A NEW GENUS OF ARBOREAL RAT FROM WEST JAVA, INDONESIA

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With 4 plates

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ABSTRACT

Kadarsanomys nov. gen. is proposed for *Rattus sodyi* Bartels, 1937, and contrasted with *Rattus* and *Lenothrix*, two genera with which *sodyi* has been closely connected in the past. *Kadarsanomys sodyi* is an arboreal rat associated with bamboo on the forested volcanoes of West Java. *Kadarsanomys* has no close relatives and is the only murid genus endemic to a single island on the Sunda Shelf. *Kadarsanomys, Pithecheir* and *Lenothrix* comprise the only endemic genera of Sundaic murids.

INTRODUCTION

During the years from 1933 to 1935, Max Bartels, Jr. collected a series of rats from places on the southwest slopes of Gunung Pangrango-Gede, a high volcanic massif in West Java. Bartels's account of the species appeared in 1937 and there he named it *Rattus canus sodyi* (after his friend, H. J. V. Sody, a biologist who had contributed much to the knowledge of Javan mammals) and described the animals in the sample as arboreal or semi-arboreal rats, each with brown upperparts, a white venter, a long monocolored tail, eight mammae and a nail on each hallux. Examples of *sodyi* have never been collected again; the nature of the form, as well as its phyletic relationship to other species of Sundaic murids, has remained enigmatic from the time it was discovered.

In the late 1960's and early 1970's, I visited museums in Europe and Indonesia and was able to study examples of *canus*, as well as all the specimens of *sodyi* in Bartels's original series. It was evident to me that *canus* was not a species of *Rattus*, but of the distinctive genus *Lenothrix*, as Miller (1903), its original describer, and Misonne (1969) had indicated; that the sample of *sodyi* did not represent a subspecies of *canus*, as Medway & Yong (1976) later concluded, or even a species of *Lenothrix*; and that *sodyi* had no special relationship to any species in the genus *Rattus*. Over the years I compared the examples of *sodyi* with murids from Africa, India and the Indo-Australian region, and have only reinforced my original impression: *sodyi* cannot be closely allied with any species known to occur in the tropical Far East, but must be placed in its own genus. To name and describe that genus is the purpose of this report.

ABBREVIATIONS AND METHODS

The specimens cited in the following pages are in collections of the American Museum of Natural History, New York (AMNH); the Museum Zoologicum Bogoriense, Bogor (MZB); and the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH).

Weights and body measurements of *sodyi* were taken by Bartels (1937a: 46), who explained that "No. 1786 (RMNH 14178) was measured after having been preserved in alcohol; all the others were measured in a fresh state. The head-and-body-length was measured from the tip of the nose to the hind-border of the thigh-muscles at the base of the tail." Some of the values which Bartels obtained for the external measurements were recorded to 0.5 mm, but I rounded them to the next whole number. Total length, and lengths of tail hind foot and ear of specimens in series of other species discussed here are those made by collectors and were taken from labels attached to skins. The combined lengths of head and body were derived by subtracting the value for tail length from that of total length. Dial calipers, graduated to tenths of millimeters, or Anderson's Craniometer attached to a Wild M5 stereomicroscope, were used to measure skulls and teeth. The limits of most of those measurements are defined elsewhere (Musser, 1970, 1979); two of them require explanation here. The distance at which the incisive foramina end in front of, or extend beyond the first molars was taken from the anterior alveolar margins of the first molars to the ends of the foramina; the extent the palatal bridge extends past the third molars, or ends in front of them, was determined by measuring the distance from the posterior alveolar margins of the third molars to the posterior edge of the palatal bridge.

I have separated the specimens of *sodyi* into old adults, adults, young adults, juveniles and nestlings. There are four very small specimens in the sample (table 3). All other specimens are in full adult pelage and can easily be separated into small individuals, in which the teeth are only slightly worn (young adults), large rats with the molars worn down to their bases (old adults), and animals of intermediate size and wear of teeth (adults).

The nomenclature I shall use to describe the positions of cusps on upper molars is a numbering system developed by Miller (1912), which has been diagrammed by Misonne (1969). There are ten primary cusps (or cones) on the first molar of a species in a genus such as *Apodemus* (the example used by Miller), arranged in three rows, with three cusps to each row, and the tenth cusp by itself at the back of the tooth. The numbering begins with the lingual cusp of the first row and extends across to the labial cusp (t1, t2, t3), then continues with the lingual cusp of the second row across to the labial side (t4, t5, t6), and across the third row beginning at the lingual cusp again (t7, t8, t9); the single posterior cusp is the posterior cingulum. The same sequence of numbering is followed for the cusps that are on the second and third molars.

Misonne used a different nomenclature for the lower molars, but I do not employ it here. Each first lower tooth of the species I shall discuss has an occlusal surface formed of three rows of large cusps (or cones), two in each row, and a single cusp (posterior cingulum) at the back of the tooth. Cusplets (or conules) occur along the labial margin of each tooth. Two rows of cusps, a single posterior one, and cusplets form the surfaces of the second molar. Only two rows of cusps, along with cusplets, are present on the third molar.

DESCRIPTION

Kadarsanomys nov. gen.

Type species. — *Rattus canus sodyi* Bartels, 1937.

Included species. — The type species only.

Known distribution. — The southwestern slopes of Gunung Pangrango-Gede in West Java (see the map in Van Peenen et al., 1974). The species is represented by 17 specimens, which were collected at Pasir Datar, Tjiparaj, and the slopes of Pangrango-Gede, all at an elevation of about 1000 meters.

Diagnosis. — A genus of arboreal murid, which differs from all other murid genera in general, and from *Rattus* (according to Misonne's, 1969, definition) and *Lenothrix* in particular, by the following combination of features: tail brown, monocolored, and much longer than combined lengths of head and body; upperparts brown; venter chalk-white; a nail on each hallux; eight mammae; stocky, high cranium; short and broad rostrum; shelf-like ridges along dorso-lateral margins of interorbital region and part of braincase; zygomatic plates narrow, their anterior edges barely extending forward past the dorsal zygomatic roots; braincase elongated and deep; long incisive foramina ending at or extending slightly beyond front margins of first molars; short, narrow and deeply troughed palatal bridge, ending at or just beyond backs of third molars; narrow mesopterygoid fossa; large bullae; broad and smooth incisors, their enamel layers orange; long, wide and nearly parallel upper toothrows; upper molars white, low-crowned and wide, their bases squarish or rectangular; five roots on each first upper molar; cusps discrete and either round, oblong or triangular, retaining their distinction after appreciable wear; rims of cusps of thin and high enamel, dentine depressions and valleys deep; cusps on first and second molars slanting back, so that molars overlap; no cusp t7 on any upper molar; cusp t3 on second molar always present and large; small or large cusp t3 always present on third molar; posterior third of first and second upper molars formed of a very large oblong central cone (cusp t8), a very small round cusp (t9) attached to middle labial flank of central cone, and a short ridge-like posterior cingulum extending from posterior-labial margin of central cusp; lower molars white, large and wide, the second wider than the first or third; rows of cusps close together and slanting forward on first and second lower molars; cusps thick, round or elliptical, meeting along middle of teeth at a sharp angle, so that backs of cusp rows appear scalloped; posterior cingulum on first and second molars, not on third; a small cusplet attached to anterior face of lingual cusp in front row on first molar; labial cusplets on all teeth, those on sides of first and second molars joined by high, narrow cingular ridges.

Description of the type species. — Adult examples of *Kadarsanomys sodyi* are of medium size (tables 1, 2). Dark brown fur, flecked with yellow or ocher, covers the middle of the head and back, then pales to grayish brown along the sides and cheeks. The coat is 15-20 mm thick over the back and rump, and is soft, dense and formed of fine underhairs, stiffer overhairs and short guard hairs. The guard hairs, so conspicuous in a species such as *Rattus rattus*, are here inconspicuous and 30-40 mm long. The underhairs and overhairs are pale gray for most of their lengths and tipped with yellow, the guard hairs are gray basally and black distally; their concentration along the middle of the head and body gives that region its darker tone compared with the sides of the body. A blackish brown ring encircles each eye, contrasting with the color of the head. Stiff, dark brown hairs are concentrated above and below each eye, forming a wide dark brown wedge above and a brown narrow patch below the eye. One or two long (up to 30 mm) sensory vibrissae emerge above each eye. The upper genal vibrissae are conspicuous and long (20-25 mm), the lower are short (6-8 mm) and barely emerge beyond the pelage. The rostral vibrissae are stiff, black and extend up to 60-70 mm. The ears are tan and covered with fine brown hairs. The upper surfaces of the front and hind feet are covered with short, dense, dark brown hairs; the undersurfaces are naked and tan. The claws are cream in color. Each claw is sparsely covered by long silvery hairs.

The underparts are white, from the chin to the anus and most of the scrotal sac, sharply demarcated from the brown upperparts. The hairs which comprise the overfur and fine underfur lack pigment from their bases to their tips. The pelage is moderately dense and 6-9 mm thick.

The tail is much longer than the combined lengths of head and body (tables 1, 2), pale brown (tan), covered with scales (9 per cm) and brown hairs (three emerge from each scale), which are short near the base of the tail and gradually increase in length along it, so that the distal third appears hairy; the hairs extend beyond the tail tip, forming a 2-4 mm long brush. There is no indication that the tail is prehensile.

Females have four pairs of mammae: one pectoral, one postaxillary, and two inguinal.

The front and hind feet are long and broad and their structure reflects adaptations to arboreal habits. The four digits on each front foot are long and slender and terminate in large pads and long claws with sharp, slightly recurved tips. The rudimentary fifth digit is thick, stumpy, and bears a nail, which is typical among murids. Most of each palmar surface is composed of three large and fleshy interdigital pads and two basal palmar pads. All these as well as the pads at the tips of the digits, are sculptured with transverse and semicircular striations. The long, slender digits of each hind foot also end in large, fleshy pads. Four of the digits are clawed, but the short first digit (hallux) terminates in a very large and fleshy pad, in which a small nail is deeply embedded (plate 1). The distal two-thirds of each plantar surface is composed of large, fleshy, thick pads (four interdigital and two plantar), which are also scored with striations as are all the digital pads. Each fifth digit appears to be always flexed and capable of being bent over toward the hallux. The fifth digit, in counteraction to the lateral movement of the hallux, may provide the hind foot with about the same degree of pseudo-opposability as that seen in some other species of arboreal rats and mice, those in *Chiropodomys*, for example (Musser, 1979).

Juveniles (table 3) have grayish brown upperparts and white underparts. The pelage is paler than that of adults and much denser and softer. The coat

TABLE I

Body weight (in grams) and measurements (in mm) from skins, skulls and toothrows of male specimens of *Kadarsanomys sodyi*

	RMNH	RMNH	RMNH	MZB	RMNH	RMNH
	14219	14179	14178	5083	14129	14135
Date collected	24-I-35	1-V-35	26-IV-35	11-I-35	20-I-35	25-X-33
Age	old ad.	adult	adult	adult	young ad.	young ad.
Length of head and body	210	206	191	182	182	178
Length of tail	305	291	270	279	286	271
Length of hind foot	44	42	40	39	40	38
Length of ear	25	24	23	22	22	22
Weight	230	-----	-----	176	-----	175
Greatest length of skull	46.5	45.3	43.9	43.2	41.6	42.3
Zygomatic breadth	22.6	21.4	21.5	20.8	20.1	20.6
Interorbital breadth	6.8	6.3	6.2	6.0	6.4	6.0
Length of nasals	16.1	15.5	14.6	14.7	14.2	13.9
Length of rostrum	13.0	12.5	12.6	12.0	11.4	12.0
Breadth of rostrum	9.0	8.9	8.4	8.6	8.3	8.0
Breadth of braincase	17.8	17.2	17.3	16.9	16.4	-----
Height of braincase	14.0	13.3	13.6	12.5	12.0	-----
Breadth of zygomatic plate	5.0	4.6	4.4	4.5	3.9	4.2
Depth of zygomatic notch	1.7	1.7	2.2	1.5	1.3	1.8
Breadth across incisor tips	3.3	3.5	3.4	3.2	3.2	3.1
Basal length	43.0	-----	39.5	-----	38.2	-----
Basilar length	39.6	-----	36.1	-----	35.2	-----
Length of diastema	13.2	12.9	11.4	11.3	11.2	11.4
Palatal length	25.4	24.5	23.0	22.3	22.2	22.2
Palatilar length	22.1	21.8	20.1	19.5	19.4	19.6
Postpalatal length	17.7	-----	16.4	16.6	15.9	-----
Length of incisive foramina	9.0	9.1	8.5	7.9	8.3	8.0
Breadth of incisive foramina	3.5	3.3	3.3	3.4	3.0	2.9
Incisive foramina beyond M^1	0.4	-----	0.6	-----	0.6	-----
Length of palatal bridge	8.8	8.5	7.9	8.3	7.5	8.2
Breadth of bridge at M^1	3.9	3.9	3.4	3.6	3.4	3.2
Breadth of bridge at M^3	4.6	4.1	4.0	4.0	4.1	4.1
Breadth of mesopterygoid fossa	2.8	3.0	2.5	2.1	3.0	2.5
Palatal bridge past M^3	0.3	-----	0.1	-----	0.1	-----
Length of bulla	8.5	8.5	8.3	7.6	7.8	7.9
Height of bulla	6.3	6.1	6.4	5.0	6.1	6.0
Alveolar length of M^{1-3}	8.9	8.4	8.4	8.4	8.1	8.0

TABLE 2

Body weight (in grams) and measurements (in mm) of skins, skulls and toothrows of female specimens of *Kadarsanomys sodyi*

	RMNH 14107	MZB 5020	RMNH 21232	RMNH 13595[a]	RMNH 14103
Date collected	24-I-35	23-VI-34	1-IV-35	18-X-33	24-I-35
Age	old ad.	adult	adult	young ad.	young ad.
Length of head and body	191	190	183	189	162
Length of tail	286	263	269	261	246
Length of hind foot	40	39	38	38	37
Length of ear	23	23	22	23	20
Weight	204	-----	-----	188	-----
Greatest length of skull	44.6	44.2	43.7	-----	40.4
Zygomatic breadth	21.9	22.1	21.6	-----	19.9
Interorbital breadth	6.3	6.2	6.1	6.1	5.7
Length of nasals	14.8	15.1	15.0	14.4	13.3
Length of rostrum	12.3	12.5	12.1	12.2	10.8
Breadth of rostrum	8.8	8.4	8.5	8.6	7.9
Breadth of braincase	17.2	17.0	17.1	-----	16.6
Height of braincase	13.1	13.0	12.6	-----	12.1
Breadth of zygomatic plate	4.9	4.5	4.3	4.4	4.2
Depth of zygomatic notch	2.3	1.7	1.6	1.3	1.4
Breadth across incisor tips	3.3	-----	3.2	3.3	3.1
Basal length	40.7	-----	39.2	-----	36.2
Basilar length	37.4	-----	36.6	-----	33.3
Length of diastema	12.2	12.2	11.7	11.6	10.9
Palatal length	24.1	23.4	23.0	23.1	21.2
Palatilar length	20.9	20.4	20.3	20.4	18.6
Postpalatal length	16.9	16.5	16.3	-----	15.0
Length of incisive foramina	8.4	8.0	8.1	8.6	7.9
Breadth of incisive foramina	3.1	3.0	3.2	3.3	2.9
Incisive foramina beyond M^1	even	-----	0.5	-----	0.4
Length of palatal bridge	8.8	8.6	8.0	8.0	7.4
Breadth of bridge at M^1	3.8	3.5	3.4	3.5	3.4
Breadth of bridge at M^3	4.5	3.7	4.0	3.9	4.0
Breadth of mesopterygoid fossa	2.6	2.0	2.4	2.4	2.5
Palatal bridge past M^3	0.1	-----	0.3	-----	even
Length of bullae	8.2	7.9	8.1	8.4	7.6
Height of bullae	6.0	5.9	5.7	6.3	5.7
Alveolar length of M^{1-3}	8.5	8.2	8.3	8.4	7.8

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[a] Holotype of *Rattus canus sodyi*

over the head and body appears woolly, is about 10 mm thick, and from it emerge 15 mm long guard hairs. In the two juveniles available for study, the first upper and lower molars had fully erupted, the second had erupted but not reached their full height, and the third are still hidden beneath bone.

The four nestlings (table 3) are completely clothed in dense pelage, which is appressed close against the body, as usual of proliferating hairs, and colored like the pelage on adults. The fur over the rump is about 3 mm long and the guard hairs extend up to 7 mm. The teats on the females are already conspicuous. The nails on the halluces are prominent. The first upper and lower molars are about half-way erupted, the tips of the second have broken through the bone, and the third molars have yet to take form.

The inner surfaces of the ears in both juveniles and nestlings are patterned differently from those of adults. The young rats have ears in which the internal surfaces are gray, but the outer surfaces are bicolored: the front half of each pinna is dark brown because of a dense patch of brown hairs, the other half is gray and was probably unpigmented when the rat was alive. The brown patch, which would be located forward and above the head, is conspicuous. Adults, in contrast, have monocolored ears; thus, the bicolored pattern seems characteristic of juveniles and nestlings.

The cranium appears compact and rectangular because of its stocky rostrum, long braincase, and parallel zygomatic arches (plate 4). The stout rostrum is short and broad (tables 1, 2). The nasals are narrow, tapered, and their tips barely extend beyond the sides of the rostrum. The lacrimal bones are very small, triangular, and barely visible along the posterior margin of the dorsal zygomatic roots. The top of the cranium between the interorbital region above the orbits is beaded, and these beads broaden into wide shelves, which jut out along the dorsolateral edges of the frontals, then diminish in height as they curve around the tip of the braincase to end at the occiput. The top of the cranium, from behind the anterior roots of the zygomatic arches to the occiput, appears lyre-shaped, the configuration formed by the strong beading. The prominence of beading around the edges of the braincase is a function of age. Young adults have a very slight bead around the tip of the braincase, and the beading becomes higher and thicker in skulls of adults and old adults. The wide prominent ridges at and just behind the interorbital region also characterize young adults and older animals. The braincase itself is long, high, with nearly vertical sides, and provides part of the rectangular appearance to the dorsal aspect of the skull. This rectangular impression is enhanced by the strong zygomatic arches, which are nearly parallel to each other. The zygomatic plates are narrow and their slim anterior edges extend forward about 2 mm past the anterior margins of the

TABLE 3

Measurements (in mm) of skins, along with other data, from nestling and juvenile specimens of *Kadarsanomys sodyi*

	RMNH 14012	RMNH 14011	RMNH 14136	RMNH 14020	RMNH 13759	RMNH 13706
Sex	♀	♀	♂	♂	♂	♀
Date caught	23-I-35	24-I-35	24-I-35	24-I-35	23-VI-34	23-VI-34
Age	nestling	nestling	nestling	nestling	juvenile	juvenile
Length of head and body	82	83	84	83	106	104
Length of tail	89	88	89	92	133	132
Length of hind foot	23	22	23	23	29	28
Length of ear	9	9	9	9	15	14
Mammae	2+2=8	2+2=8				2+2=8

dorsal zygomatic roots. The front edge of each zygomatic plate is vertical in most specimens, but slants forward in a few.

Long incisive foramina, a short palatal bridge, wide and heavy molars, and large bullae combine to make the ventral side of the cranium distinctive. The incisive foramina are long and wide. Their outer margins are nearly straight from the back to about two-thirds their lengths, then gradually converge. The posterior margins of the foramina either end at the fronts of the first molars or extend beyond them by 0.4-0.6 mm; the latter condition occurs more often. The palatal bridge is short, narrow, and trough-like along its midline. Its posterior margin in most specimens terminates at the backs of the third molars, but in a few skulls extends beyond them by 0.1-0.3 mm. The mesopterygoid fossa is narrow. The sphenopalatine vacuities, plainly evident just below and beyond the back edge of the palatal bridge, are small and oblong. The bullae are large, not only absolutely, but also relative to the cranium (table 6).

The upper and lower incisors are wide and appear strong. Their anterior and lateral faces are smooth. The uppers emerge from the rostrum at a right angle (orthodont). The enamel layers of both uppers and lowers are deep orange.

Each mandible is robust and appears strong (plate 4). The coronoid process is small, but well developed. Each angular process has a curved posterio-ventral outline. The lower toothrow is long and wide (table 4) and the teeth appear large relative to the size of each mandible.

The upper molars are large, low-crowned and with rectangular or squarish occlusal outlines; the combination gives them a stocky appearance. They are large, both absolutely (tables 1, 2, 4) and relative to the cranium (table 6). The long, wide and nearly parallel toothrows, combined with the short and narrow palatal bridge set off the teeth and make them a prominent part of the ventral surface of the cranium. The first upper molars have five roots. The cusps on the first and second teeth slant back, so that the first molar overlaps a bit of the second and that tooth overlaps a small part of the third. The second molar is as wide as the first, but the third is narrower than the first two (table 4). All cusps and bases of the molars are brilliant white, without the hard, black substance which adheres to the sides of the cusps and molar bases in species such as *Lenothrix canus*, for example (see plate 1 in Medway & Yong, 1976). The hard enamel rims of the cusps are high and thin, enclosing deep valleys and circular depressions of softer dentine.

The configurations formed by the cusps on the occlusal surfaces of the upper molars are simple, distinctive (plate 2), and do not vary significantly among the specimens I examined. Part of their distinction is that the occlusal surfaces are formed by gently arched rows of discrete, rounded cusps, weakly joined together and distinct until worn down nearly to their bases. Three rows of cusps form the occlusal surface of the first upper molar. In the first row, the round cusp t3 is about in line with the much larger triangular central cone, and the oblong cusp t1 is set a bit posterior relative to the other two. The second row consists of a large triangular central cone flanked by thick, rounded labial and lingual cusps, which are narrowly attached to the middle cusp. A very large, oblong cusp t8 comprises nearly all of the third row; a small round cusp t9 is weakly attached to the flank of that central cone, appearing as if it had budded out of the larger one. There is no cusp t7 in the third row. There is a posterior cingulum: a thin, narrow ridge, extending outward from the posterio-labial edge of the central cone.

The three anterior cusps of the first molar are represented in the second only by a large round cusp t3 and a larger rounded cusp t1. Behind these is a row of three cusps, shaped very much like the second row of cusps on the first molar. The remainder of the tooth is formed almost entirely of a large oblong cusp t8, to which is attached a very small, discrete cusp t9 and a short, thin, ridge-like posterior cingulum, extending from the posterio-labial margin of the large cone. There is no cusp t7 on the second molar.

The occlusal surface of the third molar is simple compared with those of the first and second teeth. A large round cusp t1 forms the anterio-lingual border of the third molar, and opposite at the anterio-labial side is a smaller, but still prominent cusp t3. A set of three cusps (round t4 and t6, and a triangular t5) merge together after moderate wear to form a chevron-like lamina behind the two front cusps. The back of the tooth consists of an oblong cusp set against a round one; both merge after wear into a nearly transverse lamina. There is no cusp t7 or a posterior cingulum on the third molar.

The lower molars are also simple and distinctive in their occlusal topography (plate 3). The second molar is wider than the first and third, and the third is, on the average, slightly wider than the first (table 4). There are three rows of cusps, with two cusps in each row, and a large, elliptical posterior cingulum on the second molar; and also two rows of cusps on the third molar, but no posterior cingulum. The rows of cusps are set close together and slant forward. The front row of cusps on the first lower molar consists of a large round lingual cone and a smaller round labial one, which

TABLE 4

Measurements (in mm; mean ± one standard deviation, observed range in parentheses) and ratios (in percent) of upper and lower molars in samples of *Lenothrix canus* from western Malaysia, *Kadarsanomys sodyi* and *Rattus rattus diardii* from West Java. (Abbreviations: N, number of specimens in sample; LM, length of molar row; BM, breadth of molar)

	L. canus	*K. sodyi*	*R. rattus*
N	22	11	15
LM^{1-3} (alveolar)	8.8 ± 0.4 (8.0-9.4)	8.3 ± 0.3 (7.8-8.9)	6.6 ± 0.4 (5.9-7.2)
BM^1	2.4 ± 0.1 (2.2-2.5)	2.5 ± 0.1 (2.4-2.5)	1.8 ± 0.1 (1.6-2.0)
BM^2	2.3 ± 0.1 (2.2-2.5)	2.5 ± 0.1 (2.3-2.6)	1.7 ± 0.1 (1.5-1.9)
BM^3	1.9 ± 0.1 (1.7-2.9)	1.9 ± 0.1 (1.8-2.1)	1.4 ± 0.1 (1.2-1.5)
BM^2/BM^1	96	100	94
BM^3/BM^1	79	76	78
BM^3/BM^2	83	76	82
N	22	6	20
LM_{1-3} (actual)[a]	8.2 ± 0.2 (8.0-8.6)	8.0 ± 0.3 (7.5-8.3)	6.1 ± 0.3 (5.5-6.6)
BM_1	2.1 ± 0.1 (2.0-2.3)	2.0 ± 0.1 (2.0-2.1)	1.6 ± 0.1 (1.4-1.8)
BM_2	2.2 ± 0.1 (2.1-2.4)	2.3 ± 0.1 (2.2-2.4)	1.7 ± 0.1 (1.5-1.9)
BM_3	2.0 ± 0.1 (1.9-2.1)	2.1 ± 0.1 (2.0-2.2)	1.5 ± 0.1 (1.3-1.7)
BM_2/BM_1	105	115	106
BM_3/BM_1	95	105	94
BM_3/BM_2	91	91	88

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[a] Limits of this measurement are from the anterior face of M_1 to the posterior margin of M_3.

meet along their posterior-medial margins. There is a cusplet attached to the anterior face of the lingual cusp, which is discrete in unworn teeth, but in young adults and older animals evident only by a bump on the anterior outline of the lingual cusp. The second row of cusps is formed by two elliptical cones, which meet at the midline of the tooth in a chevron-like lamina. The apex of that row is connected to the back of the front row by a ridge of enamel and dentine. The third row of thick, elliptical cusps resembles the second, but is larger. The posterior outlines of the chevron-like laminae are scalloped.

Shapes and positions of the cusps in the two rows on the second lower molar are similar to the two back rows on the first molar. The thick, elliptical cusps at the front of the third molar join each other at a broad angle, so that the lamina they form is straighter than those on the first and second molars. The posterior lamina on the third tooth consists of a thick and wide lingual cusp similar in shape to those on the first two teeth, and a small round labial cusp, which loses its discretness in the worn teeth of adults.

In addition to the cusps and the cusplet at the front of the first molar, there are round or oblong cusplets along the labial margins of all three teeth. Similar cusplets may be present or absent in samples of some species of rats, but they are always present, though variable in size, in the specimens of *K. sodyi.* On the labial margin of the first lower molar there is a large cusplet next to the anterio-labial corner of the second row of cusps and a large cusplet at the corner of the third row. In addition, there is a much smaller, slightly flattened cusplet plastered against the labial side of the second labial cusp. The two larger cusplets are connected by a flattened cingular ridge, from which the small cusplet emerges. On the second lower molar there is a cingular ridge on the labial side, a small flattened cusplet adhering to the side of the first labial cusp, a large cusplet at the anterio-labial corner of the first row of cusps, and a smaller cusp at the corner of the second row. The labial side of the third molar has no cingular ridge and only a single large cusplet at the anterio-labial corner of the first row of cusps.

LENOTHRIX CANUS COMPARED WITH *KADARSANOMYS SODYI*

On January 27, 1902, Dr. W. L. Abbott obtained an adult rat from the island of Tuangku, off the northwest coast of Sumatra. This specimen became the basis for *Lenothrix canus*, a new genus and species named and described by Miller in 1903. Miller compared the specimen with *Lenomys meyeri* and various species of *Mus* (the name then applied to species in the genus that is now called *Rattus*). His description, based on skin, skull and teeth, and illustration of *canus* indicated an animal very different from any

Rattus, but this distinction was lost by the way other taxonomists handled the relationship of *Lenothrix*, as Medway & Yong (1976) noted when discussing the validity of the genus. They pointed out that no other specimens of *Lenothrix* were collected until Kloss, in 1931, reported specimens from Sarawak and Selangor, which he named *malaisia*. Kloss arranged *malaisia* as a subspecies of *canus*, which he treated as a species of *Rattus*, not *Lenothrix*. To Ellerman and his associates, writing during the period from the 1940's to the 1960's, the characters of *Lenothrix canus* were simply a part of the morphological diversity encompassed by the genus *Rattus*. Not until 1969 was *Lenothrix* again recognized as a genus by Misonne, who reiterated its distinctive dental characters. To Misonne, *Lenothrix* is not just a genus that should be separated from *Rattus*, but one that contains animals which, at least among living Muridae, may represent the morphology of the primitive murid, especially in the structure of the molars. 1)

The holotype of *Lenothrix canus* remains the only specimen recorded from the island of Tuangku. A few examples have been obtained from Sarawak (Medway, 1965), and Malaya is the only other place where the species is known to occur (Medway, 1969). Muul & Lim (1971: 435) reported *L. canus* to be common in Malaya, and explained that "Whenever we set traps in trees, ...we usually obtained specimens of this species. In Selangor, aside from foothill forests such as Bukit Lagong, Bukit Kutu, and Bukit Lanjan, we obtained *L. canus* from lowland secondary forests at Subang and Meru. Kampong rubber plantations at Bt. Mandol also yielded large numbers of the species. It was trapped in primary and in disturbed primary forests in Pahang and Johore."

Medway & Yong (1976: 45) indicated that the holotype of *L. canus* is larger than the specimens described by Kloss as *malaisia*; however, according to them, "More topotypes of *L. canus* are needed to verify the relations of the two taxa, but for conservative reasons it may be desirable to continue to treat them as conspecific at present." I share this opinion. In this report, I shall consider *canus* and *malaisia* to be geographic variants of one species. The examples of *L. canus* that I shall compare with *K. sodyi* come from Malaya.

Specimens of *L. canus* are similar to those of *K. sodyi* in body size and proportions, but have smaller ears and shorter hind feet (table 5); gray to

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1) However, Chan, Dhaliwal & Yong (1979: 335), who analyzed electrophoretic phenotypes of nine erythrocyte proteins from Malayan murids, claim the biochemical evidence suggests that *canus* should be grouped with *cameroni*, *bukit*, and *cremoriventer*, and that their results "...do not support Misonne's (1969) suggestion that *canus* be regarded as a species of a different genus..."

grayish brown, woolly fur over the dorsum, instead of soft brown fur tinged with buff; white to cream and pale buff underparts, instead of chalk-white; tails which are brown over the basal two-thirds and white for the distal one-third, instead of brown everywhere; short and wide hind feet, instead of long and wide; halluces with claws, instead of nails; and ten mammae (a pectoral pair, two postaxillary pairs, and two inguinal pairs), instead of eight. Sexually mature males of *L. canus* have a cutaneous glandular area, 4-8 mm wide and 80-100 mm long, tapered at each end, located along the midline of the stomach. The gland is conspicuous and the nearby fur is stained by its sebaceous secretions. Rudd (1966) noted similar midventral glands on adult males of *canus*, and claimed them to be histologically similar to the midventral cutaneous glands in *Rattus exulans* as described by Quay & Tomich (1963). I could not find evidence of comparable cutaneous glandular strips on the venters of *K. sodyi*.

Skulls of comparable ages of *L. canus* and *K. sodyi* are similar in size (table 5), but dissimilar in proportions (table 6) and in prominent details of their morphology (plate 4). The cranium of *L. canus* is low, its dorsal profile nearly flat, especially from the interorbital area to the tips of the nasals; the cranium of *K. sodyi* is thicker, with a gently convex dorsal profile; the tips of the nasals and sides of the rostrum do not extend as far forward past the incisors as they do in *L. canus*. In dorsal view, there are several conspicuous distinctions between crania of the two species. *Lenothrix canus* has a longer rostrum, which is narrower relative to its length, much larger lacrimal bones, and a lower braincase, in which the sides slope out towards the squamosal roots of the zygomatic arches; in contrast, the braincase of *K. sodyi* is higher, also relative to its breadth, and the sides are vertical or slope only slightly. The zygomatic plates are narrower in *L. canus* than in *K. sodyi*, and the anterior margins hardly extend beyond the dorsal roots of the zygomatic arches. Each dorsal edge of the interorbital region on skulls of *L. canus* is smoothly and deeply concave from the back of the lacrimals to the suture between the frontals and parietals and only low beading outlines the dorsolateral margins of the interorbital area and braincase; this configuration contrasts with the interorbital region on crania of *K. sodyi*, which is concave between the orbits only and widens quickly into convex margins, because of the wide and high shelves which outline them.

There are also prominent differences in the ventral surface of the cranium. The incisive foramina in skulls of *L. canus* are much shorter than those of *K. sodyi*, and terminate 1.2-2.4 mm in front of the anterior faces of the first molars, instead of penetrating between them as in *K. sodyi*. As a result, the palatal bridge of *L. canus* is longer than that of *K. sodyi*. The posterior

TABLE 5

External, cranial and dental measurements (in mm) of adults in samples of *Lenothrix canus, Kadarsanomys sodyi* and *Rattus diardii.* (Values for the mean ± one standard deviation, observed range in parantheses, and number of specimens in each sample are listed in that order for each measurement. Males and females were pooled)

	Lenothrix canus		*Kadarsanomys sodyi*		*Rattus rattus*	
Length of head and body	200.2 ± 13.6 (161-215)	19	187.6 ± 13.0 (162-210)	11	164.9 ± 10.6 (139-185)	20
Length of tail	241.2 ± 20.7 (190-270)	17	275.2 ± 16.3 (246-305)	11	183.5 ± 14.5 (151-201)	18
Length of hind foot	35.2 ± 1.4 (33-37)	19	39.5 ± 2.0 (37-44)	11	35.1 ± 1.9 (32-38)	20
Length of ear	20.6 ± 1.1 (19-22)	19	22.6 ± 1.3 (20-25)	11	20.6 ± 1.0 (18-22)	20
Greatest length of skull	45.9 ± 1.1 (43.8-48.4)	19	43.6 ± 1.8 (40.4-46.5)	10	40.2 ± 1.7 (36.6-44.1)	20
Zygomatic breadth	22.9 ± 0.9 (21.1-24.7)	19	21.3 ± 0.9 (19.9-22.6)	10	18.6 ± 1.0 (17.2-21.3)	20
Interorbital breadth	6.2 ± 0.4 (5.6-7.1)	19	6.2 ± 0.3 (5.7-6.8)	11	5.8 ± 0.3 (5.2-6.5)	20
Length of nasals	16.8 ± 0.7 (15.2-18.3)	19	14.7 ± 0.8 (13.3-16.1)	11	13.9 ± 0.9 (12.3-15.7)	20
Length of rostrum	13.7 ± 0.6 (12.5-14.6)	19	12.1 ± 0.6 (10.8-13.0)	11	12.4 ± 0.7 (11.1-13.9)	20
Breadth of rostrum	8.4 ± 0.5 (7.4-9.2)	19	8.5 ± 0.3 (7.9-9.0)	11	6.9 ± 0.5 (5.9-7.7)	20
Breadth of braincase	17.2 ± 0.6 (16.1-18.3)	19	17.1 ± 0.4 (16.4-17.8)	9	16.0 ± 0.6 (15.0-17.1)	20
Height of braincase	11.9 ± 0.4 (11.2-12.5)	19	12.9 ± 0.7 (12.0-14.0)	9	11.4 ± 0.6 (10.5-12.8)	19
Breadth of zygomatic plate	3.7 ± 0.3 (3.2-4.4)	19	4.4 ± 0.3 (3.9-5.0)	11	4.0 ± 0.3 (3.5-4.5)	20
Depth of zygomatic notch	0.9 ± 0.2 (0.6-1.3)	19	1.7 ± 0.3 (1.3-2.3)	11	2.3 ± 0.3 (1.7-3.0)	20
Length of diastema	12.5 ± 0.5 (11.6-13.3)	19	11.8 ± 0.7 (10.9-13.2)	11	10.5 ± 0.8 (9.0-12.0)	20
Palatal length	22.9 ± 0.6 (21.7-24.0)	19	23.1 ± 1.2 (21.2-25.4)	11	21.5 ± 1.1 (19.4-23.7)	20
Palatilar length	20.2 ± 0.5 (19.2-21.3)	19	20.3 ± 1.0 (18.6-22.1)	11	19.0 ± 1.0 (17.1-20.8)	20
Length of incisive foramina	6.9 ± 0.4 (6.2-7.7)	19	8.3 ± 0.4 (7.9-9.1)	11	7.6 ± 0.4 (7.1-8.4)	20
Breadth of incisive foramina	3.0 ± 0.2 (2.7-3.4)	19	3.2 ± 0.2 (2.9-3.5)	11	2.5 ± 0.2 (2.2-2.9)	20
Incisive foramina beyond M^1			0.4 ± 0.2 (even-0.6)	6	0.8 ± 0.3 (0.2-1.4)	20
Incisive foramina before M^1	1.8 ± 0.4 (1.2-2.4)	19				
Length of palatal bridge	9.9 ± 0.5 (9.1-10.6)	19	8.2 ± 0.5 (7.4-8.8)	11	7.8 ± 0.6 (6.5-8.5)	20
Breadth of bridge at M^1	3.9 ± 0.3 (3.4-4.5)	19	3.5 ± 0.2 (3.2-3.9)	11	3.6 ± 0.4 (2.9-4.6)	20
Breadth of bridge at M^3	4.5 ± 0.3 (4.0-5.3)	19	4.1 ± 0.3 (3.7-4.6)	11	4.4 ± 0.3 (3.9-4.7)	20
Breadth of mesopterygoid fossa	3.8 ± 0.3 (3.4-4.1)	19	2.5 ± 0.3 (2.0-3.0)	11	2.6 ± 0.2 (2.3-3.1)	20
Palatal bridge past M^3			0.2 ± 0.1 (even-0.3)	6	1.6 ± 0.4 (1.0-2.4)	20
Palatal bridge before M^3	0.7 ± 0.2 (0.3-1.1)	19				
Length of bulla	6.0 ± 0.3 (5.5-6.4)	18	8.1 ± 0.3 (7.6-8.5)	11	6.5 ± 0.4 (6.0-7.4)	20
Height of bulla	4.8 ± 0.3 (4.4-5.4)	18	6.0 ± 0.4 (5.0-6.4)	11	5.7 ± 0.3 (5.2-6.4)	20
Alveolar length of M^{1-3}	8.8 ± 0.3 (8.4-9.3)	19	8.3 ± 0.3 (7.8-8.9)	11	6.8 ± 0.4 (6.2-7.3)	20

margin of the bridge in skulls of *L. canus* ends well in front of the back margins of the third molars (by 0.3-1.1 mm) instead of even with the backs of the third molars or just beyond them, as is characteristic of *K. sodyi.* The palatal bridge of *L. canus* is also wider than that of *K. sodyi,* and the mesopterygoid fossa of *L. canus* is much wider, forming a striking difference between the two. The basioccipital is wider in skulls of *L. canus* than in those of *K. sodyi,* which reflects the contrast between the small bullae of *L. canus* and the much larger bullae in *K. sodyi.*

TABLE 6

Percentage (derived from mean values listed in table 4) expressing proportions of some measurements from samples of *Lenothrix canus*, *Kadarsanomys sodyi* and *Rattus rattus diardii*

	L. canus	*K. sodyi*	*R. rattus*
Interorbital breadth / Greatest length skull	14	14	14
Interorbital breadth / Breadth rostrum	74	73	84
Length rostrum / Greatest length skull	30	28	31
Breadth rostrum / Length rostrum	61	70	56
Height braincase / Breadth braincase	69	75	71
Palatal length / Greatest length skull	50	53	54
Length incisive foramina / Palatilar length	34	41	40
Length incisive foramina / Length diastema	55	70	72
Length palatal bridge / Greatest length skull	22	19	19
Length palatal bridge / Palatilar length	49	40	41
Palatal bridge beyond M^3 / Length palatal bridge	--	2	21
Breadth mesopterygoid fossa/ Breadth palatal bridge at M^3	84	61	59
Length bulla / Greatest length skull	13	19	17
Height bulla / Length bulla	80	74	88
Length M^{1-3} / Greatest length skull	19	19	17
Length M^{1-3} / Palatilar length	44	41	36
Length M^{1-3} / Length palatal bridge	89	101	87

Mandibles of the two species are similar in general configuration, but differ in details (plate 4). The mandibles of *L. canus* are not as high as those of *K. sodyi*, their coronoid processes are larger, and the concave posterior margin between the condyloid and angular processes is shallower — reflecting the squarish posterior outline of the angular processes in *L. canus* as opposed to those in *K. sodyi,* which are lower and longer. The ridge extending from the back of each toothrow to the lower part of the condyloid process is wide and shelf-like in *L. canus,* narrow and ridge-like in *K. sodyi.*

The upper and lower toothrows of each species are about the same length, but there the similarity ends (tables 4-6, plates 2 and 3). One dissimilarity between the two species is the number of roots on each first molar. In all examples of *K. sodyi* each upper molar has five roots. In a sample of 78 specimens of *L. canus,* the number of roots on each first molar ranges from three to five. Three specimens have anterior, lingual and posterior roots, all large and prominent; 48 individuals have three large roots and either a short labial nubbin or slender thread-like labial rootlet; 21 specimens have four roots, the basic three large roots and a cylindrical large labial root; four examples have a large anterior root, a large posterior one, a small or tiny labial rootlet, and two small roots in place of the large lingual root — apparently the result of the single lingual root splitting into two smaller, but strong ones; and two specimens had five roots, a configuration formed by large anterior and posterior roots, the two prominent lingual roots and a large labial root — a number and conformation like that in *K. sodyi* and species of *Rattus.*

Other dissimilarities between the two species exist in their toothrows. In *L. canus,* there is little overlap of the first molar over the second and the second over the third, which contrasts with the conspicuous overlapping in the other species. The first and second upper molars of *K. sodyi* are wider than those in *L. canus,* and the third upper molar is narrower relative to the first and second. Each third molar of *K. sodyi* is about as long as it is wide, but conspicuously longer than wide in *L. canus.* In lower toothrows of *K. sodyi,* the second molar is wider than the first or third, and wider than its counterpart in toothrows of *L. canus*; in the latter, the first and second lower teeth are about the same width. The third molars of *K. sodyi* average wider than their counterparts in *L. canus,* but their respective breadths relative to the widths of the other teeth are the same. Finally, the occlusal edges of the cusps are wide and flat or gently rounded on the upper and lower teeth of *L. canus,* but the cusps on the molars of *K. sodyi* have high and thin enamel rims.

The occlusal patterns formed by the cusps on the upper molars are very different in the two species (plate 2). Where most of the cuspidate laminae on the teeth of *K. sodyi* are gently arcuate, those in *L. canus* are slanted back and to the lingual side. Furthermore, the cusps of *K. sodyi* are cylindrical, triangular with rounded corners, or oblong; the occlusal surfaces are formed of rounded shapes. In teeth of *L. canus,* the cusps are elongated, triangular or diamond-shaped; the occlusal configurations are angular and elongated rather than rounded. The first, second and third molars of *L. canus* have a small but prominent posterior cingulum, and there is usually, not always, a cusp t7 on the first and second molars; a cusp t7 is not present on any molar in *K. sodyi*; there is a posterior cingulum on the first and second molars in *K. sodyi*, but each is small and inconspicuous. In addition, there is no cusp t3 on each third molar of *L. canus*; this cusp, though often small, is present and prominent on all third molars of *K. sodyi*. On each first molar of *L. canus* there is a small round cusp, situated just posterior to cusp t6 on the second row. After a bit of wear, this small cusp merges with cusp t6 to form a long ridge; such cusps or ridges are not found on the first molars of *K. sodyi*. Finally, there is a prominent ridge (triangular in cross-section) which extends back from the connection between the labial and central cusps in the front row on the first and second molars of *L. canus*; there are no such ridges on the teeth of *K. sodyi*.

The occlusal patterns of the lower molars of *L. canus* and *K. sodyi* resemble each other more closely than do the patterns of the upper teeth, but there are still conspicuous differences between the two species (plate 3). The rows of cusps on the molars of *L. canus* are farther from each other than are those of *K. sodyi*, and the cusps are higher and nearly erect, not slanted forward as in *K. sodyi*. There is a large, prominent cusplet at the anterior margin of each first lower molar in toothrows of *L. canus*. This cusplet is distinctly separated from the front row of cusps and remains discrete even after much wear. Its counterpart on the first molars of *K. sodyi* is smaller, pressed against the side of the lingual cusp, and loses its identity after only little wear. The other prominent difference involves the labial cusplets and ridges. The labial cusplets are larger in *L. canus*, and those along the margins of the first and second molars are often joined by a thick and high ridge, larger and more prominent than the cingular ridges on the molars of *K. sodyi*.

RATTUS RATTUS DIARDII COMPARED WITH *KADARSANOMYS SODYI*

In the following account, I contrast specimens of *K. sodyi* with those of *R. rattus diardii* from several localities in West Java. The morphological features of that species form a good example of the general characteristics of species at the core of the genus *Rattus*, those, for example, which most taxonomists would include in the subgenus *Rattus* (Ellerman, 1949; Misonne, 1969). The name *diardii* is the one that applies to populations from areas on the Sunda Shelf, populations which are closely related to those of Asian *R. rattus* found north of the Isthmus of Kra, and not to the true *R. rattus*, referred to as European house rats or Oceanian black rats. The Asian and European rats differ significantly in external features (Johnson, 1962; Jones & Johnson, 1965), karyotypic characteristics (Yosida, Tsuchiya & Moriwaki, 1971), giemsa-banding patterns of chromosomes (Yosida & Sagai, 1973), frequencies of chromosome polymorphism in pairs no. 1 and 9 (Yosida, 1977b), variation of C-bands in the chromosomes (Yosida & Sagai, 1975), and serum transferrin patterns (Yosida, Tsuchiya & Moriwaki, 1971). F_1 hybrids can easily be obtained from reciprocal crosses between the Asian and European forms kept in the laboratory (Yosida, Tsuchiya, Imai & Moriwaki, 1969; Yosida, Kato, Tsuchiya & Moriwaki, 1971; Moriwaki, Tsuchiya & Yosida, 1973), but according to Yosida (1976: 304), "Delivery of F_2 offspring has so far been poor in the laboratory. This suggests that the F_1 hybrids seem to be semisterile."

Apparently, hybrids between Asian and Oceanian (European) rats also occur in the wild. Yosida, Kato, Tsuchiya & Moriwaki (1971) reported that animals obtained from Eniwetok Island in the South Pacific had karyotypes and serum transferrin patterns typical of the F_1 hybrids between the Asian and Oceanian types of rats. When Yosida and his colleagues crossed two of the rats from Eniwetok, one offspring was produced, which had the same karyotype as that of a single F_2 obtained in the laboratory. There is no published indication that such F_2 individuals occur naturally on Eniwetok Island.

Earlier, Yong (1969), on the basis of karyological evidence, stated that *diardii* should be treated as a distinct species. Lately, Medway & Yong (1976: 48) wrote that the best taxonomic way to reflect the incomplete genetic isolation between the Asian and Oceanian rats would be to recognize each as a species, and so: "Although older names exist (particularly from India) as a provisional expedient we are applying to the house rat the earliest available name from the Sunda region, *diardii* Jentink 1880." Possibly the two kinds of rats are different species, but the genetic compatability or incompatability between the Asian and Oceanian rats living in the wild is still unknown. For example, Yosida (1977a: 269), in a report on the karyological study of hybrids between Asian and Oceanian types, noted that "The Asian type black rats... can be divided into two groups on the basis of electrophoretic transferrin pattern and morphology of chromosome pairs 1 and 9. The Asian type rats distributed in eastern and southeastern Asia showed the R-type transferrin pattern and polymorphic pairs 1 and 9, while those distributed in the northern part of southwestern Asia (India and Pakistan) invariably showed the C-type transferrin pattern and the subtelocentric pairs 1 and 9, similar to the situation in the Ceylonese and Oceanian type black rats. If the Asian type black rats in northern India or Pakistan can be used for the cross experiment, the hybrids might be fertile, ..." The genetic relationships between rats in populations from the Indian region and those occurring farther east still require crystallization. For now I am treating *diardii* as a subspecies of *R. rattus*; when I refer to that species in the comparison to follow, I explicitly mean the sample of *diardii* from West Java.

Examples of *R. rattus diardii* are smaller-bodied (table 5) than *K. sodyi*, and also differ in other external features. Compared with adults of *K. sodyi*, those of *R. rattus* have coarser, darker pelage over the dorsum, and darker underparts that range from cream (which occurs infrequently) to dark grayish buff; darker monocolored tails; shorter hind feet; halluces which bear claws, not nails; and ten mammae (one pectoral pair, two postaxillary pairs, one abdominal pair and two inguinal pairs), instead of eight.

The cranium of *R. rattus* is more gracile than that of *K. sodyi*, not as deep, and differs in the absolute size of some dimensions and in certain proportions (tables 5, 6; plate 4). The dorsal profile is flat in *R. rattus* instead of gently convex, and the tips of the nasals and sides of the rostrum extend farther beyond the incisors than in *K. sodyi*. Specimens of *R. rattus* also have a longer and much narrower rostrum, narrower incisors, broader zygomatic plates in which the vertical anterior edges extend up to 3 mm beyond the anterior roots of the zygomatic arches, and a lower braincase. There are also distinctive differences in the ventral part of the cranium. In *R. rattus*, the incisive foramina tend to be narrower and longer than those in *K. sodyi*, the posterior margins extending farther past the front molars. The toothrows are much shorter, the individual teeth narrower; and the toothrows diverge posteriorly, in contrast to the long, wide and nearly parellel toothrows of *K. sodyi*. The palatal bridge in *R. rattus* is wider and longer than in *K. sodyi*, and always extends 2-3 mm beyond the third molars, whereas in *K. sodyi* it terminates at the back of the third molars or barely beyond them. The configuration of the palatal bridge in *R. rattus* is characteristic of most species of *Rattus*. The walls of the mesopterygoid fossa differ appreciably between the two species. In *R. rattus*, the sphenopalatine vacuities are huge, so spacious that the presphenoid and anterior projection of the basisphenoid seem suspended in air; in *K. sodyi*, the sphenopalatine vacuities are small, and the bottom of the mesopterygoid fossa is more like a trough. Finally, the bullae in *R. rattus* are smaller, both absolutely and relative to the cranium, than those in *K. sodyi*.

The first upper molars of *R. rattus* have five roots, the rows of cusps on the first and second teeth slant backwards, so that the first molar overlaps the second and the second overlaps the third, and a cusp t7 does not occur on any of the molars. These characteristics are shared by *K. sodyi*, but any close similarity ends there (plate 2). In addition to the much shorter toothrows and smaller teeth than *K. sodyi*, the second upper molars of *R. rattus* are slightly narrower than the first ones (whereas they are of the same width in *K. sodyi*) and each third molar of *R. rattus* is broader relative to either the first or second than in *K. sodyi* (table 4). The enamel rims of the cusps on upper and lower molars in *R. rattus* are wide and flat or gently rounded, but the cusps on teeth of *K. sodyi* end in high, thin enamel rims.

The occlusal patterns of the upper molars in the two species are dissimilar. The rows of cusps on the first and second molars of *R. rattus* are chevron-like in configuration, because they are formed of broadly joined cusps, merging even more after only little wear. Even in nestlings of *R. rattus*, where only the first upper molars have erupted, the labial and medial cusps are completely merged to form half of a lamina, and only the lingual cusp is separate. In contrast, the cusps on the first and second molars of *K. sodyi* are discrete and laid out in gently convex rows. In nestlings of *K. sodyi*, the cusps are joined to each other by thin margins only and appear nearly isolated. Even in adult teeth, with appreciable wear, the cusps are only weakly joined. The occlusal surfaces of the teeth in *K. sodyi* appear cuspidate in configuration, rather than formed of chevron-like laminae as in *R. rattus*.

There are other distinctive differences between *R. rattus* and *K. sodyi* in cuspidation on the upper molars. Cusp t9 of each first and second molar in *R. rattus* is large and its posterior margin is confluent with the back edge of the central cusp, with which it is broadly merged. Cusps t9 on molars of *K. sodyi* are very small, retain their identities even after appreciable wear, and appear to have budded out of the side of the large central cone. Cusp t3 on the second and third molars in *R. rattus* varies in size and occurrence, but is present and usually large on the first and second molars in all examples of *K. sodyi*. In a sample of 20 specimens of *R. rattus* from West Java, for example, cusp t3 of the second molar was present in 14 (70%) of the specimens and ranged in size from a tiny bump to a clear cusp, but always less prominent than cusp t3 on second molars of *K. sodyi*. Cusp t3 of the third molar is, as in *Lenothrix canus*, usually absent in *R. rattus*; out of the 20 specimens, only one individual (5%) had very small front labial cusps here. Finally, there is no posterior cingulum on the upper molars in the sample of *R. rattus*, but a posterior cingulum, small and ridge-like, does occur on the first and second upper molars in *K. sodyi*.

The lower toothrows of *R. rattus* and *K. sodyi* also differ in size and proportions (table 4). In addition to being shorter, the toothrows of *R. rattus* contain narrower molars. The second molar of *R. rattus* is narrower relative to the first than in *K. sodyi*, and the third is narrower relative to both the first and second. The occlusal patterns formed by the rows of cusps on the lower molars are superficially similar in the two species, but quite different in details (plate 3). First lower molars of *R. rattus* do not have cusplets at their anterior margins. The cusps are not as discrete as in *K. sodyi* and meet at a broader angle, to coalesce into laminae shaped like broad chevrons. The posterior margins of these laminae are not scalloped as in *K. sodyi*.

The size and occurrence of the labial cusplets are also different in the two species. The first lower molar of *R. rattus* has only a posterior labial cusplet; both anterior and posterior cusplets are present on the molars of *K. sodyi*. A cingular labial ridge comparable to that in *K. sodyi* is also absent from the first molars of *R. rattus*. There are two labial cusplets on the second molar, as in *K. sodyi*, but no cingular ridge, and a labial cusplet occurs on all third molars. There is variation in the occurrence of the labial cusplets on the lower molars in the sample of *R. rattus*, but that variation is minor. In the 20 specimens of *R. rattus* from West Java, for example, the posterior cusplet of the first molar occurred on 19; the anterior cusplet of the second molar was found on all 20, the posterior cusplet on 19; and the cusplet of the third molar again occurred in every individual.

HABITAT AND HABITS OF *KADARSANOMYS SODYI*

The only information about the habitat of *K. sodyi* is that published in Bartels's original account (1937a: 46): "The majority of the specimens was caught from dead and more or less decaying big bamboo-stems in the forest, into which the rats had gnawed little entrance-holes measuring about 3-4 cm in diametre. Such holes had also been gnawed in the partitions between the internodia. A nest made of dry leaves etc. containing four young rats was found in such a situation on January 24th, 1935. The peculiar hallux and short foot showing well-developed pads probably indicate arboreal or semi-arboreal habits."

Breeding information is also meager, but apparently as many as four young can be contained in a litter. Since nestlings were found in January and juveniles caught in June (table 3), there probably are at least two litters a year.

Both Bartels's observations and the morphology of the external features, skull and teeth of these rats support the hypothesis that the animals may be associated with bamboo as intimately as another murid, *Hapalomys longi-*

caudatus, seems to be (Medway, 1964). The latter lives in forests in southern and peninsular Burma, southwestern and peninsular Thailand, and the Malay Peninsula (Musser, 1972); it is arboreal and adapted to living in bamboo stems, utilizing bamboo products in its diet. Medway (1964), who studied the species in Malaya, found *H. longicaudatus* associated with the bamboo *Gigantochloa scortechinii*. The animals made their nests in the larger stems. One captive rat preferred the growing tips and fruiting twigs of bamboo to other food offered.

Several external features of *K. sodyi* point to arboreal habits: a tail that is much longer than the combined length of head and body; dark rings around the eyes, long vibrissae on the muzzle, above the eyes and on the cheeks; large, fleshy, striated pads which cover the palms and much of the plantar surfaces; large digital pads; long claws with sharp, recurved tips; long and wide hind feet; a nail imbedded in a very large, grooved digital pad on each hallux; and some pseudo-opposability of the hallux and fifth digit. The relative length of the tail and the structure of the hind feet are particularly adaptive to an animal moving about on surfaces above the ground. The long tail would provide counterbalance to the body motion; the fleshy, striated plantar and digital pads would provide good adhesion to smooth surfaces, such as bamboo stems. The sharp claws would dig into the substrate and help maintain balance. A stout hallux terminating in a large fleshy pad and nail would provide the adhesion and strength to enhance the forces involved in gripping the substrate. Most arboreal murids are active at night and the dark mask about the eyes would enhance use of the available light. Long vibrissae would help distinguish objects and surfaces in the arboreal habitat, and gauge diameters of nest holes and the hollow interior of bamboo stems. These characteristics of the body, tail and feet are adaptive not only to moving about over bamboo stems, whether lying on the ground, vertical or at other angles, but to moving up and down inside the hollow internodes as well.

The arboreal adaptations of body, tail and feet of *K. sodyi* are complemented by the structure of the skull and teeth, configurations which may reflect adaptations to dealing with hard, fibrous, silaceous substances, such as those encountered in gnawing entry holes into the internodes of bamboo stems, gnawing through the hard partitions between internodes, stripping sheathing bases of outer leaves to get at the soft meristematic parts of bamboo twigs, and masticating bamboo products. The cranium of *K. sodyi* is compact, stocky and robust. The upper incisors are wide, emerge at a right angle, and appear strong. The rostrum is short and seems stout enough to absorb the force generated by gnawing motions of the incisors when chipping away hard substances. The wide, shelf-like ridges which margin the frontal bones and part of the parietals, offer additional surface for the insertion of the temporal muscles. Surfaces of both the bases of the molars and their occlusal areas are smooth and gleaming white. The cusps are distinct and outlined on their occlusal ends by high, hard and thin enamel walls, enclosing deep valleys and oval depressions of softer dentine. Such a smooth and sharply cuspidate surface may be associated with masticating growing tips, fruit and flowers of bamboo (although the teeth could also tackle insects, such as moths and katydids). It may be significant that the occlusal surface of the molars of *Hapalomys longicaudatus*, a species known to feed on the tips of twigs, fruit and flowers of bamboo, are also mainly formed of cusps that are polished, discrete and capped with thin and high enamel rims (see figs. 10 and 11 in Musser, 1972).

If this hypothesis is correct, then in the tropical forest of West Java, *K. sodyi* may be the ecological counterpart of *H. longicaudatus*, which on the Sunda Shelf has been collected on the Malay Peninsula only. There *H. longicaudatus* and *Chiropodomys gliroides* nest in the same bamboo clumps (Medway, 1964). The latter is a highly arboreal mouse; its distinctive features are a short head and a small body clothed in dense fur, large eyes, long vibrissae on the muzzle and above the eye, a long tufted tail, short and wide feet with large palmar and plantar pads, short recurved claws, and halluces with nails (Musser, 1979). Throughout its range, *C. gliroides* lives in hollow trees and the crowns of palms, but its most common nesting places seem to be the internodes of slender bamboo stems (Musser, 1979). *Hapalomys longicaudatus* is a medium-sized rat (lengths of head and body in six specimens: 140-165 mm); *C. gliroides* is a small mouse (lengths of head and body in 57 specimens from the Malay Peninsula: 69-102 mm).

Specimens of *C. gliroides* were also collected by Bartels at 1000 meters on the southwestern slopes of Gunung Pangrango-Gede, in the same localities where *K. sodyi* was obtained (Musser, 1979). I have no evidence, either from tags attached to specimens, or from any of Bartels's field notes or published accounts, as to whether *C. gliroides* was taken with *K. sodyi* in the same bamboo clumps. I would, however, expect to find both species nesting in the same clump, provided that it contained both wide and slender stems. So, in evergreen forest on the Malay Peninsula and from there north into peninsular Burma and southwestern Thailand, the bamboo is occupied by a medium-sized rat, *H. longicaudatus*, and a small mouse, *C. gliroides*. In the evergreen forests on the steep volcanic slopes of West-Java, the inhabitants of bamboo clumps probably are the medium-sized *K. sodyi* and the small *C. gliroides*.

The occurrence of two species-pairs in different parts of Southeast Asia and the Sunda Shelf, each associated with bamboo, poses intriguing evolutionary problems, requiring further field study. Bamboo is found in clearings in primary and old secondary tropical forests in the Far East. According to Janzen (1976: 347): "Nearly all species of bamboo seem to have one of two life histories. Some species outside of the Indian-Asian tropics, and a very few in, have populations composed of individuals (clones) that grow to maturity and then flower/seed annually for many years." But, "Many of the more common Indian-Asian species... have populations made up of individuals that seed synchronously at regular and long supra-annual intervals." Janzen (1976: 355) also noted that "The seeds range from the size of a rice kernel up to 100-350 grams..., and may cover the ground to as much as 5-6 inches in depth below the parent plant." The seeds are eaten by many kinds of animals, and "Local animals should be major predators on bamboo seeds from the day the mast crop begins until the day it ends." Janzen mentioned that in India, species of *Nesokia, Mus, Rattus, Golunda* and *Rhizomys* showed population explosions in response to mast crops from bamboo. These are terrestrial animals, which may feed on fallen seeds, but do not climb up to the growing tips or flowers, which are not part of their usual diet; they are not adapted to nesting in the hollow internodes of the bamboo stems.

Only very few species of rats and mice are known to be capable of utilizing bamboo for nesting. Apart from the species discussed above, *Hapalomys delacouri*, occurring in Indochina and smaller than *H. longicaudatus* (Musser, 1972) may be another, but nothing is known about its habits. The other four species of *Chiropodomys* (*major, muroides, calamianensis,* and *karlkoopmani*), either larger or smaller than *C. gliroides* (Musser, 1979), may also utilize bamboo, but their habitat and nesting preferences are poorly documented or unknown.

Being arboreal does not mean that a rat or mouse can exploit nesting sites in bamboo stems. There are many species of arboreal murids in the forests from Southeast Asia to New Guinea, which do not nest in bamboo. *Niviventer cremoriventer* and *Pithecheir melanurus* on Java — both collected by Bartels at the same localities where *K. sodyi* was obtained (Bartels, 1937b; Musser, 1973) — are examples of such species; *Lenothrix canus* from the Malay Peninsula is another. There are several species of highly arboreal rats and mice in the forests on Sulawesi, but I never found any of them nesting in bamboo.

The morphological adaptations in rats and mice utilizing bamboo require further study. One problem is the way a rat or mouse has become adapted to moving about in bamboo clumps: a dense stand of smooth bamboo stems is not easily negotiated. Some large dead and decaying stems will have fallen on the ground, but most of them are still erect, supported by the living stems at different angles. To move over the smooth surfaces of the stems, and to run up and down through the hollow internodes, requires feet with good adhesive qualities. To climb about in the slim twigs at the end of bamboo stems, on the other hand requires abilities to grasp and negotiate very slender supports. A nail imbedded in a very large distal pad on the hallux apparently is one of the specializations of the hind feet associated with grasping and moving over smooth round surfaces. Of the many arboreal species of murids in the Old World, especially in tropical Africa, India and the Far East, the only species with nails on the halluces are *Kadarsanomys*, the five species of *Chiropodomys*, the two species of *Hapalomys*, *Chiromyscus fulvus*, and the two species of *Vandeleuria* (Musser, 1979). The species of *Vandeleuria* build nests in tall canes, shrubs, hollow trees or slender branches of trees and shrubs. The other species in this assemblage on which there is some information, are in some way associated with bamboo, either as both nesting site and food source (*H. longicaudatus*) or at least as a place to nest (*C. gliroides*, *K. sodyi*).

From the few short sentences Bartels used to deescribe the places where he collected *K. sodyi*, I have speculated about the possible association between this rat and bamboo. I did so to point out some questions about the ecology of not only *K. sodyi*, but of other highly specialized, tropical arboreal murids as well. The ecological relationship between the pair *H. longicaudatus*-*C. gliroides* and bamboo on the one hand, and *K. sodyi*-*C. gliroides* and bamboo on the other, needs further study to elucidate the morphological, physiological and ecological adaptations of rats to bamboo, and the possible co-evolution between bamboo and rats [1]).

ZOOGEOGRAPHICAL NOTES

Kadarsanomys sodyi is one of the more than 40 species of rats and mice recorded from the major islands on the Sunda Shelf (table 7). *Kadarsanomys*

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[1]) After the above was written, I received Rudd's (1979) report on niche dimension in *Chiropodomys gliroides*, results based on study of movements of this mouse in Ulu Gombak, Selangor. Mice were trapped, marked, released and many recaptured; most were recaptured in or near bamboo. To Rudd (1979: 348), "...it seems particularly fascinating to consider the co-adaptive interactions of a floral community (interrupted primary forest), the species and conformations of bamboo, the rodent species *Chiropodomys*, the small bat species dependent on bamboo for roosting (*Tylonycteris pachypus* — Kelawar buluh kecil), and stem-boring beetle larvae that in part provide living spaces for both the mammals. We seem to have here a focal problem in co-evolutionary phenomena worthy and capable of close analysis."

is the only genus endemic to a single island on the Shelf. This one, and two others, *Pithecheir* and *Lenothrix*, comprise the only endemic Sundaic genera; all the others (*Rattus, Berylmys, Mus, Leopoldamys, Niviventer, Maxomys, Chiropodomys* and *Haeromys*) are also represented in India and Indochina or on the islands and continent east of Borneo and Bali. *Kadarsanomys sodyi*, along with *Mus vulcani, Niviventer lepturus, Rattus maxi* and *Maxomys bartelsii*, are endemic to Java. That island has three endemic species of murid more than are now found on the Malay Peninsula, the same number as occurs on Sumatra, and two less than recorded from Borneo. Java has fewer native murid species than the Peninsula or the large islands of Sumatra and Borneo, but on Java the number of endemics is larger relative to the total number of native species found there (42%) than on the Malay Peninsula (13%), Sumatra (19%) and Borneo (37%).

The addition of an endemic genus to the rats and mice on Java emphasizes the aspects that distinguish the Javan fauna from the assemblages on the Malay Peninsula and larger islands of the Sunda Shelf.[1] There are 21 species of rats and mice now living on Java (table 7). Two were certainly introduced there through human agency, seven others probably were also introduced, and 12 are native. Java shares seven of those 12, in different combinations with the Peninsula and other islands on the Shelf, and five are found on Java only. The other aspect, that there are species absent from Java which are widespread elsewhere on the Shelf, adds to the distinctive quality of the species composition. *Rattus muelleri, Maxomys rajah, Maxomys whiteheadi* and *Lenothrix canus* are found on the Malay Peninsula, Sumatra (or at least one of its offshore islands) and Borneo; none of these have even been collected on Java.

Samples of fossil murids from Java are on record, but the information is insufficient for assessing the relationship of *K. sodyi* with the species that are represented. There is material from the Sampung Cave (1000 B.C.) in Central Java (Dammerman, 1934), and the Djetis and Trinil faunas (Middle Pleistocene, according to Hooijer, 1952, but Late Pliocene-Early Pleistocene in the opinion of Ninkovich & Burckle, 1978) of Java. Dammerman recorded *sabanus* (which he listed as a species of *Rattus*), though the identification was questionable, *Rattus rattus* and another species of *Rattus*, which he could not identify. Hooijer's records referred only to *Rattus*. None of the

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[1] The Palawan and Calamian islands are also on the Sunda Shelf, but I exclude them from discussion here, because they have been inadequately sampled and their murid fauna is poorly known. *Rattus rattus* and *R. exulans* comprise the recorded introductions. *Rattus tiomanicus, R. muelleri, Maxomys panglima* and *Chiropodomys calamianensis* are the known native species, the latter two occurring nowhere else.

TABLE 7

The living murids of Malaya (the Peninsula south of the Isthmus of Kra), Sumatra, Borneo, Java and Bali, including offshore islands (abbreviations: —, apparently absent; E, endemic to the Peninsula or one particular offshore island; I, indigenous to the Sunda Shelf; O, also found in areas outside the Sunda Region)

Data are from my own studies supplemented by information gleaned from Chasen (1940), Medway (1965, 1969) and Marshall (1977). Elsewhere I explain why I use the generic names listed here, and give the reasons for recognizing some of the species, in reports either published (Musser, Marshall & Boeadi, 1979; Musser, 1981) or soon to be submitted for publication. The scientific names associated with each of the species are or will be provided in those papers.

	Malaya	Sumatra	Borneo	Java	Bali
Introduced					
Mus castaneus	O	O	O	O	O
Rattus norvegicus	O	O	O	O	O
Probably introduced					
Rattus rattus (diardii)	O	O	O	O	O
Rattus argentiventer	O	O	O	O	O
Rattus exulans	O	O	O	O	O
Mus caroli	O	O	—	O	—
Mus cervicolor	—	O	—	O	—
Bandicota indica	O	O	—	O	—
Bandicota bengalensis	O	O	—	O	—
Native					
Rattus tiomanicus	I	I	I	I	I
Rattus baluensis	—	I	I	—	—
Rattus hoogerwerfi	—	E	—	—	—
Rattus annandalei	I	I	—	—	—
Rattus muelleri	I	I	I	—	—
Rattus infraluteus	—	I	I	—	—
Rattus maxi	—	—	—	E	—
Berylyms bowersii	O	O	—	—	—
Mus crociduroides	—	E	—	—	—
Mus vulcani	—	—	—	E	—
Leopoldamys sabanus	O	O	O	O	—
Leopoldamys edwardsi	O	O	—	—	—
Niviventer bukit	O	O	—	O	O
Niviventer cremoriventer	I	I	I	I	I
Niviventer rapit	I	I	I	—	—
Niviventer lepturus	—	—	—	E	—
Maxomys surifer	O	O	O	O	—
Maxomys rajah	I	I	I	—	—
Maxomys whiteheadi	I	I	I	—	—
Maxomys bartelsii	—	—	—	E	—

	Malaya	Sumatra	Borneo	Java	Bali
Maxomys inflatus	—	E	—	—	—
Maxomys hylomyoides	—	E	—	—	—
Maxomys inas	E	—	—	—	—
Maxomys alticola	—	—	E	—	—
Maxomys ochraceiventer	—	—	E	—	—
Maxomys baeodon	—	—	E	—	—
Chiropodomys gliroides	I	I	I	I	I
Chiropodomys muroides	—	—	E	—	—
Chiropodomys major	—	—	E	—	—
Haeromys margarettae	—	—	E	—	—
Haeromys pusillus	—	—	E	—	—
Pithecheir melanurus	—	I	—	I	—
Pithecheir parvus	E	—	—	—	—
Lenothrix canus	I	I	I	—	—
Kadarsanomys sodyi	—	—	—	E	—
Total species	24	30	24	21	9
Total introduced	8	9	5	9	5
Total native	16	21	19	12	4
Total endemic	2	5	7	5	0

murid fragments from those places have been properly studied; all of them must be re-examined and compared with *K. sodyi* and the other native Javan rats to determine the actual species represented by the fossils.

By studying characters derived from skins, skulls and teeth, I conclude that *Kadarsanomys sodyi* has no close ally among the 12 native species now living on Java or the others found on the Sunda Shelf, nor among groups now living elsewhere. Above, I compared *K. sodyi* with *Lenothrix canus* simply because *sodyi* was originally described as a subspecies of *canus*, which at that time was included in the genus *Rattus*. I contrasted *K. sodyi* with *R. rattus diardii*, because the morphological features of that form are representative of the species in the subgenus *Rattus*, because it also occurs on Java, and because the genus *Rattus* as defined by Misonne (1969) formed one of the largest groups of murids on the Sunda Shelf and might have included species that were morphologically close to *K. sodyi*. I also compared specimens of *K. sodyi* with all the other genera and species which are known to occur, not only in the Sunda Region, but also in Africa, India, Southeast Asia and that vast area east of the Sunda Shelf from the Philippines and Sulawesi to New Guinea and Australia.

Not only is *K. sodyi* geographically isolated in the volcanoes of West Java, but by its morphological attributes is set apart from any other known species of murid. Neither *K. sodyi* nor *L. canus* share any derived features in the skin, skull or teeth, which would indicate close evolutiony relationship. The skull of *K. sodyi*, in its general configuration, resembles the skulls of some species in *Rattus* more than that of *L. canus*, but it differs from all *Rattus* by the distinctions discussed above. Nails on the halluces are not a derived character present in any species of *Rattus*, and those other rats and mice that have nails do not share other particular specializations with *K. sodyi* except those associated with arboreal habits. Finally, the structure of the molars of *K. sodyi* is unlike that of any other species.

Set within the context of the present fauna in the Far East, *K. sodyi* must be a relict. It appears to have no close relative and to be one specialized segment of an adaptive radiation that may have had its origin very early in the development of Indochinese and Sundaic murids.

ETYMOLOGY

Dr. Sampurno Kadarsan, born into the old Javanese Culture, teaches biology and studies the taxonomy and life cycles of ticks. He is an expert on the biology of ticks that parasitize Indonesian mammals. During the period I worked in Indonesia, Dr. Kadarsan was Director of the Museum Zoologicum Bogoriense. At that time and in that capacity, he supported my research endeavors, as well as the projects of many other foreign investigators. He was always available with any professional help he could provide, and his gracious hospitality always included an open invitation to his home. I am very pleased to name *Kadarsanomys* after him.

Combining the name *Kadarsanomys* with *sodyi*, reflects an historical connection between the generation of bright, competent Indonesian scientists, who came into their own after independence from the Dutch Colonial Government; and H. J. V. Sody, a professional biologist who provided some of the best contributions to the natural history and taxonomy of Indonesian mammals during the 1920's to 1940's (Van Bemmel, 1960); and Max Bartels, Jr., the describer and author of *sodyi*, son of a German plantation owner, friend of Sody and self-trained naturalist, whose astute observations on the natural history of Javan mammals still comprise the best records available (Bartels, 1937b). All three men were born and grew up at a time when Europe still defined the governmental context of the East Indies. Bartels, a victim of World War II, never lived to see Indonesian independence; Sody, although incarcerated by the Japanese, lived through the transition of a colonial East Indies to an independent Indonesia, and died in Amsterdam in 1959; Kadarsan, a Javanese, and an Indonesian nationalist, is now biologist, scholar and teacher. It is appropriate that the etymological associations of an exceptional species of rat, endemic to the volcanoes of West Java, be woven from the threads of Indonesian history which these three men represent.

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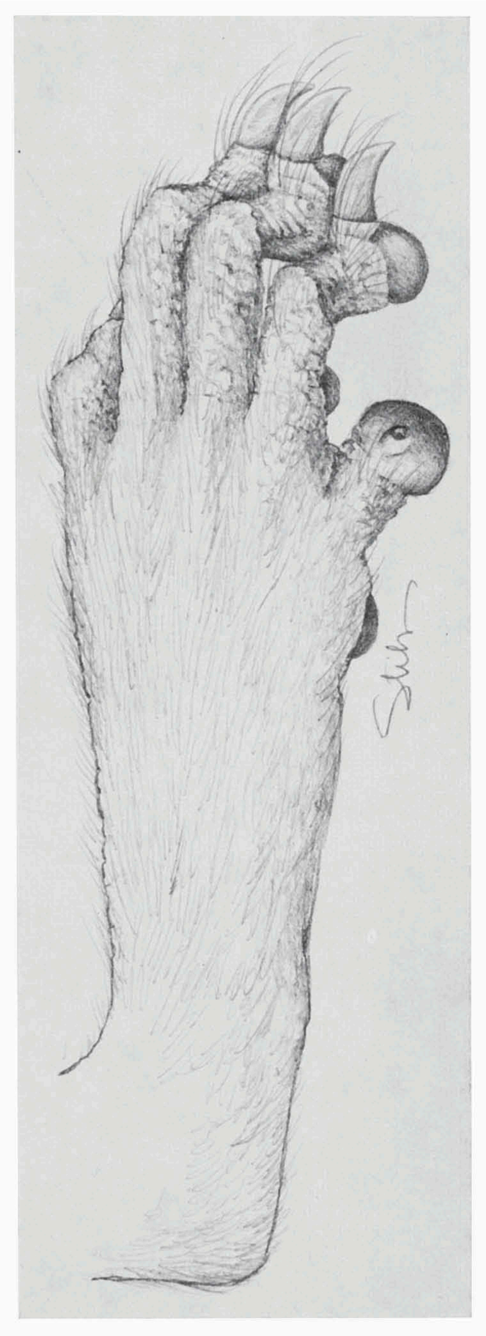
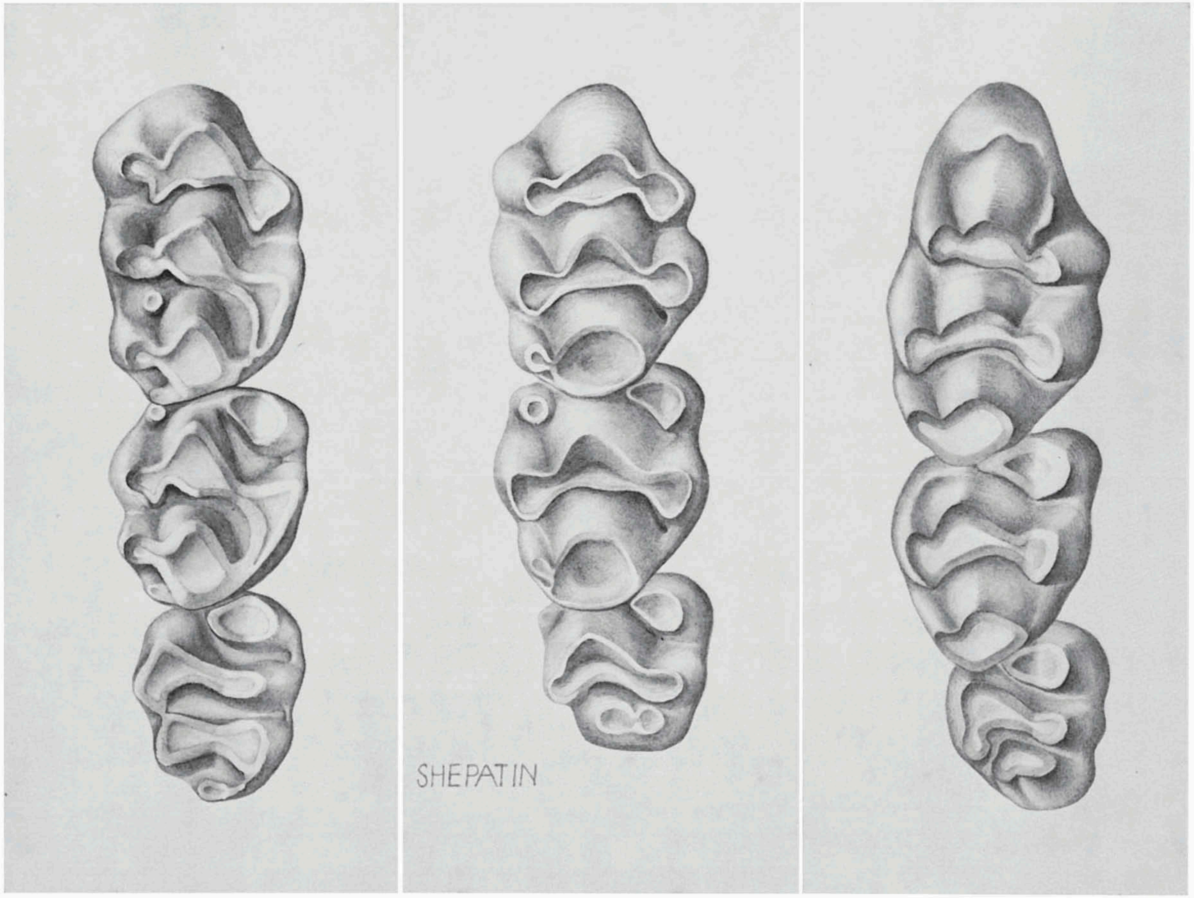
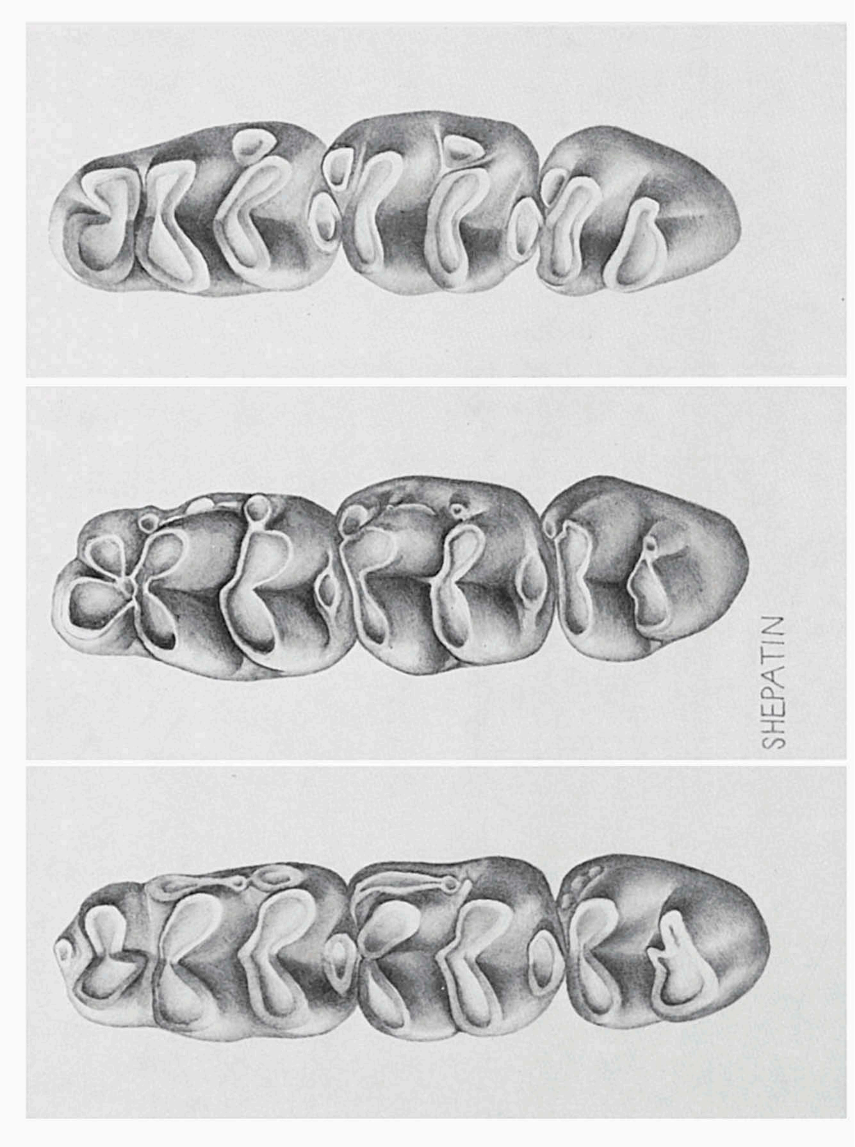


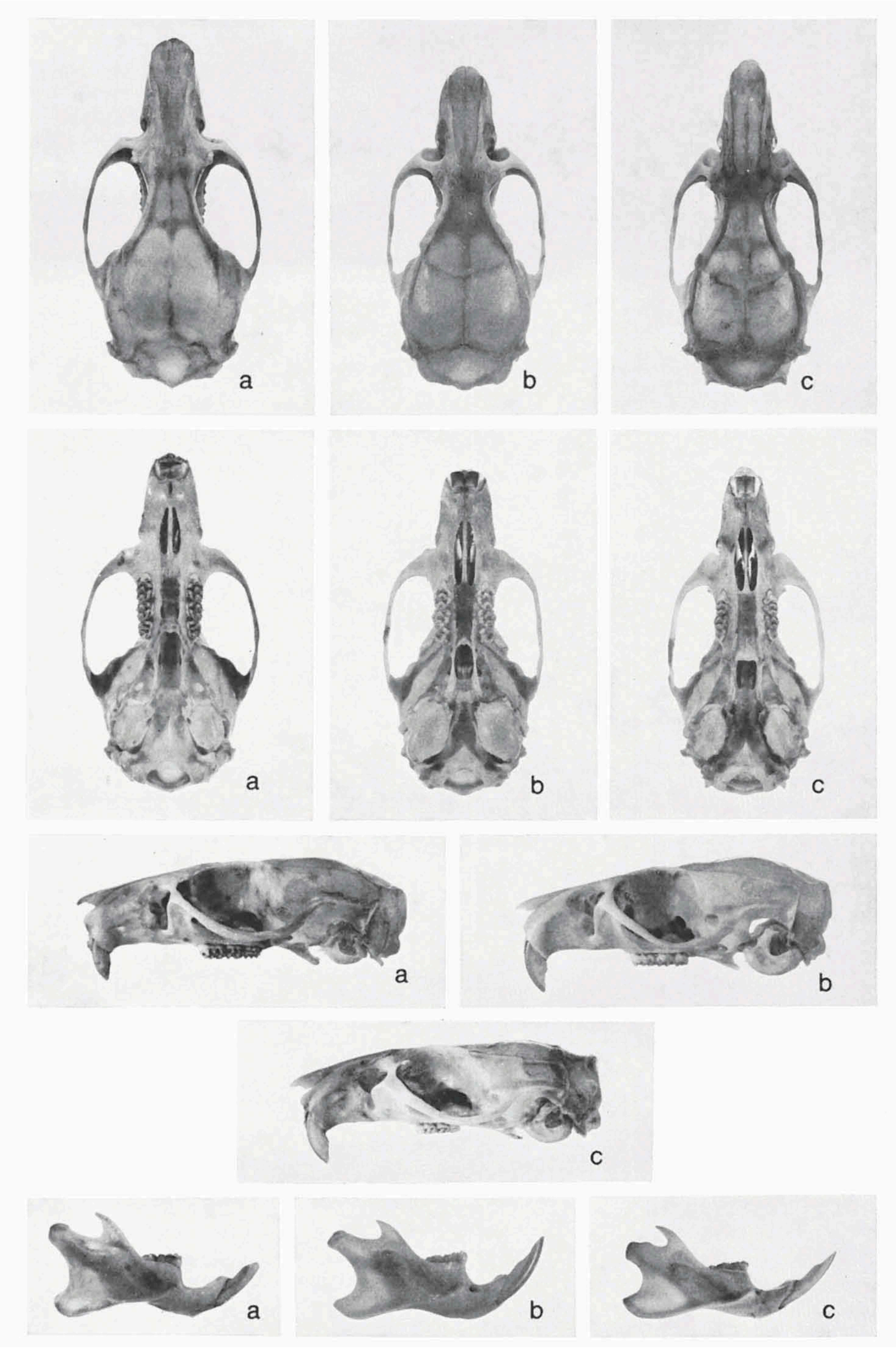
The hind foot of *Kadarsanomys sodyi*. Drawn by Ms. Fran Stiles.



Occlusal views of right upper toothrows. From left to right: *Lenothrix canus* from Malaya (AMNH 217617, length = 8.0 mm), *Kadarsanomys sodyi* from West Java (RMNH 14103, length = 7.4 mm), and *Rattus rattus diardii* from West Java (AMNH 250096, length = 7.2 mm). Rendered by Ms. Marjorie Shepatin.



Occlusal views of right lower toothrows, same individuals as on plate 2. From left to right: *L. canus* (length = 7.6 mm), *K. sodyi* (length = 7.5 mm), and *R. r. diardii* (length = 6.5 mm). Rendered by Ms. Marjorie Shepatin.



Views of crania and mandibles of adults: Fig. a. *Lenothrix canus* (AMNH 240358) from Malaya. Fig. b. *Kadarsanomys sodyi* (RMNH 14178) from West Java. Fig. c. *Rattus rattus diardii* (AMNH 250104) from West Java. Natural size. Photographed by Mr. Arthur Singer.