

SHORT COMMUNICATION

Non-seasonal Breeding Patterns in Stumptail
Macaques (*Macaca arctoides*)EUCLID O. SMITH
Emory University

ABSTRACT. This paper summarizes published reports of breeding patterns across the genus *Macaca*. Patterns range from strictly seasonal to non-seasonal. Data on sexual behavior and birth patterns are presented which confirm previous reports of non-seasonality for *Macaca arctoides*. In a captive colony, 63 births were recorded, and individuals were born during every month of the year. Heterosexual mounting activity was recorded over a two-year period and occurred during every month of that period. It is clear that *M. arctoides* does not exhibit the seasonal cyclicity observed in some other macaque species.

OBSERVATIONS

Birth and breeding cyclicities have been the focus of considerable research dealing with non-human primates. ZUCKERMAN (1931, 1932) noted that monkeys and apes demonstrate uninterrupted sexual activity throughout the year, and this is the basis of the coordinated activities so fundamental to primate social life. However, with the initiation of systematic field research, primatologists became aware of considerable variability within the Order Primates. Non-human primates have been characterized as strictly seasonal breeders, those in which there is an annual birth peak but not strict seasonality, and those which exhibit year-round sexual activity and births (LANCASTER & LEE, 1965). Even if the focus of inquiry is narrowed to only one genus (*Macaca*), we find considerable variability in breeding patterns, ranging from strictly seasonal breeders to strictly non-seasonal forms. Table 1 summarizes representative reports on the genus *Macaca*. The purpose of this paper is to present data on birth and breeding seasonality among stumptail macaques and to contrast it with studies of other macaque species.

Comparison of the various macaque species shown in Table 1 reveals a complex pattern relating housing conditions, breeding cyclicity and conspicuous swelling of the sexual skin. In an attempt to determine if there exist any consistent taxonomic patterns among species with conspicuous swelling or seasonal reproduction, data were organized following FOODEN (1976). Of the six species that are classified consistently as exhibiting conspicuous swelling around midcycle, four belong to the *silenus-sylvanus* group, with one each in the *sinica* and *cyclopis* groups. Of the seven species that are reported to be seasonal breeders, three belong to the *sinica* group, three belong to the *fascicularis* group and one belongs to the *silenus-sylvanus* group (FOODEN, 1976). As can be seen, no consistent taxonomic pattern emerges for classificatory purposes.

The subjects of the present study were a captive group of stumptail macaques (*Macaca arctoides*) housed at the Yerkes Regional Primate Research Center near Lawrenceville,

Table 1. Summary of representative studies of breeding cyclicity in macaques.

Species	Conspicuous swelling ^{1,2)}	Seasonal	Housing	Reference
<i>Macaca arctoides</i>	No	No	Free-ranging	BERTRAND (1969); ESTRADA & ESTRADA (1981)
		No	Outdoor enclosure	ESTRADA & ESTRADA (1976); HADIDIAN & BERNSTEIN (1979); SLOB, OOMS & VREEBURG (1979)
		No	Captive	DUKELOW (1974)
		No	Indoors	BRÜGGEMANN & GRAUWILER (1972); MACDONALD (1971)
		No	Indoors, large windows and artificial light	TROLLOPE (1978)
<i>M. assamensis</i>	Yes	No	Laboratory	SCHRIER & POVAR (1983)
<i>M. cyclopis</i>	Yes	Yes	Free-ranging	FOODEN (1971)
<i>M. fascicularis</i>	No ¹⁾ (Yes ²⁾)	No	Free-ranging	PENG et al. (1973a, b)
		Yes	Free-ranging	WHEATLEY (1981)
<i>M. fuscata</i>	No	No	Outdoor enclosure	HADIDIAN & BERNSTEIN (1979); LAURSEN (1980)
		No	Indoor cage	HONJO et al. (1978)
		No	Captive	DUKELOW (1974)
		No	Indoors, light-controlled	MAHONE & DUKELOW (1979)
		No	Indoors, natural daylight	DANG (1977)
<i>M. mulatta</i>	No	Yes	Free-ranging	KAWAI, AZUMA & YOSHIBA (1967); NIGI (1976); NIGI et al. (1980); TIBA & NIGI (1980)
		Yes	Outdoor enclosure	HANBY, ROBERTSON & PHOENIX (1971); VAN HORN (1980)
		Yes	Indoors, light-controlled	NIGI (1975)
<i>M. nemestrina</i>	Yes	Yes	Free-ranging	CARPENTER (1942a, b); CONAWAY & SADE (1965); LINDBURG (1971); SADE (1964); SOUTHWICK, BEG & SIDDIQI (1965)
		Yes	Outdoor enclosure	GORDON (1981); HADIDIAN & BERNSTEIN (1979)
		No	Laboratory	ECKSTEIN & KELLEY (1966)
<i>M. nigra</i>	Yes	Yes	Laboratory	VALERIO, PALLOTTA & COURTNEY (1969)
		No	Free-ranging	MCCANN (1933)
		No	Captive	DUKELOW (1974)
<i>M. radiata</i>	No	No	Outdoor enclosure	HADIDIAN & BERNSTEIN (1979)
		Yes	Outdoor enclosure	DIXSON (1977); HADIDIAN & BERNSTEIN (1979)
<i>M. silenus</i>	Yes	Yes	Free-ranging	RAHMAN & PARTHASARATHY (1969); SIMONDS (1965)
		No	Outdoor enclosure	GLICK (1979); HADIDIAN & BERNSTEIN (1979)
<i>M. sinica</i>	No	Yes	Free-ranging	ROONWAL & MOHNOT (1977); SUGIYAMA (1968)
<i>M. sylvanus</i>	Yes	Yes	Free-ranging	DITTUS (1977)
				MACROBERTS & MACROBERTS (1966); TAUB (1980)

1) NAPIER & NAPIER (1967); 2) BUTLER (1974).

Georgia. Previously, they had been housed at the Wisconsin Primate Center's Breeding Research Facility [see WEISBARD & GOY (1976) for details]. The group, numbering 39 animals, was housed in a 28.4 × 32.7 m open-air compound and was provisioned daily with monkey

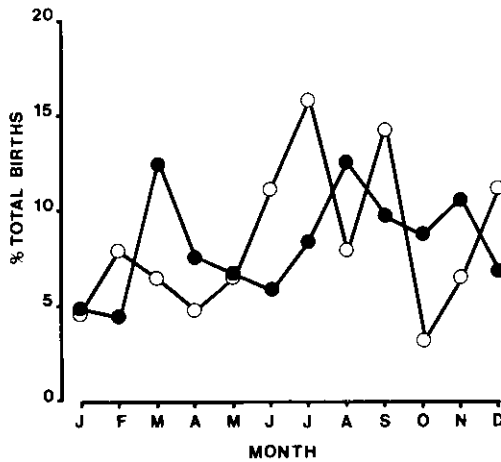


Fig. 1. Percentage of total births by month from 1968–1983. Open circles show data from this study. Closed circles show pooled data from all published studies (ESTRADA & ESTRADA, 1976, 1981; HADIDIAN & BERNSTEIN, 1979; MACDONALD, 1971; SCHRIER & POVAR, 1983; SLOB, OOMS & VREEBURG, 1979; TROLLOPE, 1978) of *Macaca arctoides* breeding patterns.

chow and fresh fruit. Observations were made from a tower overlooking the enclosure. The group and facilities are described in greater detail in SMITH and PEPPER-SMITH (in press).

All observed adult, heterosexual mounts were recorded on an *ad lib* basis (ALTMANN, 1974) over a two-year period. A total of 682 mounts was recorded from May, 1981, through April 1983. Mounts were minimally defined as intromission accompanied by pelvic thrusts. The scoring did not distinguish between mounts meeting these minimum criteria and mounts terminating with ejaculation and/or copulatory tie (CHEVALIER-SKOLNIKOFF, 1975). Birth dates have been recorded for the colony for 15 years.

Figure 1 shows the pattern of births in our colony ($n = 63$), and it also summarizes the data from all other published studies of stumptail macaque birth patterns (total $n = 204$). As can be seen, there is no month for which births were not reported. These data are impressive, given that they are comprised of reports of animals in environmentally-controlled conditions (MACDONALD, 1971; SCHRIER & POVAR, 1983; TROLLOPE, 1978) as well as in free-ranging or compound environments (ESTRADA & ESTRADA, 1976, 1981; HADIDIAN & BERNSTEIN, 1979; SLOB, OOMS & VREEBURG, 1979). Of the 267 total births reported, 66 (24.7%) are of laboratory-housed animals. Even if the laboratory data are analyzed separately, there is no month in which there is not at least one birth.

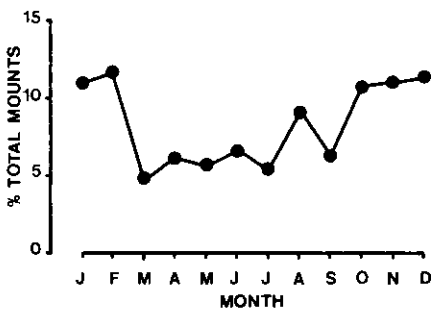


Fig. 2. Percentage of total heterosexual adult mounts by month from May, 1981 through April, 1983.

To verify further this lack of seasonality in *M. arctoides*, data on mounting activity were collected over a two-year period. The data on heterosexual mounting activity are shown in Figure 2. These data further substantiate our classification of stumptail macaques as non-seasonal breeders. Throughout the study period, mounting behavior was observed every month, unlike some seasonal breeding forms in which there is quiescence of sexual activity for several months of the year.

In conclusion, it is interesting to note that of the 12 macaque species listed in Table 1, only one (*M. arctoides*) has been found consistently to be a non-seasonal breeder in both laboratory and free-ranging environments. However, it should be noted that all species have not been studied under both conditions, and it may well be that *M. fascicularis* and *M. nemestrina* are non-seasonal breeders under both free-ranging and laboratory conditions. The relationship between conspicuous swelling and cyclicity, however, is much less clear. Careful study of subjects under both field and laboratory conditions will be required to explain fully these complicated relationships.

Acknowledgements. This research was supported by U. S. Public Health Service Grants DA-02128, RR-00165 and RR-00167 (Division of Research Resources, National Institutes of Health). Technical assistance in the collection of data and in the preparation of this manuscript by F. W. HAMAN, F. H. KIERNAN, S. P. MARTIN, P. G. PEFFER-SMITH and P. M. PLANT is acknowledged.

REFERENCES

- ALTMANN, J., 1974. Observational study of behavior: sampling methods. *Behaviour*, 49: 227-265.
- BERTRAND, M., 1969. The behavioral repertoire of the stumptail macaque: a descriptive and comparative study. *Bibl. Primatol.*, 11: 1-273.
- BRÜGGEMANN, S. & J. GRAUWILER, 1972. Breeding results from an experimental colony of *Macaca arctoides*. In: *Medical Primatology, Part I*, E. I. GOLDSMITH & J. MOOR-JANKOWSKI (eds.), S. Karger, Basel, pp. 216-226.
- BUTLER, H., 1974. Evolutionary trends in primate sex cycles. *Contrib. Primatol.*, 3: 2-35.
- CARPENTER, C. R., 1942a. Sexual behavior of free ranging rhesus monkeys (*Macaca mulatta*). I. Specimens, procedures and behavioral characteristics of estrus. *J. Comp. Psychol.*, 33: 113-142.
- , 1942b. Sexual behavior of free ranging rhesus monkeys (*Macaca mulatta*). II. Periodicity of estrus, homosexual, auto-erotic and non-conformist behavior. *J. Comp. Psychol.*, 33: 143-162.
- CHEVALIER-SKOLNIKOFF, S., 1975. Heterosexual copulatory patterns in stumptail macaques (*Macaca arctoides*) and in other species. *Arch. Sex. Behav.*, 4: 199-220.
- CONAWAY, C. H. & D. S. SADE, 1965. The seasonal spermatogenic cycle in free ranging rhesus monkeys. *Folia Primatol.*, 3: 1-12.
- DANG, D. C., 1977. Absence of seasonal variation in the length of the menstrual cycle and fertility of the crab-eating macaque (*Macaca fascicularis*) raised under natural daylight. *Ann. Biol. Anim. Biochem. Biophys.*, 17: 1-7.
- DITTUS, W. P. J., 1977. The social regulation of population density and age-sex distribution in the toque monkey. *Behaviour*, 63: 281-322.
- DIXSON, A. F., 1977. Observations on the displays, menstrual cycles, and sexual behaviour of the "black ape" of Celebes (*Macaca nigra*). *J. Zool. (London)*, 182: 63-84.
- DUKELOW, W. R., 1974. Captive breeding of nonhuman primates. In: *American Association of Zoo Veterinarians: Annual Proceedings*, Privately Published, Topeka, Kansas, pp. 52-67.
- ECKSTEIN, P. & W. A. KELLEY, 1966. A survey of breeding performance of rhesus monkeys in the laboratory. *Symp. Zool. Soc. London*, 17: 91-112.
- ESTRADA, A. & R. ESTRADA, 1976. Birth and breeding cyclicity in an outdoor living stumptail macaque (*Macaca arctoides*) group. *Primates*, 17: 225-231.
- & ———, 1981. Reproductive seasonality in a free-ranging troop of stumptail macaques (*Macaca arctoides*): a five-year report. *Primates*, 22: 503-511.

- FOODEN, J., 1971. Report on Primates Collected in Western Thailand January–April, 1967. *Fieldiana (Zoology)*, 59: 1–62.
- , 1976. Provisional classification and key to living species of macaques (Primates: *Macaca*). *Folia Primatol.*, 25: 225–236.
- GLICK, B. B., 1979. Testicular size, testosterone level and body weight in male *Macaca radiata*. *Folia Primatol.*, 32: 268–289.
- GORDON, T. P., 1981. Reproductive behavior in the rhesus monkey: social and endocrine variables. *Amer. Zool.*, 21: 185–195.
- HADIDIAN, J. & I. S. BERNSTEIN, 1979. Female reproductive cycles and birth data from an Old World monkey colony. *Primates*, 20: 429–442.
- HANBY, J. P., L. T. ROBERTSON & C. H. PHOENIX, 1971. The sexual behavior of a confined troop of Japanese macaques. *Folia Primatol.*, 16: 123–143.
- HONJO, S., F. CHO, T. FUJIWARA, Y. YOSHIOKA, K. MASUKO, K. KURIHARA, M. YABE & Y. NOGUCHI, 1978. Breeding cynomologus monkeys through successive generations by indoor cage system. *Jap. J. Med. Sci. Biol.*, 31: 301–310.
- KAWAI, M., S. AZUMA & K. YOSHIBA, 1967. Ecological studies of reproduction in Japanese monkeys (*Macaca fuscata*). I. Problems of the birth season. *Primates*, 8: 35–74.
- LANCASTER, J. B. & R. B. LEE, 1965. The annual reproductive cycle in monkeys and apes. In: *Primate Behavior: Field Studies of Monkeys and Apes*, I. DEVORE (ed.), Holt, Rinehart & Winston, New York, pp. 486–513.
- LAURSEN, E., 1980. Captive breeding *M. fascicularis* (cynomologus) monkeys in Malaysia. *Prim. Supp.*, 5: 9–11.
- LINDBURG, D. G., 1971. The rhesus monkey in north India: an ecological and behavioral study. In: *Primate Behavior: Developments in Field and Laboratory Research, Vol. 2*, L. A. ROSENBLUM (ed.), Academic Press, New York, pp. 1–106.
- MACDONALD, G. J., 1971. Reproductive patterns in three species of macaques. *Fertil. & Steril.*, 22: 373–377.
- MACROBERTS, M. H. & B. R. MACROBERTS, 1966. The annual reproductive cycle of the Barbary ape (*Macaca sylvana*) on Gibraltar. *Amer. J. Phys. Anthropol.*, 25: 299–304.
- MAHONE, J. P. & W. R. DUKELOW, 1979. Seasonal variation of reproductive parameters in the laboratory-housed male cynomologus macaque (*Macaca fascicularis*). *J. Med. Primatol.*, 8: 179–183.
- MCCANN, C., 1933. Notes on some Indian macaques. *J. Bombay Nat. Hist. Soc.*, 3: 796–810.
- NAPIER, J. R. & P. H. NAPIER, 1967. *A Handbook of Living Primates*. Academic Press, New York.
- NIGI, H., 1975. Menstrual cycle and some other related aspects of Japanese monkeys (*Macaca fuscata*). *Primates*, 16: 207–216.
- , 1976. Some aspects related to conception of the Japanese monkey (*Macaca fuscata*). *Primates*, 17: 81–87.
- , T. TIBA, S. YAMAMOTO, Y. FLOESCHEIM & N. OHSAWA, 1980. Sexual maturation and seasonal changes in reproductive phenomena of male Japanese monkeys (*Macaca fuscata*) at Takasakiyama. *Primates*, 21: 230–240.
- PENG, M. T., Y. L. LAI, C. S. YANG & H. S. CHIANG, 1973a. Formosan monkey (*Macaca cyclopis*): present situation in Taiwan and its reproductive biology. *Exp. Anim.*, 22: 447–451.
- , ———, ———, A. E. NEW & C. P. CHANG, 1973b. Reproductive parameters of the Taiwan monkey (*Macaca cyclopis*). *Primates*, 14: 201–213.
- RAHAMAN, H. & M. D. PARTHASARATHY, 1969. Studies on the social behavior of bonnet monkeys. *Primates*, 10: 149–162.
- ROONWAL, M. L. & S. M. MOHNOT, 1977. *Primates of South Asia: Ecology, Sociobiology and Behavior*. Harvard Univ. Press, Cambridge.
- SADE, D. S., 1964. Seasonal cycle in the size of testes of free-ranging *Macaca mulatta*. *Folia Primatol.*, 2: 171–180.
- SCHRIER, A. M. & M. L. POVAR, 1983. Results of a small-scale stumptailed monkey breeding program in a laboratory. *Lab. Primate Newsl.*, 22(3): 1–4.
- SIMONDS, P. E., 1965. The bonnet macaque in south India. In: *Primate Behavior: Field Studies of Monkeys and Apes*, I. DEVORE (ed.), Holt, Rinehart & Winston, New York, pp. 175–196.
- SLOB, A. K., M. P. OOMS & J. T. M. VREEBURG, 1979. Annual changes in serum testosterone in laboratory housed male stumptail macaques (*M. arctoides*). *Biol. Reprod.*, 20: 981–984.

- SMITH, E. O. & P. G. PEFFER-SMITH, in press. Adult male-immature interactions in captive stump-tail macaques (*Macaca arctoides*). In: *Primate Paternalism: Comparative View of Male Investment*, D. M. TAUB (ed.), Van Nostrand Reinhold, New York.
- SOUTHWICK, C. H., M. A. BEG & M. R. SIDDIQI, 1965. Rhesus monkey in north India. In: *Primate Behavior: Field Studies of Monkeys and Apes*, I. DEVORE (ed.), Holt, Rinehart & Winston, New York, pp. 111–159.
- SUGIYAMA, Y., 1968. Ecology of the lion-tailed macaque (*Macaca silenus* LINNAEUS)—a pilot study. *J. Bombay Nat. Hist. Soc.*, 65: 283–292.
- TAUB, D. M., 1980. Female choice and mating strategies among wild barbary macaques (*Macaca sylvanus* L.). In: *The Macaques: Studies in Ecology, Behavior and Evolution*, D. G. LINDBURG (ed.), Van Nostrand Reinhold, New York, pp. 287–344.
- TIBA, T. & H. NIGI, 1980. Jahreszeitliche Schwankung in der Spermatogenese beim "free-ranging" Japanischen Makak (*Macaca fuscata*). *Zool. Anz., Jena*, 204: 371–387.
- TROLLOPE, J., 1978. Reproduction in a closed colony of *Macaca arctoides*. In: *Recent Advances in Primatology, Vol. 2, Conservation*, D. J. CHIVERS & W. LANE-PETTER (eds.), Academic Press, London, pp. 243–250.
- VALERIO, D. A., A. J. PALLOTTA & K. D. COURTNEY, 1969. Experiences in large-scale breeding of simians for medical experimentation. *Ann. N. Y. Acad. Sci.*, 162: 282–296.
- VAN HORN, R. N., 1980. Seasonal reproductive patterns in primates. In: *Progress in Reproductive Biology, Vol. 5*, P. O. HUBINONT (ed.), S. Karger, Basel, pp. 181–221.
- WEISBARD, C. & R. W. GOY, 1976. Effect of parturition and group composition on competitive drinking order in stump-tail macaques (*Macaca arctoides*). *Folia Primatol.*, 25: 95–121.
- WHEATLEY, B. P., 1981. Birth seasonality in wild *Macaca fascicularis*. In: *Program and Abstracts, American Society of Primatologists, 4th Annual Meeting, San Antonio, Texas*, p. 39.
- ZUCKERMAN, S., 1931. The menstrual cycle of primates. III. The alleged breeding-season of primates, with special reference to the chacma baboon (*Papio porcarius*). *Proc. Zool. Soc. London*: 325–343.
- , 1932. *The Social Life of Monkeys and Apes*. Harcourt & Brace, New York.

—Received June 27, 1983; Accepted September 15, 1983

Author's Name and Address: EUCLID O. SMITH, Yerkes Regional Primate Research Center, Field Station, Emory University, 2409 Collins Hill Road, Lawrenceville, Georgia 30245, U.S.A.