, walking)*		
2. Wholely pendant (except in alpha male and in non-alpha males in the temporary absence of alpha). (Fig. IA)	2. Tail bent down at a right angle (almost 7-shaped), except in certain categories mentioned below. (Fig. ID)	Not known.
3. Amoug non-alpha males in the temporary absence of alpha, the tail of the beta male is raised, with the extreme distal end arched, outward in a semi-loop.	3. In females carrying infant on back and in non-alpha males in the temporary absence of alpha, tail raised vertically up with the distal half arched outward in a broad arch. (Figs. IE, IF)	
4. In alpha male tail carried vertically up with a small, closed, outward end-loop. (Fig. IC)	4. In alpha male as in *M. m. mulatta*. (Fig. IG)	

alpha ; and when threatening, females tend to raise the normally pendant tail to a sub-horizontal position (Fig. 1B).

In the Himalayan subspecies, *M. m. villosa*, the tail is uniformly thick throughout its length, densely hairy and olive brown. It does not taper but is sharply truncated as in a fox-terrier (a feature noted long ago by McMahon, 1901a, b), and is without a terminal tuft. In the relaxed state in all individuals (except in females carrying an infant on the back, alpha males and non-alpha males in the temporary absence of the alpha) it is bent down rather away from the body, almost at a right angle (nearly 7-shaped, Fig. 1D). In females carrying an infant on the back and in non-alpha males in the temporary absence of the alpha the tail is carried nearly vertically up with the distal half forming a broad arch (Figs. 1E, F). Females and non-alpha males in stress situations, as while giving a threat, raise the tail to the subhorizontal position but without the distal arch. In Kulu district, when negotiating steep slopes both uphill and downhill, *all* individuals carried the tail straight horizontally. The alpha male normally carries the tail vertically up, with a closed end-loop, as in *M. m. mulatta*. In the Murree Hills in northwestern Pakistan, according to Roberts (1977), in the normal

TABLE 2.—Summary of data on sizes of body-parts in adults of two subspecies of *Macaca mulatta*.
[Sources : Pocock, 1932 ; Roberts, 1977; and fresh measurements from collections in the Zoological Survey of India.]

R., range ; Av., average : n, number of examples.

Item	Length of Head-and-Body (mm)			Length of Tail (mm)		
	Males	Females	Both sexes	Males	Females	Both sexes
			1. *Macaca mulatta mulatta*			
R.	417 — 584	411 — 559	411 — 584	198 — 250	187 — 285	187 — 285
Av.	516.9	485.0	502.5	226.6	221.0	224.0
n=	14	12	26	14	12	26
			2. *Macaca mulatta villosa*			
R.	508 — 635	470 — 483	470 — 635	229 — 318	218 — 254	218 — 318
Av.	549.0	476.5	534.5	271.4	236.0	266. *
n=	12	2	14	13	2	14

* In examples from Pakistan, Roberts (1977) gave the tail average as 203 mm.

TABLE 3.—*Macaca mulatta*. Tail length as percentage of head-and-body length in adults.

Subspecies	Males		Females		Both sexes	
	Range	Average	Range	Average	Range	Average
M. m. mulatta	35.7—55.2 (n=14)	43.6	40.1—59.6 (n=12)	45.7	35.7—59.6 (n=26)	44.6
M. m. villosa	43.5—62.5 (n=8)	49.4	46.4—52.6 (n=2)	49.5	43.5—62.5 (n=10)	49.4

mode of carriage in *all* individuals the entire tail (not merely the distal half as in the Kumaun Hills) takes part in the formation of the arch, the tail assuming a ∩-shape (Fig. 1H). Whether the occurrence of the latter mode of carriage and the absence of variations, in contrast to those observed in the Kumaun Hills, are peculiarities of the Pakistan population or are due to paucity of opportunity for more detailed observations, is difficult to say without further study in the field.

Of the giant rhesus of Chitral (Pakistan) no field data are available, but Pocock (1932, Plate) figures a male with a pendant tail ; it is most likely that this figure *is* from a museum example and the tail *is* arbitrarily shown as pendant. Some other characters of the tail (Fig. 1 I) are, however, clear, *viz.*, that (i) the tail is uniformly thick throughout its length and does not taper ; (ii) it is densely hairy throughout ; and (iii) the tail tip is sharply truncated and is without a tuft. In all these respects it resembles the tail of *M. m. villosa*.

Nothing is known about the Tibetan subspecies, *M. m. vestita*.

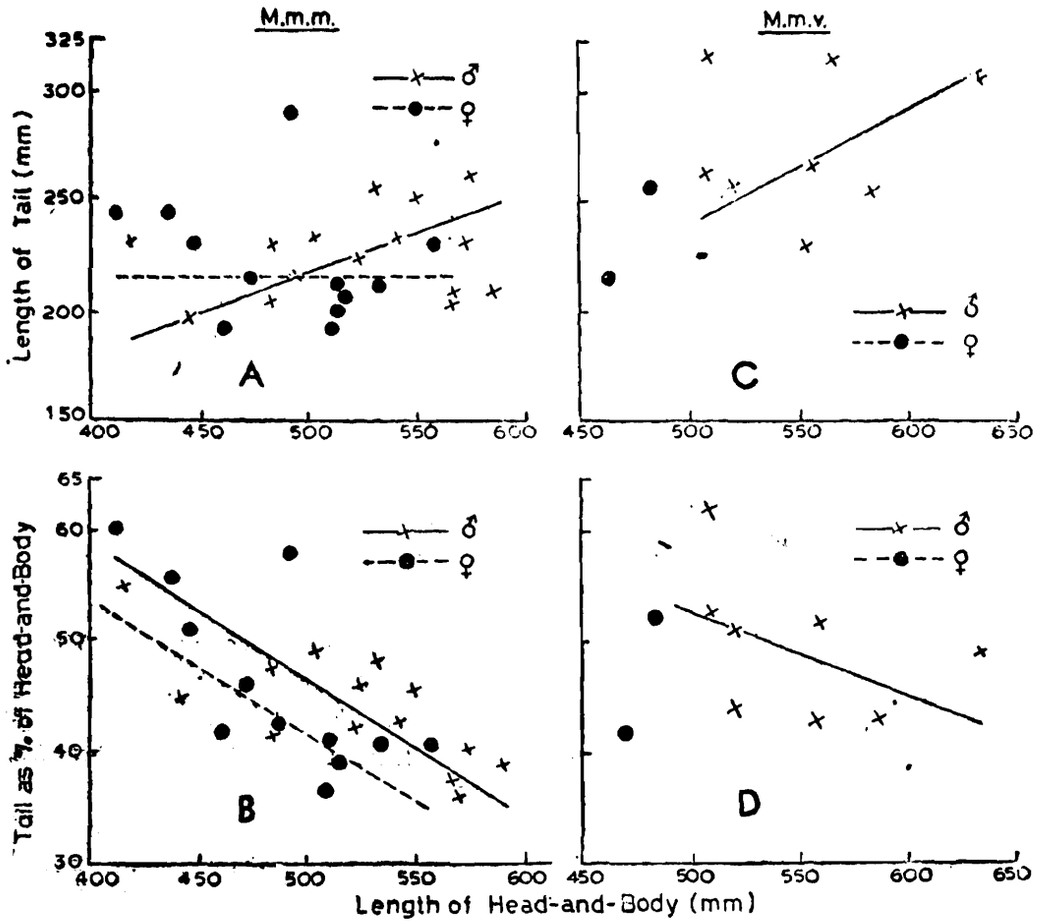

Fig. 2. *Macaca mulatta.* Graphs showing sub- specific variation in lengths of head-and-body and tail and the proportion (as percentage) of the latter to the former.
(A) *M. m. mulatta*, lengths. (B) Same, tail percentages. (C) *M. m. villosa*, lengths.
(D) Same, tail percentages.

[2. *Tail proportions*] (Fig. 2 and Tables 2 and 3).

Available data on flesh measurements of the lengths of head-and-body and tail (both as straight line distances, not along curves) in Indian examples (Table 2) show that in both respects *M. m. villosa* is larger than *M. m. mulatta*, and in both subspecies males are appreciably larger than females. The average tail length (both sexes) is 224.0 mm. in *M. m. mulatta* and 264.3 mm. in *M. m. villosa*, but the Pakistan population of the latter subspecies, according to Roberts 1977), has a much shorter tail (average 209 mm only).

As regards tail length in relation to that of head-and-body the position is as follows : (i) In males of both *M. m. mulatta* and *M. m. villosa* the tail length increases directly with that of head-and-body (Figs. 2A, C). But in females of *M. m. mulatta* no such correlation is apparent, and in *M. m. villosa* the data are too scanty to permit any conclusion to be reached. (ii) The tail length is 35.7—62·5 per cent of head-and-body (Table 3). It is appreciably shorter in *M. m. mulatta* average 44·6 per cent of head-and-body) than in *M. m. villosa* (av. 49·4 per cent). (iii) In both subspecies the tail percentage decreases with the increase of head-and-body length (Figs. 2B, D).

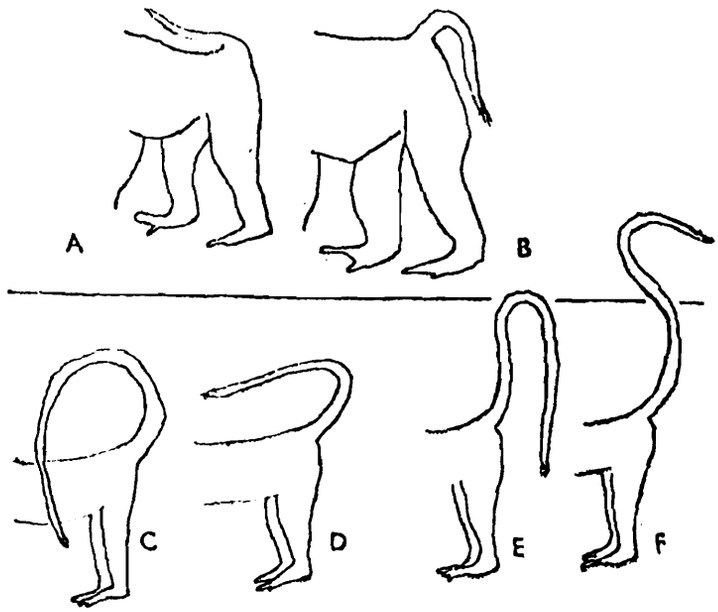

Fig. 3. Subspecific tail variation in some other cercopithecids. Upper row : *Macaca nemestrina* (adapted from Fooden, 1975). (A) *M. n. leonina*. (B) *M. n. nemestrina*. Lower row : *Presbytis entellus*. (C, D) Northern group (C, the plains, *P. e. entellus* ; D, the sub-Himalayas, *P. e. schistaceus*). (E, F) Southern group (E, *P. e. achates*, Karnataka : E. *P. e. thersites*, Sri Lanka.)

Fooden (1976, p. 230) gave the species range of the length ratio Tail/Head-and-Body for the species as 0·28—0·74 (the tail proportion is thus 28—74 per cent of head-and-body) ; subspecific differences were not mentioned by him. The very small tail (av. 203 mm) of the Pakistan population of *M. m. villosa* is noteworthy since the mode of tail carriage there is also said to be different from that of the Kumaun Hills (∩—shaped instead of 7-shaped). This would suggest that the Pakistan population, being long isolated from the Indian one, may have evolved different racial characteristics.

Discussion

Subspecific variation in tail form and carriage is known in two other cercopithecids from South and Southeast Asia.

In the pig-tailed macaque *Macaca nemestrina* (Linn.), which has 3 or 4 subspecies, Fooden (1975) has recorded taildifferences as follows :— In *M. n. leonina* (Blyth) [Fooden regards *M. n. blythi* Pocock as its synonym], which is found from Burma to Vietnam, the tail fur is dark brown to black dorsally and buff ventrally, there is no terminal tuft, and the tail is normally bent *forward* over the back, with the tip directed upward and forward (Fig. 3A). In *M. n. nemestrina* (Linn.), which is found in Malaya, Sumatra and Borneo, the tail is coloured as in *leonina*, has a weak terminal tuft, and is curved *backward* and downward (Fig. 3B). In *M. n. pagensis* Miller, which is confined to the Pagi Islands in the Mentawi group off the western coast of Sumatra, the tail is virtually naked so that the skin is clearly visible ; its mode of carriage is unknown (Fodden arbitrarily depicts it as bent backward). No special mode of tail carriage (as in *M. mulatta*) is known in the alpha male in *M. nemestrina*. The length ratio Tail/Head-and-body also shows some subspecific differences, being 0·24—0·34 in *M. n. pagensis*, 0·24—0·45 in *M. n. nemestrina*, and 0·30—0·46 in *M. n. leonina*.

In the Hanuman langur, *Presbytis entellus*

(Dufresne) (subfamily Colobinae), which has 15 subspecies, the relaxed tail carriage shows subspecific, geographical and clinal variations (Roonwal, 1976, 1979). In the Northern Group of subspecies (above about 20° N latitude) the tail is bent *forward* over the back, while in the Southern Group it is bent *backward* (cf. *Macaca nemestrina*) ; within each group there are further variations (Figs. 2C-F). The relative tail length also shows subspecific variations (see Roonwal, 1979 and in press).

ACKNOWLEDGEMENTS

We are indebted to the following officers of the Zoological Survey of India for assistance :— To Dr. B. S. Lamba (Deputy Director, Dehra Dun) for photographic and other facilities ; to Dr. B. Biswas (Deputy Director, Calcutta) for supplying measurements of several examples of the rhesus macaque ; and to Mr. Girish Kumar for field assistance.

REFERENCES

FOODEN, J. 1975. Taxonomy and evolution of liontail and pigtail macaques (Primates : Cercopithecidae). *Fieldiana (Zool.)* Chicago, 67: 8+II+ 169 pp.

FOODEN, J. 1976. Provisional classification and key to living species of macaques (Primates : *Macaca*). *Folia primatol* Basel 25 : 225—236.

HILL W. G. OSMAN. 1974. *Primates : Comparative Anatomy and Taxonomy.* VII. Cynopithecinae ; *Cercocebus, Macaca, Cynopithecus.* New York (Wiley and Sons).

MCMAHON, A. H. 1901a. Notes on the fauna of Chitral, *J. Asiat, Soc. Bengal,* Calcutta, 70 (pt. II, *Nat. Hist*). No. 1 : 1-7.

MCMAHON, A. H. 1901b. Notes on the fauna of Dir and Swat. *J. Asiat. Soc. Bengal,* Calcutta, 70 (pt. II, *Nat. Hist.*), No. 1 : 7-12.

OJHA, P. R. 1974. Tail carriage and dominance in the rhesus monkey, *Macaca mulatta. Mammalia,* Paris, 38 : 163-170.

POCOCK, R, I. 1932. The rhesus macaques (*Macaca mulatta*) *J. Bombay Nat. Hist. Soc.,* Bombay, 35 (3) : 530 551, 1 pl.

ROBERTS, T. J. 1977. *The Mammals of Pakistan.* xxvi + 361 pp., 4 col pls. London (E. Benn Ltd.).

ROONWAL, M. L. 1976. Dominance behaviour in South Asian primates. *J. sci. indust. Res.,* New Delhi, 35 : 244-260.

ROONWAL, M. L. 1977. Urbanization in primates and comparison with man. *J. sci. indust. Res.,* New Delhi, 36 : 179-187.

ROONWAL, M. L. 1979. Field study of geographical, subspecific and clinal variations in tail carriage in the Hanuman Langur, *Presbytis entellus* (Primates), in South Asia. *Zool. Anz.,* Jena, 202 : 235-255.

ROONWAL, M. L. (In press.) Intraspecific variation in size, proportion of body-parts and weight in the Hanuman Langur, *Presbytis entellus* (Primates), in South Asia, with remarks on subspeciation. *Rec. zool Surv, India* Delhi.

ROONWAL, M. L. and MOHNOT, S. M. 1977. *Primates of South Asia : Ecology, Sociobiology and Behavior.* xx + 422 pp. Cambridge (Mass.) and London (Harvard University Press).

SADE, D S, 1971. Communication by tail positions in rhesus monkeys (*Macaca mulatta*). *Am. J. phys. Anthrop.* (N. S.), 35 : 294.