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Mammal Holotypes in the American Museum of Natural History: the Lectotype of *Prionailurus bengalensis alleni* Sody (1949)

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ABSTRACT

H. J. V. Sody (1949) assigned the subspecies name *alleni* to a series of *Prionailurus bengalensis* specimens from Nodoa (Danxian), on the island of Hainan (Guangdong Province), but did not select a holotype. Traits of the specimens had originally been documented by G. M. Allen (1938) under the name *Felis bengalensis.* A specimen is selected from that series, designated a lectotype of *P. b. alleni,* and described. This is one of several reports which have been generated by revision of the "Catalogue of Type Specimens of Recent Mammals in the American Museum of Natural History" (Goodwin, 1953).

INTRODUCTION

The description of mammalian biological diversity is a principal task of systematic zoologists interested in its origin, its magnitude, and its significance in the organic world. Applying a scientific name to the discrete taxonomic units that comprise the sweep of mammalian variation is part of the larger endeavor. At the levels of species and subspecies, names should be formally linked to a specimen so that a physical entity exists, unambiguously reflecting a particular investigator's definition of a unit of diversity—a type specimen. These objects are usually kept in a special place in collections of museums, and it is part of the responsibilities of the curatorial staff to care for and preserve type collections, and to make them accessible to qualified researchers.

Type specimens are an important source of primary data, and to fulfill our curatorial obligation, we have been recurating the large collection of holotypes in the Department of Mammalogy at the American Museum of Natural History. Ultimately, a revision of Goodwin's "Catalogue of Type Specimens of Recent Mammals in the American Museum of Natural History," which appeared in 1953, will be published. In the meantime, we have encountered problems with some specimens in which either an entire skull or only a cranium was associated with the wrong skin, and have paused to provide published solutions

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(Lawrence, 1988; Musser and Patton, 1989; Musser and Williams, 1985). Another problem results from the habits of some workers who named and described taxa but did not select holotypes. We recently encountered this quirk when Dr. Karl F. Koopman pointed out to us that the leopard cats (*Felis bengalensis*) from Hainan Dao, collected by a member of the American Museum Asiatic Expeditions and stored in the museum collections, had been identified as a new subspecies without the designation of a holotype.

The mammals collected during the American Museum Asiatic Expeditions (1916–1930) were sent to G. M. Allen for identification and study. Allen authored a series of preliminary reports on the material during the 1920s and ultimately wrote his monumental work, "The Mammals of China and Mongolia," published in 1938. Among the carnivores discussed was a series of 23 spotted cats from Yunan, Fujian (Fukien), Jiangsu (Kiangsu), Hunan, Hebei (Hopei), Sichuan (Szechuan), and Guangdong's island of Hainan that Allen identified as *Felis bengalensis.* He considered the species to be in the subgenus *Prionailurus.*

Allen recognized two subspecies, *Felis bengalensis bengalensis* from Yunan and *Felis bengalensis chinensis* from the rest of China. He listed the seven specimens collected by Clifford Pope at Nodoa (Nada or Danxian), Hainan Dao, observing that the Hainan skulls "may average slightly smaller than those from the mainland" and that the nasals of mainland males "seem to be a trifle longer." He did not separate the Hainan specimens taxonomically, writing only that "the differences are insignificant and the color characters are the same" (Allen, 1938: 462).

What was trifling to Allen was significant to Sody (1949) who, in a report on mammals of the Indo-Malayan and Indo-Australian regions, placed the species *bengalensis* in the genus *Prionailurus* and designated the small spotted cats from Hainan a subspecies of *bengalensis.* He quoted Allen's (1938) statement about comparative skull size and nasal length and named the Hainan population *P. bengalensis alleni.* Sody designated the Hainan specimens referred to by Allen as the type series but did not select a type specimen to bear the name.

That is our purpose here. We select a specimen from Allen's series of small-bodied spotted cats collected on Hainan, designate it as lectotype for *Prionailurus bengalensis alleni,* and provide a short description of the specimen.

Materials and Methods

The seven specimens of *bengalensis* from Hainan were obtained by Clifford Pope during December, 1922, and March, 1923, at Nodoa. Pope's (1931: 402) gazetteer located Nodoa or Nada (Danxian) "in northern central Hainan, near the foothills of the island's southern highlands." When Allen originally studied the material, all the cats were in the collections of the American Museum of Natural History in New York (AMNH). Two of the series, AMNH 59958 and AMNH 60055, were exchanged with the Field Museum of Natural History in Chicago (FMNH) in 1929. These examples now bear the catalog numbers FMNH 39338 and FMNH 39339. One skin and skull, AMNH 59961, is known to have been missing from the American Museum since 1978. The remaining six specimens recorded by Allen (1938) and Sody (1949) were available to us for this study; they were listed in table 1.

For ease of presentation, and referral to the reports by both Allen and Sody, we will cite all the specimens by their AMNH numbers.

Skulls of adults were measured with dial calipers graduated to tenths of millimeters. Limits of those measurements are defined by DeBlase and Martin (1974). We also measured rostral breadth (taken lateral to the canines), palatal width (medial to the first molar), and length of braincase (from the midpoint between postorbital constrictions to the midpoint of the lambdoidal ridge).

Color terminology follows the "Naturalist's Color Guide" (Smithe, 1975).

Because we wanted to select an adult for the lectotype, we tried to assess the age of the six specimens. There have been no studies of age determination for *Felis bengalensis.* Recent work on estimating age in species of small

TABLE 1
Allen's Specimens of *Felis bengalensis chinensis* from Hainan Dao

Specimen (AMNH)	Sex	Composition	Age	Museum
59961	M	Skin and skull	—	Missing
59957	F	Skin and skull	Adult	AMNH
59959	F	Skin and skull	Adult	AMNH
60054	M	Complete skeleton	Adult	AMNH
59958	M	Skin and skull	Yearling	FMNH 39338
60055	M	Skin and skull	Yearling	FMNH 39339
60093	F	Skin and skull	Yearling	AMNH

felids shows that times of ossification and development of cranial crests are individually variable and unreliable for determining age (Kvam, 1983; Stuart and Stuart, 1985). Studies of *Lynx, Felis caracul,* and *F. bengalensis* indicate that the permanent dentition of these animals is in place by 12 to 13 months (Stuart and Stuart, 1985; Saunders, 1964; Glass and Todd, 1977). The permanent dentition is present in each of the six skulls of the *F. bengalensis* from Hainan. Using criteria based primarily on degree of tooth wear, we could divide the sample into a group of adults and one of yearlings, assuming similar diets and rates of wear.

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SELECTION

Three adults and three yearlings comprise the six specimens of *Felis bengalensis* from Hainan (table 1). The oldest individual is a male, AMNH 60054, represented by a skull and postcranial skeleton. Its canine tips are well rounded, and the incisors are worn. The sagittal crest extends approximately 8 mm anterior to the interparietal-parietal suture; that interface is almost obliterated.

The canine tips of the female, AMNH 59957, are slightly rounded and the incisors are worn, though less so than those of AMNH 60054. The sagittal crest extends 5.9 mm beyond the parietal-interparietal suture. Wear is clear on the canine tips and incisors of AMNH female 59959 (at 10× magnification), and the sagittal crest extends 2.9 mm beyond the parietal-interparietal suture. Fusion of the median parietal suture in this individual is less than that seen on AMNH 59958 (FMNH 39338), a younger individual as indicated by the lack of wear on its teeth and less developed sagittal crest.

At 10× magnification, we found only faint traces of wear on the incisors of AMNH male 60055 (FMNH 39339), and no sign of abrasion on the dentition of AMNH male 59958 (FMNH 39338). The sagittal crests on the crania of these yearlings do not extend anterior to the parietal-interparietal suture, unlike the crests of the three older individuals discussed above.

TABLE 2
Absolute (in millimeters) and Relative Postorbital Constriction in Examples of *Felis bengalensis* from Hainan Dao

Specimen (AMNH)	Basilar length	Postorbital constriction	POC/BL
60054	76.9	25.8	0.335
59957	76.9	24.0	0.313
59959	75.5	25.4	0.336
60055	73.8	26.0	0.352
59958	72.0	24.6	0.341
60093	70.0	26.0	0.371

TABLE 3
Cranial Measurements (in millimeters) of Adult *Felis bengalensis* from Hainan Dao

Measurement	AMNH 59957	AMNH 59959	AMNH 60054	Mean	Standard deviation
Greatest length	90.8	86.5	90.6	89.3	2.42
Basilar length	76.6	75.5	76.9	76.3	0.73
Condylobasal length	82.7	81.8	82.7	82.4	0.51
Length of braincase	49.9	47.0	52.4	49.7	2.70
Breadth of braincase	37.6	37.7	35.1	36.8	1.47
Mastoid breadth	35.6	34.3	36.8	35.5	1.25
Infraorbital breadth	14.8	14.1	14.5	14.4	0.35
Postorbital breadth	24.0	25.4	25.8	25.0	0.94
Zygomatic breadth	59.0	57.2	62.6	59.6	2.74
Breadth of rostrum	22.0	21.2	22.7	21.9	0.75
Breadth of diastema	6.5	6.7	5.0	6.0	0.92
Length of incisive foramina	4.2	4.2	4.6	4.3	0.23
Palatilar length	32.0	32.9	32.8	32.5	0.49
Length of upper toothrow	26.7	27.3	27.5	27.1	0.41
Palatal width	28.8	28.4	30.0	29.0	0.83
Postpalatal length	43.0	42.0	43.4	42.7	0.68
Nasal breadth	10.3	11.5	11.4	11.0	0.66
Length of nasals	18.6	18.3	18.0	18.3	0.30
Length of bulla	19.2	19.1	18.7	19.0	0.26
Breadth of bulla	12.6	12.0	12.3	12.3	0.30
Diastemal length of mandible	6.6	6.8	6.0	6.4	0.41
Length of mandible	55.1	54.2	56.9	55.1	1.55
Length of lower toothrow	19.0	18.5	19.8	19.0	0.68

The sixth and youngest of the series from Hainan is a female, yearling, AMNH 60093. Its adult dentition is in place, but we could not detect evidence of wear (under 10× magnification). The sagittal crest is indicated by a slight rise along the midline of the interparietal, and is even less pronounced than in AMNH 60055 and AMNH 59958. Interdigitation of the sutures is clearly visible in this specimen.

In their study of the two species of *Lynx*, Kurten and Rausch (1959) found a longer skull to be associated with a narrower postorbital constriction. Glass and Todd (1977) used this trait to determine age in their analyses of *Felis bengalensis*. The absolute breadth of the postorbital constriction does not correlate directly with either skull length or estimated age among the six examples of *F. bengalensis* from Hainan. However, the ratio of postorbital constriction to basilar length was a useful index that we could use to separate the yearlings from the adults (table 2).

Values of measurements from the three adults are listed in table 3. Selected measurements obtained by Allen (1938) and by Sody (1949) from samples of *F. bengalensis* collected on the mainland and on Hainan are compared in table 4 with our figures from the three adults. In his report, Sody added values from three specimens to Allen's mainland sample but otherwise used Allen's measurements.

Allen (1938) separated *Felis bengalensis chinensis* from *F. b. bengalensis* on the basis of the "buffy ochraceous ground" in the latter and the grayer ground color in the pelage of the former. He described the pelage of *F. b. chinensis* as "ground grayer without any buffy; the color pattern subject to wide variation in tint of background and details of spots, which may be enlarged to blotches, or more or less confluent to form broken stripes; markings larger in males than in females." He went on to point out that skulls of adult males were slightly larger than those of adult

TABLE 4
Selected Cranial Measurements (in millimeters) of Male *Felis bengalensis*

	From Allen (1938)		Sody (1949)	This report
Variable	Mainland	Hainan	Mainland	Hainan
Greatest length				
Mean	90.9	81.9	94.0	89.3
Range	86.3–95.6	80–94	86.3–100.5	86.5–90.8
SD	4.0	2.0	5.2	2.4
N	5	4	8	3
Basilar length				
Mean	85.6	76.3	84.8	76.3
Range	81–89	74–79	81–89	75.5–76.9
SD	3.6	2.2	2.8	0.73
N	5	4	8	3
Zygomatic breadth				
Mean	67.2	59.6	67.2	59.6
Range	62.6–72.3	57–63	62.6–72.3	57.2–62.6
SD	4.5	2.5	3.5	2.7
N	5	4	8	3
Length of upper toothrow				
Mean	29.1	27.3	29.4	27.7
Range	28.6–30.6	25.5–28.5	28.2–30.7	27.2–28.0
SD	0.84	1.3	0.95	0.43
N	5	4	8	3
Nasal length				
Mean	21.6	17.8	—	18.3
Range	20–23	17.3–18.5	—	18.0–18.6
SD	1.1	0.49	—	0.3
N	5	4	—	3

females; temporal ridges in old males united to form a sagittal crest, but no old females had a crest; the orbital ring was usually complete; and the anterointernal cusp of the upper carnassial was poorly developed. Allen's comment that the Hainan tiger cats had slightly smaller skulls and that the males had slightly shorter nasals than the mainland animals was cited by Sody (1949) as the diagnosis for the subspecies *Prionailurus bengalensis alleni.* Allen (1938: 462) considered "the differences insignificant and the color characters the same."

DESIGNATION AND DESCRIPTION

We designate AMNH 59957, the skin and skull of an adult female, as the lectotype of *Prionailurus bengalensis alleni* Sody (1949). It was collected by Clifford Pope at Nodoa (Nada or Danxian in modern orthography) on Hainan Dao in the Guangdong Province of The People's Republic of China. The original field number is 220. Its traits exemplify the distinctions between samples from mainland and island that Sody interpreted as significant in identifying morphological boundaries of *P. bengalensis alleni.*

The tanned study skin is illustrated in figures 3 and 4. Hairs of the pelage are silky, those in the dorsal coat extend up to 13 mm long, and the longest in the ventral coat rarely exceed 15 mm. All the hairs have pale drab gray (Smithe, 119D) bases (first 3 mm). Color pattern of the dorsum is formed by warm sepia (Smithe, 221A) markings on a tawny

Fig. 1. Cranium (×1) of AMNH 59957, the lectotype of *Prionailurus bengalensis alleni* Sody (1949); dorsal, ventral, and lateral views.

olive (Smithe, 223D) background; this ground color is paler on shoulders and haunches. The markings consist of spots of different sizes that coalesce into distinct stripes on the crown, nape, and shoulders. Spots along the midline are spaced closely together, giving the impression of a warm sepia dorsal band. Outer surfaces of the pinna are also warm sepia, and each has a clear white spot. A white stripe, lateral to the rhinarium, extends to the frontal region medial to the eyes. Another white stripe, extending from the outer corner of the eye caudad over the cheeks, is enclosed by warm sepia stripes. Dorsal surfaces of the paws are tawny olive with flecks of warm sepia. The tail is densely haired and patterned with irregular sepia markings.

The ventral coat is white with warm sepia spots that grade into two rings encircling the throat. The ventral spots are larger than those on the back and sides. Pale tawny olive is the transition tone between those of upperparts and underparts.

The cranium of the lectotype (figs. 1 and

Fig. 2. Mandible (×1) of the lectotype; dorsal and lateral views.

2) appears gracile and elongate compared with crania of other small-bodied felid species such as *F. catus, F. sylvestris, F. geoffroyi,* or *F. weidii,* for example. Length of the braincase, from postorbital constriction to lambdoidal crest, is 54 percent of greatest skull length; 57 percent of the condylobasal length; and 75 percent of the braincase breadth. A moderately developed sagittal crest extends 5.0 mm anterior to the parietal-interparietal suture. The nasals are moderately compressed and the premaxilla-maxilla suture is almost straight, not concave. Both orbital rings are complete. The sphenopalatine foramen is large (5 mm wide), and there is a narrow process of palatine bone separating it from the frontals. The posterior margin of the bony palate is almost straight, indented slightly at the suture.

The upper and lower teeth are moderately worn and demonstrate deterioration. The left upper canine is broken lengthwise and the pulp cavity is exposed. All of the upper cheekteeth are cracked. The lower right third premolar is severely damaged, probably during life, as there is wear on the posterior fragment and the alveolus seems enlarged.

The upper dentition is not unusual and lacks a second premolar in each toothrow. Each third premolar has one primary cusp with a smaller cusp posterior to it. The fourth premolar is a characteristic feline carnassial except that the anterointernal cusp is small.

In its general conformation, the mandible resembles that in other species of small felids. The following characters are distinctive: the body of the ramus is robust for the overall size of the dentary; each coronoid process is round; and there is a bony flange on the medial side of each angular process (fig. 2).

CONCLUDING THOUGHTS

Selecting this specimen to be a lectotype introduced us to the published conflict between the view of Allen (1938) and that of Sody (1949). The contrast in perceptions is instructive at two levels. First, it reflects present-day conflicting interpretations about the generic allocation of the species *bengalensis.* Second, it mirrors our ignorance of geographic character variation in the species: whether it is continuous or partitioned into discrete segments that are definable by unambiguous characters and concordant with biological patterns causally rooted in a particular biogeographic history.

For G. M. Allen, the characteristics of *bengalensis* placed it within the subgenus *Prionailurus,* embraced by the broader generic category, *Felis.* To Sody, the distinguishing traits of *bengalensis* excluded it from *Felis,* and the genus *Prionailurus* better expressed the phylogenetic relationships of that spotted cat. The debate persists today. On one side are the opinions expressed in some compilations retaining *bengalensis* in the genus *Felis* (Honacki et al., 1982; Corbet and Hill, 1986; Wozencraft, 1989). On the other are those reports recognizing the generic integrity

Fig. 3. Dorsal aspect of the tanned study skin of AMNH 59957, the lectotype of *P. b. alleni.*

Fig. 4. Skin of the lectotype from a ventral aspect.

of *Prionailurus* (Weigel, 1961; Ewer, 1973; Groves, 1982).

G. M. Allen detected body size and cranial differences between samples of *bengalensis* from mainland China and the island of Hainan but thought them trivial. Sody interpreted the same distinctions to be an index of insular isolation and subsequent morphological modification. Neither view has been tested; no present-day comprehensive evaluation of geographic character variation in *bengalensis* is available.

We are not illuminating either the phylogenetic relationships of *bengalensis* or the nature of its intraspecific variation—that resolution awaits results from inquiries undertaken by those who specialize in evolution and biology of the Carnivora. The information we provide here simply documents the mechanical solution to a taxonomic legal problem.

REFERENCES

Allen, G. M.
1938. The mammals of China and Mongolia. Natural History of Central Asia, vol. 11, pt. 1. New York: American Museum of Natural History, 620 pp.

Corbet, G. B., and J. E. Hill
1986. A world list of mammalian species, 2nd ed. London: British Museum (Nat. Hist.), 254 pp.

DeBlase, A. F., and R. E. Martin
1974. A manual of mammalogy. Dubuque: William C. Brown, 329 pp.

Ewer, R. F.
1973. The carnivores. New York: Cornell Univ. Press.

Glass, G. E., and N. B. Todd
1977. Quasi-continuous variation of the second upper premolar in *Felis bengalensis* Kerr, 1792 and its significance for some fossil lynxes. Z. Saeugetierkd. 42: 36–44.

Goodwin, G. G.
1953. Catalogue of type specimens of Recent mammals in the American Museum of Natural History. Bull. Am. Mus. Nat. Hist. 102: 207–412.

Groves, C. P.
1982. Cranial and dental characteristics in the systematics of Old World Felidae. Carnivore 2: 35–46.

Honacki, J. H., K. E. Kinman, and J. W. Koeppl
1982. Mammalian species of the world. Kansas: Assoc. Syst. Coll., 694 pp.

Kurten, B., and R. Rausch
1959. Biometric comparisons between North American and European mammals. II. A comparison between the northern lynxes of Fennoscandia and Alaska. Acta Arctica 11: 21–44.

Kvam, T.
1983. Age determination in European lynx *Lynx l. lynx* (L.) based on cranial development. Fauna Norv., ser. A, 4: 31–36.

Lawrence, M. A.
1988. The identity of *Sciurus duida* J. A. Allen (Rodentia: Sciuridae). Am. Mus. Novitates 2919: 6 pp.

Musser, G. G., and M. M. Williams
1985. Systematic studies of oryzomyine rodents (Muridae): definitions of *Oryzomys villosus* and *Oryzomys talamancae*. Am. Mus. Novitates 2810: 22 pp.

Musser, G. G., and J. L. Patton
1989. Systematic studies of oryzomyine rodents (Muridae): the identity of *Oecomys phelpsi* Tate. Am. Mus. Novitates 2861: 6 pp.

Pope, C. H.
1931. Notes on amphibians from Fukien, Hainan, and other parts of China. Bull. Am. Mus. Nat. Hist. 61: 397–611.

Saunders, J. K.
1964. Physical characteristics of the Newfoundland lynx. J. Mammal. 45: 36–47.

Smithe, F. B.
1975. Naturalist's color guide. New York: American Museum of Natural History.

Sody, H. J. V.
1949. Notes on some primates, Carnivora, and the babirusa from the Indo-Malayan and Indo-Australian regions. Treubia 20: 121–190.

Stuart, C. T., and T. D. Stuart
1985. Age determination and development of foetal and juvenile *Felis caracul* Schreber, 1776. Saeugetierk. Mitt. 32: 217–229.

Weigel, I.
1961. Das fellmuster der wildlebenden katzenarten und der houskatze in vergleichender und stammesgeschichtlicher hinsicht. Saeugetierk. Mitt. 4: 120 pp.

Wozencraft, W. C.
1989. Classification of the Recent Carnivora. *In* J. L. Gittleman (ed.), Carnivore behavior, ecology, and evolution, 569–593. New York: Cornell Univ. Press.