Bull. Natn. Sci. Mus., Ser. C (Geol.), 2 (1), March 22, 1976

Quaternary Rodents from Japan

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Notwithstanding numerous discoveries of mammalian remains made in the Japanese Islands during last hundred years, the data on fossil rodents from this territory are scarce. MATSUMOTO (1921) described and illustrated an incisor of an undetermined sciurid from the Miocene Mizunami Formation in Gifu Prefecture. This description was repeated by KAMEI and OKAZAKI (1974). All other remains of rodents from Japan mentioned in the literature and described in the present paper are of Quaternary.

In his preliminary report on the fauna of the Kuzuü Formation in Tochigi Prefecture, SHIKAMA (1937) mentioned the presence of two species of rodents, *Microtus montebelli* and *Apodemus speciosus*. In the excellent monograph on the Kuzuü fossil fauna the same author (SHIKAMA 1949) described and illustrated remains of *Petaurista* cf. *leucogenys* and undetermined teeth of other forms of Sciuridae.

In 1952 SHIKAMA, SIMAOKA (=HASEGAWA), CHINZEI and KAGAMI published the list of Holocene animal remains of Same Cave in Shiga Prefecture including rodent species such as *Microtus montebelli, Petaurista leucogenys oreas* and *Apodemus* sp.

In 1954 NAORA described fossil remains from numerous localities, mostly in the Kuzuü region in his monograph on Old Stone Age of Japan (in Japanese). A few of them contain rodents, determined as *Microtus montebelli, Petaurista leucogenys, Apodemus sylvaticus speciousus, Mus molossimus molossimus* and *Sciurus* sp. The book includes some figures of teeth and other bones of rodents.

NAKAJIMA and KUWANO (1957) and NAKAJIMA (1958) published a list of mammalian remains unearthed from the fissures of Shiriya quarry in Aomori Prefecture. Among these, the following rodent species were recognized (specific determination by N. NAORA): *Microtus montebelli, Clethrionomys rufocanus andersoni, Apodemus sylvaticus speciosus, Rattus rattus, Mus* cf. *molossimus molossimus.*

In 1958 two papers describing Pleistocene and Holocene remains from the caves of the Akiyoshi district in Yamaguchi Prefecture were published as a preliminary report by SHIKAMA, HASEGAWA and OKAFUJI and a more comprehensive paper by SHIKAMA and OKAFUJI. The sediments of many localities could be stratigraphically divided into several stages ranging from Upper Pleistocene to Holocene. The Upper Pleistocene fauna contained remains of *Microtus montebelli*. The same species, accompanied by *Apodemus speciosus, Apodemus geisha* and *Apodemus* sp. was found in layers of uppermost Pleistocene of some localities and accompanied by *Rattus* sp., *Apodemus speciosus* and *Apodemus geisha* in the horizons dated as Lower Holocene. Finally, in the fauna of the surface soil *Microtus montebelli* was found in association with *Petaurista leucogenys, Rattus norvegicus, Apodemus speciosus* and *Apodemus geisha*. No description of rodent remains was given.

In 1959 TAKAI (in SUZUKI and TAKAI, 1959) published a list of vertebrate species found in the sediments of a fissure in Ushikawa, Aichi Prefecture. The fauna contained, among others, *Microtus montebelli*. It was dated as upper part of the Middle Pleistocene and contemporaneous with the Upper Kuzuü fauna.

In 1962 TAKAI compiled a list of vertebrates from the fissure-filling sediments of Tadaki Limestone quarry at Mikkabi in Shizuoka Prefecture. The fauna was of the same age as Upper Kuzuü and contained a unique rodent, *Microtus montebelli*. In the same year SHIKAMA and HASEGAWA reported about a fissure fauna from a quarry in Shikimizu in Ehime Prefecture. The fauna, which contained remains of the giant salamander, *Megalobatrachus japonicus* (TEMMINCK), was determined broadly as Pleistocene. *Clethrionomys* sp., *Apodemus* sp. and *Sciurus* sp. were determined.

In 1963 HASEGAWA in a short paper (in Japanese) listed the fossil vertebrates from Ikumo quarry, Yamaguchi Prefecture. The presence of *Microtus montebelli, Myopus* aff. *schisticolor, Clethrionomys* sp., *Apodemus argenteus, Apodemus speciosus* and *Sciurus* sp. was reported.

In 1966 HASEGAWA published a short summary of contemporary knowledge of Quaternary smaller mammalian fauna of Japan (in Japanese). The lists of mammals, including rodents, from all previously published small mammalian localities were given in addition to the first lists of two other localities: Ando quarry in Yamaguchi Prefecture and Shiraiwa Mine inShizuoka Prefecture. He lised *Clethrionomys rufocanus andersoni, Apodemus speciosus* and *Petaurista leucogenys*, from Ando and *Microtus montebelli, Apodemus speciosus, Apodemus geisha* and *Sciurus lis* from Shiraiwa.

In 1968 HASEGAWA, YAMAUCHI and OKAFUJI reported the presence of a subrecent assemblage of bones in Ojikado Cave in northern Kyushu. *Clethrionomys* sp. and *Petaurista leucogenys* represent rodents in this fanua.

In 1972 HASEGAWA, discussing the stratigraphic position of *Palaeoloxodon naumanni* (MAKIYAMA) in Japan, gave faunal lists of some localities, where the remains of this Proboscidean were found in company with other vertebrates. The lists contain also rodent species. It is to be noted that on p. 560 of this paper *Myopus schisticolor* is erroneously given as a member of Ando quarry fauna.

A first note about rodents remains from the Ryukyu Islands was published by TAKAI and HASEGAWA (1971) who described locality at Minatogawa of Okinawa, and noted the presence of *Rattus* sp. and *Diplothrix legata*. In 1973 HASEGAWA, OTSUKA and NOHARA noted the presence of *Rattus* cf. *legata* at fossil localities of the Miyako Islands in Ryukyu.

As can be seen above, fossil rodents were found at numerous Quaternary localities in Japan, ranging from Middle Pleistocene to Holocene. Their stratigraphic position can be determined only on the basis of accompanying fauna as a rule. Only one species of fossil rodents, i.e., *Myopus schisticolor*, which does not persist in the Recent fauna, was mentioned in the previously published papers. In nearly all publications only the names of fossil rodents were given, without description, dimensions nor illustrations.

The material described in this paper is preserved mostly in the collections of the Department of Paleontology of the National Science Museum in Tokyo (NSM). Some materials from the collections of the Geological Institute of the Yokohama National University (GI Yok) were also studied. A few studied specimens from Ando quarry are in the private collection of Mr. G. OKAFUJI of Mine City (OKAFUJI coll.), and those from Ikumo in the private collection of Mr. T. HARA in Ikumo (HARA coll.). Some specimens collected by K. KOWALSKI or received in exchange from the National Science Museum in Tokyo are now in the Institute of Systematic and Experimental Zoology (ISEZ), Polish Academy of Sciences in Kraków.

As synonymies of particular species in Systematic Description of the present paper, only names used for materials studied by the authors are listed.

Acknowledgements

The accomplishment of this paper would not be possible without a grant of the Japan Society for the Promotion of Science, which permitted K. KOWALSKI to study the collections in Japan during the period from March through June 1975. The authors' deep gratitude is expressed to Prof. Tokio SHIKAMA of the Geological Institute of Yokohama National University who made accessible the fossil rodents preserved in the collections of this Institute, as well as to Mr. Goro OKAFUJI of the Omine High School of Mine City, Mr. T. HARA of Ikumo, Mr. S. ÔYAMA of Nara City, and Mr. K. OKAMOTO of Hirara City, who made accessible for study their private collections. Dr. Yoshinori IMAIZUMI and Miss Mizuko YOSHIYUKI of the National Science Museum provided us with comparative Recent materials of rodents. Mr. Krzysztof MALCZEWSKI of the Institute of Systematic and Experimental Zoology in Kraków prepared the drawings for the present paper.

Systematic Description

Order Rodentia

Family Sciuridae GRAY

Sciurus vulgaris LINNAEUS 1758

1966 *Sciurus lis* TEM. et SCH.; HASEGAWA, p. 34, from Shiraiwa.

Material. Shiraiwa mine, fissure no. 5, Shizuoka Pref., Late Pleistocene: two upper incisors, probably of the same specimen, NSM 10352, 10353.

Description. These very high and laterally flattened teeth are 1.4 mm broad, 3.2 mm high. Upper surface is of orange coloration.

Discussion. The form of the teeth suggest their appurtenance to the Sciuridae. The dimensions agree with Recent specimens of *Sciurus vulgaris lis* TEMMINCK 1845 from Honshu.

Recent *Sciurus vulgaris* is widely distributed throughout the Japanese Islands. The populations from Honshu, Shikoku and Kyushu were described as *S. vulgaris lis* TEMMINCK 1845, whereas those from Hokkaido as *S. vulgaris orientis* THOMAS 1906. The subspecific determination of fossil remains was not possible.

Fossil remains of the Red Squirrel were mentioned from Japan under the name *Sciurus* sp. from Ikumo quarry (HASEGAWA 1963, 1966) and under the name *Sciurus* sp. (SHIKAMA and HASEGAWA, 1962) or *"Sciurus lis* TEM. et SCH.?" (HASEGAWA, 1966) from Shikimizu. SHIKAMA (1949) described incisors of undetermined Sciurids from two fossil localities in the Kuzuü region.

Genus *Petaurista* LINK 1975

Petaurista leucogenys (TEMMINCK, 1827)

1966 *Petaurista leucogenys* TEM.; HASEGAWA, p. 34, from Ando.
1972 *Petaurista leucogenys* TEM.; HASEGAWA, p. 560, 566, from Ando.

Material. Ando quarry, Yamaguchi Pref., Middle Pleistocene. Evidently from one adult individual: 1-right maxilla with p^3–m^3, 2-left maxilla with p^4–m^3, 3-right mandible with p_4–m_3, 4-left mandible with m_1–m_2, 5-isolated left p_4, 6-isolated left m_3. From another, young individual: 7-isolated left m_1, 8-isolated right m_2, 9-isolated right p_4. Further, there are 10-fragments of m_3 of a very young individual (unworn), 11-fragment of incisor, 12–8 fragments of upper and lower incisors. Of the enumerated material specimens 1, 2, 3, 5, 6, 7, 10 and 11 are in NSM (unnumbered) and the remains OKAFUJI Coll. Shiraiwa mine, fissure no. 5, Shizuoka Pref., Late Pleistocene: small fragment of the lower incisor. Fissure no 4, depth 0–1–2: fragment of the lower incisor (NSM, unnumbered).

Description. Lower incisor with orange coloration on its lower surface. Its breadth 2.4–2.6 mm, height 3.4–4.0 mm. Upper incisor pigmented on its upper surface, 2.7–2.8 mm in breadth, about 3.4 mm in height. The molar pattern as in Recent specimens of *Petaurista leucogenys* from Japan.

Dimensions. See Tables 1 and 2.

Discussion. The described material does not differ morphologically from the Recent comparative material of *Petaurista leucogenys* and seems to be of the same size. *Petaurista leucogenys* is now distributed in Honshu, Shikoku and Kyushu as well as in Korea and in Southern China.

Fossil remains of *Petaurista leucogenys* were also discovered, beside of Ando and Shiraiwa, at the 1st cave in Miyata quarry, Ôkubo (Kuzuü Formation). They were described and illustrated by SHIKAMA (1949) under the name of *"Petaurista* cf. *leucogenys* TEMMINCK, 1827". According to his opinion, the specimen was larger than comparative Recent material of *Petaurista leucogenys:* the length of the lower tooth-row was 18.5 mm; evidently larger than the dimensions of the Recent populations

Table 1. Dimensions of upper teeth of *Petaurista leucogenys* (in mm)

	p^3	p^4		m^1		m^2		m^3		upper tooth-row
	L	L	W	L	W	L	W	L	W	L
Ando, no 1	1.8	—	4.2	3.7	4.7	3.7	4.5	3.6	4.0	15.0
Ando, no 2	—	3.8	4.3	3.7	4.8	3.6	4.6	—	4.0	—
Recent, Japan	1.7–2.1	3.9–4.5	4.6–5.0	3.5–3.7	4.5–4.9	3.4–3.8	4.4–4.9	3.1–3.5	3.9–4.3	14.2–15.7
(n=8)	(1.9)	(4.1)	(4.8)	(3.6)	(4.7)	(3.6)	(4.7)	(3.3)	(4.0)	(15.0)

L=lenght, W=width. For Recent materials, minimum, maximum and median values are given for each dimension.

Table 2. Dimensions of lower teeth of *Petaurista leucogenys* (in mm)

	p_4		m_1		m_2		m_3		lower tooth-row
	L	W	L	W	L	W	L	W	L
Ando, no 3	3.7	3.2	3.7	3.5	4.2	3.7	4.2	3.9	15.5
Ando, no 4	—	—	3.7	3.6	4.1	3.8	—	—	
Ando, no 5	3.6	3.1	—	—	—	—	—	—	15.4
Ando, no 6	—	—	—	—	—	—	4.2	—	
Ando, no 7	—	—	3.8	3.5	—	—	—	—	—
Ando, no 8	—	—	—	—	3.9	3.9	—	—	—
Ando, no 9	3.5	3.3	—	—	—	—	—	—	—
Recent, Japan	3.7–4.0	3.3–3.7	3.4–3.9	3.6–3.9	3.5–4.0	4.0–4.2	4.0–4.4	3.9–4.3	14.6–15.6
(n=8)	(3.85)	(3.4)	(3.6)	(3.7)	(3.8)	(4.0)	(4.2)	(4.1)	(15.2)

For explanations see Table 1.

and also of the specimen from Ando. We were unable to study the specimen from Kuzuü.

Petaurista leucogenys was found also in a few Holocene deposits in Japan: Ojikado cave in Kyushu (HASEGAWA, YAMAUCHI, and OKAFUJI 1968), Makurazinoana cave in the Akiyoshi district (SHIKAMA and OKAFUJI 1958) and in Same cave, Shiga Pref. (SHIKAMA, SHIMAOKA, CHINZEI, and KAGAMI 1952).

Genus *Pteromys* CUVIER 1800

Pteromys cf. *volans* (LINNAEUS 1758)

Material. Ando quarry, Yamaguchi Pref., Middle Pleistocene: right lower m_3 and right upper deciduous p^4, NSM 10354, 10355.

Description. The two teeth have no traces of wear and may belong to the same young individual. In their crown pattern they are identical with respective teeth of *P. volans orii* (KURODA, 1921) and *P. momonga* TEMMINCK, 1845.

Dimensions. Maximal length of m_3 is 2.5 mm, breadth 1.8 mm. Length of dp^4 1.35 mm, breadth 1.4 mm.

Discussion. Fossil m_3 from Ando was compared directly with a series of 11 skulls of *P. momonga.* The maximal length of this tooth in the Recent material is 2.6–2.8 mm ($m=2.7$ mm); our tooth is therefore evidently smaller. It was also compared with one specimen of *P. volans orii* from Hokkaido, in which maximal length of m_3 was 2.5 mm and its pattern as well as remaining dimensions were identical with those of the specimen from Ando. However, one skull (holotype) of *P. volans wulungschanensis* (MORI, 1939) from North China had m_3 2.7 mm long so that it was closer to *P. momonga* than *P. volans orii.* This form was described as a separate species, although it was listed by ELLERMAN and MORRISON-SCOTT (1951) as a subspecies of *P. volans.*

Even though the fossil material studied is very scarce, it can be concluded that the form from Ando differs from the smaller Japanese flyings quirrel in Recent Honshu and resembles the Russian flying squirrel living now in Hokkaido. It cannot also be excluded that in the Middle Pleistocene the species *P. momonga* and *P. volans* were not yet differentiated.

Pteromys sp.

Material. Shikimizu, Ehime Pref., Late Pleistocene: fragment of a juvenile mandible with incisor and alveolae of dp_4 and m_1–m_2, NSM 10356.

Description. Incisor flattened laterally, 0.9 mm broad, 1.5 mm high. Its lower surface with yellowish-orange coloration. Dp_4 have two roots, (m_1 and m_2) which are three-rooted.

Discussion. The form of alveoles excludes the appurtenance of our specimen to the Gliridae or Muridae; it suggests, together with the form of the incisor, that it belongs to sciurid. Among Japanese Sciuridae *Pteromys* is the smallest: In Recent specimens of this genus the incisor is 0.9 mm broad and 1.6 mm high. Compared with a very young skull of Recent *P. momonga* without molars, in which only the surface of dp_4 can be seen in the alveole, our specimen differs in having shorter diastema. It seems evidently that the fossil specimen belongs to the genus *Pteromys* but the specific determination is impossible. Compared to *Tamias* ILLIGER (1918) the lower incisor is striated and the diastema is much longer.

Remains of representatives of the genus *Pteromys* were not hitherto discovered in Japan. Recently two species of this genus inhabit in the Japanese Islands: *P. volans* is represented in Hokkaido by its endemic subspecies *orii*, while *P. momonga* is endemic for Honshu, Shikoku and Kyushu.

Family Glirulidae THOMAS

Genus *Glirulus* THOMAS 1906

Glirulus japonicus (SCHINZ, 1845)

Material. Ando quarry, Yamaguchi Pref., Middle Pleistocene: fragment of the upper molar with one root preserved, NSM 10357.

Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: m_1, strongly worn, NSM 10358.

Takanosu-zawa, Tochigi Pref., Kuzuü Formation, Upper Pleistocene: right m^2, NSM 10359.

Description. Crowns very low, with numerous enamel ridges and broad cingulum. Dimensions very small: m_1 1.1 mm long, 1.0 mm broad, m^2 1.1 mm long, 1.2 mm broad. Both these teeth with three roots.

Discussion. The dimensions of the teeth and their crown-pattern point to *Glirulus japonicus,* the unique representative of Gliridae in the recent fauna of Japan. *Gilrulus japonicus* is now endemic for Japan and is distributed over Honshu, Shikoku and Kyushu. Its fossil remains were never found in Japan before. It is to be noted that the genus *Glirulus* was represented by the species *Glirulus pusillus* (HELLER, 1936) in the Pliocene and Early Pleistocene of Europe (KOWALSKI, 1963).

Family Muridae MURRAY

Genus *Tokudaia* KURODA 1943

Tokudaia osimensis (ABE 1934)

(Pl. 1, figs. 1–6)

1971. *Rattus* sp., TAKAI and HASEGAWA, p. 108, from Minatogawa.

Material: Minatogawa, southern Okinawa, Late Pleistocene: 14 mandibles with m_1–m_3, 47 mandibles with m_1–m_2, 30 mandibles with m_1, 10 mandibles with m_2, 38 isolated m_1, 11 isolated m_2, 1 isolated m_3, numerous mandibles without teeth, 13 maxillae with m^1–m^3, 45 maxillae with incomplete tooth-row, 27 isolated m^1, 5 isolated m^2, 1 isolated m^3, numerous isolated incisors, NSM, unnumbered. 1 mandible with m_1–m_3, 3 mandibles with m_1–m_2, 1 mandible with m_1, 1 maxilla with m^1–m^3, 3 maxillae with m^1–m^2, 3 isolated m^1, 3 isolated m_1, 2 isolated m_2, ISEZ, no MF 1479. 137 specimens of m_1 are studied here.

Higigushiku, shell mound, Okinawa, Holocene (Jômon period): 1 skull fragment with complete upper molar-rows, NSM 10366.

Description. The molars are hypsodont. Lower molars with two roots each, m^1

and m^2 have four roots, m^3 three roots. On the anterior end of m_1 there is a central cusp, which becomes confluent with the main pair of anterior cusps in older teeth. There are two additional external cusps on m_2, not connected by a longitudinal shelf. M^2 without antero-external additional cusp. M^3 relatively very small. Medial part of lower molars, especially in younger specimens, much deeper worn than their labial and lingual sides, so that these teeth are strongly concave. Accordingly, the upper molars are convex. General tooth-pattern (see Pl. 1, figs. 1–6) resembles more *Apodemus* than *Rattus*.

Dimensions: see Table 3.

Table 3. Dimensions of lower molars of *Tokudaia osimensis* (in mm)

	m_1		m_2	m_3	m_1–m_3
	L	W	L	L	L
	min-m-max	min-m-max	min-m-max	min-m-max	min-m-max
Minatogawa (n=25)	2.4–2.6–3.0	1.5–1.8–2.0	1.7–1.9–2.0	1.0–1.4–1.6	4.9–5.6–6.0
T. o. osimensis, Amami Is., Recent (n=7)	2.2–2.4–2.5	1.5–1.6–1.7	1.6–1.7–1.8	1.3–1.4–1.5	5.1–5.3–5.5
T. o. muenninki, Okinawa, Recent (n=3)	2.6–2.7–2.8	1.6–1.8–1.9	1.9–1.9–2.0	1.3–1.5–1.8	5.7–6.0–6.4

Discussion: The fossil material is identical in its morphology with Recent populations of *Tokudaia osimensis*. As can be seen in Table 3, the dimensions are slightly larger than in the Recent material of *T. osimensis* (s.s.) from the Amami Islands and agree better with the subspecies *T. osimensis muenninki* (JOHNSON, 1946) from northern Okinawa.

Tokudaia osimensis is an endemic form of the Ryukyu Islands, living in Amami and northern Okinawa. Today it is absent in southern part of Okinawa. It was never before found as fossil.

Genus *Apodemus* KAUP 1829

Apodemus speciosus (TEMMINCK, 1845)

1937 *Apodemus speciosus* TEM.; SHIKAMA, p. 366, from Kuzuü Formaton.

1947 *Apodemus speciosus* TEM.; SHIKAMA, p. 43–44, 50, 51, 55, 57, from Kuzuü Formation.

1954 *Apodemus sylvaticus speciosus*; NAORA, p. 129, 165, 167, 182, 205, 229, 236, 238, 245, text-figures 80/1, 97, 148, 171, from many localities, mostly of Kuzuü Formation.

1958 *Apodemus sylvaticus speciosus*; NAKAJIMA, p. 38, from Shiriya.

1958 *Apodemus speciosus* (TEM.); SHIKAMA and OKAFUJI, p. 56, 69, pl. XIV (5–6), from Makurazino-ana.

1963 *Apodemus speciosus* TEM. et SCH.; HASEGAWA, p. 13, from Ikumo.

1966 *Apodemus speciosus* THO. et SCH.; HASEGAWA, p. 34, from Ikumo, Ando, Shiraiwa, Shiriya, and Kuzuü.

1972 *Apodemus speciosus* (THOMAS et SCHLEGEL); HASEGAWA, p. 563, 566, from Ando and Kuzuü.
1972 *Apodemus speciosus* TEMMINCK; HASEGAWA, p. 560, from Kuzuü.
1972 *Apodemus sylvaticus speciosus* (TEMMINCK); HASEGAWA, p. 559, 567, from Shiriya.
Material. Sumitomo quarry, Yamaguchi Pref., Middle Pleistocene: 2 mandibles with m_1–m_2, NSM, unnumbered.

Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 2 maxillae with m^1–m^3, NSM 10242 (1) and 10243; 1 maxilla with m^1–m^2, NSM 10242 (2); 6 isolated m^1, NSM 10246; 2 isolated m^2, NSM 10246; 1 isolated m^3, NSM, 9937; 2 maxillae without teeth, NSM, 10242; 7 mandibles with m_1–m_3, NSM 10224, 10225, 10226, 10229, 10231, 10232, 10240; 5 mandibles with m_1, NSM 10227, 10233, 10234, 10236, 10244; 9 isolated m_1, NSM 10246; 3 mandibles with m_2, NSM, 10228, 10230, 10235; numerous mandibles without molars. 1 mandible with m_1–m_3, 2 mandibles with m_1–m_2, 1 mandible with m_1, 1 mandible with m_2–m_3, 8 mandibles without molars, 1 isolated m_2, HARA Coll. 24 m_1 are represented in the studied material.

Ando quarry, Yamaguchi Pref., Middle Pleistocene: 31 mandibles with m_1, partly with other molars numerous isolated teeth (NSM, unnumbered). 2 mandibles with m_1–m_3, numerous isolated molars (ISEZ, no MF 1478). 596 m_1 are also in the studied material.

Shiraiwa mine, Shizuoka Pref., Late Pleisotocene. Fissure no 5: 1 maxilla with m^1–m^2, 1 maxilla with m^2, 2 maxillae without teeth, NSM 10296; 2 isolated m^1, NSM 10297; 4 mandibles with m_1–m_3, NSM 8099, 8116, 8134, 10305; 19 mandibles with m_1–m_2, NSM 8095, 8096, 8100, 8103–8105, 8115, 8123–8128, 8135–8138, 8164, 10284; 12 mandibles with m_1, NSM 8093, 8101, 8102, 8139, 8153, 10281–10283, 10285, 10286, 10290, 10291; 1 mandible with m_2, NSM 8130; 6 isolated m_1 NSM 8094, 10297; numerous mandibles without molars. 41 m_1 were studied. Fissure no 4, level 0–1–2: 2 mandibles with m_1, NSM 10341 and 10342; 1 mandible with m_3, NSM 10343. Fissure no 4, level 4–5: 1 mandible with m_1–m_2, NSM 10346; 2 mandibles with m_1, NSM 10347 and 10348; 1 mandible with m_1, NSM 10344. Fissure no 4: 2 mandibles with m_1–m_3, NSM 10219 and 10221; 7 mandibles with m_1–m_2, NSM 10211–10213, 10218, 10220, 10222, 10223; 3 mandibles with m_1, NSM, 10214–10216; 1 isolated m, NSM 10223. Fissure no 2: 1 maxilla with m^2, NSM 10319; 1 maxilla with m^3, NSM 10320; 5 mandibles with m_1–m_3, NSM 10321, 10324, 10325, 10330, 10331; 6 mandibles with m_1–m_2, NSM 10323, 10326, 10333, 10334, 10336; 1 mandible with m_2–m_3, NSM 10327; 1 mandible with m_2, NSM 10335; 1 mandible with m_3, NSM 10332. "Chiroptera-bed": 1 maxilla with m^1–m^3, NSM 10270; 2 maxillae with m^1–m^2, NSM 10271 and 10273; 1 maxilla with m^2, NSM 10276; 4 fragmentary maxillae without molars, NSM 10276; 3 mandibles with m_1–m_3, NSM 10272, 10275, 10276; 1 mandible with m_1–m_2, NSM 10274; 1 mandible with m_2, NSM 10278; 1 isolated m_2, NSM 10276. Fissure no 3: 2 fragments of mandibles without molar, NSM 10340.

Shiriya quarry, Aomori Pref., Late Pleistocene: 3 mandibles with m_1–m_3, NSM 10302, 10307, 10308; 2 mandibles with m_1, NSM 10303 and 10304; 3 isolated m_2, NSM 10309.

Takanosu-zawa cave, Kamitada, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 3 mandibles with m_1–m_3, 1 mandible with m_1–m_2, 1 mandible with m_3, numerous isolated molars, NSM, unnumbered 2 mandibles without molars, NSM 10316 and 10317. 16 m_1 were studied.

Tuidi, Kuzuü Formation, Tochigi Pref., Late Pleisocene: 1 mandible with m_1–m_3, 1 mandible without molars, GI Yok. unnumbered.

Miyata, 1st cave (=Okubo, 1st cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 5 mandibles with m_1–m_3, 7 mandibles with m_1–m_2, 4 mandibles with m_1, 1 mandible with m_2, GI Yok, unnumbered.

Miyata, 2nd cave (=Okubo, 2nd cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 2 mandibles with m_1–m_3, 3 mandibles with m_1–m_2, 1 mandible with m_2, a few mandibles without molars, IG Yok, unnumbered.

Okada quarry, Izuruhara, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_2, 1 mandible with m_3, IG Yok. unnumbered.

Aizawa (=Yoshizawa), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with

m_1–m_3, IG Yok, unnumbered.

Yoshizawa Sekkai Co, quarry no 8, Ôgano, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 3 mandibles with m_1–m_3, NSM, unnumbered.

Yoshizawa Sekkai Co, quarry no 10, Ôgano, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 2 mandibles with m_1–m_3, 1 mandible with m_1, NSM, unnumbered.

Ushikawa, Aichi Pref., Late Pleistocene: 1 isolated m^1, 1 isolated m_1, 1 isolated m_2, NSM, unnumbered.

Shikimizu quarry, Kanogawa, Ehime Pref., Late Pleistocene: 1 mandible with m_1–m_2, 1 mandible with m_1, IG Yok, unnumbered, labelled "*Apodemus geisha*".

Makurazino-ana, Akiyoshi, Yamaguchi Pref., Holocene: 1 mandible with m_1–m_3, 1 mandible without molars, 2 isolated m^1, 1 isolated m_1, NSM, unnumbered.

Description. In all Quaternary localities in Japan with adequate material of small mammals there were two species of *Apodemus* present. They differ clearly in size and in some other characters from one another and therefore can be easily distinguished. The larger species agrees with Recent *Apodemus speciosus* in all the details of its dental morphology and in the dimensions. M_1 has a well developed row of internal cusps, which form a shelf in old-aged specimens. All of the upper molars are three-rooted. Upper m^3 usually lacks the accessory antero-external cusp, but in two specimens from Shiraiwa this cusp is present though small.

Dimensions: see Tables 4 and 5.

Discussion: The crown pattern and the dimensions of teeth are very stable and no differences could be found among the samples studied here as well as between the fossil material and the Recent populations of *A. speciosus*. In Recent fauna this species is common not only all over the Japanese Islands but also in the eastern and central Asiatic continent.

Apodemus argenteus (TEMMINCK, 1845)

1958 *Apodemus geisha* (THOMAS); SHIKAMA and OKAFUJI, p. 56, 58, 68, 69, from Makurazino-ana.
1958 *Mus molossimus molossimus* TEMMINCK; NAKAJIMA, p. 38, from Shiriya.
1963 *Apodemus geisha* (THOMAS); HASEGAWA, p. 13, from Ikumo.
1966 *Apodemus geisha* (THO.); HASEGAWA, p. 34, from Ikumo, Shiraiwa and Shiriya.
1972 *Apodemus argenteus* (TEMMINCK); HASEGAWA, p. 560, from Shiriya and Miyata, 1st cave.

Material. Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 1 maxilla with m^1–m^3, NSM, 10247; 1 maxilla with m^2–m^3, NSM, unnumbered; 5 mandibles with m_1–m_3, NSM 10249, 10253, 10259–10261; 5 mandibles with m_1–m_2, NSM 10245, 10250, 10252, 10254, 10257; 2 mandibles with m_1, NSM 10251 and 10255; 1 isolated m_1, NSM 10245; 4 mandibles with m_2–m_3 or m_2 only, NSM 10256, 10262, 10263, 10265; 1 mandible with m_1–m_3, 4 mandibles with m_1–m_2, 1 mandible with m_1, 1 mandible without molars, HARA Coll., 19 m_1 are studied.

Ando quarry, Yamaguchi Pref., Middle Pleistocene: numerous mandibles and isolated upper and lower molars, NSM, unnumbered. 1 mandible with m_1–m_2, 1 mandible with m_1, several isolated molars, ISEZ, no MF 1477. 353 m_1 were studied.

Shiraiwa mine, Shizuoka Pref., Late Pleistocene. Fissure no 5: 2 mandibles with m_1–m_3, NSM 7881 and 7888, 5 mandibles with m_1–m_2, NSM 7867, 7880, 7887, 7891, 7908, 7 mandibles with m_1, NSM 7866, 7868, 7886, 7896–7898, 7905, 8 mandibles with m_2, NSM 7863–7865, 7870, 7882, 7883, 7890, 7906; 14 m_1 were studied. Fissure no 4, layer 4–5: 1 mandible with m_1–m_2, NSM 10350. "Chiroptera bed": 3 fragments of maxillae, two with m^1–m^3, one with m^1–m^2, NSM 10267; 2 mandibles,

Table 4. Dimensions of upper molars of *Apodemus speciosus* (in mm)

	m^1				m^2		m^3		m^1–m^3	
	L		W		L		L		L	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	9	2.0–2.1–2.3	9	1.3–1.4–1.4	5	1.2–1.4–1.5	3	1.0–1.1–1.2	2	4.1–4.15–4.2
Shiraiwa, fissure 5	3	1.9–2.1–2.3	2	1.3–1.35–1.4	2	1.4–1.45–1.5	—	—	—	—
Shiraiwa, fissure 2	—	—	—	—	1	1.5	1	1.0	—	—
Shiraiwa, "*Chiroptera* bed"	2	2.0–2.1–2.2	2	1.3–1.35–1.4	3	1.4–1.4–1.4	1	1.0	1	4.3
Ushikawa	1	1.9	1	1.4	—	—	—	—	—	—
Recent, Tsushima	8	2.0–2.0–2.2	8	1.3–1.4–1.5	8	1.3–1.4–1.5	8	0.9–1.0–1.1	8	4.1–4.2–4.3

Table 5. Dimensions of lower molars of *Apodemus speciosus* (in mm)

	m_1				m_2		m_3		m_1–m_3	
	L		W		L		L		L	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Sumitomo	2	2.0–2.0–2.0	2	1.2–1.2–1.2	2	1.4–1.45–1.5	—	—	—	—
Ikumo	20	1.9.2–0.2.1	20	1.1–1.2–1.3	10	1.2–1.3–1.4	9	0.9–1.0–1.2	7	4.0–4.2–4.4
Ando	5	1.9–2.0–2.0	5	1.1–1.2–1.2	5	1.4–1.4–1.4	5	1.1–1.1–1.1	5	4.2–4.3–4.4
Shiraiwa, fissure 5	40	1.9–2.0–2.1	25	1.2–1.2–1.3	25	1.3–1.4–1.5	4	1.0–1.1–1.2	3	4.1–4.3–4.6
Shiraiwa, fissure 4	17	1.9–2.0–2.1	17	1.1–1.2–1.3	10	1.3–1.4–1.5	3	1.0–1.0–1.1	2	4.2–4.3–4.4
Shiraiwa, fissure 2	10	1.9–2.0–2.0	10	1.1–1.2–1.3	14	1.3–1.4–1.5	7	0.9–1.0–1–1	5	4.0–4.2–4.3
Shiraiwa, "*Chiroptera* bed"	3	1.9–2.0–2.0	3	1.1–1.2–1.3	4	1.3–1.4–1.4	3	1.0–1.1–1.2	2	4.0–4.2–4.4
Shiriya	4	2.0–2.0–2.0	4	1.2–1.3–1.4	4	1.4–1.4–1.5	2	1.0–1.05–1.1	2	4.2–4.2–4.2
Takanosu-zawa	4	1.9–1.95–2.0	4	1.2–1.3–1.3	6	1.4–1.4–1.4	4	1.1–1.1–1.1	2	4.3–4.4–4.5
Tuidi	1	2.1	—	—	1	1.3	1	1.1	1	4.3
Miyata, 1st Cave	14	1.8–2.0–2.1	—	—	13	1.3–1.4–1.5	5	1.0–1.1–1.2	3	4.2–4.4–4.6
Miyata, 2nd Cave	3	2.0–2.1–2.1	—	—	6	1.3–1.4–1.5	2	1.0–1.05–1.1	—	—
Okada	—	—	—	—	1	1.3	1	1.2	—	—
Aizawa	1	2.1	—	—	1	1.5	1	1.2	1	4.6
Yoshizawa-Sekkai, no 8	3	1.9–1.9–2.0	3	1.2–1.2–1.3	3	1.4–1.4–1.4	3	1.1–1.1–1.1	3	4.3–4.3–4.4
Yoshizawa-Sekkai, no 10	3	1.8–1.9–2.0	3	1.1–1.2–1.2	2	1.4–1.4–1.4	1	1.1	1	4.2
Ushikawa	1	2.0	1	1.2	1	1.4	—	—	—	—
Shikimizu	2	1.9–1.95–2.0	2	1.2–1.2–1.2	1	1.3	—	—	—	—
Makurazino-ana	2	2.0–2.0–2.0	1	1.3	1	1.4	1	1.1	1	4.5
Recent, Tsushima	7	1.9–2.0–2.2	7	1.2–1.2–1.4	7	1.4–1.5–1.6	7	1.0–1.0–1.1	7	4.1–4.3–4.4

Table 6. Dimensions of upper molars of *Apodemus argenteus* (in mm)

	m^1				m^2		m^3		m^1–m^3	
	L		W		L		L		L	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	1	1.8	1	1.0	2	1.0–1.05–1.1	2	0.7–0.7–0.7	1	3.4
Ando	21	1.6–1.8–1.9	—	—	6	1.1–1.1–1.2	—	—	—	—
Shiraiwa, "*Chiroptera* bed"	2	1.7–1.8–1.9	2	1.1–1.1–1.1	3	1.0–1.1–1.2	3	0.7–0.8–0.8	3	3.2–3.3–3.5
Miyata, 2nd Cave	—	—	—	—	1	1.1	—	—	—	—
Recent, Mt. Zao, Japan	10	1.7–1.85–1.9	10	1.1–1.1–1.2	10	1.0–1.1–1.3	10	0.8–0.9–0.9	10	3.4–3.6–3.7

Table 7. Dimensions of lower molars of *Apodemus argenteus* (in mm)

	m_1				m_2		m_3		m_1–m_3	
	L		W		L		L		L	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	19	1.4–1.6–1.8	19	0.9–1.0–1.1	20	1.0–1.1–1.3	10	0.7–0.8–1.0	6	3.2–3.4–3.5
Ando	18	1.5–1.6–1.8	—	—	—	—	—	—	—	—
Shiraiwa, fissure 5	12	1.5–1.6–1.8	12	0.9–1.0–1.0	15	1.0–1.0–1.2	2	0.9–0.9–0.9	2	3.5–3.6–3.7
Shiraiwa, fissure 4	1	1.7	1	1.1	1	1.3	—	—	—	—
Shiraiwa, "*Chiroptera* bed"	—	—	—	—	1	1.1	—	—	—	—
Shiriya	1	1.6	1	1.0	1	1.1	2	0.7–0.75–0.8	—	—
Miyata, 1st Cave	1	1.5	—	—	1	1.1	—	—	—	—
Miyata, 2nd Cave	4	1.5–1.6–1.7	—	—	4	1.0–1.1–1.1	4	0.8–0.9–0.9	3	3.2–3.4–3.6
Okada	1	1.7	—	—	1	1.1	1	0.9	1	3.6
Aizawa	1	1.7	—	—	1	1.2	1	0.9	1	3.6
Ushikawa	1	1.7	1	1.0	—	—	—	—	—	—
Shikimizu	3	1.7–1.7–1.7	—	—	5	1.1–1.2–1.1	1	1.0	1	3.7
Makurazino-ana	2	1.6–1.65–1.7	2	1.0–1.05–1.1	1	1.2	—	—	—	—
Recent, Mt. Zao, Japan	9	1.6–1.7–1.8	9	0.9–1.0–1.1	9	1.1–1.2–1.3	9	0.8–0.9.1.0	9	3.4–3.7–3–8

one with m_2–m_3, another with m_2, NSM 10269.

Shiriya quarry, Aomori Pref., Late Pleistocene: 1 isolated m_1, NSM 10301, 1 mandible with m_2–m_3, NSM 10300; 1 mandible with m_3, NSM 10299.

Takanosu-zawa cave, Kamitada, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 2 mandibles with m_1, 1 mandible without molars, NSM, unnumbered.

Miyata, 1st cave (=Okubo, 1st cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_2, 1 mandible without molars, IG Yok., unnumbered, labelled "*Apodemus speciosus*".

Miyata, 2nd cave (=Okubo, 2nd cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 maxilla with m^2, 4 mandibles with m_1–m_3, 1 mandible with m_1, IG Yok., unnumbered, labelled "*Apodemus speciosus*".

Okada quarry, Izuruhara, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_3, IG Yok., unnumbered.

Aizawa (=Yoshizawa), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_3, IG Yok., unnumbered.

Ushikawa, Aichi Pref., Late Pleistocene: 1 mandible with m_1, NMS, unnumbered.

Shikimizu quarry, Kanogawa, Ehime Pref., Late Pleistocene: 1 mandible with m_1–m_3, 4 mandibles with m_1–m_2, 3 mandibles without molars, IG Yok., unnumbered.

Makurazino-ana, Akiyoshi, Yamaguchi Pref., Holocene: 1 mandible with m_1–m_2, 1 mandible with m_1, NSM, unnumbered.

Description. The tooth-pattern does not differ from that in Recent population of *A. argenteus* from Japan. In m_1 the row of internal accessory cusps is well developed. In m^2 there is usually a well developed antero-external cusp. On m_1 sometimes a minuscule third root is present and in m_3 the anterior root is sometimes divided into two. M^1 and m^2 are four-rooted.

Dimensions. See Tables 6 and 7.

Discussion. The fossil material is identical with Recent *A. argenteus* from Japan. This species is now present in major part of the Japanese Islands and is endemic for Japan. According to ELLERMANN and MORRISON-SCOTT *A. argenteus* is a subspecies of *Apodemus sylvaticus* (LINNAEUS, 1758). *A. sylvaticus,* now widely distributed in temperate Eurasia, was found in fossil assemblage of Choukoutien loc. 1 in China (YOUNG, 1934).

Genus *Rattus* FISCHER 1803

Rattus norvegicus (BERKENHOUT, 1769)

1958 *Rattus* aff. *R. rattus* LINNÉ; NAKAJIMA, p. 38.
1966 *Rattus* sp.; HASEGAWA, p. 34.
1972 *Rattus rattus* LINNAEUS; HASEGAWA, p. 559, 560.

Material. Shiriya quarry, Aomori Pref., Late Pleistocene: 1 fragment of maxilla with m^1, NSM 9841, 2 mandibles with m_1–m_3, NSM 9839, 9840.

Description. M^1 with five roots; its crown without antero-external cusp, so that the anterior lamina is asymmetrical. Lower incisor orange on external surface. On m_1 there is only one, posterior, external cusp. M_2 with two additional external cusps. All specimens from Shiriya represent probably one individual being in the same stage of wear.

Dimensions. M^1 is 3.2 mm long, 2.3 mm wide. In the two mandibles the dimensions of molars are identical: m_1 L 2.9 mm, m_1 W 1.8 mm, m_2 L 2.1 mm, m_3 L 1.8 mm, length of m_1–m_3 6.6 mm.

Discussion. The absence of antero-external cusp on m^1 in the Shiriya specimens points out that it belongs to *Rattus norvegicus*. In about 20 specimens of *R. norvegicus* from Japan this cusp is always lacking, whereas it was present in all specimen of similar series of *Rattus rattus*. The described material was mentioned by NAKAJIMA (1958) and HASEGAWA (1966, 1972) as *Rattus rattus*, resp. *Rattus* sp. *Rattus norvegicus* is now widely distributed in Japan, mostly as synanthropic form, but also living outside human settlements.

Rattus norvegicus (BERKENHOUT, 1769) or *R. rattus* (LINNAEUS, 1758)

1958 *Rattus norvegicus* ERXLEBEN; SHIKAMA and OKAFUJI, p. 58, 68.

Material. Makurazino-ana, Akiyoshi, Yamaguchi Pref., Holocene: fragments of maxilla, 2 upper incisors, 1 lower incisor, 3 m_1, NSM, unnumbered.

Description. Incisors with orange coloration on their external surfaces. M_1 with four roots, on its crown only the posterior external cusp is developed.

Dimensions. The three m_1 are 2.9, 2.9 and 3.1 mm long, 2.0, 1.9 and 1.9 mm wide.

Discussion. The present material does not permit exact specific determination. The first lower molars have the structure typical for both *R. rattus* and *R. norvegicus* and the upper teeth, which are specifically different between these two forms, are lacking.

Rattus sp.

1963 *Rattus* cf. *R. rattus* L.; HASEGAWA, p. 13.

1966 *Rattus* aff. *R. rattus* L.; HASEGAWA, p. 34.

Material. Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 1 isolated m^2, NSM 9838, 1 mandible with m_1–m_3, NSM 9837.

Description. The two specimens probably belong to a single young individual. The molar pattern is same as in *R. norvegicus* or *R. rattus*, but on m_1 there are two additional external cusps, whereas in the Recent Japanese specimens of the above-mentioned two species there is nearly always only one posterio-external cusp. The teeth are also broader than in the Recent species. M^2 has four roots; m_2 and m_3 three roots each.

Dimensions. M^2 is 2.3 mm long, 2.0 mm wide. The mandibular tooth-row is 6.2 mm long, m_1 2.9 mm long, 1.9 mm wide, m_2 2.1 mm long, m_3 1.5 mm long.

Discussion. The specimens from Ikumo undoubtedly belong to the genus *Rattus* but seem to be different from its two Recent Japanese species. In a few Recent specimens of *R. rattus,* however, the second additional cusp on m_1 is present, so that the possibility of the fossil specimens from Ikumo belonging to this species cannot be excluded.

Genus *Diplothrix* THOMAS, 1905

Diplothrix legata (THOMAS, 1905)

1971. *Diplothrix legata* (THOMAS); TAKAI and HASEGAWA, p. 108, from Minatogawa.

1973. *Rattus* cf. *R. legata* (THOMAS); HASEGAWA, OTSUKA and NOHARA p. 47 pl. 6, fig. 6–14, from Miyako Is.

Material. Minatogawa site, Okinawa, Upper Pleistocene: 4 upper incisors, 1 mandible with m_1–m_3, 1 isolated m_1, 1 fragmentary mandible with m_3, 1 lower incisor, bones of the postcranial skeleton, NSM, unnumbered.

Tanabaru-cave, Onogoshi, Hirara City Miyako Is.: 1 skull fragment with upper incisor, NSM 15108; 1 upper incisor, NSM 15107; 1 mandible with m_1–m_3, NSM 15102; 1 fragment of mandible without molars, NSM 15103; 1 mandibular fragment with m_1, NSM 15111; 1 fragmentary isolated m_2, NSM 15112; 1 lower incisor, NSM 15109; bones of postcranial skeleton.

Amagawa-do, Tomori, Miyako Is.: 1 mandible with m_1–m_3.

Description. Molars moderately hypsodont. In unworn m_1 the cuspidate structure is clearly visible. On m_1, there are two additional external cusps much lower than the main cusp. In older specimens the cusps form transversal ridges, but the original cuspidate structure remains visible.

Dimensions: see Table 8.

Table 8. Dimensions of lower teeth of *Diplothrix legata* (in mm)

	m_1		m_2	m_3	m_1–m_3
	L	W	L	L	L
Minatogawa, no 1	4.7	3.0	3.1	—	±11
no 2	4.6	2.8	—	—	—
no 3	—	—	—	2.4	—
Tanabaru, no 15102	4.5	2.7	3.2	2.2	9.6
no 15111	4.5	2.8	—	—	—
Amagawa-do, no 15099	4.3	2.6	3.0	2.5	9.6
Recent material (n=4)	4.2–4.3–4.4	2.7–2.9–3.0	2.9–3.0–3.1	2.2–2.5–2.9	9.4–9.7–10.1

Discussion. The fossil material agrees with the Recent *Diplothrix legata* from Ryukyu in morphology and dimensions. Only another form, which should be taken in consideration, is *Bandicota indica* (BECHSTEIN, 1800), widely distributed in SE Asia including Taiwan. We could compare our fossil material with Recent specimens of this species from Cambodia and Taiwan. They are clearly different from the fossil specimens studied. In *Bandicota* the lower incisors reach near the end of processes articularis, while in our material and in Recent *Diplothrix* they are much shorter. In *Bandicota* the cuspidate structure of the molars is much more modified and there is only external accessory cusp on m_1. *Diplothrix legata* is endemic for the Ryukyu Islands. According to ELLERMAN and MORRISON-SCOTT (1951) *Diplothrix* is a subgenus of Rattus.

Family Arvicolidae GRAY

Genus *Myopus* MILLER 1910

Myopus schisticolor (LILLJEBORG, 1844)

(Fig. 1, 1-2)

1963 *Myopus* aff. *schisticolor* LILLJEBORG; HASEGAWA, p. 13.
1966 *Myopus* aff. *schisticolor* LILLJEBORG; HASEGAWA, p. 34.

Material. Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 1 fragment of skull (palatinum) with m^1–m^3 of both sides, NSM, 9829; 4 mandibles with m_1–m_2, NSM 8930–9833; isolated molars: 2 m_1, 5 m_2, 2 m_3, 2 m^1, 1 m^2, 1 m^3, NSM 9834, 9835, 9836, 9855, 9927, 9934, 9938. 1 mandible with m_1–m_2, HARA Coll. 1 isolated m_1, ISEZ, no MF 598; 1 isolated m^3, ISEZ, no MF 1475.

Description. Width of the palatinum at the anterior end of m^1 is 2.9 mm, at the posterior end of m^2 3.2 mm. Posterior border of the palatinum with short medial process ("nasal spine"). Lower incisor is short, situated on its whole length lingually to the molars and terminating in the horizontal ramus of the mandible below the end of m_2 or slightly more backwards. No trace of pigmentation is preserved on the incisor. The breadth of the lower incisor at the beginning of its free end is 0.9–1.0 mm.

Molars are rootless, evergrowing, with abundant crown-cementum in re-entrant angles. The enamel-band is thin with interruptions at the top of salient angles. M^1 with anterior and posterior loops and three intermediate, closed triangles; the exterior triangle much larger than the two interior ones. M^2 with two closed triangles. In M^3 the triangles are confluent and the crown consists of four transversal loops. The connection between the second loop and third one is situated at about 1/3 of the width of the tooth so that the inner re-entrant angle is about twice as deep as the external one.

M_1 consists of the anterior loop, pointed in front and situated obliquely to the long axis of the tooth, of three closed triangles and of posterior loop. The external triangle is small and truncate, while the internal ones are more pointed and large. Small and rounded anterior triangle of M_2 is situated externally. In m_3 the second (external) triangle is always present, but it is small and rounded.

Dimensions. In the unique preserved fragment of skull (NSM 9829) the dimensions of molars are as follows: m^1–m^3 L 7.0 mm, m^1 L 2.6, W 1.2, m^2 L 2.1, m^3 L 2.2. The dimensions of molars preserved in mandibles are as follows (Table 9). The lengths of isolated molars are: m^1 2.9, m^2 2.1, m^3 2.1, 2.2, m_1 3.1, 3.1, 3.1, m_2 1.9, 2.0, 2.0, 2.1, 2.1, m_3 1.8, 1.8.

Table 9. Dimensions of molars of *Myopus schisticolor* from Ikumo (preserved in mandibles)

	m_1–m_3	m_1		m_2	m_3
	L	L	W	L	L
NSM no 9830	7.0	2.9	1.2	2.2	2.0
NSM no 9831	—	3.4	1.3	2.3	—
NSM no 9832	7.1	2.9	1.3	2.0	1.9
NSM no 9833	—	3.0	1.2	2.1	—
HARA Coll.	—	2.8	1.4	2.1	—

Discussion. According to the position of the lower incisor and the presence of the crown-cementum, only three genera of Arvicolidae must be down for discussion: *Synaptomys* BAIRD 1858, *Myopus* MILLER 1910 and *Lemmus* LINK 1795. *Synaptomys* is now limited in distribution to North America, but its fossil remains were recently discovered also in northern Eurasia. The molars of *Synaptomys* are more elongate than in our specimens from Ikumo and the second and third transversal loops of m^3

in the former are connected near the internal (lingual) border of this tooth so that there is only one internal re-entrant angle, whereas in the latter there are the two

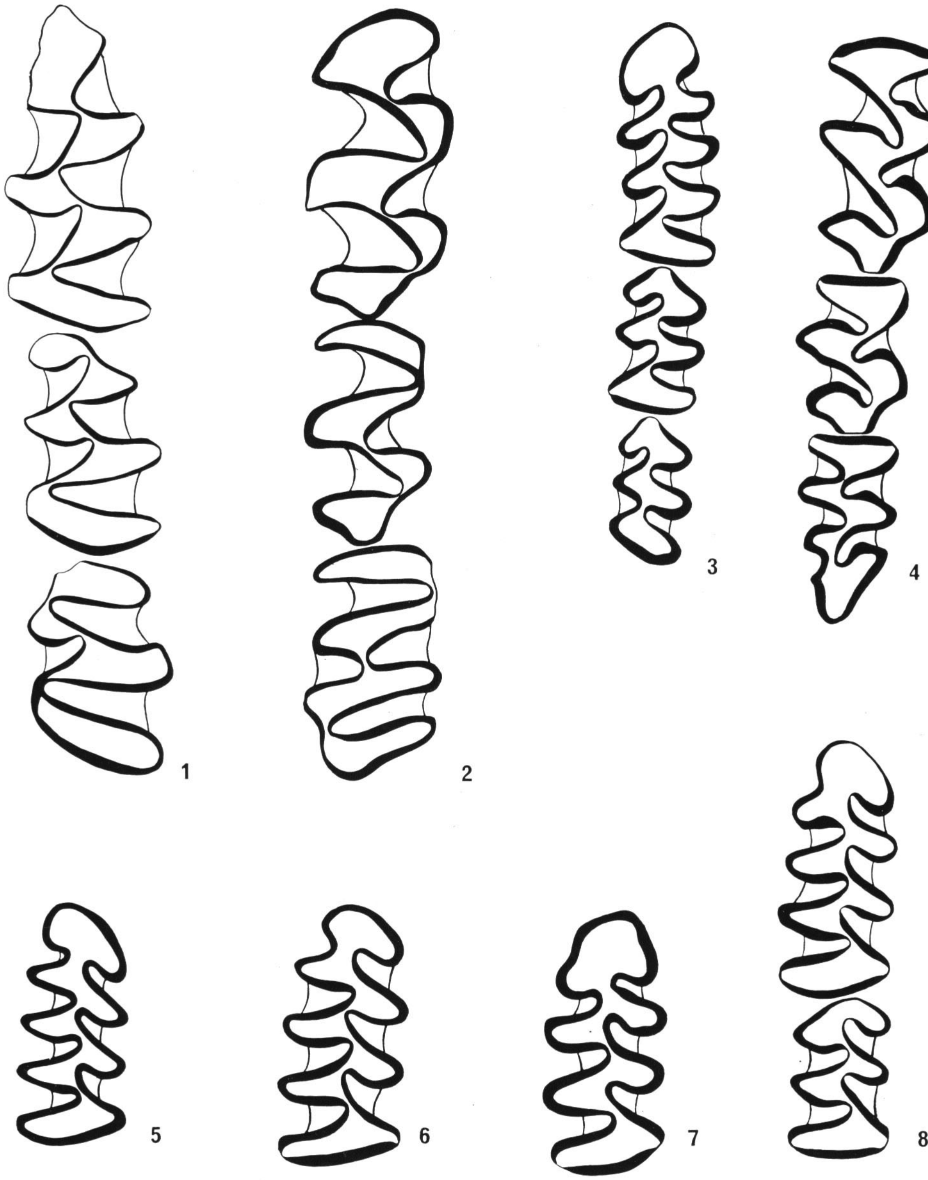

Fig. 1. 1–2 *Myopus schisticolor*, Ikumo. 1: m_1–m_3, NSM 9830, L=7.0 mm; 2: m^1–m^3, NSM 9829, L=7.0 mm. 3–7 *Clethrionomys rufocanus*, Ikumo. 3: m_1–m_3, NSM 9856, L=4.9 mm; 4: m^1–m^3, NSM 9844, L=5.0 mm; 5: m_1, NSM 9932–1, L=2.3 mm; 6: m_1, NSM 9932–2, L=2.5 mm; 7: m_1, NSM 9920, L=2.5 mm. 8 *Clethrionomys rufocanus*, Ando, m_1–m_2, NSM 10195, L=3.9 mm.

angles. The molars of *Lemmus* and *Myopus* are extremely similar. However, some characters in the specimens from Ikumo point that they may belong to the genus *Myopus*. The lower incisor ends below or slightly behind the posterior border of m_2, whereas in *Lemmus* it ends below the middle of m_3. The dimensions of molars are usually smaller than in *Lemmus*, m^3 is shorter the relation to m^1 and m^2, and its elements are more serrated. All these indicate the generic characters of *Myopus*, in addition to the sylvan character of the fauna from Ikumo.

Only one species is now recognized in this genus, i.e., *Myopus schisticolor* (LILLJEBORG, 1844). It is at present distributed in the subarctic zone of coniferous forests (taiga) and in the northern part of mixed forest zone from Scandinavia to Kamtschatka. In East Asia it is known in Sakhalin, in northern Mongolia and Northeast China. Its fossil remains are known only from the Late Pleistocene of Siberia. Some of European fossils determined as *Lemmus* sp. may also belong here.

Genus *Clethrionomys* TILESIUS 1850

Clethrionomys rufocanus SUNDEVALL, 1846

(Figs. 1, 3–8; 2; 3, 1–6)

1963 *Clethrionomys* sp.; HASEGAWA, p. 13, from Ikumo.
1966 *Clethrionomys* sp.; HASEGAWA, p. 34, from Ikumo.
1966 *Clethrionomys rufocanus andersoni* (THO.); HASEGAWA, p. 34, from Ando.
1972 *Clethrionomys* sp.; HASEGAWA, p. 560, from Ando.
1972 *Clethrionomys rufocanus andersoni* (THOMAS); HASEGAWA, p. 560, 566, from Ando.

Material. Sumitomo quarry, Yamaguchi Pref., Middle Pleistocene: 2 fragmentary molars, NSM, unnumbered.

Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 11 fragments of skulls with m^1–m^3, NSM 9843, 9844, 9847, 9850, 9854, 9958, 9959, 9961; 6 fragments of skulls with m^1–m^2, NSM 9851, 9853, 9902, 9904, 9942, 9958; 1 fragment of skul with m^1, NSM 9903; 16 mandibles with m_1–m_3, NSM 9856, 9860, 9866, 9881, 9882, 9884, 9885, 9887–9889, 9892, 9900, 9905, 9906, 9955, 9956; 17 mandibles with m_1–m_2, NSM 9862, 9865, 9869, 9870–9874, 9879, 9880, 9890, 9891, 9893, 9894, 9897, 9954, 9957; 57 m_1, isolated or in mandibular fragments, NSM 9852, 9859, 9877, 9895, 9908, 9910, 9911, 9912, 9916, 9917, 9920, 9922, 9925, 9931, 9932 9940; 21 isolated m^3, NSM 9921, 9929; numerous isolated m^1, m^2, m_2 and m_3, NSM 9855, 9907, 9909, 9913, 9914, 9918, 9919, 9923, 9924, 9926, 9927, 9936, 9941. A few mandibles without teeth and isolated incisors. 1 fragment of skull with m^1–m^3, 1 mandible with m_1–m_3, 5 isolated m_1, 3 isolated m^3, ISEZ, no MF 1474. 1 fragment of skull with m^1–m^3, 3 mandibles with m_1–m_3, 3 mandibles with m_1–m_2, 12 isolated m_1, 2 isolated m^3, numerous isolated m^1, m^2, m_2 and m_3, HARA Coll. 115 m_1 are studied.

Ando quarry, Yamaguchi Pref., Middle Pleistocene: 4 mandibles with m_1–m_3, NSM 10193–10195, 10202; 2 m_1, 15 m^3 and numerous isolated m^1, m^2, m_2 and m_3, NSM 10205, 10206.

Shiraiwa mine, Shizuoka Pref., Late Pleistocene: 1 m_2, NSM 10119.

Shiriya quarry, Aomori Pref., Late Pleistocene: 3 isolated m_1, 2 isolated m_2, NSM, unnumbered.

Miyata, 1st cave (=Okubo, 1st cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_3, 1 isolated m_1, 2 isolated m_2, 1 isolated m_3, IG Yok. labelled "*Microtus montebelli*".

Miyata, 2nd cave (=Okubo, 2nd cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_3, 1 mandible with m_1–m_2, 1 mandible with m_1, 1 isolated m_1, IG Yok., labelled "*Microtus montebelli*".

Description. Molars hypsodont, but pulp cavities close in early stage of growth. Re-entrant angles filled with crown-cementum, which is never very abundant. Enamel differentiated. In older specimens enamel-bands of lower molars are interrupted on both sides of the posterior loops and on the top of the anterior loop. In upper molars interruptions appear on both sides of anterior loops and on the posterior end of m^1 and m^2. The enamel-band is thick, especially in older specimens, and the salient angles are rounded.

M^1 with five dentine-fields. This tooth developed two roots, but the anterior one is composed of two parts divided by a groove; namely, the larger anterior and smaller interior parts. M^2 with four closed dentine-fields. M^3 is very variable, usually composed, behind anterior loop, of two closed triangles and a third one which is confluent with the posterior loop. This tooth has three salient angles on each side as a rule, but in many specimens a more or less conspicuous external salient angle appears, so that four external salient angles may be present. M^3 is rather long as a rule, because its posterior loop is elongate, but there is quite a large variability of its length. The end of the upper incisor is far in front of the anterior border of m^1.

M_1 has, in front of posterior loop, five enamel triangles and the anterior loop. Two foremost triangles are confluent and they are broadly connected with the anterior loop, which is short and oblique. M_2 has three salient angles on each side. In m_3 there are also three salient angles on each side and its triangles are not particularly confluent.

Table 10. Dimensions of upper molars of *Clethrionomys rufocanus* (in mm)

	Lm^1		Lm^2		Lm^3		Lm^1–m^3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	36	1.8–2.1–2.4	21	1.3–1.6–1.8	34	1.5–1.8–2.0	11	4.6–5.2–5.7
Ando	—	—	—	—	10	1.5–1.6–1.8	—	—
C.r. bedfordiae, Hokkaido	—	—	—	—	15	1.9–2.0–2.1	14	5.8–6.0–6.2
C. r. regulus, Korea	4	1.9–1.9–2.0	—	—	—	—	4	5.1–5.5–5.8

Table 11. Dimensions of lower molars of *Clethrionomys rufocanus* (in mm)

	Lm_1		Lm_2		Lm_3		Lm_1–m_3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	96	2.0–2.4–2.9	38	1.4–1.6–1.9	17	1.2–1.5–1.7	14	4.8–5.4.6.0
Ando	4	2.2–2.4–2.6	—	—	—	—	—	—
Shiraiwa	—	—	1	1.7	—	—	—	—
Shiriya	2	2.3–2.4–2.5	—	—	—	—	—	—
Miyata, 1st Cave	1	2.5	3	1.5–1.5–1.6	2	1.5–1.55–1.6	—	—
Miyata, 2nd Cave	4	2.2–2.4–2.6	2	1.5–1.55–1.6	1	1.6	1	5.6
C. r. bedfordiae, Hokkaido	16	2.4–2.6–2.8	16	1.6–1.7–1.8	16	1.5–1.6–1.7	16	5.5–5.9–6.1
C. r. regulus, Korea	4	2.5–2.6–2.7	4	1.5–1.6–1.6	4	1.5–1.6–1.6	4	5.6–5.7–5.8

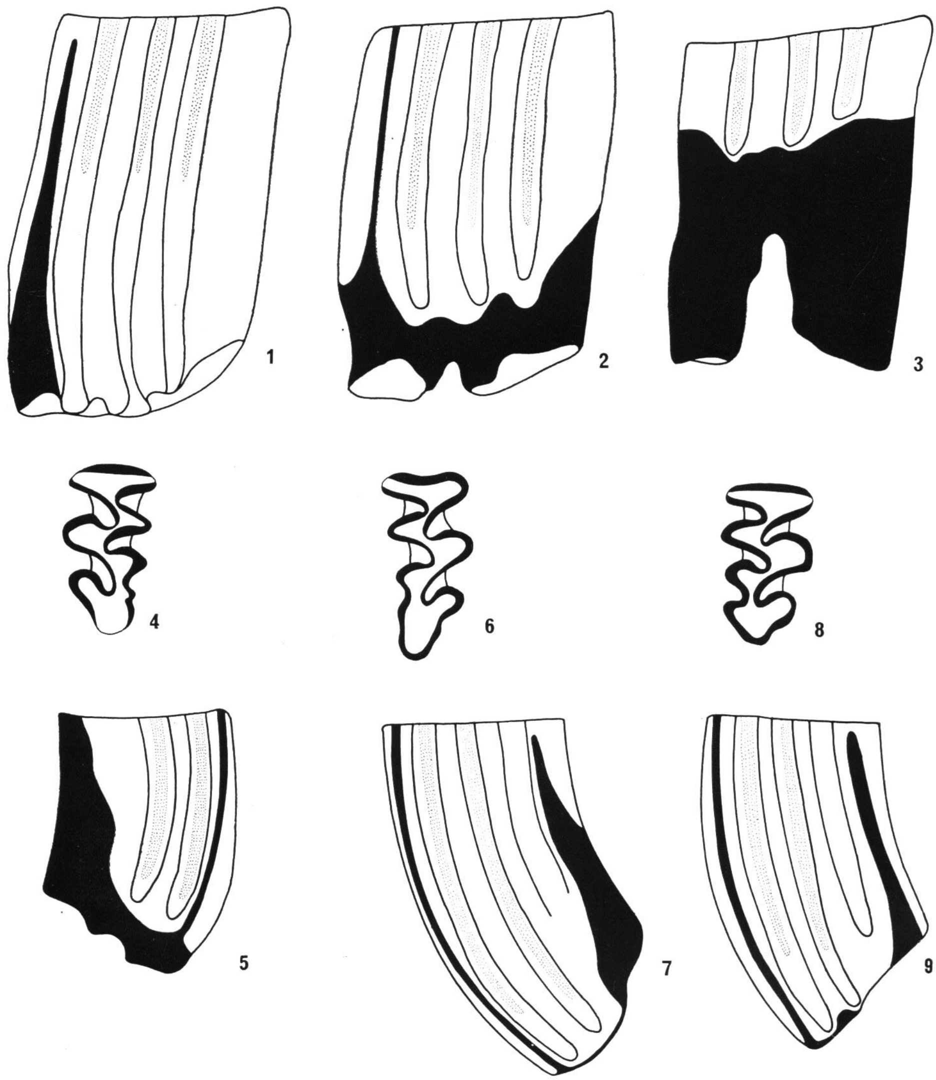

Fig. 2. *Clethrionomys rufocanus*, Ikumo. 1: m_1, NSM 9932–1, L=2.3 mm, side-view; 2: m_1 NSM 9932–2, L=2.5 mm, side-view; 3: m_1, NSM 9920, L=2.5 mm, side-view; 4–5: m^3, NSM 9929–3, L=1.8 mm, crown and side-view; 6–7: m^3, NSM 9929–4, L=1.9 mm, crown and side-view; 8–9: m^3, NSM 9929–5, L=1.7 mm, crown and side-view.

Dimensions. (see Tables 10 and 11). It must be noted that the dimensions are variable depending on individual age. Youngest molars, without traces of wear, were not measured.

Discussion. The hypsodont but rooted molars suggest generic characters of *Clethrionomys*. Large dimensions as well as general pattern of crown point to the species, *C. rufocanus*. This species is now represented in Korea by *C. rufocanus regulus* (THOMAS, 1907) and in Hokkaido by *C. rufocanus bedfordiae* (THOMAS, 1905). Both forms differ slightly in the pattern of their molars from the fossil population described above, but are similarily hypsodont. In *C. rufocanus regulus* the anterior loop of m_1 and m^3 are more elongate than in fossil specimens. In *C. rufocanus bedfordiae*, on the contrary, the anterior loop of m_1 is usually shorter and m^3 less elongate than in our form. Besides, the fossil Quaternary form of Japan is evidently smaller than the Recent population of *C. rufocanus bedfordiae* from Hokkaido (see Tables 10 and 11).

Genus *Eothenomys* MILLER, 1896

Eothenomys smithi (THOMAS, 1905)

(Fig. 3, 7–15)

1962 *Clethrionomys* sp.; SHIKAMA and HASEGAWA, p. 197, from Shikimizu.
1966 *Clethrionomys* sp.; HASEGAWA, p. 34, from Shikimizu.

Material. Makurazino-ana, Yamaguchi Pref., Holocene: 3 mandibles with m_1, isolated molars: 74 m^1, 31 m^2, 20 m^3, 74 m_1, 30 m_2, 9 m_3, NSM, unnumbered. 1 mandible with m_1–m_2, 4 m_1, 3 m^3, ISEZ, no MF 1476.

Miyata, 2nd cave (=Okubo 2nd cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_2, 2 isolated m_1, IG Yok. unnumbered.

Shikimizu quarry, Kanogawa, Shikoku Is., Late Pleistocene: 1 fragment of skull with m^1–m^2, 2 mandibles with m_1–m_2, 2 mandibles with m_1, isolated molars: 3 m^1, 1 m^2, 1 m^3, 1 m_1, 1 m_3, 2 mandibles without molars, IG Yok. unnumbered, labelled "*Clethrionomys rufocanus*".

Description. Molars rootless. Crown-cementum abundant. Enamel-band broad, not differentiated, interrupted on both sides of the posterior loop and on the middle of anterior loop of lower molars. Enamel-triangles rounded; re-entrant angles are not particularly wide. In m^1 there are five dentine-fields rather broadly interconnected. M^2 with four dentine-fields. M^3 usually with four salient angles on both sides. It is composed of the anterior loop, of usually three triangles (two anterior ones in many specimens are interconnected) and of a more or less complicated posterior loop. Its variability is extensive, but it is never particularly long.

M_1 is composed of the anterior and posterior loops and of four to five intermediate triangles. The anterior ones are interconnected; two posterior ones sometimes broadly confluent. Sometimes the foremost triangles form part of the anterior loop. M_2 is composed of four confluent triangles and of anterior loop. M_3 is composed of three enamel-fields; the opposite triangles are completely confluent.

Dimensions. See Tables 12 and 13.

Discussion. The fossil material, which is of Latest Pleistocene or Holocene in age, does not differ in tooth pattern from the Recent *Eothenomys smithi*. According to IMAIZUMI (1960) there is another species of this genus, *E. kageus* IMAIZUMI, 1957, living in Honshu. Both the forms are identical in molar-pattern and very similar in size so that they may be conspecific. It must be noted that the fossil population from Makurazino-ana is smaller than that from Miyata, 2nd cave.

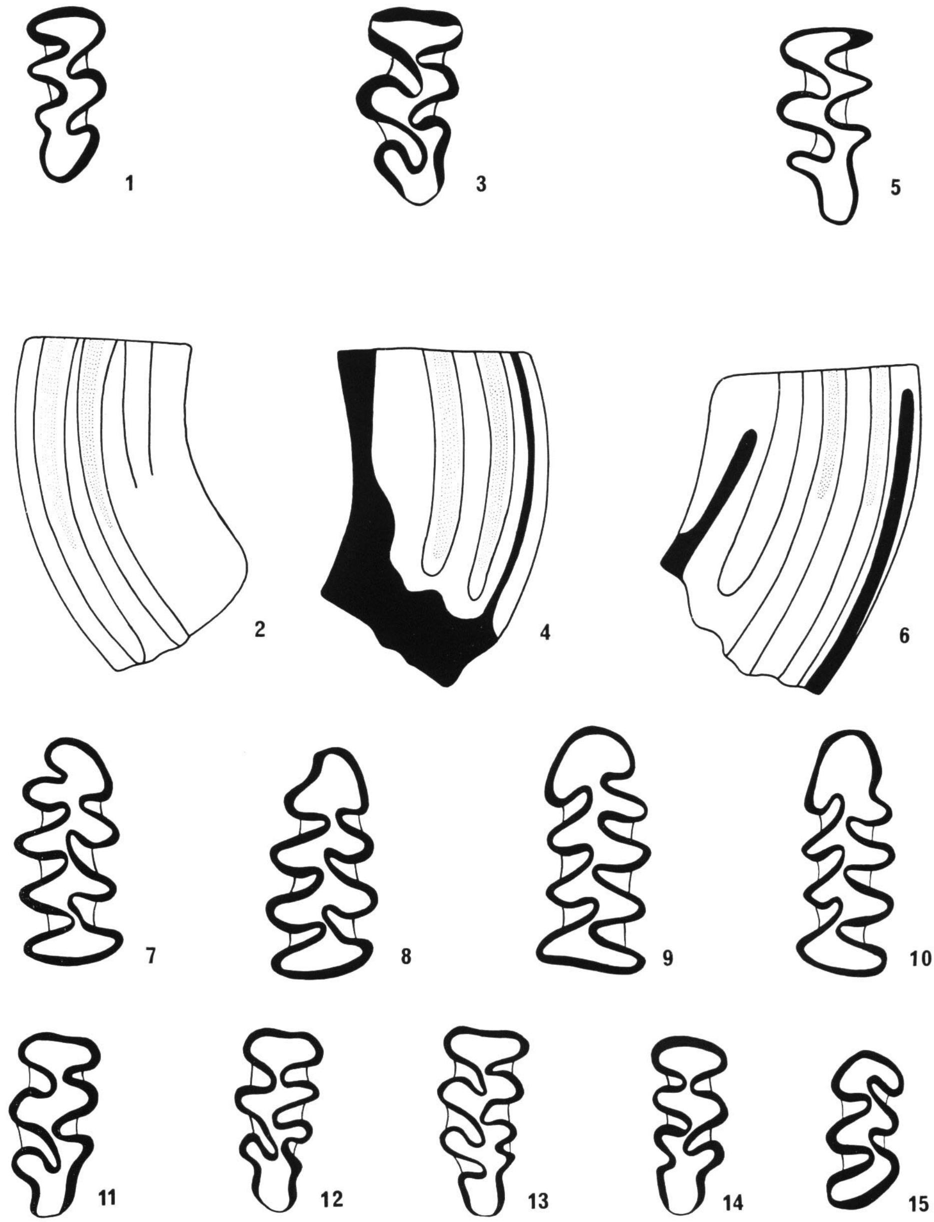

Fig. 3. 1–6 *Clethrionomys rufocanus*, Ikumo. m^3, 1–2: NSM 9929–1, L=1.7 mm, crown and side-view; 3–4: NSM 9929–2, L=1.8 mm, crown and side-view; 5–6: NSM 9929–6, L=1.9 mm, crown and side-view. 7–15 *Eothenomys smithi*, Makurazino-ana, NSM, unnumbered. 7: m_1, L=2.1 mm; 8: m_1, L=2.1 mm; 9: m_1, L=2.3 mm; 10: m_1, L=2.3 mm; 11: m^3, L=1.8 mm; 12: m^3, L=1.8 mm; 13: m^3, L=1.9 mm; 14: m^3, L=1.7 mm; 15: m_3, L=1.6 mm.

Table 12. Dimensions of upper molars of *Eothenomys smithi* (in mm)

	Lm¹		Lm²		Lm³		Lm¹–m³	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Makurazino-ana	—	—	—	—	19	1.6–1.7–1.9	—	—
Shikimizu	3	2.2–2.3–2.5	2	1.5–1.6–1.7	2	1.8–1.85–1.9	—	—
E. smithi, Recent, Kyushu	10	1.9–2.0–2.2	10	1.5–1.6–1.7	10	1.7–1.8–1.9	10	5.2–5.3–5.5
E. smithi, Recent, Shikoku	6	1.9–2.0–2.3	6	1.5–1.6–1.7	6	1.8–1.9–2.0	10	5.3–5.5–5.9
E. kagens, Recent	17	1.8–1.9–2.1	17	1.4–1.5–1.7	17	1.6–1.8–2.0	17	4.9–5.2–5.6

Table 13. Dimensions of lower molars of *Eothenomys smithi* (in mm)

	Lm_1		Lm_2		Lm_3		Lm_1–m_3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Makurazino-ana	63	2.0–2.3–2.5	—	—	—	—	—	—
Miyata, 2nd Cave	3	2.3–2.5–2.7	1	1.5	—	—	—	—
Shikimizu	7	2.1–2.4–2.8	3	1.4–1.5–1.5	1	1.4	1	5.2
E. smithi, Recent, Kyushu	10	2.3–2.4–2.4	10	1.4–1.5–1.6	10	1.4–1.5–1.6	10	5.2–5.3–5.5
E. smithi, Recent, Shikoku	6	2.3–2.5–2.7	6	1.5–1.6–1.7	6	1.5–1.6–1.6	6	5.4–5.5–6.0
E. kageus, Recent	17	2.0–2.3–2.5	17	1.4–1.5–1.7	17	1.4–1.5–1.7	17	5.0–5.2–5.7

Genus *Aschizomys* MILLER 1898

Aschizomys andersoni (THOMAS, 1905)

(Fig. 4, 1–4)

1958 *Clethrionomys rufocanus andersoni* (THOMAS); NAKAJIMA, p. 38.
1966 *Clethrionomys rufocanus andersoni* (THO.); HASEGAWA, p. 34.
1972 *Clethrionomys rufocanus andersoni* (KURODA); HASEGAWA, p. 559, 560.

Material. Shiriya quarry, Aomori Pref., Late Pleistocene: 2 fragments of skulls with m^1–m^3, NSM 10177, 10195; 2 fragments of skulls with m^1–m^2, NSM 10183, 10191; 6 mandibles with m_1–m_3, NSM 10151, 10156, 10160, 10161, 11 mandibles with m_1–m_2, NSM 10142, 10144, 10145, 10149, 10153–10155, 10158, 10159, 10162, 10163; 1 mandible with m_1, NSM 10147; 1 mandible with m_2, NSM 10152; 8 isolated m_1, NSM 10169, 10170; 1 isolated m^1, NSM 10172; 2 isolated m^2, NSM 10172; 1 isolated m^3, NSM 10173; 7 isolated m_2, NSM 10174; 6 isolated m_3, NSM 10176; a few fragments of skulls and mandibles without molars. 1 mandible with m_1–m_3, 1 isolated m_1, 1 isolated m^3 ISEZ, no MF 1481. 29 m_1 are represented in the studied material.

Description. Molars rootless, much lower than the molars of *Clethrionomys rufocanus* at the moment of closing their pulp-cavities. There is very high variability in the details of the crown-pattern of the molars, which are similar to those in the Recent *Aschizomys andersoni*. In general, these teeth are more similar to *Eothenomys smithi* than to *Clethrionomys rufocanus*. The peculiar characters of the teeth are confluent dentine-fields the oblique position of the posterior field of m_3, as well as widely open re-entrant angles of all molars. M^3 in our fossil population shows usually four salient angles on each side, as in Recent *A. andersoni*.

Table 14. Dimensions of upper molars of *Aschizomys andersoni* (in mm)

	Lm^1		Lm^2		Lm^3		Lm^1–m^3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Shiriya	5	1.9–2.0–2.2	5	1.5–1.6–1.8	6	1.6–1.8–2.0	3	4.9–5.3–5.7
A. andersoni, Recent	6	1.9–2.0–2.2	6	1.4–1.5–1.6	6	1.8–1.9–1.9	13	4.9–5.4–6.2
A. niigatae, Recent	7	2.0–2.2–2.5	7	1.5–1.6–1.8	7	1.9–2.0–2.1	10	5.1–5.7–6.0

Table 15. Dimensions of lower molars of *Aschizomys andersoni* (in mm)

	Lm_1		Lm_2		Lm_3		Lm_1–m_3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Shiriya	29	2.0–2.3–2.6	19	1.4–1.5–1.6	6	1.5–1.6–1.7	6	4.5–5.2–5.8
A. andersoni, Recent	13	2.1–2.4–2.7	13	1.4–1.5–1.7	13	1.3–1.6–1.9	13	5.0–5.5–6.2
A. niigatae, Recent	10	2.3–2.5–2.7	10	1.4–1.65–1.8	10	1.5–1.7–2.0	9	5.0–5.7–6.0

Dimensions. See Tables 14 and 15.

Discussion. The fossil material is identical with the Recent population of *Aschizomys andersoni* from Honshu. This species, now distributed widely in northern Honshu and in the mountainous zone in the southern part of this island, is endemic for Japan. The systematic position of this species has been for a long time object of controversy among mammalogists. It was described by THOMAS (1905) as *Evotomys andersoni.* HINTON (1926) expressed the opinion that this form is identical with *Evotomys smithi,* which was regarded as only a subspecies of *E. rufocanus* by him. This opinion was also held by ELLERMAN and MORRISON-SCOTT (1951). IMAIZUMI (1957) first recognized the similarity of *andersoni* to the genus *Aschizomys.* OGNEV (1950) and lately other Soviet mammalogists included *Aschizomys* as a subgenus in the genus *Alticola* BLANFORD 1881. According to JAMESON (1961) *Aschizomys* is a subgenus of *Clethrionomys.* We have not studied the external characters of this group of voles, but in our opinion the rootless molars exclude the possibility that *A. andersoni* and other species of *Aschizomys* belong to the genus *Clethrionomys.* On the other hand, the pattern of m^3 in *Aschizomys* and *Alticola* are entirely different. Probably *Alticola, Eothenomys* and *Aschizomys* were all derived from *Clethrionomys,* having been developed independently as different genera in eastern Asia. *Aschizomys niigatae* (ANDERSON 1909) is very similar to *A. andersoni* in its tooth-pattern probably being only subspecifically different. The fossil population from Shiriya is slightly smaller than the Recent populations of *A. andersoni* and *A. niigatae.*

Genus *Microtus* SCHRANK 1798

Microtus montebelli (MILNE-EDWARDS, 1872)

(Fig. 6, 1–2)

1937 *Microtus montebelli* (MILNE-EDWARDS); SHIKAMA, p. 366, from Kuzuü Formation.
1949 *Microtus montebelli* (MILNE-EDWARDS); SHIKAMA, p. 20, 43, 50, 51, 57, from Kuzuü Formation.

1954 *Microtus montebelli montebelli*; NAORA, p. 182, 205, 227, 236, 245, fig. 162, from Kuzuü Formation.
1957 *Microtus montebelli* (MILNE-EDWARDS); NAKAJIMA and KUWANO, p. 156, from Shiriya.
1958 *Microtus montebelli* (MILNE-EDWARDS); SHIKAMA and OKAFUJI, p. 56, pl. XIV/9, from Makurazino-ana.
1966 *Microtus montebelli* (MILNE-EDWARDS); HASEGAWA, p. 34, from Shiriya, Shiraiwa, Ushikawa and from the Kuzuü Formation.
1972 *Microtus montebelli* (MILNE-EDWARDS); HASEGAWA, p. 559, 560, 563, from Shiriya and from the Kuzuü Formation.

Material. Shiraiwa mine, Shizuoka Pref., Late Pleistocene. Fissure no 5: 4 fragments of skulls with m^1–m^3, NSM 10053, 10127, 10133, 10136; 17 isolated m^3, NSM 10122; 9 mandibles with m_1–m_3, NSM 7992, 7995, 8032, 8035, 8048, 8054, 10061, 10113, 10129; 70 mandibles with m_1–m_2, NSM 7988–7990, 7993, 7994, 7996, 7997, 8001–8004, 8027, 8028, 8031, 8033, 8055–8067, 8071–8077, 88084–8087, 10062, 10065, 10069, 10074, 10081, 10083, 10089, 10093; 10101, 10102, 10105, 10108, 10110, 10111, 10114, 30 mandibles with m_1, NSM 8005, 8026, 8034, 8040–8042, 8068, 8078–8081, 8083, 8089, 10056, 10060, 10062, 10073, 10079, 10087, 10094–10096, 10098–10100, 10103, 10106, 10107, 10109, 10114; 97 isolated m_1, NSM 7935–7937, 7941, 7942, 7945–7947, 7949, 7950, 7954, 7958, 7960, 7962, 7963, 7970–7972, 7975, 7976, 7978, 7990, 8002, 1014–1017, 10119. 204 m_1 were studied. Fragments of skulls without m^3, mandibles without m_1 and isolated molars other than m_1 and m^3 could not be determined specifically, because they do not differ from respective remains of *Microtus epiratticeps* associated in this locality. Fissure no 4, level 4–5: 2 fragments of skulls with m^1–m^3, NSM 9967, 9969; 3 mandibles with m_1–m_3, NSM 10000, 10001, 10013; 5 mandibles with m_1–m_2, NSM 10002, 10004–10006, 10009; 2 mandibles with m_1, NSM 9998, 10011. Fissure no 4, level 3–4: 1 mandible with m_1–m_3, NSM 9987; 3 mandibles with m_1–m_2, NSM 9985, 9986, 9989; 1 mandible with m_1, NSM 10036. Fissure no 2: 1 mandible with m_1–m_3 and 1 isolated m_1, NSM 9962. "Shiraiwa mine": 3 mandibles with m_1–m_2, 10 m_1, 2 m^3, ISEZ, no MF 595.

Shiriya quarry, Aomori Pref., Late Pleistocene: 1 fragment of skull with m^1–m^3, NSM 10140; 1 mandible with m_1–m_2, NSM 10186; 3 mandibles with m_1, NSM 10188–10190; 2 mandibles with m_2, NSM 10146, 10187; 5 isolated m_1, NSM 10170, 10192; 1 isolated m^1 and 1 isolated m_2, NSM 10192. 10 mandibles with m_1–m_2, 156 mandibles with m_1 or isolated m_1, numerous isolated m^1, m^2, m_2 and m_3, fragments of skulls and mandibles without molars, NSM, unnumbered.

Takanosu-zawa cave, Kamitada, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 3 mandibles with m_1–m_2, 9 isolated m_1, 3 isolated m^3, a few other isolated molars, NSM, unnumbered.

Miyata, 1st cave (=Okubo, 1st cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 2 fragments of skulls with m^1–m^3, 1 fragment of skull with m^1–m^2, 2 fragments of skulls with m_1, 4 mandibles with m_1–m_3, 9 mandibles with m_1–m_2, 3 mandibles with m_1, 6 isolated m_1, few other isolated molars and mandibles without molars, IG Yok. unnumbered.

Miyata, 2nd cave (=Okubo, 2nd cave), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 5 mandibles with m_1–m_3, 49 mandibles with m_1–m_2, 19 mandibles with m_1, 12 isolated m_1, other isolated molars and mandibles without molars, IG Yok. unnumbered.

Aizawa (=Yoshizawa), Kuzuü Formation, Tochigi Pref., Late Pleistocene: 2 mandibles with m_1–m_2, 1 mandible with m_1, IG Yok. unnumbered.

Yoshizawa Sekkai Co., quarry no 8, Ogano, Kuzuü Formation, Tochigi Pref., Late Pleistocene: 1 mandible with m_1–m_3, 4 mandibles with m_1–m_2, 4 isolated m_1, 4 isolated m^3, other isolated molars, NSM, unnumbered.

Ushikawa, Aichi Pref., Late Pleistocene: 1 mandible with m_1–m_2, 3 isolated m^1, 1 isolated m^3, 1 isolated m_3, NSM, unnumbered.

Makurazino-ana, Akiyoshi, Yamaguchi Pref., Holocene: 2 mandibles with m_1–m_2, 8 isolated m_1, 5 isolated m^3, other isolated molars, NSM, unnumbered.

Description. Structure of palatinum typical for *Microtus*. Incisors with orange coloration. Molars rootless, with abundant crown-cementum and differentiated enamel-band.

M_1 with posterior loop, four closed triangles and anterior loop, which is nearly symmetrical, with one re-entrant angle on each side, the lingual one being shallower and situated more forwards, so that the anterior loop is slightly inclined to the labial side. M_2 with three alternating, closed, intermediate triangles. M^3 complicated. Behind its anterior loop there are three closed triangles; the interior one is largest. The posterior loop of m^3 has its deep internal re-entrant angle situated obliquely. M^3 has, therefore, four internal and three external salient angles. The variability of the molar-pattern is limited; only the anterior loop of m_1 is more or less obliquely situated. In some specimens this loop has an additional, smaller, re-entrant angle on the lingual side. In a specimen from Shiraiwa the re-entrant angle on the anterior loop of m_1 is so deep that a sixth closed intermediate triangle is formed.

Dimensions. See Tables 16 and 17.

Discussion. The material described above does not differ from the Recent populations of *Microtus montebelli* neither in the pattern of its molars nor in the variability and dimensions. *Microtus montebelli,* now endemic for the main Japanese Islands, undoubtedly belongs to the group of *Microtus arvalis* (PALLAS, 1779). The distribution of *M. arvalis* including *M. mongolicus* (RADDE, 1862), which are only subspecifically different from each other, covers major parts of Europe and temperate Asia at present. For the east it reaches Manchuria but is absent in Korea.

Table 16. Dimensions of upper molars of *Microtus montebelli* (in mm)

	Lm^1		Lm^2		Lm^3		Lm^1–m^3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Shiraiwa, fissure no 5	4	2.1–2.4–2.5	4	1.6–1.7–1.8	19	1.8–2.0–2.3	4	5.6–6.0–6.4
Shiraiwa, fissure no 4	1	2.4	—	—	1	2.3	1	6.4
Shiriya	—	—	—	—	76	1.8–2.1–2.4	—	—
Takanosu-zawa	—	—	—	—	3	1.9–2.0–2.2	—	—
Miyata, 1st Cave	5	2.0–2.3–2.6	4	1.5–1.7–1.8	2	2.1–2.1–2.1	2	5.9–6.3–6.7
Yoshizawa-Sekkai, no 8	—	—	—	—	4	2.0–2.1–2.3	—	—
Makurazino-ana	—	—	—	—	5	1.8–1.9–2.1	—	—
M. montebelli, Recent, Chubu distr.	—	—	—	—	10	1.8–2.0–2.2	10	5.5–6.1–6.5
M. montebelli, Recent, Tohoku distr.	—	—	—	—	6	1.9–2.0–2.1	6	5.7–6.0–6.4
M. montebelli, Recent, Mt. Fuji	—	—	—	—	10	1.9–2.0–2.3	10	5.4–6.1–6.5

Table 17. Dimensions of lower molars of *Microtus montebelli* (in mm)

	Lm_1		Lm_2		Lm_3		Lm_1–m_3	
	n	min-m-max	n	min-m-max	n	min-m-max	n	min-m-max
Shiraiwa, fissure no 5	110	2.6–2.9–3.2	69	1.4–1.6–1.8	6	1.4–1.6–1.8	6	5.7–6.0–6.2
Shiraiwa, fissure no 4	22	2.7–2.9–3.2	16	1.5–1.6–1.7	6	1.4–1.5–1.5	6	5.7–5.9–6.3
Shiraiwa, fissure no 2	2	3.1–3.2–3.3	1	1.7	1	1.7	1	6.7
Shiriya	101	2.6–3.0–3.4	12	1.5–1.7–1.8	—	—	—	—
Takanosu-zawa	12	2.7–2.9–3.2	2	1.5–1.55–1.6	—	—	—	—
Miyata, 1st Cave	22	2.6–2.9–3.2	12	1.5–1.6–1.8	3	1.5–1.5–1.6	3	6.2–6.2–6.3
Miyata, 2nd Cave	52	2.6–2.9–3.1	43	1.4–1.6–1.9	5	1.4–1.6–1.8	5	5.4–5.9–6.5
Aizawa	3	3.0–3.1–3.2	2	1.6–1.7–1.8	—	—	—	—
Yoshizawa-Sekkai, no 8	8	2.8–2.9–3.1	5	1.6–1.6–1.7	1	1.5	1	6.0
Ushikawa	1	2.9	1	1.5	—	—	—	—
Makurazino-ana	5	2.8–2.9–3.1	1	1.8	—	—	—	—
M. montebelli, Recent, Chubu distr.	10	2.8–3.0–3.2	—	—	—	—	10	5.5–6.0–6.4
M. montebelli, Recent, Tohoku distr.	6	2.5–2.9–3.1	—	—	—	—	6	5.7–6.0–6.0
M. montebelli, Recent, Mt. Fuji	10	2.8–3.1–3.4	—	—	—	—	10	5.7–6.2–6.5

Microtus epiratticeps YOUNG 1934

(Figs. 4, 5–8; Fig. 5, 1–15; Fig. 6, 3–7)

1954 *Microtus montebelli montebelli*; NAORA, p. 128–129, fig. 80, from Tsunemi.
1963 *Microtus montebelli* (MILNE-EDWARDS); HASEGAWA, p. 13, from Ikumo.
1966 *Microtus montebelli* (MILNE-EDWARDS); HASEGAWA, p. 34, from Ikumo and Ando.
1972 *Microtus montebelli* (MILNE-EDWARDS); HASEGAWA, p. 560, 566, 567, from Ikumo and Tsunemi.
1976 *Microtus epiratticeps* YOUNG; HASEGAWA, AIMI and OKAFUJI, from Ando.

Material. Ikumo quarry, Yamaguchi Pref., Middle Pleistocene: 1 damaged skull with m^1–m^3, NSM 9842; 1 fragment of skull with m^1, NSM 9845; 11 mandibles with m_1–m_3, m_1–m_2 or m_1, NSM 9857, 9858, 9861, 9863, 9867, 9868, 9876, 9884, 9896, 9953; 39 isolated m_1, NSM 9928, 9930, 9932, 9939; 15 m^3, NSM 9933, 9938; many isolated m^1, m^2, m_2 and m_3 NSM 9927, 9932, 9935, 9938. 1 fragment of skull with m^1–m^3, 1 mandible with m_1–m_3, 5 mandibles with m_1–m_2, 1 mandible with m_1, 3 isolated m_1, 6 isolated m^1, HARA Coll. 1 mandible with m_1–m_2, 7 m_1, 1 m_2, 1 m_3, 1 m^1, 1 m^2, 3 m^3 ISEZ, no MF 1473. 68 m_1 were studied.

Ando quarry, Yamaguchi, Pref., Middle Pleistocene: 2 mandibles with NSM m_1 10367, 10368.

Shiraiwa mine, Shizuoka Pref., Late Pleistocene. Fissure no 5: 1 mandible with m_1–m_3, NSM 8047; 4 mandibles with m_1–m_2, NSM 8029, 8036, 10068, 10112; 5 isolated m_1, NSM 7979, 10115, 10116, 10134; 1 isolated m^3, NSM 10121. Fissure no 4, level 0–1–2: 3 mandibles with m_1–m_2, NSM 9973, 9974, 9976. Fissure 4, level 2–3: 2 mandibles with m_1–m_2, NSM 9982, 9983. Fissure 4 without stratigraphic data: 4 mandibles with m_1–m_2, NSM 10028, 10032, 10034, 10042.

Shiriya quarry, Aomori Pref., Late Pleistocene: 1 mandible with m_1–m_2, NSM 10369.

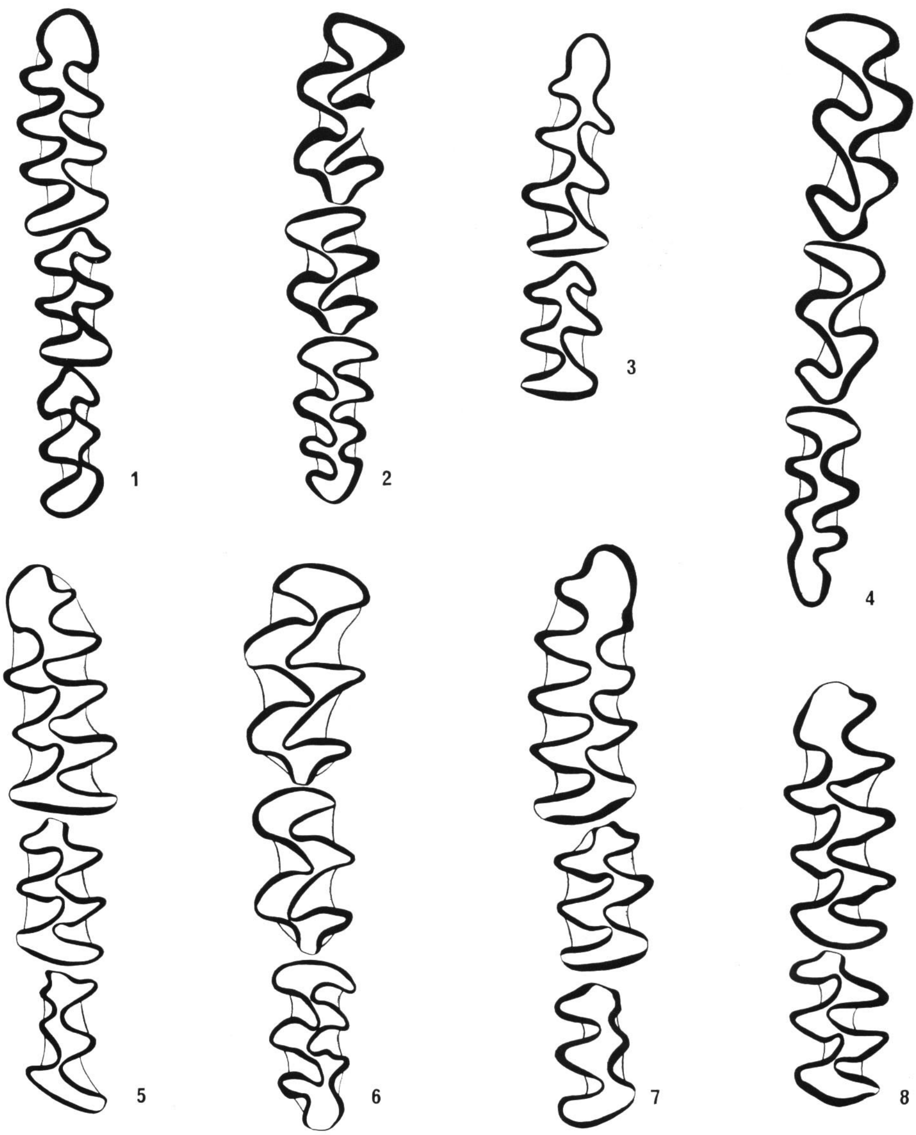

Fig. 4. 1–4 *Aschizomys andersoni*, Shiriya. 1: m_1–m_3, NSM 10161, L=5.0 mm; 2: m^1–m^3, NSM 10177, L=4.9 mm; 3: m_1–m_2, NSM 10164, L=3.8 mm; 4: m^1–m^3, NSM 10141, L=5.7 mm. 5–8 *Microtus epiratticeps*. 5: Ikumo, m_1–m_3, NSM 9861, L=5.5 mm; 6: Ikumo, m^1–m^3, HARA Coll., unnumbered, L=5.7 mm; 7: Shiriya, fissure no 5, m_1–m_3, NSM 8047, L=6.0 mm; 8: Shiriya, m_1–m_2, NSM, unnumbered, L=4.3 mm.

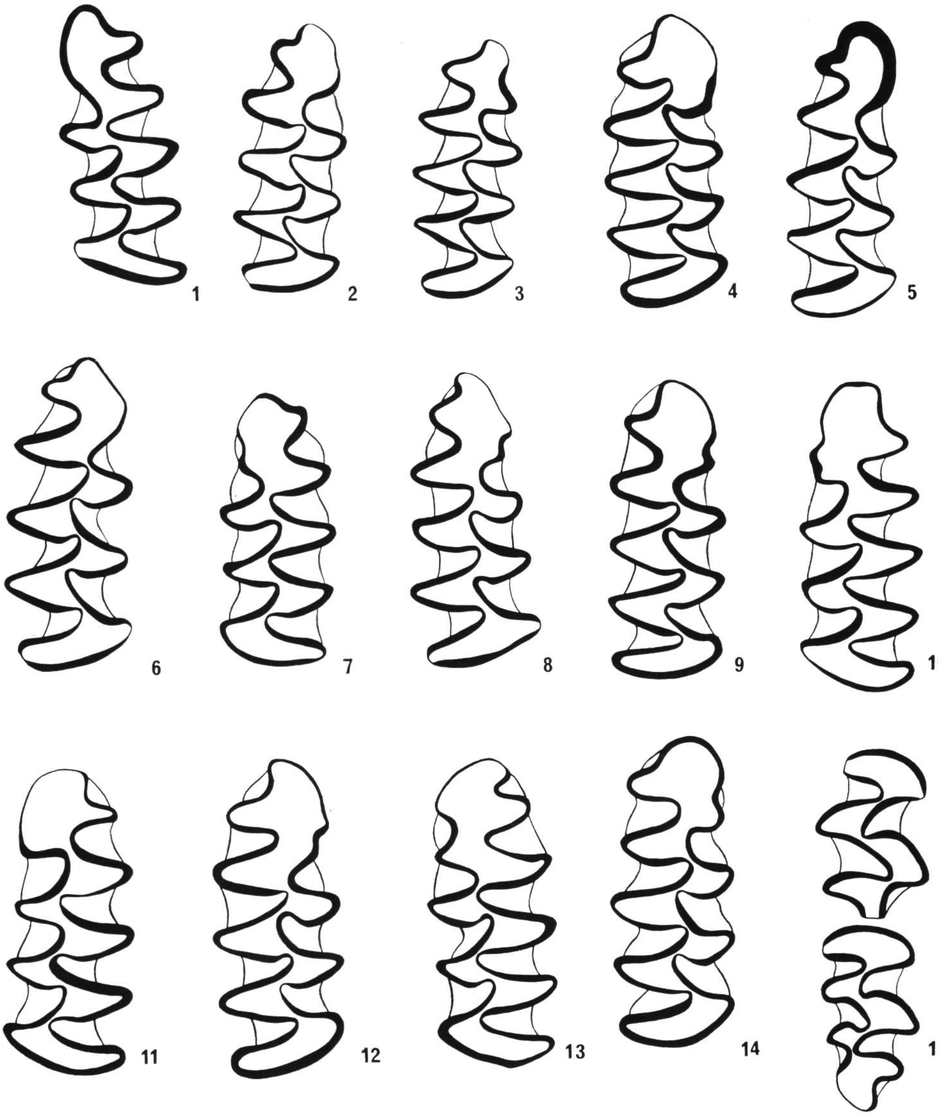

Fig. 5. *Microtus epiratticeps*, 1–6: Ikumo, m_1. 1: NSM 9939–1, L=2.8 mm; 2: NSM 9939–2, L=2.8 mm; 3: NSM, no 9939–3, L=2.7 mm; 4: NSM 9939–6, L=3.0 mm; 5: NSM, no 9939–5, L=3.0 mm; 6: NSM 9939–7; L=3.1 mm. 7–8: Ando, m_1, NSM, unnumbered; 7: L=2.8 mm; 8: L=3.0 mm. 9–11: Shiraiwa, fissure 4, m_1. 9: NSM 9974, L=3.0 mm; 10: NSM 9973, L=3.1 mm, 11: NSM 10028, L=3.1 mm. 12–14: Shiraiwa, fissure 5, m_1. 12: NSM 7979, L=3.2 mm; 13: NSM 10068, L=3.2 mm. 14: NSM 10112, L=3.1 mm. 15: Ikumo, m^2–m^3, NSM 9842, L=3.7 mm.

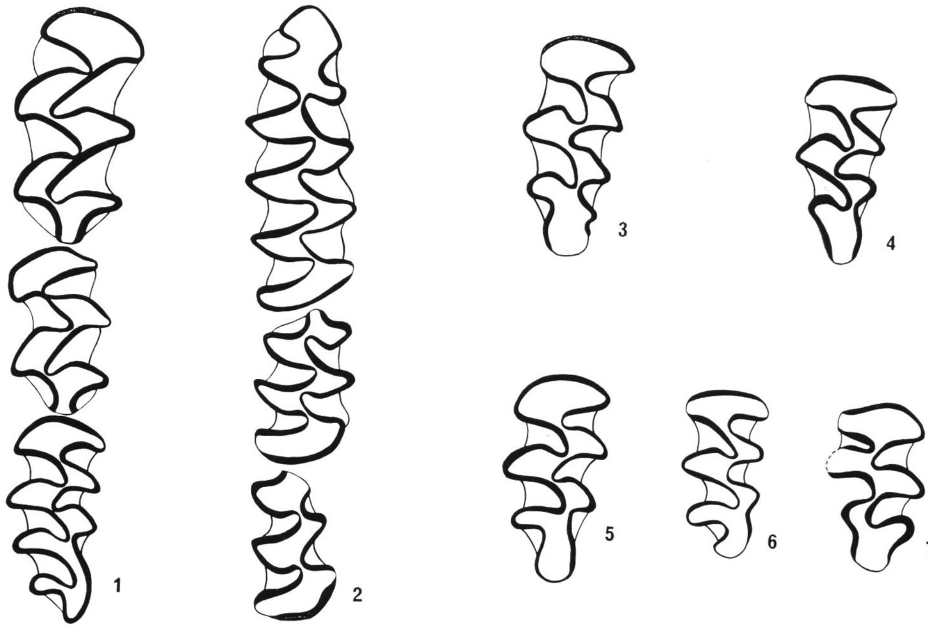

Fig. 6. 1–2 *Microtus montebelli*, Shiraiwa, fissure 5. 1: m^1–m^3, NSM 10133, L=6.0 mm; 2: m_1–m_3, NSM 8054, L=6.2 mm. 3–7: *Microtus epiratticeps*, m^3. 3: Ikumo, NSM 9933–1, L=2.4 mm; 4: Ikumo, NSM 9933–2, L=2.0 mm; 5: Ikumo, NSM 9933–3, L=2.2 mm; 6: Ikumo, NSM 9933–4, L=1.8 mm; 7: Shiraiwa, fissure 5, NSM 10121, L=1.8 mm.

Description. Molars rootless, with abundant crown-cementum in re-entrant angles. Enamel-band differentiated, thinner at the bottom of re-entrant angles and with interruptions on both ends of posterior loop in m_1. M_1 composed of a posterior loop, four closed triangles and an anterior loop. Anterior loop is greatly variable, although in the majority of specimens it has such a shape typical for *M. oeconomus* (PALLAS, 1776) as be convex on the labial side with a more or less deep re-entrant angle on the lingual side. Sometimes there is an additional, shallow re-entrant angle near the top of the loop on its lingual side. In some cases a shallow re-entrant angle is present on the labial side, with or without crown-cementum. In some teeth the fifth triangle is almost closed and such teeth have a pattern of European *Microtus nivalis* (MARTINS, 1842).

M_2 with 3 intermediate triangles, which are completely closed and alternating. In m_3 intermediate triangles are confluent.

M^1 is same as in other species of *Microtus*. M^2 has only three closed enamel fields behind the anterior loop. M^3 is rather uniform in shape, short and simple, being composed of the anterior loop, three intermediate triangles and a posterior loop, which has a more or less deep transversal re-entrant angle on its lingual side. This tooth has, therefore, only three salient angles on each side. In a specimen the second

Table 18. Dimensions of lower molars of *Microtus epiratticeps* (in mm)

	Lm_1		Lm_2		Lm_3	
	n	min-m-max	n	min-m-max	n	min-m-max
Ikumo	56	2.5–2.8–3.3	12	1.6–1.7–1.8	5	1.4–1.5–1.6
Ando	2	2.8–2.9–3.0	—	—	—	—
Shiraiwa, fissure no. 5	10	2.9–3.1–3.2	5	1.7–1.7–1.8	1	1.4
Shiraiwa, fissure no. 4	8	3.0–3.1–3.2	8	1.6–1.7–1.8	—	—
Shiriya	1	2.7	1	1.6	—	—

	Lm_1–m_2		Lm_1–m_3	
	n	min-m-max	n	min-m-max
Ikumo	11	4.1–4.4–4.6	4	5.5–5.8.5.9
Ando	—	—	—	—
Shiraiwa, fissure no. 5	4	4.5–4.8–4.9	1	6.0
Shiraiwa, fissure no. 4	8	4.5–4.6–4.8	—	—
Shiriya	1	4.3	—	—

and third triangles are confluent, while in another one the third triangle is confluent with the posterior loop.

Dimensions. In the material from Ikumo, L m^1–m^3 is 5.7 and 6.1 mm. M^1 (n=8) is 2.0–2.4 mm long (m=2.2). M^2 (n=2) is 1.7–1.9 mm long (m=1.8). M^3 (n=15) is 1.7–2.3 mm long (m=1.9). Unique m^3 from Shiraiwa, Fissure 5, is 1.8 mm long. For dimensions of lower molars see Table 18.

Discussion. The material described above represents a single species, although there is wide variability in the pattern of m_1. It belongs undoubtedly to the group of *Microtus oeconomus,* now widely distributed in humid meadows and forests of the boreal zone of Eurasia. It differs, however, from the Recent *M. oeconomus* by larger variability of m_1 and simpler pattern of m^3. In the structure of m^3 our specimens approach character of Recent *M. nivalis*, which is living in alpine meadows of Europe and western Asia. The fossil population from Japan is similar, especially in the variability of m_1, to the representatives of *M. oeconomus* from European Middle Pleistocene (before last glaciation, i.e. Riss) which have been known under the name of *Microtus malei* HINTON 1907 and regarded by many palaeontologists as the ancestors of *oeconomus* and *nivalis*. However, its greatest similarity is with *Microtus epiratticeps* from Choukoutien and other Chinese localities of similar geologic age. We were able to compare directly our specimens with mandibles of *M. epiratticeps* from Choukoutien, loc. 1 and to recognize their identity, even though the population from Choukoutien is slightly larger than ours and differs in the pattern of m^3.

NAORA (1954) published a figure of m_1 from Tsunemi limestone quarry, Matsugae-cho, Kita-Kyushu City, Fukuoka Pref. This author determines this form as *Microtus montebelli montebelli*. We have not seen the material, but from the picture it is evident that the speimen is identical with *Microtus epiratticeps*.

Table 19. Occurrence of fossil rodents in Japan

Species \ Locality	Amagawa-do	Tanabaru	Minatogawa	Hinigushiku	Shikimizu	Ojikado	Tsunemi	Ando	Sumitomo	Ikumo	Tokuyama-soda	Isa	Koziki-ana	Makurazino-ana	Same Cave	Ushikawa	Tadaki	Shiraiwa	Miyata 1st Cave	Miyata 2nd Cave	Aizawa	Tuidi	Yoshizawa-Sekkai no. 8	Yoshizawa-Sekkai no 10	Okada	Takanosu-zawa	Shiriya
Myopus schisticolor	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Clethrionomys rufocanus	—	—	—	—	—	—	—	5	+	115	—	—	—	—	—	—	—	1	2	4	—	—	—	—	—	—	3
Microtus epiratticeps	—	—	—	—	—	—	●	2	—	68	—	—	—	—	—	—	—	19	—	—	—	—	—	—	—	—	+
Microtus montebelli	—	—	—	—	—	—	—	—	—	—	●	●	●	10	●	1	●	233	21	85	3	●	9	—	●	12	175
Eothenomys smithi	—	—	—	—	5	?	—	—	—	—	—	—	—	82	—	—	—	—	—	3	—	—	—	—	—	—	—
Aschizomys andersoni	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29
Apodemus speciosus	—	—	—	—	2	—	●	596	2	24	—	—	●	2	?	1	—	74	16	5	1	1	3	3	+	16	5
Apodemus argenteus	—	—	—	—	5	—	—	353	—	19	—	—	●	2	—	1	—	15	1	5	1	—	—	—	1	2	1
Rattus sp.	—	—	—	—	—	—	—	—	—	1	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rattus rattus or *norvegicus*	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Rattus norvegicus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Tokudaia osimensis	—	—	137	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diplothrix legata	1	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pteromys cf. *volans*	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pteromys sp.	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Petaurista leucogenys	—	—	—	—	—	●	—	3	—	—	—	—	—	●	●	—	—	+	●	—	—	—	—	—	—	—	—
Sciurus vulgaris	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	●	—	+	—	—	—	—	—	—	—	—	—
Glirulus japonicus	—	—	—	—	—	—	—	+	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—

General Remarks

In Table 19 the fossil rodents from all the known localities in Japan are listed. The numerals represent the specimen numbers of studied m_1 (m_1 of both sides were counted). When no m_1 was present, the occurrence was shown by +. The occurrence stated in the previous papers, which were not ascertained by this study, was marked by a dot. It must be noted that the numbers do not represent the true number of specimens at a particular locality. Not all the materials collected from each locality, especially from Ando, were offered for the present study. Besides, by the screening and, especially, hand-picking of specimens from the sediments, larger bones and teeth are selectively collected to compare with small ones. This can be seen when teeth of one species are counted: in the voles, larger teeth (m_1 and m^1) are much more numerous in the collections than smaller teeth (m_3 and m^3). The smallest teeth, e.g. molars of *Glirulus*, which are below 1 mm in diameter, were generally lost; they were found by us only from unsorted materials from three localities. The sylvan species of the families Sciuridae and Gliridae are not found generally in fossil thanatocoenoses, which resulted from the accumulations of pelletes of owl as the bird preys principally on the species in field.

Nevertheless, some remarks about the palaeoenvironment based on the study of fossil rodents can be made. All the Quaternary faunal assemblages in Japan, in contrast to those in continental Eurasia, are sylvan in character. Groups of rodents connected with steppe or tundra environments (ground-squirrels, hamsters, mole-rats) are lacking. Such sylvan species as *Apodemus speciosus*, *A. argenteus* and tree-squirrels were present without interruption from Middle Pleistocene till Recent.

The studied materials represent only the upper part of Quaternary. Sumitomo, Ikumo and Ando are localities of the time before the third glaciation (Riss glacial age in European alpine stratigraphy). This age is also suggested by their roudent-fauna, which contains no archaic elements. *Microtus epiratticeps* is the East-Asian equivalent of *M. malei* from the sediments of this time in Western Europe. The fauna points to a boreal forest particularly based upon *Myopus schisticolor* and *Microtus epiratticeps*. Besides these two species it contained *Clethrionomys rufocanus*, *Rattus* sp., *Apodemus argenteus*, *A. speciosus*, *Sciurus vulgaris*, *Pteromys volans*, *Petaurista leucogenys* and *Glirulus japonicus*. It must be noted that in all probability *Microtus montebelli*, *Eothenomys smithi* and *Aschizomys andersoni* were not present in Japan during this period. The fauna from Tsunemi, not studied by us, may be of the same period.

The other fossil rodents localities in Japan are younger in age at all. Particular problem is here arisen concerning numerous localities of the Kuzuü region. From the point of view of large mammals, the Kuzuü Formation was divided into three levels (SHIKAMA, 1949): Lower Kuzuü with *Stegodon*, and Middle and Upper Kuzuü with *Palaeoloxodon*. The rodents were collected from the Upper Kuzuü Formation according to published papers. But they evidently represent a mixture of older and younger elements, as a usual case of fissure deposits.

In a stage when the climate became continental in type, probably at the beginning of the last glaciation (Würm in European stratigraphy), the voles of the group of *Microtus arvalis* invaded Japan through Korea and differentiated as *Microtus montebelli* there by the isolation. In the faunal assemblages of Shiraiwa and Shiriya *M. montebelli* coexisted with *M. epiratticeps,* as well as with *Clethrionomys rufocanus* and many other elements (*Apodemus, Petaurista, Sciurus,* and *Rattus*) which have lived continuously in Japan since Middle Pleistocene. Lemmings and probably *Pteromys volans* did not reach the main Japanese Islands during the last glacial age. *Eothenomys* was absent, but *Aschizomys* was present in Shiriya although its remains may be of later age.

In still later stages of the last glaciation *Microtus epiratticeps* became extinct, but *Clethrionomys rufocanus* persisted more, showing the last occurrence in the Miyata 1st and 2nd caves in addition to *Microtus montebelli* and *Eothenomys smithi.* In other localities of the Kuzuü Formation *Microtus montebelli* is only representative of voles. *Eothenomys* was probably absent in this particular region for ecologic reasons, but was present elsewhere in Japan.

It is evident that *Clethrionomys rufocanus* became extinct in latest Pleistocene in the main Japanese Islands and was not an ancestor of *Aschizomys* or *Eothenomys* which developed outside Japan and then arrived in the country, during the last glaciation, as an already separated species.

It is interesting to note that neither *Micromys minutus* (PALLAS, 1771) nor *Mus musculus* LINNAEUS, 1758 were present in any of the studied localities including Holocene ones. The presence of *"Mus molossimus"* (Japanese form of *Mus musculus*) was reported by NAORA (1954) from Takanosu-zawa cave and Shimizu-sekkai quarry, but in our opinion its determinations need revision partly because no remains of *Mus* were found by us from Takanosu-zawa. In all probability these two species arrived in Japan most recently, with early human populations.

It is also interesting to note that endemic species of the Japanese mammalian fauna are evidently of different age. *Glirulus japonicus* and *Apodemus argenteus* lived in the Japanese Islands before these were isolated from the continent. On the contrary, *Microtus montebelli, Eothenomys smithi* and *Aschizomys andersoni* are later additions to the fauna of Japan having been differentiated from their continental ancestors rather recently.

As to the fauna of the Ryukyu Islands, the results of our study suggest that their two endemic species of rodents, *Tokudaia osimensis* and *Diplothrix legata,* were present there already in Late Pleistocene as unique representatives of rodent.

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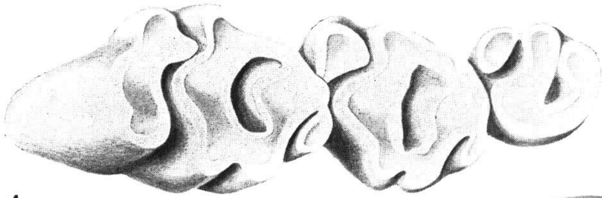
Explanation of Plate

Tokudaia osimensis, occulsal view. Minatogawa-site, Okinawa.

1: M^1–M^3, NSM 10360, juv., L=5.0 mm; 2: M^1–M^3, NSM 10361, ad., L=5.2 mm; 3: M^1–M^3, NSM 10362, sen., L=5.8 mm; 4: M_1–M_3, NSM 10363, juv., L=5.2 mm; 5: M_1–M_3, NMS 10364, ad., L=5.5 mm; 6: M_1–M_3, NMS 10365, sen., L=5.7 mm.



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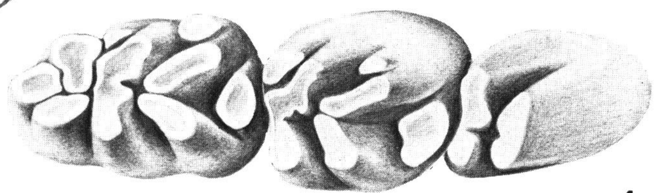

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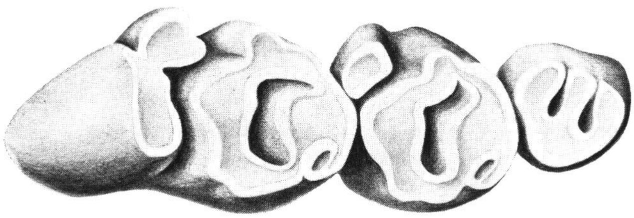

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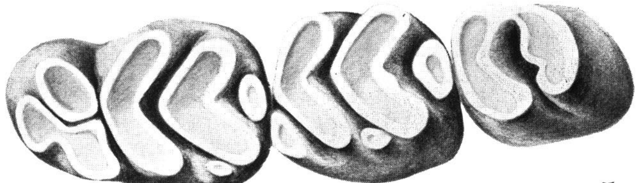

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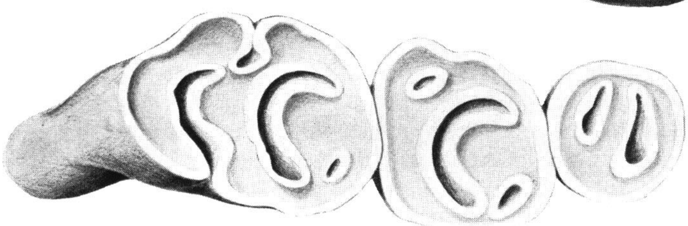

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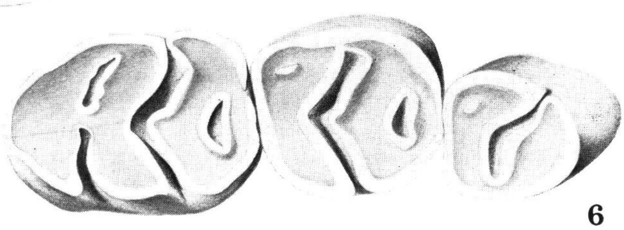

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