

191 Murtaugh

COPULATORY BEHAVIOR AND REPRODUCTION IN THE BINTURONG, *ARCTICTIS BINTURONG*

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ABSTRACT.—Observations of binturongs (*Arctictis binturong*) in captivity revealed that copulation was usually arboreal and was characterized by repeated mounts with multiple bouts of intravaginal thrusting. Receptive females showed increased activity, a vaginal mucous discharge, and increased frequency of two vocalizations. Neck-biting was absent, but tail wrapping was unique to the female. Known-aged females first copulated at a mean age of 30.4 months (range = 12.9–47.9), and conceived for the first time at 30.0 months (range = 13–47.9). Males copulated for the first time at 27.7 months (range = 13–45.7). Both sexes can remain fertile until at least 15 years old. The maximum life-time productivity in captivity was estimated to be 23 young. Quantitative reproductive data obtained from a zoo survey revealed that binturongs breed year-round, but show a pronounced birth peak from January through March. Estrous cycles averaged 81.8 days and copulations were seen over a period of 1 to 15 days (\bar{X} = 6.1), suggesting a long period of estrus. Mean gestation was 91.1 days (range = 84–99), litter size ranged from one to six (\bar{X} = 1.98), and the sex ratio at birth was not significantly different from 1:1. The prenatal growth rate was approximately 3.5g/foetus/day; neonatal weight ranged from 283.8 to 340.5 g (\bar{X} = 319), or about 2.9% of the nonpregnant female's weight.

Binturongs (*Arctictis binturong*) are the largest viverrids and the most specialized species in the subfamily Paradoxurinae. They inhabit forests from sea level to the Himalayan foothills through South Asia from Nepal and Assam to Sumatra, Java, Borneo, and Palawan (Pocock, 1939; Wenzel and Haltenorth, 1972). Their most notable traits (prehensile tail, hindfeet with syndactylous third and fourth toes, and crushing cheekteeth) are adaptive to their arboreal habit and frugivorous diet.

Our knowledge of reproduction in this species and other civets is based largely on anecdotal and fragmentary information. Ewer (1973a) compiled this material, but only two major studies appeared since her review. Charles-Dominique's (1978) field study of the African palm civet (*Nandinia binotata*) included information on length of breeding season, litter size, and age at sexual maturity, and Tsui et al. (1974) reported on seasonal histochemical changes in testes of masked palm civets (*Paguma larvata*). The objectives of this paper are to summarize our findings on copulatory behavior of binturongs, to provide basic statistics on reproduction, and to compare our results with findings on other civets.

MATERIALS AND METHODS

Because binturongs commonly breed in captivity, 139 questionnaires were sent to zoos on all continents. Forty-seven returns from North America, Europe, Asia, and Australia contained usable information on husbandry, mortality, and reproductive histories.

From June 1977 to February 1980 we monitored the sexual behavior and reproductive cycles of six males and three females (aged 1 to 6 years) born to wild-caught parents. These animals were maintained at the Conservation and Research Center in Front Royal, Virginia, and were housed singly in adjoining cages each with equal sized indoor and outdoor sections averaging 3.2 by 5 by 2.8 m (width by length by height).

Diet included a commercially prepared meat mix (Central Nebraska Brand Feline Diet), bananas, apples, oranges, canned peaches, and Vionate Mineral Supplement (E. R. Squibb and Sons). Windows in each cage provided natural lighting, but a year-round 12L:12D artificial photoperiod changing at 0600 and 1800 h obscured the natural daylight cycle in winter months of 1977 and 1978. Thereafter, artificial lighting was provided only between sunrise and sunset.

We maintained the animals singly, but attempted to detect estrus several days a week by allowing pairs to interact briefly. Later these encounters often proved unnecessary because

receptivity could be detected by behavioral changes in solitary females. Receptive females were left with males either continuously or for several hours each day until copulations ceased. We recorded notes on observations with a Sony dictaphone and stopwatch. Durations of copulatory elements were recorded with an Esterline-Angus operations recorder and keyboard, or by dictating timed observations to a secretary. Durations of behavioral variables were rounded to the nearest second. Copulations involving two females and three males were observed on 16 occasions for 12.2 h of data. Electro-ejaculation methodology was the same as that described in Platz and Seager (1978). The estimate of wild female body weight was based on references from Pocock (1933, 1939) and data from specimens in the National Museum of Natural History (Washington, D.C.), and Museum Zoologicum Bogoriense (Bogor, Indonesia). Vocalizations were recorded with a Uher 4000 Report L-stereo recorder, and analyzed with a Kay Sonograph 7029A. Probability of 5% was selected as minimum level of statistical significance. Unless otherwise stated, all statistical values are based on both personal and questionnaire data.

RESULTS

Copulatory Behavior

Interaction during anestrus.—Although captive binturongs of opposite sex coexist adequately, if not completely peacefully, zoo keepers recognize that females are usually dominant, as evidenced by priority to food and resting sites. Encounters between males and anestrus females maintained singly were often characterized by mutual avoidance or aggression. During encounters not so characterized, anestrus females exhibited greater social initiative than males, which typically assumed an agitated defensive posture. If females tried to sniff them, males usually responded by cuffing at the females with the forefeet and protesting vocally with a graded series of high-pitched snorts and squawks. Defensiveness of males often seemed over-reactive and contrasted to the relaxed curiosity of females. Young females (2–4 years) often playfully attacked the protesting males, nipping and jumping on them repeatedly. Ironically, under these circumstances males did not flee immediately, defend themselves effectively, or play. Older females were not often playful, and males usually avoided them and screamed at them with little provocation. Frequent play either with cage-mates or during encounters was typical of young animals which had not yet copulated.

Interaction during estrus.—Increased activity and calling characterized estrus in isolated females. A call, consisting of a single blowing sound, was made by expelling air through the nose. This call also was made by males in adjacent cages, which suggests it served a contact-promoting function. Females showed continued restlessness when they encountered males, and males, now no longer defensive, followed the females and paused frequently to sniff the cage or to sniff towards them as they passed. Eventually, females reclined and, after brief mutual sniffing, males investigated the perineal region of females and often exposed the area by pulling the tailbase aside with their forepaws. Huf (1965) remarked that the basal third of the tail was angled upward during estrus. Labia of the perineal gland became firmer and enlarged during estrus. The vulva, situated in the middle of the glandular pouch (Pocock, 1939; Story, 1945), secreted a profuse mucus, which, together with perineal gland secretions, presumably was responsible for a strong odor resembling cooked popcorn. Males often flehmened after licking the perineal gland of females. Production by females of a coarse purring sound (geckering) was indicative of receptivity, and occurred most often during contact with males.

Males showed significant changes in the incidence of three of six behavior patterns when they encountered geckering females (Table 1). There was a significant decrease in the incidence of defensive squawking ($P = 0.019 - <0.001$), and a significant increase in sniffing of females ($P < 0.001$). Only one male showed a significant relationship between incidence of contact calls and geckering. One female that geckered in 45 of 159 encounters showed a significant reduction in aggressive play during

TABLE 1.—The effect of female behavior as evidenced by the occurrence of the female's geckering call on the incidence of six behavior patterns in two male binturongs during heterosexual encounters. Values refer to the number of encounters in which the pattern occurred at least once (yes) or was absent (no).

Behavior	Animal	Geckering call				χ^2	P value
		Present		Absent			
		Yes	No	Yes	No		
Head cuff	1	13	25	36	94	0.604	0.556
	2	1	4	9	39	0.004	0.944
Squawk	1	15	23	97	33	16.340	<0.001
	2	9	1	24	24	5.399	0.019
Sniff female	1	22	16	30	100	16.679	<0.001
	2	6	4	3	45	18.238	<0.001
Aggressive play	1	0	38	1	129	0.294	0.294
	2	0	10	0	48		
Contact call	1	9	29	14	116	4.150	0.039
	2	0	10	4	44	0.895	0.653
Attack	1	0	38	4	126	1.197	0.273
	2	0	10	3	45	0.659	0.577

encounters in which she geckered ($\chi^2 = 6.52$, d.f. = 1, $P = 0.01$). Females that geckered displayed less aggressive play with males. Males were less defensive and showed increased social initiative with females that geckered.

Metatarsus scuffing, perineal gland marking, and licking urine of females also were seen (Kleiman, 1974), but neither exclusively nor more frequently during estrus. Between copulations, females occasionally left traces of vaginal fluid and perineal gland secretions on branches in the cage. This was usually a passive form of marking; only on occasion was an estrous female seen to scent mark with the perineal gland.

Copulation.—When first encountering males, receptive females trotted briskly about the cage. This usually incited males to follow. When females abruptly laid down they were usually mounted; if males hesitated, females sometimes departed and made a circuit of the cage or they stood, turned around, and briefly presented their hind-quarters to the males. Males mounted reclining females by standing on their backs with the forepaws, clasping them about the midbody, or by simply standing on the substrate while straddling them with their forelegs. Lordosis was not pronounced; the pelvis was sometimes elevated during a mount, but the posture never approached the extreme seen in domestic cats (*Felis catus*). Likewise, neckbiting by males was never seen, and Huf's (1965) secondhand account of neck-biting is doubtful. Females often grasped the male torso or tail base with their tails and seemed to pull the males down and secure them in the mounted position. This pattern also occurred as males dismounted and when the animals made contact between copulations (Fig. 1).

Thrusting most often occurred in bouts and frequently alternated with periods of back licking. Whether intromission was continuous during and between thrusting bouts was not defined. We suspect that thrusting facilitated the first intromission. However, when the proper orientation was achieved the penis may have been withdrawn partially or completely between successive bouts of thrusting.

Females almost always terminated mounts by quickly departing. They paused and sometimes licked the perineal gland and vulva. Males typically remained at the copulation site and almost invariably licked the penis. After pausing, females often circuted the cage before returning and initiating another mounting sequence. Copulations almost always were observed to occur at the same site.

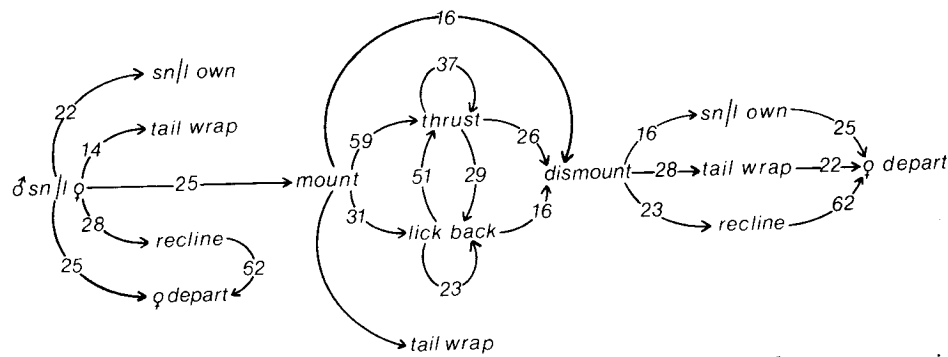


FIG. 1.—Sequences of copulatory behavior based on 161 min of interaction between two pairs of binturongs. Numerals refer to the percentage of time one act was preceded by another. ♂ sn/l ♀ indicates that male sniffs or licks the genitalia of female; sn/l own indicates that male sniffs or licks his own genitalia.

Females geckered continuously during copulation. This sound resembled a loud coarse purring, and was referred to as such (“Knurren”) by Vosseler (1929) and Huf (1965). The sonogram (Fig. 2) revealed a repetitive pulse structure of the call (11–16 pulses/s). A fine-grain analysis by Peters (in litt.) revealed that each apparent pulse consisted of about eight very brief strophs. The continuous nature of the call suggested that, like purring, it was produced both during inspiration and expiration. Geckering was highly modulated during copulation. Pulse rate decreased, and pitch and volume increased during maximal stimulation such as thrusting or postural adjustments during intromission.

Quantitative measures.—Quantitative data on copulation in three males (Table 2) revealed that two animals showed great similarities. The third male differed from the other two in all but one comparison by at least a twofold difference in means. Two males licked the backs of the females between thrusting bouts, but the third male did not. Only one male licked the back of the female when not mounted. Binomial tests of frequency of genital licking revealed that females always groomed their genitalia significantly less often than the male partner ($P < 0.05$). However, the mean duration of self-licking bouts did not differ between the sexes in a consistent fashion.

The time between introduction of a pair and the first mount (mount latency) ranged

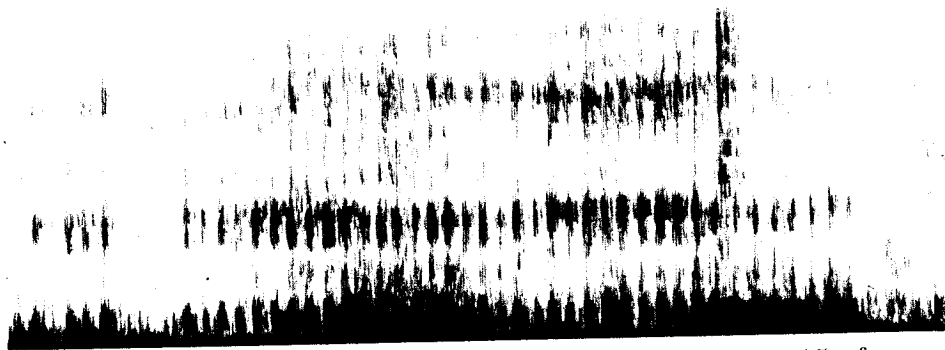


FIG. 2.—Sonogram of the geckering call of the female binturong. Duration = 4.5 s, frequency range = 40–4,000 Hz.

TABLE 2.—Durations ($\bar{X} \pm SE$ seconds) and (n) of seven copulatory variables in male binturongs.

Variable	Animal		
	1	2	3
Mount	51.8 \pm 6.7 (51)	48.8 \pm 7.8 (14)	136.4 \pm 20.4 (31)
Intermount interval	40.8 \pm 9.1 (71)	23.8 \pm 4.4 (13)	128.0 \pm 22.7 (28)
Thrusting	5.3 \pm 0.2 (160)	7.5 \pm 0.8 (19)	6.9 \pm 0.6 (91)
Inter-thrust interval	9.5 \pm 0.7 (109)	13.2 \pm 3.4 (7)	26.4 \pm 1.8 (67)
Lick-back (dismounted)	3.0 \pm 0.7 (24)		
Lick-back (mounted)	7.2 \pm 1.5 (72)	2.6 \pm 0.8 (6)	
Genital licking (self)	4.3 \pm 0.4 (97)	7.0 \pm 1.0 (25)	28.2 \pm 3.1 (41)

from 8 s to 20.7 min and averaged ($\pm SE$) 6.7 \pm 1.3 min (n = 19). The behavior of both partners contributed to the variability of this measure. As one female approached the end of estrus she rolled about on her back, manipulated her tail, and playfully annoyed the male who waited beside her. When her playful demeanor changed and she reclined 10 to 20 min later she was mounted promptly. After several successive nights of copulation, males often showed disinterest evidenced by long mount latencies and an absence of thrusting. On two occasions substitution of a new male was followed by renewed copulation, suggesting possible sexual exhaustion of the first male.

Copulation attempts by an inexperienced male.—The behavior of one male during his first encounters with an estrous female provided some insights into the integration of adult copulatory behavior. This animal was kept with his mother and a male litter mate until 9 months old. Afterwards he interacted with anestrus females during occasional staged encounters. He encountered his first estrous female at the age of 2.3 years. Thirty-two mounts were attempted with this experienced female during the first 43-min encounter, but none achieved intromission. He thrusting without contact while straddling her tail on five occasions, and in 18 instances stood on her back with all four feet. Nine other mounting attempts were either too far forward or too far to the rear. In two instances he lost balance and fell off of the female because of inadequate clasping, and in another instance he failed to dismount when she departed and was dragged along on her hindquarters. He achieved intromission on the second night after 46 min during which 24 mounts were attempted. Proper mounting orientation quickly became more frequent thereafter; inappropriate straddling of the tail and standing on the female disappeared by the third encounter (after 1 h, 43 min of experience). During the learning period he was easily distracted during mounts and showed inappropriate responses to female copulatory behavior. Intromission obviously reinforced proper pelvic orientation during mounting and promoted an effective integration of male and female responses.

Reproduction in Captivity

Litter size, sex ratio, and breeding season.—Data on 148 litters of known size were analyzed. The modal litter size was 2 (43%) and the mean $\pm SE$ was 1.9 \pm 0.1 young (range = 1–6). The sex ratio at birth of 191 young was 0.9:1 in favor of females, not

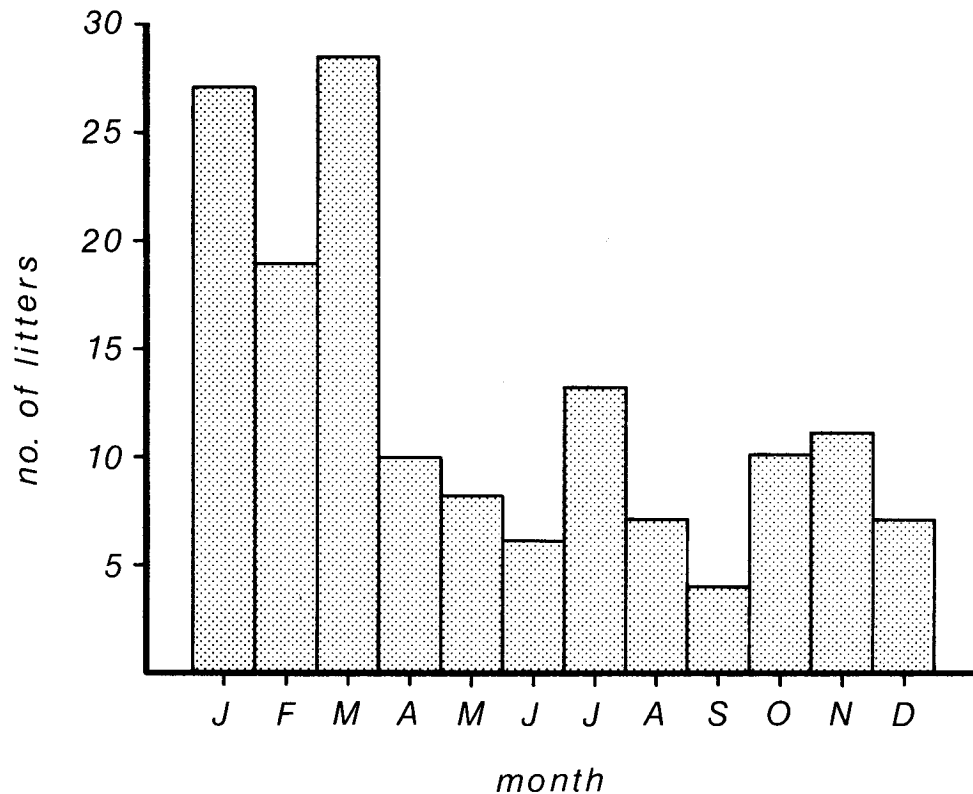


FIG. 3.—The distribution by month of 150 binturong births in captivity.

significantly different from 1:1 ($\chi^2 = 0.455$, $P > 0.05$). Numbers of births peaked from January through March with relatively low birth frequencies during the remainder of the year (Fig. 3). To test for latitudinal differences in monthly distribution of births, data were divided into 17 latitudinal groups (1–56°N), and standardized by dividing the number for that latitude by the maximum number of births in any month. A regression analysis of these data yielded an r value of 0.44 ($F = 3.7_{(1,15)}$, $P > 0.05$). Although not significant, the r^2 of 0.194 suggests that considerable variation was explained by latitude.

Duration of estrous cycle and estrus.—The length of 15 estrous cycles in five females averaged (\pm SE) 82.5 ± 11.8 days (range = 18–187). Almost all copulations were reported by other zoos to occur during a single day. However, we suspect that females are receptive for a longer period and that individual males often become sexually exhausted before estrus ends. Two females copulated for a mean \pm SE duration of 6 ± 1 days (range = 2–15) and often evidenced receptivity for longer periods during a single estrus.

Gestation period, neonate-mother weight ratio, and prenatal growth.—Gestation periods of 92, 96, and 99 days were reported for binturong by Gensch (1962, 1963) and Kuschinski (1974). Combining these records with our own and those from returned questionnaires revealed a gestation of 84 to 99 days ($\bar{X} \pm$ SE = 91.5 ± 1 , $n = 13$). If copulations occurred over several days the median day was used to determine gestation.

The mean weight of individuals in a litter of four neonates reported by Aquilina and Beyer (1979) was 319 g (range = 283.8–340.5). Another litter of four was weighed

TABLE 3.—Summary of age distribution and longevity in captive binturongs.

Age classes	Number living			Number dead		
	Known age	Estimated age ¹	Total	Known age	Estimated age	Total
<6 months	3		3	111		111
>6 months <1 year	14		14	2		2
>1-5	34	4	38	4	35	39
6-10	9	17	26	2	14	16
11-15		10	10	3	13	16
16-20	2	6	8		5	5
20-25		1	1			

¹ Captive longevity plus 2 years (animals of unknown age received as adults were assumed to be 2 years old).

on the 2nd day and estimated to have a mean individual birth weight of 289.3 g based on an average neonatal weight gain of 3.5g/day. These litters constituted 4.3 and 4.4% of the nonpregnant maternal masses (29.5 and 25.85 kg). Mean weights of captive neonates (307.4 g, $n = 9$) and nonpregnant adult females (21.9 kg, $n = 11$, $s = 6.821$, range = 11-32) yielded a neonate:female ratio of 1.42% or approximately 2.8% for the usual litter of two. Captive animals, however, often weigh more than wild counterparts. Therefore, if the mean weight of wild adult females is assumed to be 10.5 kg, the neonate:female mass ratio is 2.9% or 5.8% for a litter of two.

The prenatal growth rate of a litter of four was 14 g/day, or 3.5 g/foetus/day (Aquilina and Beyer, 1979).

Age of sexual maturity, interbirth interval, longevity, and reproductive lifespan.—The mean (\pm SE) at which known-aged females first copulated was 30.4 ± 3.7 months ($n = 10$, range = 12.9-47.9). First conceptions occurred at an average (\pm SE) of 30.0 ± 5.6 months ($n = 6$, range = 13-47.9). Males first copulated at an average (\pm SE) age of 27.7 ± 3.2 months ($n = 5$, range = 20.5-37.8). Gensch (1966) reported that a 21-month-old captive-born male successfully inseminated a female. Three males were electro-ejaculated when 18 months old. All produced spermatozoa showing 20 to 30% motility with counts ranging from $1-45 \times 10^6$ per ml. The variation was probably related to differences in electrical stimulation of the accessory sex glands. Spermatozoa were absent in a very small volume of ejaculate from a fourth 21-month-old male. However, an ejaculate evoked mechanically under anesthesia at 22 months contained spermatozoa (M. Bush, pers. comm.). Motility ranged from 20 to 50%.

Fifty-three interbirth intervals averaged 334.0 ± 27.2 days (range = 107-1168). Among females that successfully reared their young, the interbirth interval was 468.3 ± 94.8 days if the mate was absent during lactation ($n = 11$, range = 128-1168), and 317.6 ± 17.6 when the mate was present ($n = 22$, range = 111-446). A shorter interval might be predicted in the latter category if the female exhibited a post-lactational estrus. Indeed, there was a significant difference between the means of these two categories ($t = 2.137$, d.f. = 31, $P < 0.025$). The interbirth interval was 271.9 ± 47.4 days in females whose mate was present, but whose cubs either died or were removed shortly after birth ($n = 17$, range = 107-926). There were no differences between this mean and that for litters that were reared by their mother in the mate's presence ($t = 0.992$, d.f. = 7, $P > 0.05$). Although interbirth intervals ranged widely, conceptions were infrequent before 4 months following birth (5 of 53 instances) whether or not the litter survived. This observation and the fact that young begin taking solid food at 6 to 8 weeks of age suggest that there was no well-defined post-lactational estrus, a conclusion in agreement with the basically seasonal occurrence of births in captivity.

Crandall (1964:351) cited longevity records of 14, 16, and 18 years, and remarked that "... comparatively long life spans have been recorded for captive binturongs." Such longevity is not exceptional (Table 3). Nine percent of binturongs living in

TABLE 4.—Productivity of five captive female binturongs that produced and reared litters at regular intervals.

Zoo	Time (months)	Litters	Young	Young surviving	Young surviving/year
Buffalo	58	8	29*	19	3.9
Salt Lake City	58	6	14	13	2.7
Hannover, Germany	54	4	6	6	1.3
Singapore a)	13	3	5	4	3.7
b)	23	3	5	3	1.6
Totals	206	24	59	45	$\bar{X} = 2.6$

* Includes two aborted litters totaling five foetuses.

captivity were known or estimated to be 16 to 25 years old (Table 3). Known-aged binturongs averaged (\pm SE) 3.6 ± 0.4 years ($n = 55$, range = 0.8–16.7), but living animals of estimated age averaged 10.6 ± 0.7 years ($n = 40$, range = 2.2–22.0). Eighty-eight percent of animals of known and estimated age died before 10 years in captivity, but the remaining animals lived to 20 years (Table 1). No differences in mean ages of living animals of different sex was noted.

Females that produced at least three litters at regular intervals and reared most of their young showed a mean \pm SE litter size (2.4 ± 0.3) higher than the overall mean, and a mean interbirth interval (271.2 ± 60.6 days) less than that for females that successfully reared their young (Table 4). The average of 2.6 young surviving/year (range = 1.3–3.9) was a result of more or less ideal conditions and a neonatal mortality of 10%.

The average age of reproductive senescence is not known. A female received as an adult at the Crandon Park Zoo (Miami, Florida) in March 1964 produced a litter in January 1974 at an estimated age of 12 years. Another female (Krefelder Zoo, West Germany) was an adult when received in February 1964. She gave birth to 19 litters and reared 9 of them between March 1964 and August 1978. She was at least 16 years old at the time of the last parturition; a conservative estimate of her reproductive life was 14 years. A captive-born male 15 years and 10 months old fertilized a female.

A consideration of mean litter size (1.9 young) and a maximum known reproductive life of 14 years (one litter/year for 14 years beginning at age 3) yielded an estimated life-time production of 26.6 young. By ignoring age-specific variation in fecundity, 23 young could be expected to survive past weaning assuming 90% survival of average litters (Table 4).

DISCUSSION

Copulatory behavior of binturongs is a mixture of felid and viverrid elements. Each intromission is characterized by intravaginal thrusting. Several intromissions possibly precede ejaculation, but multiple ejaculation is inferred from the occurrence of male genital grooming between mounts. However, these two points require confirmation. Felids, conversely, do not exhibit intravaginal thrusting; their mounts and intromissions are briefer, and the average interval between mounts is longer (Michael, 1961; Dewsbury, 1972; Schaller, 1972). The orgasmic post-copulatory rolling of some female felids also is absent in the binturong. The basic behavioral similarities between the binturong and felids include female prerogative in initiating copulation, absence of a copulatory lock, and the female's mating posture.

Speculation that the reclining mating stance of female felids and certain viverrids is a vestige of arboreal copulation is based on the observation that it imparts greater stability to the mating pair (Ewer, 1973b). *Cryptoprocta*, like *Arctictis*, copulates arboreally; the reclining female is clasped by the torso and licked by the male while *in copulo* (Albignac, 1975). In general, no viverrid straddles the female, treads the

hindlegs, or bites the neck in felid fashion. Felid neck-biting presumably makes the female remain passive, but licking of the female seems to function similarly in *Arctictis* and *Cryptoprocta*. There is no counterpart to either of these copulatory elements in the ground mating viverrids [i.e., *Genetta tigrina*, Dücker (1957), Wemmer (1977); *Civettictis*, Ewer and Wemmer (1974); *Galidia*, Albignac (1969, 1973), Larkin and Roberts (1979); or *Fossa*, Albignac (1970)]. However, licking of the female occurs in the lion (*Panthera leo*), the olingo (*Bassaricyon*), and the kinkajou (*Potos*), in which neck-biting is of reduced importance (Schaller, 1972; Poglayen-Neuwall, 1976a, 1976b). The latter two species probably copulate arboreally, at least on occasion. The reclining copulatory posture of the female does not occur in *Galidia* or *Fossa* and is, therefore, not a universal viverrid pattern. Similarities between *Cryptoprocta* and *Arctictis* represent convergent adaptations. The reclining copulatory stance in the felids may be considered primitive until more comparative evidence is at hand.

Hamilton and Arrowwood (1978) suggested that copulatory vocalizations of certain primates may mutually stimulate sex partners or incite male competition. Geckering of the female binturong is of insufficient amplitude to attract other males, but its modulation in response to copulatory events suggests that it functions as an "excitation indicator" providing feedback to the male (Gould, 1971). Similar calls sharing low intensity and variable repetition rate were identified in *Bassariscus astutus* (Bailey, 1970), *Bassaricyon* (Poglayen-Neuwall, 1976a), and *Potos* (Poglayen-Neuwall, 1976b). These and other resemblances demonstrate that several elements of copulatory behavior of binturongs have convergent analogues in a number of similar but distantly related carnivores.

The binturong is a long-lived viverrid with a relatively low reproductive potential. These traits are often associated with, but are not necessarily predicted by, large body size (Eisenberg, in press). *Arctictis* deviates little from the basic reproductive strategy of other civets. Litter size also seems to average 2 in *Nandinia*, *Paradoxurus*, *Arctogalidia*, and *Paguma* (Acharyo and Tripathy, 1974; Acharyo and Mohapatra, 1978; Charles-Dominique, 1978; Heubel, 1940; Hoogerwerf, 1970; M. Crotty, in litt.). Single birth weight as a percentage of nonpregnant female weight was calculated from these works to be 2.4% in *Nandinia*, 3.2% in *Paradoxurus*, and 4.5% in *Arctogalidia*. The values in *Prionodon linsang*, *Genetta tigrina*, and *Civettictis* are 5.6%, 3.9%, and 2.5%, respectively (Louwman, 1970; Lim, 1973; Mallinson, 1973; Smithers, 1971; Taylor, 1969; Volf, 1959; R. Randall, in litt.). Evidently smaller civets (*Prionodon* and *Arctogalidia*) give birth to proportionately larger young, and *Arctictis* (2.9%) falls within the middle range.

Fetal growth rate of binturongs (3.5g/day) is two to three times greater than in *Genetta* (1.1g/day; Volf, 1959) and *Paradoxurus* (1.6g/day; Acharyo and Tripathy, 1974), but less than in *Civettictis* (4.8g/day; Mallinson, 1973; Ewer and Wemmer, 1974; R. Randall, in litt.), suggesting that large-bodied civets (i.e., *Arctictis* and *Civettictis*) are particularly efficient in gestating fetal biomass.

Whether seasonally or continuously polyestrous, limited evidence suggests that binturongs have long estrous cycles. The breeding peak may be related to a seasonal increase in the frequency of estrus or to other causes. It can be inferred from interbirth intervals that the species is physiologically geared to one birth a year. The occurrence of both year-round births and a seasonal birth peak is characteristic of a number of tropical mammals in captivity and in the wild (Asdell, 1964; Zuckerman, 1952). The breeding season of binturongs in the wild is not known, but *Nandinia* has an October birth peak (Charles-Dominique, 1978), and Tsui et al. (1974) inferred from testicular changes that *Paguma* has a May-June breeding season. Monthly rainfall maxima at five localities in Java, Borneo, and Singapore coincide with the January to March birth peak or precede it by 2 months or less (Richards, 1979). Strong local effects, however,

commonly impede generalities about tropical rainfall. If birth season is climatically influenced, the timing of wild births should reflect the broad range of regional variation characteristic of southern Asia.

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