CLASSIFICATION AND BIOLOGY OF JAPANESE INSECTIVORA (MAMMALIA)

I. Studies on Variation and Classification

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Contents

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I. Introduction

The mammalian fauna of Japan has been fairly well studied by many investigators except for the orders of Insectivora and Chiroptera. Although the Insectivora of Japan comprise a large number of species as compared with the majority of other mammalian groups in Japan, no comprehensive study has ever been carried out, mainly because of difficulties in collecting specimens.

The Japanese insectivores, together with many other animals, were first investigated scientifically by TEMMINCK (40), who described four species of Insectivora, i. e., *Crocidura dsinezumi* TEMMINCK, *Sorex platycephala* TEMMINCK (=*Chimarrogale platycephala*), *Urotrichus talpoides* TEMMINCK, and *Talpa wogura* TEMMINCK (=*Mogera wogura*). To these, GÜNTHER (10) and TRUE (49) added two important species, *Talpa mizura* GÜNTHER (=*Euroscaptor mizura*) and *Dymecodon pilirostris* TRUE, both of which are peculiar to Japan.

Later THOMAS (41, 42, 44, 45), KURODA (19, 23–25), KISHIDA (17), TOKUDA (46), and IMAIZUMI (12–14) published papers and monographs in which several other species and subspecies were described. Recently, "Colored Illustrations of the Mammals of Japan" by IMAIZUMI (15), including the species and subspecies hitherto described in the literature enumerated above, has appeared. This book and "A Monograph of the Japanese Mammals" by KURODA (24), which is also fairly comprehensive, are useful for the purpose of gaining general knowledge of the Japanese Insectivora.

The Insectivora of the Asiatic Continent, Sakhalin, and Formosa were studied by DOBSON (7), THOMAS (43, 44,) SOWERBY (38), KURODA (18–24), ALLEN (2), ELLERMAN and MORRISON-SCOTT (9), and STROGANOV (39). Their works give useful information to the investigators of this group.

Though all the above-mentioned works concerning Insectivora have been restricted mainly to taxonomy, there still remain many problems in this field, especially concerning the treatment of intraspecific variations.

In the present work, in order to dispell much confusion in the taxonomy of the Insectivora, the author has laid stress on the necessity both of collecting adequate numbers of specimens and of consideration of morphological variation and geographical distribution. A reevaluation based on these conditions has resulted in the discarding of a number of subspecies and of certain species, the latter now recognized in this study as mere variants within single specific groups.

Comparisons have been made of as many specimens of Insectivora as were available to the author. Although material from Eastern Asia was limited, that examined as part of this study has indicated the desirability of including these groups in any account of intraspecific variation. Few works on the taxonomy of the Insectivora have adequately considered the mainland fauna.

Ecological studies which were conducted in the field proved to be useful in carrying out the present work.

Acknowledgment. The author wishes to express his sincere gratitude to Prof. Emer. Dr. T. INUKAI for his valuable advice and help during the course of this work. The author must not omit an expression of his hearty thanks to many gentlemen who have generously placed their specimens at his disposal. Among them the author is particulary indebted to Dr. M. TOKUDA, Dr. E. KINOSHITA, Dr. R. TANAKA, Dr. K. ÔTA, Dr. R. HAGA, Dr. H. NISHIDA, and Mr. M. YAMASHIRO. The author's thanks are also due to Dr. Y. IMAIZUMI of the National Science Museum and Dr. M. YOSHII of the Yamashina Institute for Ornithology and Zoology, who allowed him an opportunity to examine the precious specimens under their care. The author was given valuable suggestions on the preparation of this English manuscript from Dr. R. L. RAUSCH, Chief of Zoonotic Disease Section, Arctic Health Research Center, Anchorage, Alaska, and Prof. Dr. K. SHIMAKURA, to whom the author's thanks are due.

II. Material and Methods

The author traveled extensively over Japan and collected as many specimens as possible in order to determine variations. A total of over 1400 specimens was thus assembled. Besides these, some valuable specimens were generously offered to the author by several gentlemen whose names have been given above. Therefore, this study includes almost all the species and subspecies of this group so far reported from Japan, as well as two species from Korea and one from Formosa.

In order to distinguish the relationships among closely related species it is preferable to make comparisons among individuals of equivalent age classes. For this purpose and for the study of population structure, the determination of age of specimens is requisite. In this work, age of the specimens was determined by the grades of tooth wear and by the transformation of cranial structure. In the genus *Sorex*, according to ABE (1), differential wearing of the hairs on the feet and tail may also be taken into account.

The characters of every age class are summarized as following:

Soricidae:

Age class	a	b	c
Teeth	Not worn	Slightly worn	Heavily worn
Maturity	Young	Subadult	Adult
Living period	Late spring to autumn	Autumn to the next spring	Spring to autumn or even thereafter of the second year

Talpinae:

Age class	a	b	c	d
Teeth	Not worn	Slightly worn	Moderately worn	Heavily worn
Maturity	Young	Young adult	Adult	Old adult
Living period	1st year	2nd year	3rd year	4th year

Scalopinae:

Age class	a-1	a-2	b, c, d
Teeth	The milk teeth are still in place.	The change from the milk teeth to the permanent is in progress or has been completed.	The same as in Talpinae
Maturity	Juvenile	Young	The same as in Talpinae
Living period	Early spring	Spring to midwinter	The same as in Talpinae

Based on the above classification, the relationship between age variation and geographic variation has been discussed. Other variation, including seasonal, individual, and sexual, has also been analyzed.

The habitat peculiarities of particular species and their ecological relationships with the other small mammals which often live in the same area have also been observed in the course of trapping.

The food habits of each species have been studied by the analysis of stomach contents and by field observations.

All the specimens were dissected to determine their sex and the status of their sexual maturity as expressed in the conditions of their genital organs and dermal glands.

The colors were described according to Ridgway's "Color Standards and Nomenclature" (34).

Specimens preserved in formalin were occasionally used for closer study of fine structures of the feet and other soft parts of the body.

Measurements were taken of the following dimensions in grams or millimeters :

Body weight. As far as possible, specimens trapped were weighed in the field.

Total length. With the animal laid on its back and stretched out, the length from the tip of nose to the tip of tail vertebrae, excluding any terminal pencils.

Length of head and body. Total length excluding the tail length.

Length of tail. Length from the upper base of tail to its tip, excluding any terminal pencils.

Length of fore foot. Length of the posterior border of manus to the tip of the longest digit without claw or with claw, as specified in particular cases.

Breadth of fore foot. The greatest breadth at about the bases of outer and inner digits.

Length of hind foot. Length from the heel to the tip of the longest digit without claw or with claw.

Ear length. Height from the notch below the ear opening to the tip of ear, excluding hairs.

Greatest length of skull. The overall length from the anterior tip of premaxilla to the posterior bulge of braincase (Talpidae) or occipital condyles (Soricidae).

Condylobasal length (Talpidae). Length in the middle line of skull, from a line connecting the anterior margins of the alveoli of upper incisors to a line connecting the posteriormost margins of condyles.

Basal length (Soricidae). Length from the posteriormost inferior border of concave tip of premaxilla to the anteriormost inferior border of foramen magnum.

Palatal length. Length, in the mid-ventral line of the skull, from the anteriormost point of the posterior border of palate to the posteriormost margin of alveoli of first upper incisor (Talpinae) or to the anteriormost margin of premaxillary bones (Scalopinae).

Breadth of braincase. The outer greatest distance across the braincase.

Depth of braincase. Vertical distance from a line connecting the tips of tympanic bullae to the highest part of cranium.

Least interorbital constoiction (Soricidae). The least distance between the inner orbital margins.

Greatest interorbital breadth (Talpidae). The greatest distance between the tips of the outward protrusions of the inner orbital margins.

Rostral breadth. The breadth of rostrum across the second upper incisors

(Scalopinae and Soricidae) or canines (Talpinae).

Zygomatic breadth (Talpidae). The greatest distance between the outer margins of zygomata.

Breadth across molars. The greatest distance between the outer surfaces of molars.

Length of posterior half braincase (Talpinae). Distance between the line connecting the tips of mastoid processes to the posteriormost bulge of braincase.

Length of upper tooth row ($I\underline{1}$–$M\underline{3}$). Distance between the outer margins of first incisor and last molar on the left side of the upper jaw.

Length of upper unicuspid row (Soricidae). Length of the upper unicuspid row in crown view.

Length of mandible. Length from the anterior tip of mandible to the posterior tip of condylar process, excluding parts of any tooth that extends forward from the anterior end of the bone.

Length of lower tooth row. Distance between the outer margins of first incisor and last molar on the left side of lower jaw.

Projection degree of incisor row (Talpinae). Percentage of the difference between the length of upper tooth row and the length from canine to the last molar of upper jaw to the rostral breadth.

III. Intraspecific Variations

A. Variation other than geographic

Insectivora have been generally conceded to be morphologically very variable in the same way as the murids, and this fact might have caused much confusion in systematics of this group.

PALMER (31) studied individual, age, sexual, and seasonal variation in *Scapanus latimanus*. EADIE (8) divided his sample of *Parascalops breweri* into certain age classes according to the variation in teeth. CONAWAY (5) also studied the age variation of *Sorex palustris navigator*. Recently, similar studies were carried out by PRUITT (33) on *Sorex cinereus*, by RUDD (35) on three species of *Sorex*, by SERAFINSKI (36) on two species of *Sorex*, by CLOTHIER (4) on *Sorex vagrans*, by ABE (1) on two species of *Sorex*, and by CROWCROFT and INGLES (6) on *Sorex araneus*, respectively.

Thus it has been made clear that the so-called "inherent variability" of insectivores is actually no greater than that in many other mammalian groups.

a. Individual variation

All variation except the four types which are considered in the following pages was tentatively designated as individual variation.

1. Individual variation in the form and size of skull and body is usually less remarkable than that of geographic character, but the ranges of the size variation are sometimes similar to those of the age and sexual variation.

2. The color of adults from a given locality is fairly constant, though there is a slight variation within some restricted ranges. Even so, a few abnormalities in color were seen in *Sorex caecutiens saevus* and *Mogera kobeae*: one subadult female of the former from Nijibetsu, Kushiro Prov., Hokkaido with light drab fur all over from the head to the tip of tail, and a subadult male of the latter from Nishinoomote, Tane Is., with a spot of orange color on the right side of body.

3. Of the individual variations, one of the most frequent is the variation in the form and the size of unicuspid teeth or of cusps of other teeth. Every species has a peculiar type in such dental characters. However, the type is not always exactly constant but varies within a certain extent, and the mode of variation is rather constant in each species. It will be described for each species in the chapter of classification.

4. Another variation is seen in the number of teeth. However, this has been observed only in *Suncus murinus*. Among fourteen individuals of this species, three were found to have abnormal dentition, in possessing a lesser number of teeth than the normal: one is lacking the third left incisor and left canine of upper jaw; a second, lacking the first right premolar of upper jaw; and the last, lacking both the first upper premolars.

In other groups tooth reduction is never seen except for that caused by old age.

b. Age variation.

The confusion in taxonomy of Insectivora has been caused by inadequate consideration of age variation as well. Recently, the age variation in this order has been studied by many investigators, as indicated above, and it has been made clear that the form varies regularly with age.

General age variation in the Japanese Insectivora is summarized as following:

1. The body weight increases until adult stage except for that of *Sorex* which slightly decreases in old age (Figs. 1 and 3).

The body weights of young individuals of *Sorex* which were born from spring to autumn increase rapidly in the next spring when they attain their full growth with sexual maturity. In *Urotrichus* the body weight increases rapidly until the "a-2" stage of age in which the milk dentition is changed to the permanent one, after which it is rather constant to the stage of old age.

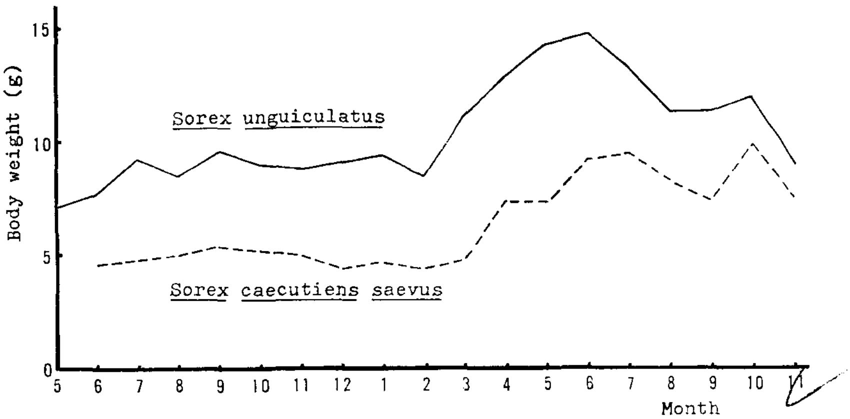


Fig. 1. Monthly changes in body weight of *Sorex unguiculatus* and *Sorex caecutiens saevus*.

2. The length of head and body increases until old age in every species. However, the degree of the change after the animal becomes old enough to fend for himself is different between Talpidae and Soricidae, i. e., the degree of the former is very much smaller than that of the latter (Figs. 2 and 3).

3. The tail grows more rapidly than does the body. Therefore, the ratio of tail length to the head and body length is variable according to age. The variability is distinctly smaller in Talpidae than in Soricidae. Thus, the tail ratio of the former may be widely used for the discrimination of species, but in Soricidae a careful arrangement of samples into the proper age classes is necessary in order to make adequate comparison.

4. The hind foot is at its maximum early in life and changes little thereafter. The size, therefore, may be utilized as a useful criterion of the characteristics of species.

5. The manus and ear also grow rapidly, and after maturity there is little increase with advancing age.

6. Immature animals have relatively shorter and more compact fur of which the color is darker than that of grown individuals. In *Sorex* the hairs on the feet and tail are worn out with advancing age, and the digits and the tail tip become naked in senile individuals.

7. The greatest length of skull is reached at an early age, and this dimension almost never increases thereafter (Figs. 2 and 4). The skull of juveniles has a weaker construction, a more rounded braincase, and ill-defined ridges. With the advance of age, the skull bones become thick and angular. This change of skull is usually more remarkable in Soricidae than in Talpidae.

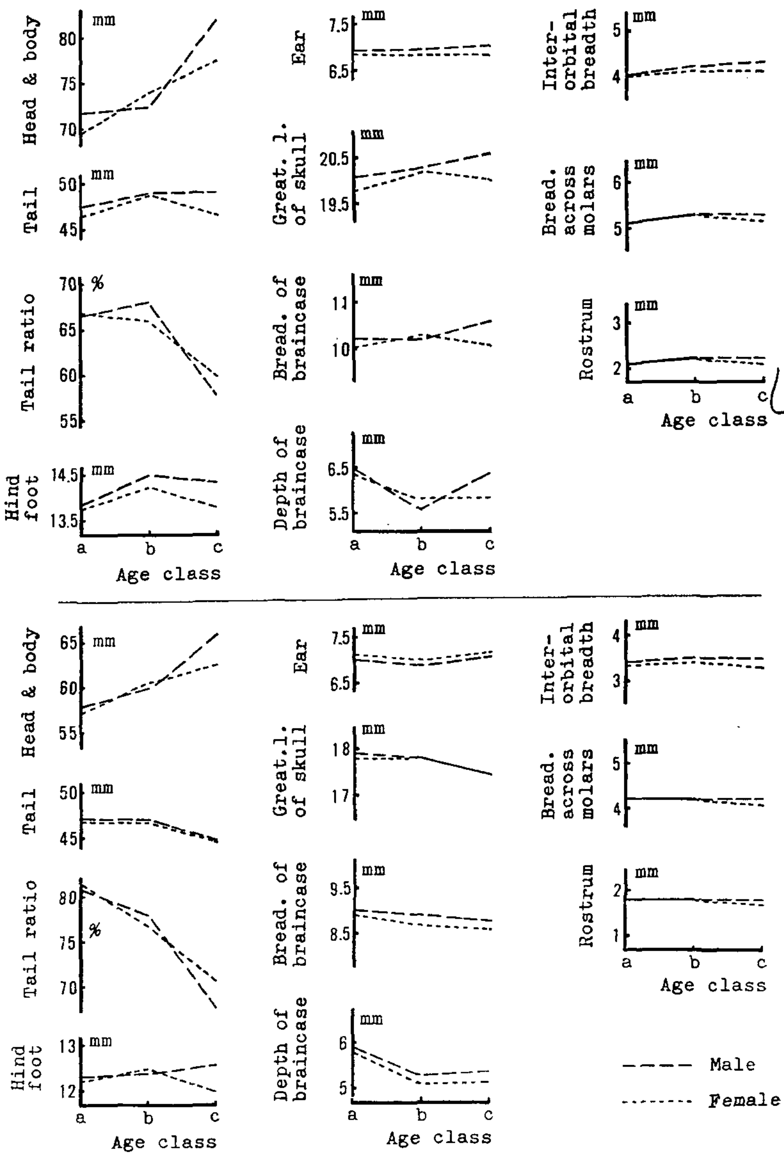


Fig. 2. Age variation in eleven dimensions of the body and the skull in *Sorex unguiculatus* (upper) and *S. caecutiens saevus* (lower).

For example, relatively high crests are formed at the sagittal and the lambdoidal sutures in full grown skulls of the former but not in the latter.

One of the most noticeable age variations is the flattening and slight broadening of the braincase as indicated by the deflation of roofing bones and by the lateral growth of mastoides. It is also seen a slight increase in maxil-

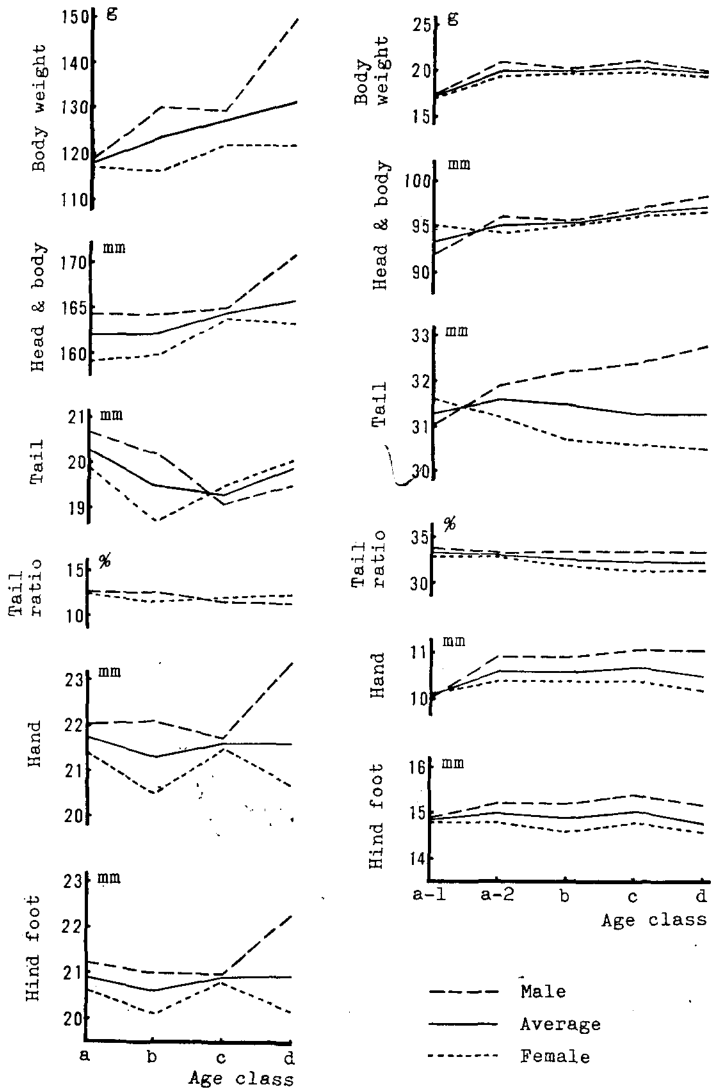


Fig. 3. Age variation in six dimensions of the body in *Mogera kobeae* (left) and *Urotrichus talpoides* (right).

lary breadth due to the thickening of sublachrimal maxillary ridges. The breadths of rostrum and zygomatic arches, if present, gradually increase with age. The posterior bulge of supraoccipital bone is less remarkable in adult skulls than in young ones.

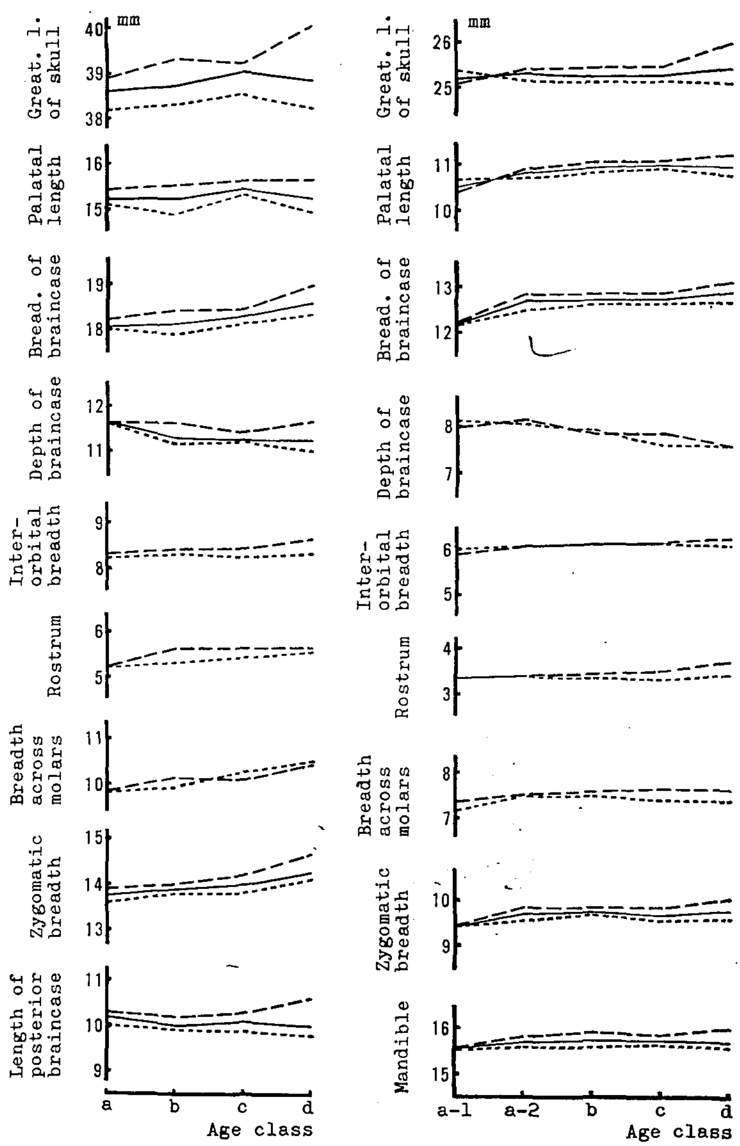


Fig. 4. Age variation in nine dimensions of the skull in *Mogera kobeae* (left) and *Urotrichus talpoides* (right).

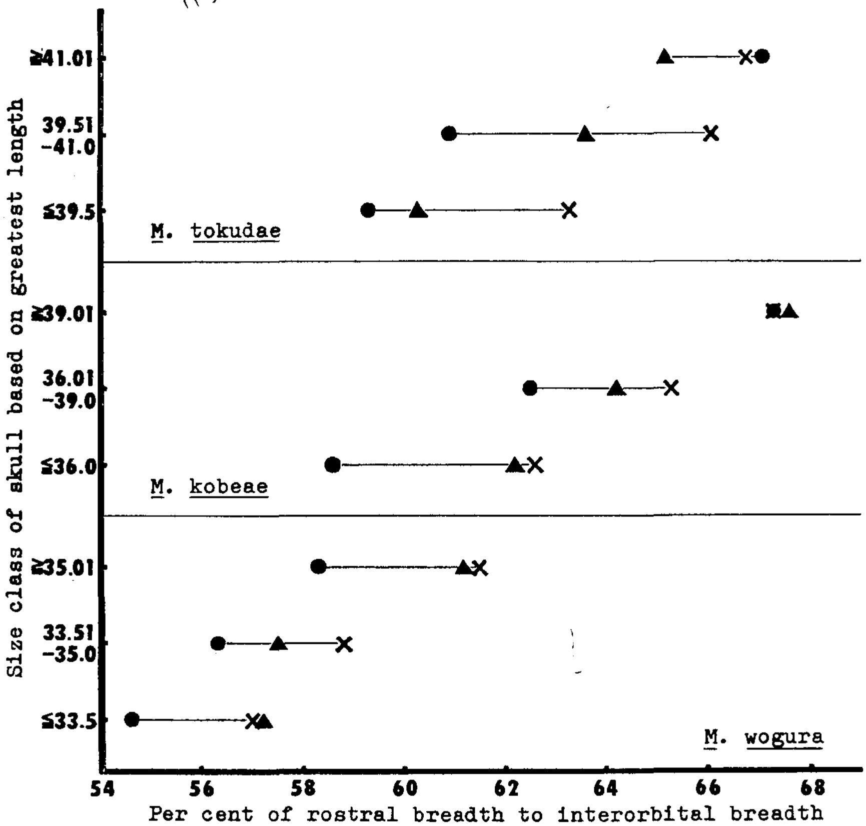


Fig. 5. Relationships of the size of skull, the A-index, and the age variation in the three species of moles.
Age class: ●—a, ▲—b, ×—c and d.
The three size classes in each species can be also regarded as geographic variation in size, i. e., the upper size class represents the larger local form and the lower size class the smaller local form.

In *Mogera*, the proportion of the rostral breadth to the interorbital breadth, the projection degree of the incisor row, the proportion of the length of the posterior half of the braincase to its breadth, and the proportion of the breadth across molars to the palatal length, which are tentatively assigned as A-, B-, C-, and D-index, respectively, represent remarkable age variations (Figs. 5–8). Aspects of the variations are distinctly different among indices and among species. A-indices of *M. wogura* and *M. kobeae* increase rapidly between "a" and "b" stages of age, except for those of the largest size class

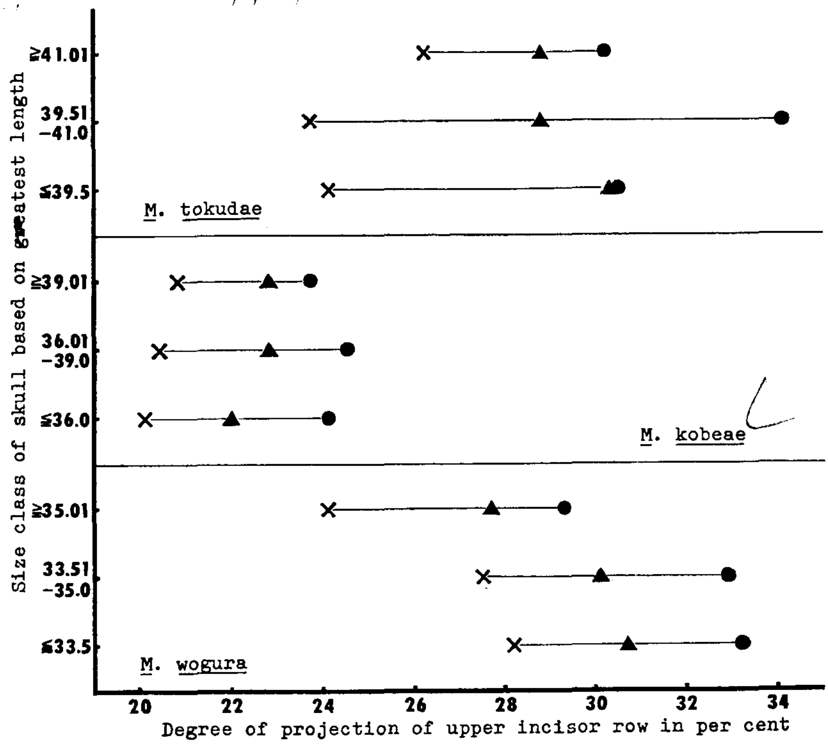


Fig. 6. Relationships of the size of skull, the B-index, and the age variation in the three species of moles (for legends cf. Fig. 5).

of the latter species which only slightly represent the age variation. The variation pattern of *M. tokudae* appears to be similar to that of the other two species. However, the absolute value of the index of the former species is small for the larger overall size of the skull and roughly corresponds with that of *M. kobeae.* B-index shows a regular decrease with age in all the three species. C-index indicates little age variation. Another index (D) also increases with advancing age, but in *M. wogura* the rate of the increase is gradually diminished with decrease in size of skull.

Many dimensions of the skull of *Urotrichus* are maximal by the "a-2" stage of age and little changes occur thereafter (Fig. 4). Maximal differentiations of the three dimensions, palatal length, breadth across molars, and breadth of braincase, are apparent at an earliar stage of age in large individuals than in small ones (Figs. 9 and 10).

In very young specimens of Soricidae, the premaxilla lies rather parallel

10 × 8.5 85

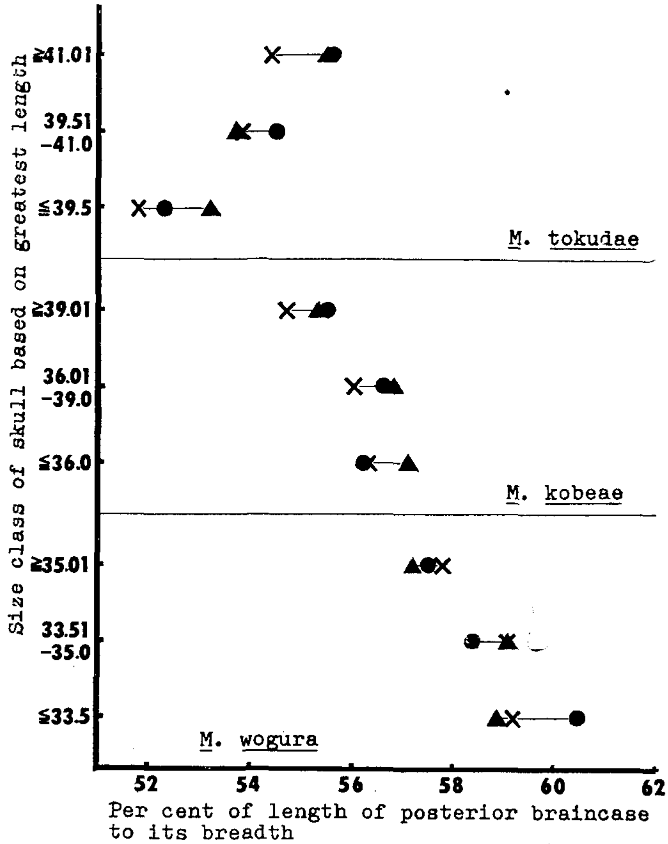


Fig. 7. Relationships of the size of skull, the C-index, and the age variation in the three species of moles (cf. Fig. 5)

with the long axis of the skull; but the anterior part of it decurves sharply in grown ones. From this effect, the direction of the incisors, projecting forward in the young, is shifted downward in the senile.

8. Milk dentition is lost at an early stage of age, except in Scalopinae. In this group the very young individuals which are old enough to fend for themselves and hence to be trapped still have the milk teeth; these teeth are used for some time, as indicated by the slight wear in evidence when the permanent dentition is erupting. The alternation between the two types of teeth occurs from the first incisors toward the last pemolars, so that the individuals which have partially the two types of teeth are often seen in the members belonging to early "a-2" stage of age.

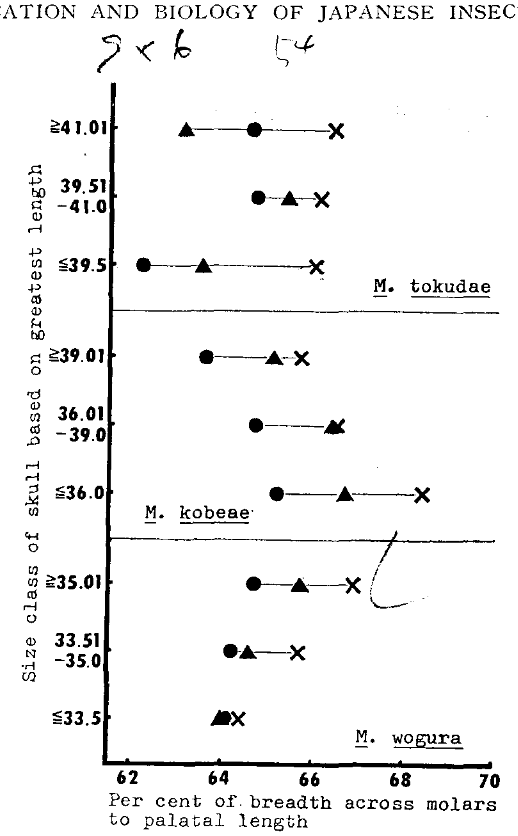


Fig. 8. Relationships of the size of skull, the D-index, and the age variation in the three species of moles (cf. Fig. 5).

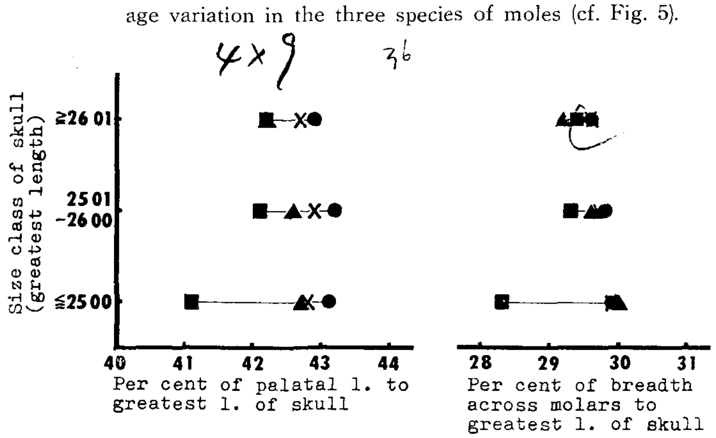


Fig. 9. Relationships of the size of skull, the proportions of two parts of skull, and the age variation in *Urotrichus talpoides*. Age class: ■—(a−1); ▲—(a−2); ×—b; ●—c and d.

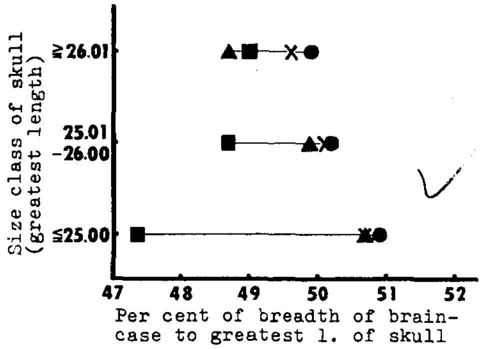


Fig. 10. Relationships of the size of skull, the proportion of the breadth of braincase to the greatest length of skull, and the age variation in *Urotrichus talpoides* (cf. Fig. 9).

Although there may be some variations with localities or with individuals, the tooth wear of insectivores appears to be relatively constant throughout the life. Therefore, this is frequently utilized for the determination of relative age as adopted in this paper. The perfect teeth which are fully erupted, usually in an early stage of age, are worn out to the gum line in the senile; in the latter, the last upper premolars and the third upper molars are occasionally so worn that only the roots remain.

The shapes and the sizes of teeth usually afford an important diagnostic criterion for each species. However, since worn teeth frequently have lost their peculiar forms, it is very difficult to distinguish species on the sole basis of such a character as teeth.

In very old specimens of Talpinae, the roots of the molariform teeth, as a result of hyperplasia, are often exposed through the lateral surfaces of the maxillae.

The young individuals of *Mogera* have more projecting rows of incisors than the old.

c. Seasonal variation.

Common seasonal variation is in the texture and in the coloration of pelage. Ordinarily, the winter coat is slightly darker and more compact than that of the summer. Thus, they can be easily distinguished.

Borowski (3) studied the density of coat during the life cycle of *Sorex araneus* in Europe and recognized that the density of winter coat is greater than that of the summer.

Molting usually occurs twice a year: autumn and spring; but the period of molt is very variable with localities and with individuals. For example, *Sorex unguiculatus* and *Sorex caecutiens saevus* molt usually between May and June in spring and from September to October in fall. But the molting periods vary to a great extent with individuals, e.g., two specimens of the former obtained on August 16 and on February 6 were just molting at the time caught and had partially the two types of pelage, and one of the latter taken in November still had a full summer pelage.

d. Sexual variation

Sexes ordinarily differ in the sizes of body and skull, with males slightly larger in average size than females. Such difference of body size is usually more marked in Soricidae than in Talpidae. In breeding adults of the former, the difference is so remarkable that the sex may be determined only by the examination of the body size in many cases. Moreover, in *Suncus murinus* the thickness of the tail is distinctly greater in the male than in the female.

In Talpidae the difference in size with sex is seen only in the subfamily Talpinae. For instance, the skull size of *Mogera* is significantly different in average between the sexes (p 0.01), while in *Urotrichus* and *Dymecodon* (subfamily Scalopinae), the difference is not significant even at the 5 per cent level.

In addition to these size differences, males in the breeding season possess a characteristic odor which is stronger than in females. In *Mogera*, it is observed that in the breeding season and for some time thereafter a brownish-yellow or golden stain appears on underparts of body, always more extensively in males. The stain in the males usually extends from the ventral surface of the lower jaw posterily over the chest, spreading laterally to the fore limbs and posteriorly along the mid-ventral area of the abdomen to the inguinal region, around which there is a heavily stained area. In females the stain, which is generally less intense than in males, is usually limited to the under side of the jaw, the chest, and a small area about the inguinal region. The characteristic breeding odor comes from the yellowish secretion emitted by special scent glands in these areas. The skin around these glandular areas heavily increases in thickness in the breeding season, assuming increased activity of the gland. Glandular activity of the young, however, is less, until the following spring when as mature adults they take part in breeding.

In *Urotrichus* and *Dymecodon*, such a pigmentation is usually less intense than in *Mogera* and is dark brown in coloration.

In Soricidae, there are similar but more localized glands on the body sides. The active period of the scent glands also coincides with the breeding activity. For example, the monthly changes in size of the dermal scent glands of *Sorex unguiculatus* and *Sorex caecutiens saevus* are shown in Figs. 11 and 12. The

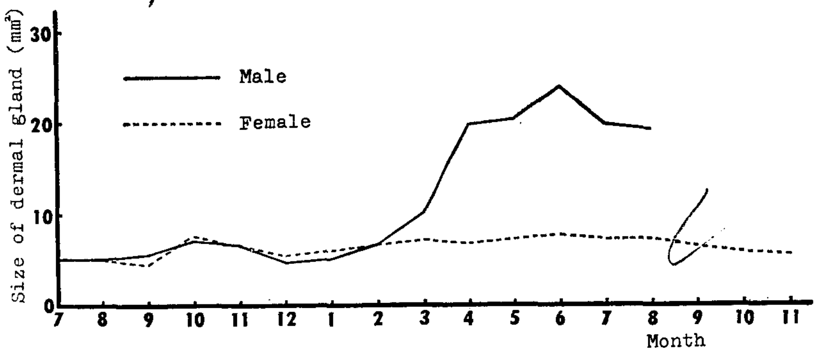


Fig. 11. Monthly changes in size of the dermal scent gland of *Sorex caecutiens saevus*.

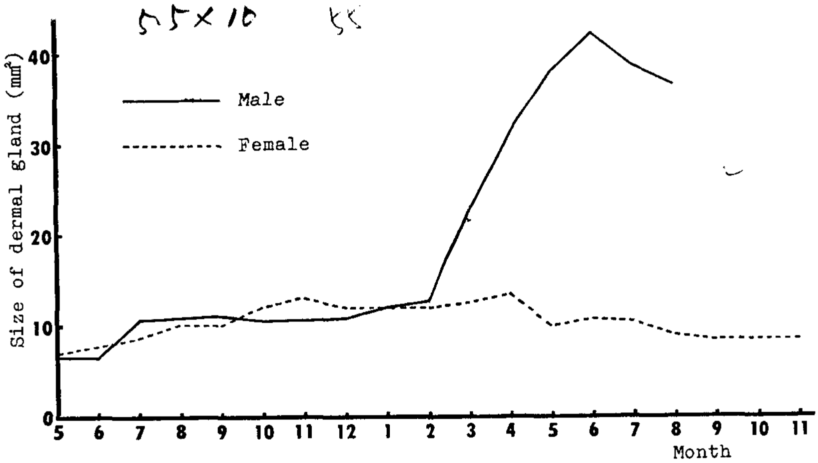


Fig. 12. Monthly changes in size of the dermal scent gland of *Sorex unguiculatus*.

change in size of the dermal glands of males coincides well with that of the testes, whereas the glands of females do not develop even in the breeding season. Males in breeding season, therefore, have scent glands conspicuous enough to be easily visible externally. The glandular areas of these adult males vary in size from $7\times2.4\,mm^2$ to $10\times6.8\,mm^2$ in *S. unguiculatus*, and $4\times3.5\,mm^2$ to $11\times3\,mm^2$ in *S. caecutiens saevus*, and those of adult females are from $5\times0.8\,mm^2$ to $8\times2\,mm^2$ and from $3\times1.2\,mm^2$ to $5\times1.5\,mm^2$, respectively. In immature animals, however, the average size of the dermal gland is not different between both sexes and the glands are not apparent externally. The scent glands of *Crocidura* and *Suncus* vary also in the same manner as in *Sorex*. In breeding season, the glands of *Suncus murinus* are very remarkable not only in the male but also in the female, though those of the latter are somewhat smaller. Those of adults in *Crocidura dsinezumi* measure from $7.3 \times 5\ mm^2$ to $10.5 \times 7\ mm^2$ in males and from $5.5 \times 4\ mm^2$ to $7.5 \times 4\ mm^2$ in females, whereas those of *Suncus murinus* are $14 \times 10\ mm^2$ to $20 \times 12\ mm^2$ in males and $10 \times 6.5\ mm^2$ to $15 \times 10\ mm^2$ in females.

B. Geographic variation

As has been popularly recognized since the famous work of DARWIN, living organisms usually vary, more or less, with the change of the environments in which they live. Therefore, a wide-spread species may naturally have various local populations within its own range as a response of the individuals to different environmental conditions. Since the physical conditions of environment usually change gradually from one district to another, it is only natural that the inhabitants therein represent a perfect cline paralleling such environmental variations. Investigators of the Insectivora, however, have often divided such variants into local subspecies without detailed research. In my opinion, such a procedure is to be criticized and excluded from the modern taxonomy, for it serves nothing but to confuse the systematics of this group and does not elucidate the nature of species.

Before proceeding into detailed accounts, general geographic variations must be considered. Related but different groups of animals obtained in the same locality occasionally show a parallel variation among themselves, with a certain tendency to change with environmental conditions. The following are the widely recognized rules of the variations in mammals and birds :

ALLEN's rule—In wide-spread species, individuals from northern populations have shorter tails, ears, and hind feet.

BERGMANN's rule—Northern populations usually consist of individuals larger than those from southern regions. This phenomenon may have a close relationship with the growth and the development of the animals in each locality.

GLOGER's rule—Coloration of animals varies with the temperature or humidity of the habitat. The black, brown or rusty-red color is more intense in the individuals from southern populations than in those from northern aggregations.

Variations found in the Japanese insectivores do not always correspond with the above rules. BERGMANN's rule, for instance, usually may be applied with regard to the variations found in a group of northern origin but not always to those found in a group of southern origin. Actually, some of the latter show the reverse mode of variation to the rule, i. e., larger individuals are found not in the northern localities but in the southern areas.

Some examples of the geographic variations found in Japan are as follows :

a. *Mogera wogura* group

Mammals of the genus *Mogera* widely range from Japan to Formosa and Hainan, through eastern parts of the Asiatic Continent. In Japan three species of moles are recognized under this genus. One, *Mogera kobeae* THOMAS, is common in the southern half of Japan, as shown in detail in the following chapter. *M. wogura* (TEMMINCK) occurs in the northern half of Honshû except in the central part of the plain of Niigata, and also is present as scattered small populations in certain mountain regions of Chûgoku and Shikoku districts, and the Kii Peninsula, the regions which are surrounded by the ranges of the former species. The distribution of *M. tokudae* KURODA is restricted to a narrow range of the lower basins of the Shinano River and the Agano River in the central plain of Niigata in Honshû, and to Sado, an island off the west coast of the plain.

The habitats of *M. kobeae* and *M. wogura* sometimes come in contact or more or less overlap with each other in their peripheral areas as at Nezame, Agematsu Town, Nagano Pref., and on the range from Ueda, Shiojiri City, to Nakanohashi, Tatsuno Town, Nagano Pref. Similarly, those of *M. wogura* and *M. tokudae* are in contact in Shibata City, Niigata Pref. Such peripheral areas are inhabited by the respective two species of moles of which the size, form, and color are sharply different (Fig. 13). In every case, however, the two species of moles usually do not uniformly mix in distribution, even within the areas, but form small colonies of the same species which in effect segregate the micro-ranges from each other. No hybrid individual has been taken from the overlapped area.

Morphologically the above three species are so similar to one another that *M. kobeae* and *M. tokudae*, considered to be distinct in this paper, have been referred, even by "splitters", to subspecies of *M. wogura*. However, a careful study of a large series of specimens from various districts of Japan and of distributional aspects has led the author to conclude that these froms have remarkable distinctions in the morphology of the skull and in the geographical distribution, respectively. Thus, the former two are accorded specific status.

As mentioned in the section on age variation, the degree of projection of the incisor row decreases gradually with advancing age. *M. kobeae* has less projecting incisors, which are arranged in the shape of a round arc even in relatively young individuals, and is sharply different, in many cases, from *M. wogura* with a more projected and V-shaped incisor row and with usually

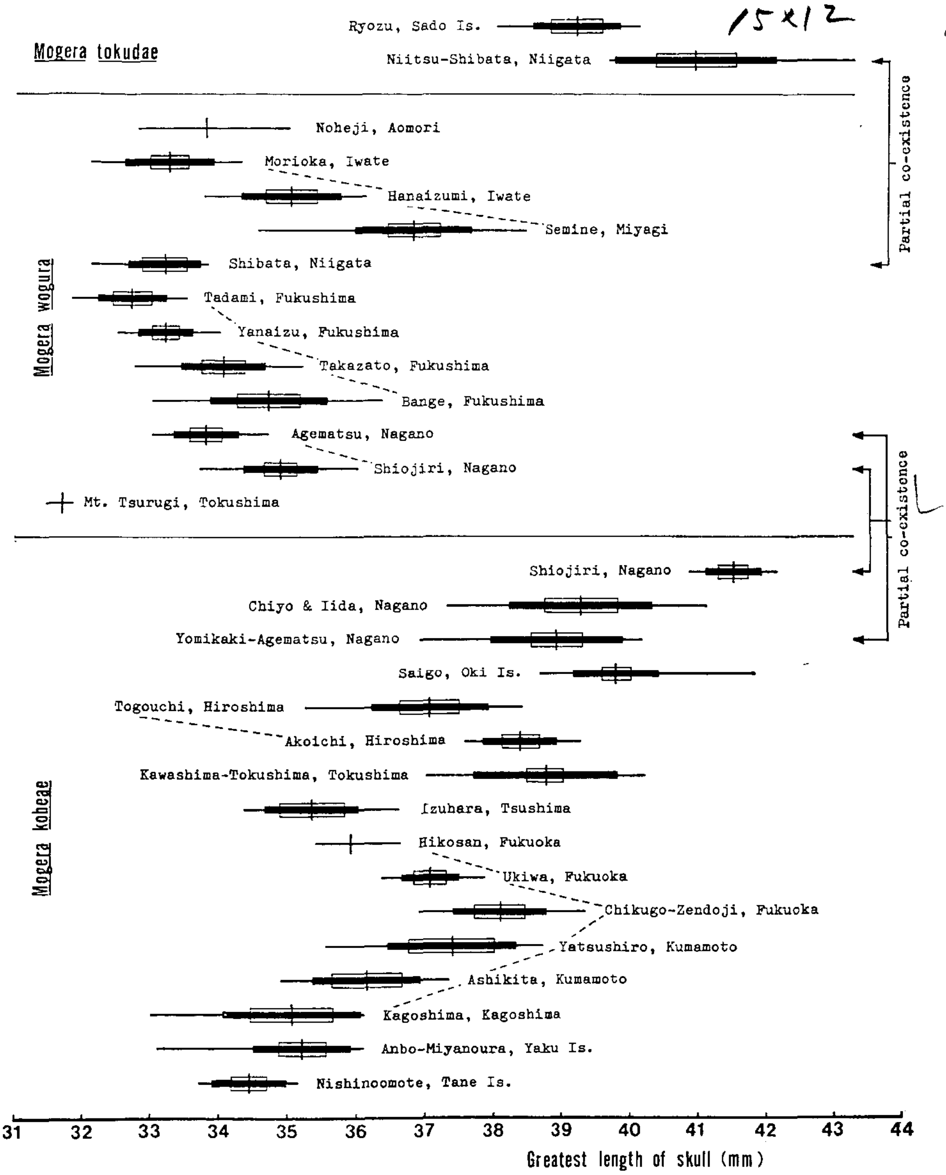


Fig. 13. Geographic variations in the greatest length of skull in *Mogera tokudae*, *M. wogura*, and *M. kobeae*.

There is no topographic barrier among the localities connected with broken lines, and the neighboring localities are relatively closely situated to each other as upper and lower ones along a river basin. The horizontal line indicates the total variation of the sample; the broad portion of the line, one standard deviation on each side of the mean; the rectangle, twice the standard error on each side of the mean; the vertical line, the mean.

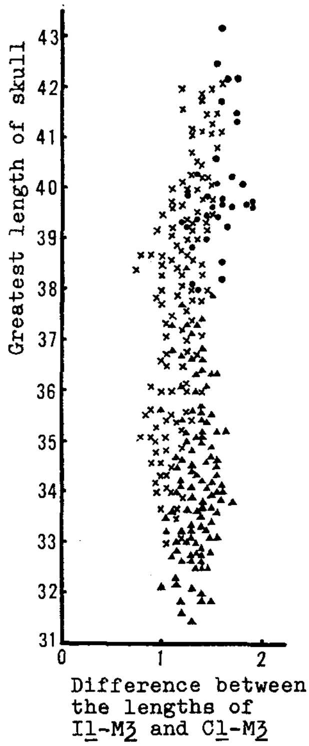


Fig. 14. Relationships between the difference of the lengths of I 1-M 3 and C 1-M 3 and the greatest length of skull in the three species of moles.
▲ *Mogera wogura*, × *M. kobeae*, ● *M. tokudae*

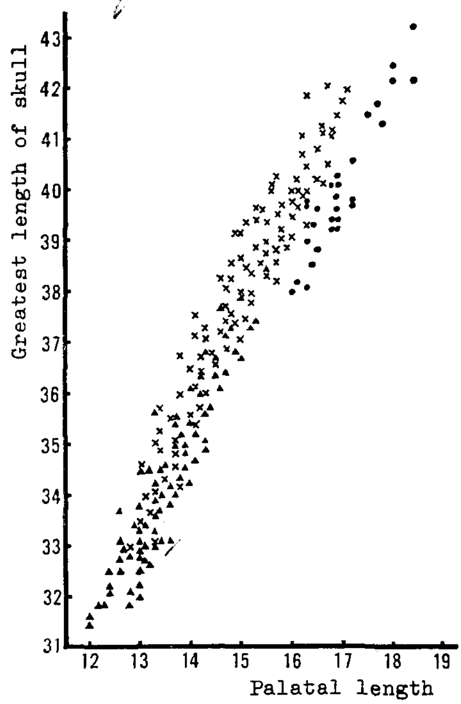


Fig. 15. Relationships between the palatal length and the greatest length of skull in the three species of moles (cf. Fig. 14).

darker color (Fig. 14 and Plate 1). On the other hand, *M. tokudae* is very characteristic in its relatively long tail and long palate (Fig. 15). These distinctive characters are, of course, prevalent over the geographic variations that they may be utilized for the discrimination of species in many cases. According to the morphological and distributional facts stated above, these three forms appear to have accomplished divergence into entirely distinct species, rather than into mere geographic variants of a single species.

Marked geographic variations are seen in many dimensions, which have been hitherto utilized for the discrimination of species. In the first place the greatest length of skull will serve here for a criterion of the geographic variation in size, as shown in Fig. 13. Usually, moles inhabiting wide, lower alluvial plains which have deep and loose soil are distinctly larger than those from restricted habitats which have shallow soil, such as upper basins of a river. In other words the decrease or increase in size of the moles usually occurs in accordance with the decrease or increase of the extent of suitable habitat for the moles in a given locality. For example, in western and southern Kyûshû, the mole, *M. kobeae* gradually decreases in size from the largest of Chikugo City and Zendôji Town, situated on the wide lower basin of the Chikugo River, toward the smaller extreme of Kagoshima City, through entire intermediates of moles at Yatsushiro City, situated at the southern end of the extensive plain of Kumamoto, and at Ashikita Town, located on more southern and restricted area. There is also seen a decrease in size from the lower Chikugo River basin toward the upper and narrower valley; namely, the size of the mole is gradually diminishing from the largest in Zendôji Town toward the smallest on the cultivated slopes of Mt. Hikosan (at 700 m alt.), through the intermediate of Ukiwa Town which intervenes between the two (Fig. 13).

Similar gradations from one extreme to another are also seen in Fig. 13, i. e. in the Akoichi-Town-Togouchi Town series along the Ôta River basin in Hiroshima Pref., in *M. kobeae*; and in the Shiojiri City-Agematsu Town series of Nagano Pref., in the Bange Town-Tadami Town series along the Tadami River basin in Fukushima Pref., and in the Semine Town-Noheji Town series in Miyagi and Aomori Prefs., in *M. wogura*. As shown by these observations, this kind of variation almost always occurs in the Japanese moles without any definite relationship to the direction of south or north, to the height of latitude, or to the species. BERGMANN's rule, therefore, can be applied only to the cases in which the individuals from the habitats having similar topography are compared among different latitudes. The local variations occurring with relation to the local topography seem to be affected more strongly by factors such as the kind and nature of soil and the richness of food than by the climatic factors which may act strongly in variations of the type to which BERGMANN's rule is applicable.

Especially large-sized animals of *M. kobeae* are found, however, at Ueda, Shiojiri City, and at Yomikaki Village, Nagano Pref., in spite of the fact that they both are located in a narrow valley of the Kiso River. This contradicts with the tendency that wide plains produce large-sized moles and narrow valleys the smaller and appears to require special explanation. This may be an ecological problem.

A more or less similar condition exists in the Japanese yellow weasel, *Mustela sibirica itatsi* (48). After the introduction of this weasel to Hokkaido, the individuals taken from the peripheral areas of distribution were very much larger than others. The animals which are progressively enlarging its distribution toward new ranges may be capable of obtaining more food, contributing to the animals' good growth. This may be an important factor for the above phenomenon. Morever, there are other instructive examples in this regard. LACK (26) studied the character divergence of Galapagos finches (*Geospiza*) and reported interesting results. Namely, some of the finches coexist on a certain island and segregate as to their available foodniche, resulting in bill characters more diverged than is the case on other islands which are inhabited by simpler bird fauna. VAURIE (50) also demonstrated a similar phenomenon in the bill characters of two species of rock nuthatches (*Sitta*). The two species are largely allopatric in eastern and western Eurasia and are very similar to each other in bill size. In Iran, however, the populations of the two species are in contact with each other, and one of the species has sharply diverged to a form with large bill, the other to one with small bill. These character divergencies seem to result in the reduction of ecological competition. The instance of the moles described above may be referable to a like situation.

Usually very cohesive clayish soil and strongly acidic soil appear to be unsuitable for moles in various respects. For example, the surface soil of the lower basin of the Kitakami River in Miyagi Pref., is loose, moist and not strongly acidic, and comparatively large individuals of *M. wogura* occur there. At Hanaizumi Town and Maezawa Town, situated on the upper basins of the river and occupied by a very cohesive soil, however, the moles become smaller in size and less in number, presumably because of the characteristic soil. This type of soil seems to make the moles' activity difficult and also to yield soil organisms poor as food. In Japan, strongly acidic soil is widely distributed in the valleys of mountain regions, of which the surface soil usually retains high moisture; occasionally it is composed of volcanic ashes. The surface soils around Morioka City, Tadami Town, and Kagoshima City are of this type. Moles from these localities are usually smaller than those from other localities (Fig. 13). The factors affecting the size of animals may not be very simple, but there must be some important correlation between the size variation of the moles and the soil types in these localities.

The proportion of the rostral breadth of skull to the interorbital breadth (A-index) and that of the posterior length of braincase to the breadth of it (C-index) also vary to a certain extent with localities or with the increase in the size of skull (Figs. 5 and 7). In these figures the three size classes in each species can be also regarded as examples of geographic variation in size, i. e., the upper size class roughly represents the large local form and the lower size class, the small local form. Usually the A-index represents a gradual increase with the increase of skull size. For example, the skulls of the large local forms from Ono, Shiojiri City, in *M. kobeae* and from Semine Town in

M. wogura have an apparently wider rostrum and a narrower interorbital portion than those of smaller local forms. The C-index decreases gradually with the increase in the size of skull except for that of *M. tokudae,* i. e., the posterior part of the braincase, viewed from above, changes from a deep bowl-shape in a small skull to a shallow bowl-shape in a large skull. In *M. tokudae,* however, it represents an entirely reverse aspect, because of the larger rate of increase in the length of posterior braincase as shown in Fig. 7.

These variations have a direct relationship with the change in the size of skull rather than with the environmental factors, though the latter may affect them indirectly. In these two indices of the small local forms there are remarkable inter-specific differences. With the increase in size of skull, both the indices of *M. wogura* approach those of the small local forms (but are subequal in size of skull to the larger ones of the former species) of *M. kobeae.* Consequently it is very difficult to distinguish such local forms of the two species only by these characters.

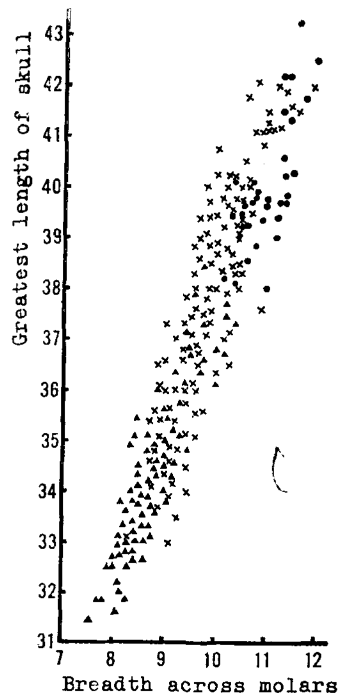


Fig. 16. Relationships between the breadth across molars and the greatest length of skull in the three species of moles (cf. Fig.14).

Another geographic variation is seen in the projection degree (B-index) or the shape of the incisor row. However, this occurs commonly only in *M. wogura,* and is seen but slightly in *M. kobeae* and *M. tokudae.* Usually the B-index is larger in *M. wogura* and *M. tokudae* than in *M. kobeae*; that of *M. wogura,* however, decreases with the growth of skull and approaches that of *M. kobeae.* Thus in this respect the large local forms of *M. wogura* are also similar to the small local ones of *M. kobeae.* Therefore, it is very difficult to distinguish them by other means than the comparison with relatively young individuals of the two species, for, in the large local form of *M. wogura,* the B-index and the V-shaped form of incisor row are remarkable only in the young, being obscured in the aged.

M. tokudae is similar in size to the largest local form of *M. kobeae,* but distinguishable from the latter by the conspicuously V-shaped form and rela-

Table 1. Geographic variation in the proportions of three dimensions of the body and the skull to the length of head and body in the three species of moles.

	n.	Tail (%)	Hind foot (%)	Greatest l. of skull (%)
Mogera tokudae				
Ryozu, Sado Is.	17	16.1	13.4	24.2
Niitsu-Shibata, Niigata	16	14.6	13.8	24.0
Mogera wogura				
Noheji, Aomori	3	12.4	13.5	25.8
Morioka, Iwate	20	13.5	13.5	25.8
Hanaizumi, Iwate	14	13.0	13.5	24.7
Semine, Miyagi	20	12.5	13.4	24.2
Shibata, Niigata	9	13.3	13.3	25.6
Tadami, Fukushima	14	13.9	13.6	25.4
Yanaizu, Fukushima	14	13.6	13.5	25.8
Takazato, Fukushima	15	13.8	13.6	25.5
Bange, Fukushima	14	13.6	13.6	25.1
Agematsu, Nagano	16	12.4	13.0	25.3
Shiojiri, Nagano	12	12.4	13.4	24.8
Mt. Tsurugi, Tokushima	4	13.5	13.6	25.6
Mogera kobeae				
Shiojiri, Nagano	13	13.4	13.0	23.3
Chiyo-Iida, Nagano	15	12.1	13.2	24.2
Yomikaki-Agematsu, Nagano	26	11.3	12.7	23.7
Saigô, Oki Is.	30	13.0	13.4	24.4
Togouchi, Hiroshima	15	12.5	12.7	24.4
Akoichi, Hiroshima	16	12.5	12.7	23.2
Kawashima-Tokushima, Tokushima	13	12.9	12.9	24.6
Izuhara, Tsushima	8	12.0	13.0	24.6
Hikosan, Fukuoka	3	12.6	12.5	25.2
Ukiwa, Fukuoka	12	13.4	12.9	24.6
Chikugo-Zendoji, Fukuoka	13	12.6	12.4	23.2
Yatsushiro, Kumamoto	9	14.1	12.9	24.0
Ashikita, Kumamoto	9	13.5	13.0	24.4
Kagoshima, Kagoshima	11	13.2	12.9	24.5
Anbô-Miyanoura, Yaku Is.	17	13.1	12.3	24.5
Nishinoomote, Tane Is.	18	13.1	12.5	24.9

tively large projection degree of the incisor row, and also from *M. wogura* by the larger body with relatively long tail.

The proportion of breadth across molars to palatal length (D-index) represents characteristic features in each species. The D-index of *M. wogura* increases with the increase of the skull size and approaches that of the small local form of *M. kobeae*, which in turn shows the reverse aspect to the former, because of the smaller rate of increase in the breadth across molars of the former species as shown in Figs. 8 and 16. It is obscured in *M. tokudae.*

The proportions of the greatest length of skull, the hind foot, and the tail to the length of head and body change to some extent with localities. The former has a slight tendency to decrease with the increase in body size which changes from one district to another, but in the latter two there are no regular variations in relation to the localities (Table 1).

In *M. wogura*, the smaller mountain forms have peculiarities of the skull and teeth, the rostrum being relatively narrow and long, the interorbital space swollen at middle, and the first upper incisors being higher than the others. But these characters gradually change toward those of the larger lowland forms which have somewhat cylindrical interorbital space, apparently broader and shorter rostrum, and three incisors subequal in height to one another with progression to lowlands or wide ranges. These features of the lowland form of *M. wogura* or that from extensive ranges are very similar to those of the small local form of *M. kobeae.*

The correlation of color with environmental factors is readily observable. From south to north in Kyûshû district, there is a general tendency for paleness of coloration, being correlated, probably, with the decrease in the wetness of climate. This has been called GLOGER's rule and has been observed in many other kinds of mammals and birds. Usually montane individuals are definitely much darker than those of lower life zones, apparently because of the higher humidity of the mountainous area. The two exceptions that do not conform to this generalization are found in the population of Mt. Hikosan in *M. kobeae* and in that of Mt. Tsurugi in *M. wogura.* Although both the localities are situated in humid regions, the moles have relatively pale fur. Another marked color variation is seen in the specimens from Oki Island. All the specimens examined exhibit a conspicuous reddish brown in color, presumably because of the reddish clay covering the island.

Those populations, presented in Fig. 13, had been formerly separated into certain local subspecies. The populations of Tane, Yaku, and Kagoshima have been so far recognized as belonging to a subspecies under the name of *M. wogura kanai* THOMAS ; the populations of Chikugo City and Zendôji Town as *M. kobeae kiusiuana* KURODA ; those of Tokushima City and Akoichi Town as *M. kobeae kobeae* THOMAS ; those of Bange Town and Semine Town as *M. wogura wogura* (TEMMINCK) ; those of Mt. Tsurugi, Tadami Town, and Morioka City as *M. wogura imaizumii* KURODA ; and that of Sado Island as *M. kobeae tokudae* KURODA. As stated above in detail, the populations referred to *M. wogura kanai* and *M. kobeae kiusiuana* are mere geographic variations of *M. kobeae,* and have no significant differences to be recognized as distinct subspecies owing to the serial and gradual variations among them. *M. wogura imaizumii* is a name applied for the smaller mountain forms of *M. wogura.* However, it should not be separated taxonomically, because of the above same reason, as a subspecies. The consideration of *M. kobeae tokudae* as the species *M. tokudae* has already been discussed above.

b. *Urotrichus talpoides*

The Japanese shrew-mole, *Urotrichus talpoides,* is one of the endemic forms of Japan, and has not been found from any other region.

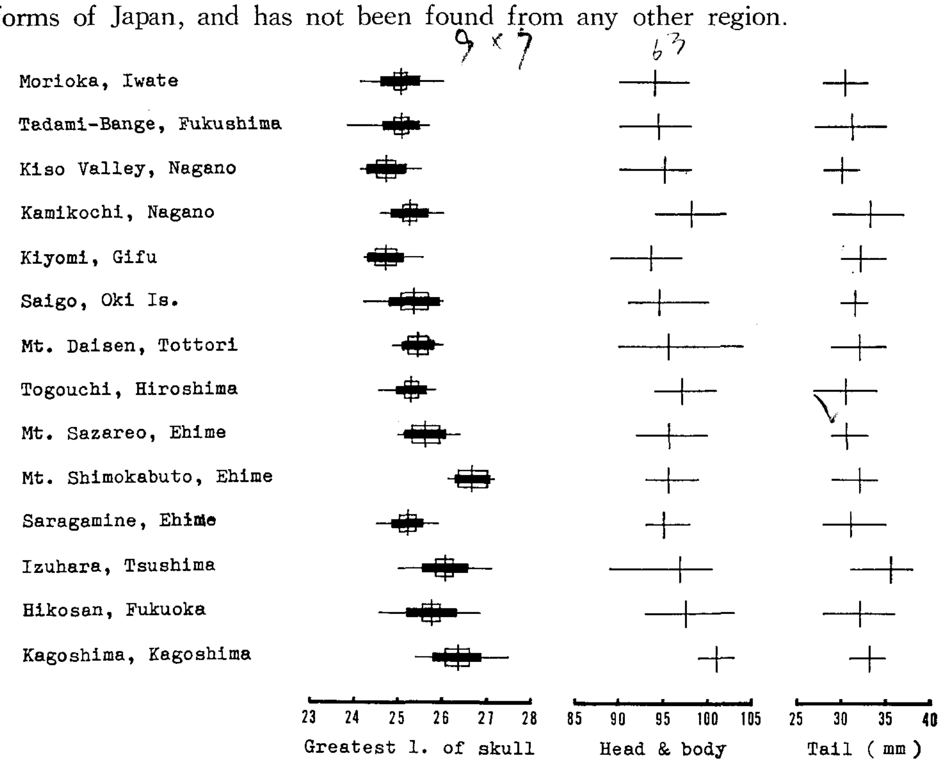


Fig. 17. Geographic variations in the greatest length of skull, the length of head and body, and the tail length of *Urotrichus talpoides.*

Though not so conspicuous as individuals of genus *Mogera*, this species also exhibits many local variations. Fig. 17 represents the geographic variations of the greatest length of skull, the length of head and body, and the tail length. Tendencies of the variations are entirely opposite to BERGMANN's rule and GLOGER's rule. Except for several instances, the shrew-mole gradually increases in size from colder north toward warmer south and reaches the largest extreme in the individuals of Kagoshima. On the other hand, the population of Kamikochi, Nagano Pref., consists of relatively large members, in spite of the relatively cold climate of the locality. Specimens from Tsushima are slightly larger than those from Hikosan, Fukuoka Pref. This may be due to the fact that, in spite of the northern location, Tsushima's climate, affected by the Tsushima Warm Current, is warmer than Hikosan's.

The relative size of upper fourth premolar to the size of skull decreases as the skull size increases. For example, the relative size of the tooth is, as far as I am aware, largest in the small specimens from Morioka City, Iwate Pref., and Mt. Hakkoda, Aomori Pref., and smallest in the large ones from Kagoshima, but in absolute size they are similar (Plate 2). The small specimens usually retain the upper fourth premolars with a round and thick proto-

Table 2. Geographic variation of the tail ratio and the proportions of three parts of skull with the greatest length of the skull in *Urotrichus talpoides*

	n.	Tail ratio (%)	Palatal length (%)	Breadth of braincase (%)	Breadth across molars (%)
Morioka, Iwate	37	32.3	43.3	50.9	30.4
Tadami-Bange, Fukushima	31	33.1	43.3	50.5	29.6
Kiso Valley, Nagano	17	31.6	42.2	49.9	29.7
Kamikochi, Nagano	23	34.0	42.4	49.8	29.1
Kiyomi, Gifu	17	34.4	42.4	50.6	29.2
Saigô, Oki Is.	13	33.4	43.3	49.8	30.4
Mt. Daisen, Tottori	14	33.7	42.9	50.6	30.2
Togouchi, Hiroshima	14	31.6	42.8	50.1	29.7
Mt. Sazareo, Ehime	9	31.9	42.6	50.3	29.2
Mt. Shimokabuto, Ehime	5	33.3	42.7	49.7	29.5
Saragamine, Ehime	15	32.9	42.4	50.2	29.5
Izuhara, Tsushima	29	36.7	44.0	48.5	29.8
Hikosan, Fukuoka	30	32.9	42.6	49.6	29.4
Kagoshima, Kagoshima	11	33.1	42.6	49.7	30.1

cone, while in the large ones the protocone is relatively thin.

Usually the tail ratio and the proportions of the length of palate, the breadth of braincase, and the breadth across molars to the greatest length of skull do not show a definite tendency of variation from one locality to another (Table 2). Furthermore, extremes of such geographic variations are bridged by many intermediates. Only the specimens from Tsushima have distinctly longer tail and longer palate than the other large local forms which are subequal in size to the former. From these characteristics and from the peculiar coloration, the population of Tsushima is considered to have gained some discontinuities to the others and is considered to be a distinct subspecies, *Urotrichus talpoides adversus*.

The pelage is usually darker in small forms from northern regions than in large forms from southern regions. The specimens from Tsushima with the palest coloration are sharply different from those of Hikosan and others.

Except for the population of Tsushima, all populations examined have not such remarkable differences among characters as to be separated into several distinct subspecies. For example, a geographic form described as *U. talpoides centralis* THOMAS ranges to the Shikoku district. Though there is observed, even in this district, a marked local variation in size, the sharp difference between both extremes of the variation, i. e., the small individuals from Saragamine and the large ones from Mt. Shimokabuto, Ehime Pref., is entirely bridged by the intermediates from Mt. Sazareo, Ehime Pref., so that they have to be regarded as mere geographic variants not deserving taxonomic recognition. On the other hand the local form from Saragamine conforms well to the population of Kamikochi, which is a mere local variant of "*U. talpoides hondonis*". Moreover, the local form from Mt. Sazareo is very similar to the population of Hikosan which is a mere local variant of *U. talpoides talpoides*. Thus many subspecies so far recognized are no more than local variations of a single subspecies, *U. talpoides talpoides*, which gradually varies from one locality to another.

c. *Dymecodon pilirostris*

Dymecodon pilirostris is also a species endemic to Japan and commonly inhabits the areas of alpine forests and shrubs of Honshû and Shikoku districts.

The geographic variation in size is quite similar to what has been indicated by the preceding species. However, it is different in other kinds of variation, i. e., the large specimens from Shikoku (situated in the southernmost region of geographic distribution) have the darkest pelage and the largest tail ratio, whereas the palest color and the smallest tail ratio are seen in the small specimens from the northern regions of Honshû. The specimens from Senjogadake and Kaikomagadake, Nagano Pref., intervening between the two localities, bridge, on the whole, the gap between the two extremes of the geographic variation. The variation of the tail ratio fits well with ALLEN's rule.

Although the proportion of palatal length to the greatest length of skull changes little from north to south, the relative breadth of rostrum, braincase, and palatal portion increases with the increase in the size of skull, resulting in the facial and palatal portions being more robust in the skulls of the large local forms than in the small local ones (Plate 2 and Table 3). From these observations and the tendency for general age variation, it is clear that the smaller local forms have, even in the adult, many characters found in immatures of the larger local ones.

Table 3. Geographic variation of the tail ratio, the greatest leng tho fskull and the proportions of three parts of the skull with the greatest length of skull in *Dymecodon pilirostris*.

	n.	Tail ratio (%)	Great. l. of skull (mm.)	Breadth across molars (%)	Breadth of braincase (%)	Rostrum (%)
Kamikôchi and Mt. Hakkoda, Honshû	10	48.0	21.7	25.8	47.5	11.1
Senjôgadake and Komagadake, Honshû	9	50.2	22.0	26.8	47.7	11.4
Mt. Shimokabuto and Mt. Tsurugi, Shikoku	6	51.7	22.6	27.4	48.2	12.4

d. *Crocidura dsinezumi*

I should like to add another example of parallelism in geographic variation. *Crocidura dsinezumi* is a common shrew on lowlands and low mountain regions of Japan. Geographic variations in the body size and in the characters of skull of this shrew essentially conform to those expressed in *Dymecodon pilirostris*. Specimens from southern regions have usually larger bodies and wider frontal parts of skulls than do those from northern areas (Fig. 18). This aspect in variation is also linked with age variation. In other words, the morphological variation which occurred with size has the same tendency as found in variation with age.

The color of pelage is very variable geographically. Specimens from Shikoku retain the palest pelages, snuff brown or bister on the back, buffy brown or drab on the belly. The color becomes darker in shrews from this

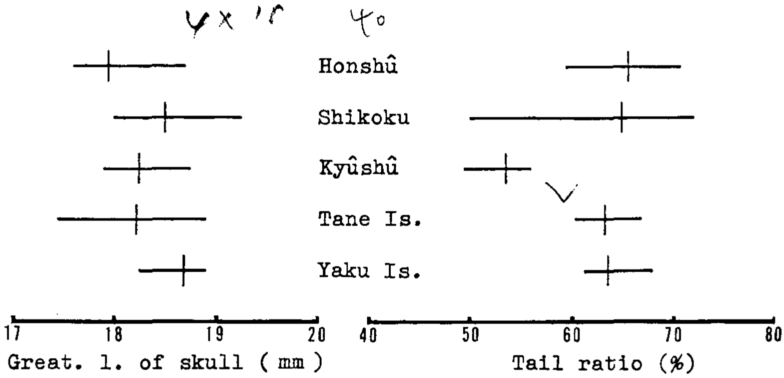


Fig. 18. Geographic variations of the greatest length of skull and the tail ratio in *Crocidura dsinezumi*.

district northward to central and northern Honshû and southward to southern Kyûshû ; in specimens from Kagoshima City and Tane Is., is seen the darkest, with the back clove brown or bister, and the belly hair brown in summer pelage. Specimens from southern Honshû and Zendôji Town, Fukuoka Pref., Kyûshû, completely intergrade in color between the two extremes and almost conform to those from Shikoku. Two relatively large specimens obtained at Agematsu Town and at Ôdaira, Iida City, Nagano Pref., have very dark pelages which are similar to those from Tane Is.

Since the variations above gradually change from one locality to another, they are regarded as mere geographic variations and are not differences so significant as to be recognized taxonomically.

The examples shown above indicate that every species in this group has a peculiar geographic variation. This appears to have resulted from the differences in the response of the respective species to the physical conditions of the respective environments, and it is very interesting that the mode of the response occasionally is the reverse with certain species.

The following conclusions are based on this study of the variations in Japanese insectivores.

1. Intraspecifically, large assemblages of geographic variants retain a number of characters as if they had progressed in age variation to an older stage, whereas in small geographic variants, even in the old stage of age, characters seem to be maintained to a relatively early stage of the age variation in the former. There may be also seen the same kind of relationship in interspecific variations as that discussed above.

2. In the insectivores, the wider the ecological distribution, the larger becomes the variation of the species. For example, *Urotrichus talpoides*,

which is confined to a habitat such as forests and shrubs of mountain regions, is less variable than *Mogera*, which lives in wider and complex habitats ranging from grass fields to forests or from lowlands to mountain regions. Although it has not been closely studied, this tendency seems to be observable in many other mammalian groups. When investigators discuss zoogeography based on the variability of some animals, therefore, this tendency must be taken into consideration.

3. BERGMANN's rule does not always fit all the geographic variations in the species of Insectivora. In certain cases, they are entirely opposed to this rule.

C. Isolation and Divergence in *Mogera*

There are many kinds of isolations which lead animals to divergence: geographic, ecological, physiological, genetical, and so on. However, geographic or ecological isolation may be followed by physiological or reproductive isolation. The following instance in the Japanese moles appears to be such a phenomenon.

As pointed out previously, geographic variation of the moles is so great that it has occasionally confused the systematics. However, it must be also appreciated that such variation offers us a useful means by which to investigate the process of species formation.

Mogera kobeae, *M. tokudae*, and *M. wogura* are morphologically so similar to one another that the former two were regarded as subspecies of the latter by some investigators (24, 41). But each has been revealed to be a distinct species by the present work on the basis of the following morphological and ecological considerations.

M. wogura is very dark in coloration and relatively small in size. The skull has a weak and slender rostrum and a posteriorly expanded braincase; the interorbital space is swollen at the middle portion; the upper incisor row is almost always distictly V-shaped in arrangement and remarkably projected foreward. *M. tokudae* differs from the former by the much larger size, the relatively pale coat, the longer tail, the proportionately longer upper tooth row, and the posteriorly less expanded braincase. Similarities also exist between these two species, i. e. in the proportionately slender rostrum, the relatively broad interorbital space, and the clearly V-shaped row of incisors. From these facts *M. tokudae* is revealed to be a form which has differentiated to an extremely large build and at the same time undergone some modifications in morphology. On the other hand, *M. kobeae* has a paler and browner coat.

The skull has a broad and robust rostrum, a slender and rather cylindrical interorbital space, a less expanded posterior bulge of the braincase, and a rounded arc-shape row of the upper incisors (Plate 1).

As shown in the former chapters morphological characters of the moles vary geographically and also with age. There is seen an interesting phenomenon when the two kinds of the variations are compared. First, the author will discuss here the relationships between *M. wogura* and *M. kobeae.* Intraspecifically the small local forms of *M. wogura* have morphological characters which appear to remain in a younger stage than actually the animals are in comparison with the case in the larger local forms. In other words, the former is "neotenous" in its characters as compared with the latter.

Interspecific differences between the two species are also linked up with the age variation. Namely, *M. wogura* is usually small in size and has a form which has likely remained in a less advanced stage in the age variation generally observed in Japanese moles than does *M. kobeae.* Even the full grown adults of the small local forms of the former, therefore, have juvenile appearance as compared with the larger local forms of the latter. Its appearance closely resembles again the form of the more neotenous and primitive Mizura mole, *Euroscaptor mizura.* With the size variation from smaller local forms to larger local ones, *M. wogura* approaches in morphological characters the smaller local forms of *M. kobeae,* the forms which in turn retain characters in younger stages of the age variation in the larger forms of this species. The latter species also approaches, with increase in size, the Manchurian mole, *M. robusta,* which is the most differentiated species in genus *Mogera. M. kobeae* is thus the most differentiated species, in age variation, among the Japanese moles and is regarded as a case of "hypermorphosis" as compared with the other species.

The above four species may stand phylogenetically along the same linear curve which represents the relationships between the growth in size and the age differentiation. These relationships are diagramatically summarized in Fig. 19.

There is another kind of differentiation in *M. tokudae.* The mole is very large and almost conforms in size to *M. robusta,* but is clearly different from the latter in characteristics of the skull. As shown previously the anterior half of the skull of *M. tokudae* is very primitive in appearance and would look like that of the small local forms of *M. wogura,* if the latter were enlarged without great modifications (Fig. 6 and Plate 1). This fact may imply that the direction of differentiation of *M. tokudae* is markedly deflected from the *M. wogura-M. robusta* line of differentiation. In other words, the species

8×8 64

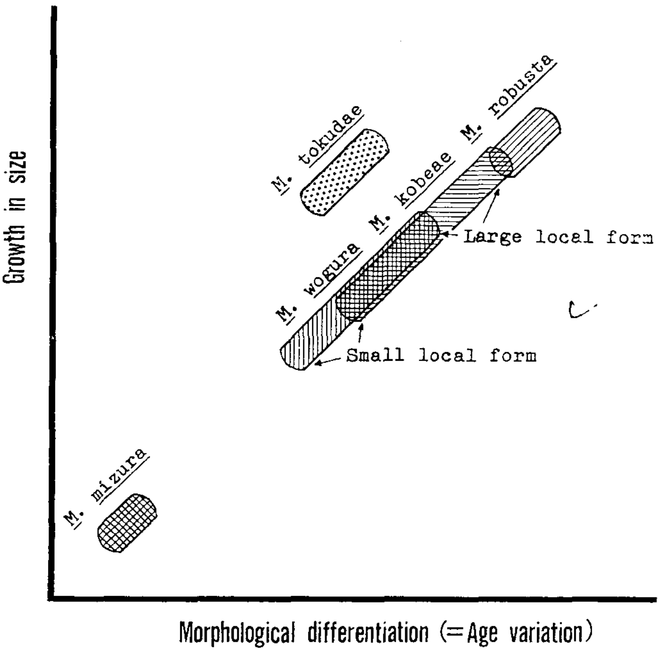


Fig. 19. Systematic relationships among the five species of moles with special reference to size and age variations.

represents a peculiar relative growth which is characterized by the retardation in age differentiation and by the acceleration in growth. Thus the systematic differences of the moles have a relation to age variation as shown by HUBBS (11) in his systematic study of fishes.

M. kobeae is found in Korea, Tsushima, Kyûshû with adjacent small islands, Shikoku, Oki, and the southwestern half of Honshû from the line through Shizuoka, Nagano, and Ishikawa Prefs., whereas *M. wogura* is widely scattered in the northeastern half of Honshû, the montane areas of Chûgoku district and the Kii Peninsula on the southern Honshû, and the high elevation of Mt. Tsurugi in Shikoku. The recent distribution of *M. tokudae* is restricted to Sado Island and to an area in the central plain of Niigata Pref. nearest to this island situated off the west coast of the plain. The peripheral population in the distribution of *M. tokudae* has contact with that of *M. wogura* in the central parts of Niigata Pref.

According to geologists (28, 29) the Japanese Archipelago, of which the original features had been built up through a long crustal movement, repeated several times connection with and isolation from the Asiatic Continent by the regression and the progression of sea water in the glacial age. Such phenomena lasted until about ten thousand years ago. Recent faunas of Honshû, Shikoku, Kyûshû, and other adjacent islands, therefore, appear to consist of several components which immigrated one after another from the continent or other islands.

To turn our attention again to the mole, it is reported by NAORA (30) and SHIKAMA *et al.* (37) that *M. wogura* had been already distributed in Japan in the Middle Pleistocene, for many mandibles and humeri* of this mole were found in the deposits of this age which are scattered in certain localities in Honshû. In early Tertiary the Japanese Islands were connected with the continent on both the northern and southwestern ends; therefore, the recent Japan Sea was a big lake. It is also recognized that Formosa formerly was a part of the continent. The ancestors of *M. wogura,* therefore, might have expanded its distribution all over these regions. Subsequently the Japanese Islands became isolated from the continent by the raised sea level in the third interglacial age. This isolation of the Japanese Islands is said to have lasted, more or less, over a hundred thousand years. During this period of isolation, the continental mole might have diverged from *M. wogura* to *M. coreana* which is synonymous, according to the author's opinion, with *M. kobeae.* The latter species is considered to have later invaded Japan probably in the Würm glacial age.

M. kobeae is at present ecologically dominant to *M. wogura.* After the former had invaded Japan, therefore, it might have gradually displaced the latter from its original habitat, especially the southern regions of Japan, and enlarged its distribution toward the present situation as stated above. Therefore, the isolated colonies of *M. wogura* which are scattered in the montane regions of Chugoku and Shikoku districts, and of the Kii Peninsula, may be regarded as relicts which were once parts of a continuous distribution but became separated in the process of the aforementioned events.

Recent geologists have advanced an important hypothesis that in the fourth glacial age, Honshû, Shikoku, and Kyûshû might have been already separated from Hokkaido and the Korean Peninsula (28). However, they still can not be sure of this hypothesis owing to a newly discovered fact in archelogy which indicates the probable connection of the Japanese Islands with the contient during this age. They are expecting other findings of facts on these problems.

* I was given an opportunity to examine some of these specimens by Mr. Y. HASEGAWA of the National Science Museum, Tokyo, and I have been inclined to identify them with *M. wogura*

The author's consideration as stated above may, in this connection, be suggestive to them. One might think of that the two species might have immigrated together into Japan in the second or third glacial age, but such a thing would be impossible if the recent distribution of them is taken into account. On the contrary, the author is thinking of that the immigration of *M. kobeae* in the fourth glacial age must have been the most probable event.

The distributions of *M. tokudae* and *M. wogura* suggest that the two species had been geographically separated at some time in the past and later established mutual contact. Thus, the former species might have diverged from *M. wogura* on Sado Island and later immigrated secondarily into the plain of Niigata. Considering the relatively little morphological differentiation, the period of isolation of *M. tokudae* from *M. wogura* may be thought to have not been so long as in the case of *M. kobeae*. Moreover, when we take the present distribution into account, the immigration of *M.tokudae* into the plain of Niigata appears to be geologically a most recent event and it may be as follows: First, it may be the third glacial age or the Würm I sub-age of the fourth glacial age when *M. wogura* immigrated into Sado Island. After the divergence of *M. tokudae* from *M. wogura* on this island, a part of the population of the newly arisen species might have immigrated into the plain of Niigata in some later glacial age, probably during the Würm II sub-age. Considering the distribution and morphological peculiarities, this is thought to be the most acceptable hypothesis on the isolation and the differentiation of *M. tokudae*. It also conforms well to the conclusion of TOKUDA (47), who studied the murid fauna of Sado Island. If the above-mentioned inference is correct, it is about twenty thousand years since *M. tokudae* immigrated into Honshû. This species is about twice as great in weight as *M. wogura*, and seems to be ecologically dominant to the latter. In spite of this, one might well wonder why its range of distribution in Honshû is restricted to such a narrow area? Usually the fossorial mammals such as moles seem to be less active in extending their range than are other terrestrial mammals and it may be especially so when encountering an antagonistic species (*M. wogura*) having closely similar habits. In the present case this appears to be the most reasonable answer to the question.

IV. Classification

Order Insectivora

The Insectivora are the most primitive of placental mammals and stand phylogenetically near the original stem from which the majority of other mammalian groups has arisen. Members of this order are usually small in size, and have a tapering snout, primitive eyes, and a uterus of the bicornuate or duplex type with a deciduous placenta. The testes never descend completely into the scrotum. The feet have usually five digits with claw. The skull is long and slender; the teeth are of nearly or quite full number as placentals; the molars are of a very primitive form, with three to four cones on the upper and five cones on the lower.

This group of mammals is widely distributed through the whole world except for Australia and South America, and is usually terrestrial or fossorial but rarely aquatic in habit. The food habit is usually insectivorous.

Two families are found in Japan.

1. Auricles remarkable; zygomatic arches absent . . . . Soricidae.
2. Auricles absent; zygomatic arches complete . . . . Talpidae.

Family **Soricidae**

Members of the Soricidae retain a slender and mouse-like body, long tapering snout, evident auricles, small but perfect eyes, and relatively light feet and claws. The skull is characterized by the loss of the zygomatic arches and tympanic bullae; the tympanic bulla is a delicate ring of bone. The first incisors of both jaws are greatly enlarged; the upper one decurves on the tip and has a remarkable lobe on the posterior side.

Two sub-families are found in Japan: Soricinae and Crocidurinae. The former occurs most abundantly in northern districts, whereas the latter is common in southern localities.

Key to the Japanese sub-families and genera of Soricidae.

1. Teeth with the cusps pigmented dark chestnut . . . . Sub-family Soricinae.
   2. Upper unicuspids five . . . . *Sorex.*

1′. Teeth white, their cusps unpigmented . . . . Sub-family Crocidurinae.
   3. Ears prominent, projecting above fur; tail with long scattered bristles, especially on its basal half.
      4. Upper unicuspids four . . . . *Suncus.*
      4′. Upper unicuspids three . . . . *Crocidura.*
   3′. Ears reduced and concealed in the fur; aquatic, the feet and toes with

fringes of short stiff hairs on the sides ; upper unicuspids three
. . . . *Chimarrogale*.

Genus *Sorex* LINNAEUS

1758. *Sorex* LINNAEUS, Syst. Nat. 10th ed. I : 53.
Sorex araneus LINNAEUS.

Size small, never very large. Ears relatively amall and nearly concealed in the fur. Tail long, slender, and haired along its total length in young but nearly naked in the terminal portion in old adults. Limbs and feet delicately formed ; all four feet with five toes well developed. Both sexes with two scent glands on the body sides ; in breeding season those of male become larger than those of female. Mammae : $0+1+2=6$.

Skull low and of delicate structure, the braincase high and round in young but flattened and angular in old adults, the rostrum pointed and narrow. Teeth with their cusps pigmented dark chestnut. Upper unicuspids five. The dental formula : $I\frac{3}{1}+C\frac{1}{1}+Pm\frac{3}{1}+M\frac{3}{3}=32$

Distribution. Northern parts of Eurasia and North America.

Key to the Japanese species of *Sorex*.

1. Body large ; fore foot very large and more than 7.8 mm. without claw and 9.6 mm. with claw ; greatest length of skull and mandible more than 19.0 mm. and 9.9 mm., respectively ; first upper unicuspid decidedly larger than third which in turn exceeds second
. . . . *S. unguiculatus*.

1′. Fore foot not more than above ; greatest length of skull and mandible not more than 18.7 mm. and 9.6 mm., respectively.

2. Body medium, greatest length of skull and upper tooth row more than 16.5 mm. and 7.0 mm., respectively.
. . . . *S. caecutiens*.

2′. Body small, greatest length of skull and upper tooth row not more than above.

3. First upper unicuspid decidedly larger than subequal second and third in lateral view, upper unicuspid row short and not more than 2.2 mm.

4. Body extremely small, hind foot and tail shorter than 10 mm. and 31 mm., respectively ; greatest length of skull and upper tooth row not more that 13.5 mm. and 5.6 mm., respectively
. . . . *S. minutissimus*.

4′. Body slightly larger, hind foot and tail more than 11 mm. and 48 mm., respectively; greatest length of skull and upper tooth row more than 15 mm. and 6.3 mm., respectively
. . . . *S. hosonoi.*

3′. Upper unicuspid row long: 2.4–2.7 mm.; anterior upper incisor small, its posterior lobe as high as anterior cusp; in lateral view subequal first, second, and third unicuspids decidedly larger than subequal fourth and fifth; rostrum narrow and elongated
. . . . *S. minutus.*

1. *Sorex minutissimus hawkeri* THOMAS

1906. *Sorex hawkeri* THOMAS, Proc. Zool. Soc. London, II: 339; KISHIDA, Honyûdobutsu Zukai 1924, 83; KURODA, Monogr. Jap. Mamm. 1940, 171; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 75; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 46.

1957. *Sorex minutissimus hawkeri* STROGANOV, Mamm. Siberia, 185; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 7: ABE, Jour. Mamm. Soc. Jap. 1961, 2: 3.

Type. *Sorex hawkeri* THOMAS, from, Inukawa, Edo, Hondo.

This species is one of the smallest mammals. Feet delicate, fully clothed with fine hairs on the dorsal surface. Tail very short, with relatively long hairs nearly concealing the annulations; its pencil about 5–6 mm. in young.

Summer pelage of young, back near clove brown, sides slightly paler than back, underparts silverly drab-gray. Tail bicolored and concolored with back above, pale drab or whitish under. Winter and summer pelages of adult unknown.

Skull very small. Besides the small size (the greatest length 13.0–13.5 mm.), skull notably differs from those of other species in the narrower, more elongated braincase; the outline, when viewed from above, distinctly oval or long hexagonal instead of sub-circular, even in young; angles of antero-external parts of braincase noticeable. Despite the fact that all specimens examined have been relatively young, the interorbital portion of skull is more abruptly marked off from the braincase than in other species. Interorbital constriction relatively wide, the proportion to the greatest length of skull 18.9 per cent in average. Proportions of breadth across molars and breadth of rostrum to the greatest length of skull very large: 24.7 and 10.2 per cent in average, respectively. Mandible short relatively.

Proportions of upper tooth row, upper unicuspid row, and lower tooth row to the greatest length of skull extremely small: 41.1, 12.6, and 38.6. per cent in average, respectively. Crowns of upper unicuspids clearly shorter than broad, and strongly crowded together, so that the unicuspid row is distinctly shorter than the combined length of first and second upper molars, about as long as the breadth of rostrum across last unicuspids. Viewed from side, anterior upper border of each unicuspid strongly convexed. In relative size among unicuspids, first decidedly larger than subequal second and third which in turn exceed fourth ; fifth still smaller than fourth in lateral view ; in crown view fifth slightly larger than fourth. Upper molars relatively large.

Measurements. Body weight 1.5–1.8 ; head & body 44.5–48.5 ; tail 27.0–31.0 ; fore foot (s. u.) 4.4–5.0 ; hind foot (s. u.) 8.2–8.7 ; ear 4.5–5.1 ; greatest length of skull 13.0–13.5, 13.5–14.0 (with I) ; basal length 11.0–11.4, 11.6–11.9 (with I) ; breadth of braincase 6.3–6.6 ; depth of braincase 3.9–4.2 ; interorbital breadth 2.4–2.7 ; breadth across molars 3.2–3.3 ; rostral breadth 1.3–1.4 ; upper tooth row 5.3–5.6 ; upper unicuspid row 1.6–1.8 ; mandible 6.1–6.4 ; lower tooth row 5.1–5.3.

Specimens examined. Hokkaido : Nijibetsu, Teshikaga T., Kushiro Prov. 9.

Distribution. Honshu (?) and Hokkaido.

Remarks. This is a relative of *Sorex hosonoi* IMAIZUMI in Honshû and has, except for the smaller size, skull and dentition very similar to those of the latter. In spite of the similarity in skull this species is easily distinguished externally by its smaller size and relatively shorter tail from *S. hosonoi*. This species may occasionally be confused with the young of *S. minutus* ; at this time, however, the relatively short tail and extremely small skull with very short upper unicuspid row will always serve as the means for discriminating this species from others.

2. *Sorex hosonoi* IMAIZUMI

1954. *Sorex hosonoi* IMAIZUMI, Bull. Nat. Sci. Mus. 1 : 94 ; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 3.

1954. *Sorex hosonoi shiroumanus* IMAIZUMI, Bull. Nat. Sci. Mus. 1 : 97 ; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 5.

Type. *Sorex hosonoi* IMAIZUMI from Tokiwa-mura, Nagano Pref., Japan.

Size medium. General external characters agree with those of *S. caecutiens shinto*. Tail relatively long. Color of back bister, underparts wood brown.

Skull small ; the general aspect well fits with that of *S. minutissimus hawkeri* except for its larger size. Braincase less elevated and narrow, the outline hexagonal when viewed from above.

Relative size of teeth and the general aspect in form very similar to those of *S. minutissimus hawkeri*. Upper molars very large ; the combined length of first and second is evidently longer than upper unicuspid row. Viewed from side, first upper unicuspid clearly larger than subequal second and third which exceed fourth. Fifth smaller than fourth in lateral view, but in crown view slightly larger than fourth.

Measurements. Body weight 4.5 ; head & body 64.0 ; tail 48.0 ; fore foot (s. u.) 6.7 ; hind foot (s. u.) 11.6 ; ear 6.7 ; greatest length of skull 16.0, 16.3 (with I) ; basal length 14.0, 14.2 (with I) ; breadth of braincase 7.0 ; depth of braincase 4.1 ; interorbital breadth 3.0 ; breadth across molars 3.8 ; rostral breadth 1.7 ; upper tooth row 6.5 ; upper unicuspid raw 2.2 ; mandible 7.8 ; lower tooth row 6.3.

Specimens examined. Honshû : Nagano Pref. : Tokiwa V. 1 (type) ; Mt. Shirouma (2900 m. alt.) 1 ; Yokoo, Kamikôchi 1.

Distribution. Mountain regions of the central Honshû, Japan.

Remarks. This is a larger relative of *S. minutissimus hawkeri* and seems to have become diversified in the course of the long isolation in the mountain regions of Honshû, along with many other animals as pointed out by other investigators.

Sorex hosonoi shiroumanus IMAIZUMI (only one old specimen, type, obtained from the adjoining locality of the *typicus*) has a slightly different coloration : as a whole, paler than that of the typical from. The skull and teeth, however, are quite similar to those of the typical form. Since the coloration of pelage is variable and that of old adults is usually paler and more brownish than that of young, the author has regarded this form as a mere variation of *typicus*.

3. *Sorex minutus gracillimus* THOMAS

1907. *Sorex minutus gracillimus* THOMAS, Proc. Zool. Soc. London, 408; SOWERBY, Nat. in Manchuria, 1923, II: 15; KISHIDA, Honyûdôbutsu Zukai 1924, 77; KURODA, Jour. Mamm. 1928, 9: 222; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 70; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 48; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 7.

Type. *Sorex minutus gracillimus* THOMAS, from Darine, 25 miles N. W. of Korsakoff, Sakhalin.

Size small. Tail relatively short, with relatively long hairs. Winter pelage (from Robun Is.), back clove brown but paler than that of *S. caecutiens saevus*, sides pale drab gray, underparts mouse gray or fine silvery neutral gray. Summer pelage of adult (from Sakhalin), back chestnut brown, sides cinnamon buff, underparts light drab ; summer pelage of young (from Hokkaido), back similar to winter pelage, sides paler than back, underparts light drab ; the specimens from Rishiri Is., back bister, sides cinnamon buff, underparts drab gray. All specimens from Rebun, Rishiri, and Sakhalin are somewhat tricolored. Tail distinctly bicolored, fuscus above, light drab or whitish below, terminal portion all around dark brown.

Skull small and delicate, rostrum distinctly narrower and longer than that of other species. The outline of braincase, when viewed from above, subcircular. Proportions of interorbital constriction, breadth across molars, and rostrum to the greatest length of skull very small; 17.7, 21.6, and 9.0 per cent in average, respectively.

Proportion of upper tooth row to the greatest length of skull small: 42.6 per cent in average, while upper unicuspid row very long, much longer than the combined length of first and second molars. Anterior upper incisor relatively small, the basal lobe nearly as high as anterior cusp but about half as thick as anterior one at the base. Crowns of upper unicuspids longer than wide; in relative size, first evidently larger than subequal second and third which in turn exceed (or subequal to) fifth; fourth decidedly smaller than fifth. When viewed from side, upper unicuspids can be roughly grouped into two combinations which consist of subequal first, second, and third, and subequal fourth and fifth; the former three clearly larger than the latter two; first largest; third slightly larger than, or subequal to, second; fourth usually larger than, or subequal to, fifth, but rarely slightly smaller.

Measurements. Body weight 1.5–5.0; head & body 49.0–58.0; tail 40.0–46.0; fore foot (s. u.) 4.7–6.5; hind foot (s. u.) 10.3–12.0; ear 4.8–6.5; greatest length of skull 15.4–16.2, 16.0–16.7 (with I); basal length 13.0–13.7, 13.4–14.1 (with I); breadth of braincase 7.2–7.8; depth of braincase 4.0–5.3; interorbital breadth 2.5–3.0; breadth across molars 3.2–3.7; rostral breadth 1.4–1.5; upper tooth row 6.6–6.9; upper unicuspid row 2.5–2.7; mandible 7.2–8.0; lower tooth row 6.2–6.6.

Specimens examined. Hokkaido: Soya Prov.: Funadomari, Rebun Is. 1; Oshidomari, Rishiri Is. 1; Wakkanai, Wakkanai C. 2; Sarobetsu, Toyotomi T. 6; Abashiri Prov.: Onneyu, Rubeshibe T. 4; Senmô-tôge, 1; Kushiro Prov.: Nakachanbetsu, Shibecha T. 5; Akkeshi, Akkeshi T. 1; Tokachi Prov.: Horoka, Kamishihoro T. 1; Iburi Prov.: Uenai, Tomakomai C. 1; Sakhalin 1. Total 24.

Distribution. Eastern Siberia, Manchuria, Korea, Sakhalin, and Hokkaido (with Rishiri Is. and Rebun Is.).

Remarks. *Sorex minutus gracillimus* is clearly different from any other species in many respects, namely, tail with long hairs, the strongly elongated rostrum and upper unicuspid row, and the characteristic combination of unicuspid teeth.

4. *Sorex caecutiens saevus* THOMAS

1907. *Sorex shinto saevus* THOMAS, Proc. Zool. Soc. London, 408; KISHIDA, Zool. Mag. Tokyo, 1923, 35: 88; SOWERBY, Nat. in Manchuria, 1923, II: 24; KURODA, Jour. Mamm. 1928, 9: 222; KURODA, Monogr. Jap. Mamm. 1940, 172; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 68; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 14.

1951. *Sorex caecutiens caecutiens* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 49 (in part).

1953. *Sorex caecutiens saevus* KURODA, Illust. Monogr. Jap. Mamm. 93.

1957. *Sorex caecutiens shinto* STROGANOV, Mamm. Siberia, 215 (in part).

Type. *Sorex shinto saevus* THOMAS, from a place 15 miles N. W. of Korsakoff, Sakhalin.

Size medium. Ears and feet as usual. Tail relatively long, the pencil in young relatively long: 5–8 mm.

Winter pelage (subadult), back and sides clove brown, underparts pale mouse gray or gray washed by cinnamon or fine silvery neutral gray; the contrast between sides and belly is rather marked, the transition abrupt; this is especially marked in the animals with fine silvery neutral gray of underparts. Summer pelage (adult), back bister, underparts avellaneus and washed by cinnamon. Summer pelage of young, back similar to that of adult, underparts drab gray or light drab. The line of demarkation along sides is usually evident but not very conspicuous. Tail concolor with back above, dark brown at tip, pale drab or wood brown below.

Proportions of interorbital breadth, breadth across molars, and mandible to the greatest length of skull relatively small: 19.0, 23.6, and 49.5 per cent in average, respectively; reversely that of upper unicuspid row relatively large: 15.9 per cent in average, because of elongated rostrum. Age variation of skull as usual.

Posterior lobe of first upper incisor relatively small. Subequal first and second upper unicuspids larger than subequal third and fourth which decidedly exceed fifth in many cases, or rarely, gradually diminishing from first to fifth when viewed from the side; in crown view the unicuspids diminishing from first to fifth in many cases, or fifth slightly larger than fourth. Length of upper unicuspid row clearly longer than the combined length of first and second molars. Fifth upper unicuspid triangular in form as the others. Upper tooth row and upper unicuspid row long, the proportions to the greatest length of skull 44.2 and 15.9 per cent in average. Age variation and pigmentation of teeth as usual.

Measurements. Body weight 3.0–11.0; head and body 48.0–78.0; tail 39.0–52.0; fore foot (s. u.) 6.3–7.3; hind foot (s. u.) 11.5–13.7; ear 6.0–8.5;

greatest length of skull 16.8–18.7, 17.4–19.3 (with I); basal length 14.4–16.2, 15.0–16.9 (with I); breadth of braincase 8.1–9.6 ; depth of braincase 4.8–6.8 ; interorbital breadth 3.1–3.8 ; breadth across molars 3.9–4.8 ; rostral breadth 1.6–2.0 ; upper tooth row 7.3–8.3 ; upper unicuspid row 2.6–3.0 ; mandible 8.3–9.3 ; lower tooth row 6.4–7.8.

Specimens examined. Hokkaido : Nemuro Prov. : Bettôga, Nemuro T. 2 ; Kushiro Prov. : Mt. Meakan 1 ; Nijibetsu, Teshikaga T. 52 ; Nakachanbetsu, Shibecha T. 52 ; Abashiri Prov. : Onneyu, Rubeshibe T. 4 ; Tokachi Prov. : Ashoro T. 11 ; Otoshirabetsu, Biroo T. 2 ; Kamikawa Prov. : Yamabe V. 3 ; Furano T. 1 ; Sorachi Prov. : Fukuzumi, Ashibetsu C. 4 ; Tômei, Bibai C. 1 ; Ishikari Prov. : Nopporo, Ebetsu C. 8 ; Shimamatsu, Eniwa T. 1 ; Sapporo, Sapporo C. 29 ; Iburi Prov. : Hobetsu V. 1 ; Uinai, Tomakomai C. 12 ; Hidaka Prov. : Atsuga, Monbetsu T. 6 ; Mt. Apoi 2. Total 192.

Distribution. Sakhalin and Hokkaido.

Remarks. THOMAS (1907) recognized a subspecific distinction between the animals of this species from Honshû and from Hokkaido, and assigned the present subspecific name to the latter which retains, as a whole, slightly larger body and skull. The distinction only by the difference in size remains a problem to be considered in detail, but the specimens from Honsnû are too few at hand to permit discussion here. Therefore, the division in this paper is no more than a temporary procedure.

5. *Sorex caecutiens shinto* THOMAS

1905. *Sorex shinto* THOMAS, Abst. Proc. Zool. Soc. London, 23 : 19; KURODA, Monogr. Jap. Mamm. 173; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 68; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 12.

1951. *Sorex caecutiens caecutiens* ELLERMANN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 49.

1953. *Sorex caecutiens shinto* KURODA, Illust. Monogr. Jap. Mamm.

1954. *Sorex chouei* IMAIZUMI, Bull. Nat. Sci. Mus. 1 : 99.

Type. *Sorex shinto* THOMAS from Makado, Aomori Pref., Honshû, Japan.

External and cranial features very similar to those of *S. caecutiens saevus* except for its slightly smaller size as a whole.

Measurements. Body weight 4.0–8.5 ; head and body 59.0–72.5 ; tail 43.5–55.0 ; fore foot (s. u.) 6.5–7.2 ; hind foot (s. u.) 11.4–12.5 ; ear 7.0–8.0 ; greatest length of skull 16.9–17.8, 17.2–18.2 (with I); basal length 14.3–15.3, 14.6–15.7 (with I) : breadth of braincase 8.2–8.8 ; depth of braincase 4.7–5.6 ; interorbital breadth 3.0–3.4 ; breadth across molars 3.9–4.3 ; rostral breadth 1.6–1.9 ; upper tooth row 7.0–7.7 ; upper unicuspid row 2.6–2.8 ; mandible 8.6–9.0 ; lower tooth row 6.7–7.2.

Specimens examined. Honshû: Aomori Pref.: Sukayu, Mt. Hakkoda 2; Nagano Pref.: Yokoo, Kamikochi, 6; Otaki V. 2; Hiratani, Iida C. 1; Kai-Komagadake 1; Kitazawa-toge, Akaishi Mts. 1 (type of *S. chouei*).

Distribution. Central and northern Honshû, Japan.

Remarks. ELLERMAN and MORRISON-SCOTT referred *S. shinto* to *S. caecutiens caecutiens*, but KURODA retained the former as a distinct subspecies of the latter: *S. caecutiens shinto*. Usually *S. caecutiens* has a short tail and short upper unicuspid row except for the typical subspecies having a relatively long upper unicuspid row. Actually *S. caecutiens shinto* is very similar in general characters to *S. caecutiens caecutiens*, especially in its long upper unicuspid row, but evidently different in the long tail. The author agrees with the opinion of KURODA.

Sorex chouei IMAIZUMI is the name assigned for the shrews having relatively shorter tail and shorter upper unicuspid row. Since the variations of these two characters appear to be continuous between typical *S. caecutiens shinto* and *S. chouei*, the latter seems to be a mere variation of the former.

6. *Sorex caecutiens shikokensis*. n. subsp.

Holotype. Adult male, obtained from Mt. Shimokabuto (900 m. alt.), Niihama City, Ehime Pref., Shikoku, Japan, on April 16, 1959, by the author

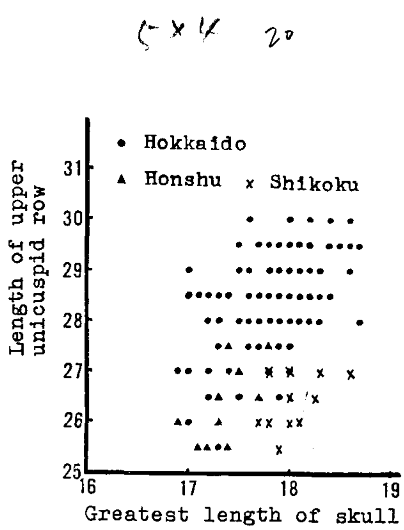


Fig. 20. Relationships between the length of upper unicuspid row and the greatest length of skull in three local subspecies of *Sorex caecutiens*.

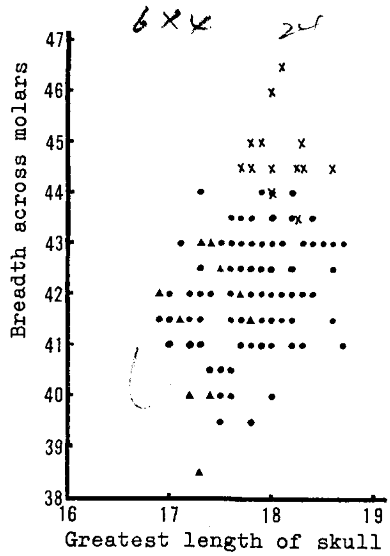


Fig. 21. Relationships between the breadth across molars and the greatest length of skull in three local subspecies of *Sorex caecutiens*.

(Natural History Museum, Faculty of Agriculture, Hokkaido University, Sapporo. No. 13311).

Size moderately large. General aspects of external features agree well with those of *S. caecutiens saevus*.

Summer pelage of adult, back near chestnut brown or burnt umber, underparts dull cinnamon brown, without any marked demarkation line between them. Summer pelage of young, back similar to that of adult, underparts buffy brown. Tail distinctly bicolored, dark brown above, cinnamon brown below.

Skull large. Rostrum and palate shorter and broader; the facial portion very massive (Fig. 20 and 21). Upper tooth row relatively short, because of the relatively short rostrum; upper unicuspids closely crowded together; crowns short, nearly square (in *S. c. saevus* and *S. c. shinto* they are clearly longer than wide); upper unicuspid row short but distinctly longer than the combined length of first and second upper molars (not so long as in *S. c. saevus*). Unicuspids gradually diminishing from first to fifth in lateral view, or first and second subequal to each other and evidently larger than subequal third and fourth. Fifth decidedly smaller than fourth. In crown view, unicuspids gradually diminishing from first to fourth; fifth evidently larger than fourth, but in some specimens fifth slightly smaller than fourth. Pigmentation of teeth normal.

Measurements. Body weight 6.0–13.5; head and body 64.0–76.0; tail 47.0–53.0; fore foot (s. u.) 7.0–7.9; hind foot (s. u.) 12.5–13.5; ear 6.5–8.0; greatest length of skull 17.7–18.6, 18.4–19.3 (with I); basal length 15.0–16.3, 15.6–16.7 (with I); breadth of braincase 8.7–9.3; depth of braincase 5.0–6.1; interorbital breadth 3.2–3.7; breadth across molars 4.4–4.7; rostral breadth 1.7–2.0; upper tooth row 7.5–7.9; upper unicuspid row 2.6–2.7; mandible 8.9–9.6; lower tooth row 7.2–7.6.

Specimens examined. Shikoku: Ehime Pref.: Mt. Sazareo (800 m. alt.), Iyo-Mishima C. 11; Mt. Shimokabuto (900 m. alt.), Niihama C. 2; Tokushima Pref.: the top of Mt. Tsurugi (1955 m.alt.), 2. Total 15.

Remarks. This interesting animal was first obtained by Mr. T. Itô at Mt. Sazareo and Mt. Tanegawa of Ehime Prefecture, Shikoku in 1958.

This subspecies is accepted because of its larger size, relatively shorter and broader rostrum, and upper unicuspid row shorter than in the other subspecies.

The peculiarities of skull and teeth mentioned above well fit with those of a Korean ally, *Sorex caecutiens macropygmeus*, though the latter is smaller as a whole and relatively shorter in tail length than the subspecies considered here. Thus, this subspecies appears to have an affinity to the Korean ally rather than to animals of Honshû and Hokkaido.

7. *Sorex unguiculatus* DOBSON

1858. *Sorex vulgaris* SCHRENK. Reisen Forsch. Amur Lande I: 106.
1890. *Sorex unguiculatus* DOBSCN, Ann. Mag. Nat. Hist. 6, 5: 155; THOMAS, Proc. Zool. Soc. London, 1907, 407; AOKI, Ann. Zool. Jap. 1913, 8: 270; SCWERBY, Nat. in Manchuria 1923, II: 23; KISHIDA, Zool. Mag. Tokyo, 1923, 35: 89; KURODA, Illust. Ency. Fauna Jap. 1927, 81; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 74; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 17.
1923. *Sorex daphaenodon* KISHIDA, Zool, Mag. Tokyo, 35: 87.
1924. *Sorex daphaenodon yesoensis* KISHIDA, Honyûdôbutsu Zukai 81.
1944. *Sorex araneus* BOBRINSKI & KUZIAKIN, Mamm. U.S.S.R. (in part).
1951. *Sorex araneus fretalis* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 52.

Type. *Sorex unguiculatus* DOBSON, from Sakhalin.

Size large. Fore foot and its claw especially large, being similar in aged specimens to those of *Dymecodon pilirostris* TRUE. Length of claw of third digit, on the back, usually one third to three sevenths of the length of fore foot (without claw). In other species the length usually not more than about one-fourth. Feet fully covered with fine hairs on the dorsal surface in young, but thinly haired or entirely naked in senile. Proportions of tail and ear to the head and body small: tail about 67 per cent and ear 9.8 per cent in average. Ears nearly concealed in the fur. Tail fully covered with hairs concealing the annulations; the pencil of tip usually well developed in young: 3–5 mm. in length, but in aged individuals usually much reduced or absent.

At the begining of breeding season the head and body length and the body weight of adult abruptly increase; especially males become usually larger than females.

Winter pelage (subadult), back blackish brown or fuscus brown, sides and underparts drab; summer pelage of adult, back bister, underparts drab but more brownish than winter pelage, or prouts brown; summer pelage of young similar to winter one of subadult; between colors of back and sides there is usually no evident line of demarkation; the contrast between sides and belly less marked, the transition less abrupt. Summer pelages of the specimens from Rebun Is. are slightly paler than those of the specimens from main land. Between back and sides of the specimens from Daikoku Is. there is seen rather marked contrast which composes an indistinct tricolored phase with the color of underparts. Tail distinctly bicolored, blackish brown or chaetula black above, drab below, terminal portion all around dark brown. Feet often have a faint dark shade along the outer edge.

Skull similar in general characters to that of *S. araneus* and usually showing the typical variation with advancing age: braincase subcircular in young, hexagonal in adult when viewed from above; skull of adult flatter and wider than that of young; sagittal suture usually forming a sagittal crest in adult; premaxilla lies parallel with the long axis of skull in young but decurving sharply with age. Proportions of interorbital portion, breadth across molars, and mandible to the greatest length of skull all relatively large: 20.2, 25.6, and 52.4 per cent in average, respectively; reversely that of upper unicuspid row small: 15.4 per cent in average, because of the shorter rostrum.

In lateral view the anterior lobe of anterior upper incisor is larger and higher than the posterior one. In upper unicuspids, first usually decidedly larger than the others; third decidedly larger than or subequal to second which in turn exceeds fourth, but in crown view second usually subequal to third. Fifth still smaller than fourth, and closely crowded between fourth and antero-external cusp of large premolar; therefore the length of fifth much shorter than the height even in unworn tooth. They have also following variations: first, second, and third subequal to one another in height or gradually diminishing from first to fifth. Proportion of upper tooth row to the greatest length of skull is 43.3 per cent in average. Length of upper unicuspid row subequal to the combined length of first and second molars. First lower unicuspid rarely has a small posterior cusp as in *S. alpinus*, differing from that of *S. araneus* in its greater length along cingulum and in the less height of the cusp; its form, when viewed from side, noticeably different from that of upper unicuspid (in *S. araneus* it is essentially similar to first and second upper unicuspid). Second with two conspicuous cusps distinctly differs from first. Lower incisor similar to that of *S. araneus*.

Very young individuals have frequently very heavily and extensively pigmented teeth. With advancing age, the teeth wear and the pigmented portion disappears.

Measurements. Body weight 6.0–19.3; head & body 54.0–97.0; tail 40.0–53.0; fore foot 7.8–10.3 (s. u.), 9.6–12.6 (c. u.); hind foot (s. u.) 12.4–15.5; ear 6.0–8.0; greatest length of skull 18.6–21.5, 19.4–22.0 (with I); basal length 16.3–18.8, 16.8–19.3 (with I); breadth of braincase 9.5–11.2; depth of braincase 5.3–7.0; interorbital breadth 3.7–4.6; breadth across molars 4.7–5.6; rostral breadth 1.8–2.4; upper tooth row 8.0–9.3; upper unicuspid row 2.8–3.4; mandible 9.9–11.4; lower tooth row 6.9–8.7.

Specimens examined. Hokkaido: Nemuro Prov.; Itokushibetsu, Nakashibetsu T. 1; Bettôga, Nemuro T. 13; Kushiro Prov.: Nijibetsu, Teshikaga

T. 86 ; Nakachanbetsu, Shibecha T. 15 ; Akkeshi T. 1 ; Daikoku Is. 3 ; Tokachi Prov. : Kamiashoro, Ashoro T. 4 ; Osoushi, Shintoku T. 3 ; Abashiri Prov. : Onneyu, Rubeshibe T. 2 ; Kamikawa Prov. : Yamabe T. 2 ; Sorachi Prov. : Fukuzumi, Ashibetsu C. 7 ; Soya Prov. : Sarobetsu, Toyotomi T. 3 ; Rebun Is. 4 ; Rishiri Is. 3 ; Ishikari Prov. : Sapporo, Sapporo C. 105 ; Nopporo, Ebetsu C. 11 ; Shimamatsu, Ebetsu C. 3 ; Zenibako, Otaru C. 1 ; Shiribeshi Prov. ; Shakotan T. 1 ; Mt. Yôtei 1 ; Iburi Prov. : Uinai, Tomakomai C. 14. Total 283.

Distribution. Hokkaido and adjacent islands : Rebun, Rishiri, and Daikoku ; Sakhalin, Ussuri, Manchuria, Amur, Shantan Is., Gizhiginsk, Kamchatka, and North and South Kurile Islands.

Remarks. *Sorex unguiculatus* is the most abundant species in Hokkaido and at once distinguishable from other species by its larger form, especially by the large fore foot with long claws. Cranial measurements, though they have wide individual variation, little overlap those of the other species ; therefore we can easily distinguish this species.

ELLERMAN and MORRISON-SCOTT referred *S. unguiculatus* to *S. araneus fretalis*, but the former evidently differs from *araneus* in its distinctly large fore foot and characteristic teeth. In *S. unguiculatus* the first upper unicuspid is decidedly larger than the others in lateral and crown view. The third is clearly larger than or subequal to the second. The second scarcely exceeds the third. In *S. araneus*, on the other hand, the first and second are subequal in size to each other, and evidently exceed the third (MILLER 1912). From these differences the author recognized *S. unguiculatus* as a distinct species in this paper.

Sorex daphaenodon yesoensis KISHIDA (one old specimen, type, obtained at Nemuro, Hokkaido) has the following dimensions : head and body 77.0 mm., tail 40.0 mm., fore foot (c. u.) 10.0 mm., hind foot (s. u.) 13.0 mm., ear 8.0 mm., greatest length of skull 18.3 mm., depth of braincase 6.0 mm., upper tooth row 8.3 mm., basal length 17.2 mm., breadth of braincase 11.3 mm., breadth across molars 5.3 mm., all of these measurements fit well with the size of *S. unguiculatus* and are decidedly larger than those of *S. caecutiens*. Thus, this old specimen seems to be a variant of *S. unguiculatus*.

Genus *Suncus* EHRENBERG.

1833. *Suncus* EHRENBERG, in HEMPRICH & EHRENBERG, Symb. Phys. Mamm. 2 : k *Suncus sacer* EHRENBERG.

External characters closely resemble those of *Crocidura* in its prominent ears and tapering tail with scattered long bristles. Scent glands remarkable in both sexes. Mammae: $0+0+3=6$.

Skull long and robust, the sagittal and the lambdoidal crests well developed. Dorsal outline of skull nearly straight in profile. Teeth white; first upper incisor large and hook-like, the posterior cusp small. Lower incisor large and nearly straight. These characters well fit with those of *Crocidura*, but *Suncus* is decidedly different from the latter genus in possessing extra upper premolars. Having a pair of the minute unicuspid premolars, upper unicuspid teeth are counted four instead of three in *Crocidura*. The dental formula, therefore, is $I\frac{3}{1}+C\frac{1}{1}+Pm\frac{2}{1}+M\frac{3}{3}=30$.

Distribution. The tropical and subtropical regions of Africa, Europe, and Asia.

8. *Suncus murinus murinus* (LINNAEUS)

1766. *Sorex murinus* LINNAEUS, Syst. Nat. 12th ed. I: 74.

1924. *Crocidura (Pachyura) caerulea* KISHIDA, Honyûdôbutsu Zukai 67.

1924. *Pachyura caerulea riukiuana* KURODA, New Mamm. Riu Kiu Islands 3.

1938. *Suncus caerulea* var. *riukiuanus* (KURODA), List Jap. Mamm. 80; KURODA, Monogr. Jap. Mamm. 1940, 176.

1949. *Suncus murinus* IMAIZUMI, Nat. Hist. Jap. Mamm. 76.

1951. *Suncus murinus riukiuana* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 67.

1951. *Suncus murinus murinus* ELLEMAN & MORRISON-SCOTT, ibid. 65.

Type. *Sorex murinus* LINNAEUS, from Java.

Size large, head and body usually 116–157 mm. Tail retains scattered long bristles along its entire length; the length of tail varies from 43.5 to 55.2 per cent of the head and body length. Tail usually more thick in male than in female: about 6–10 mm. at the base in male, about 6 mm. in female. Scent glands large, at their maximum about 10×6 mm. on outer side, 20×12 mm. on inner side of skin.

Pelage, hair brown above, mouse gray below.

Skull long, narrow but robust. Interorbital portion narrow, nearly cylindrical; braincase low, with prominent sagittal crest and sharper and higher lambdoidal crests.

First upper unicuspid about twice as large as third which usually exceeds second; fourth much smaller than second, just visible between third unicuspid and large premolar.

Measurements. Body weight 45.0–78.0; head & body 116.0–157.0: tail 61.0–77.0; fore foot (s. u.) 12.5–15.0; hind foot (s. u.) 18.5–22.0; ear 11.7–14.2; greatest length of skull 27.0–33.0, 27.9–33.6 (with I); basal length 23.8–

29.0, 25.1–30.4 (with I); breadth of braincase 11.8–14.6; depth of braincase 6.7–8.5; interorbital breadth 5.7–6.7; breadth across molars 8.6–9.7; rostral breadth 3.6–4.6; upper tooth row 12.6–14.3; upper unicuspid row 4.3–5.0; mandible 15.5–17.7; lower tooth row 11.6–13.0.

Specimens examined. Kyûshû: Shimoarata-machi, Kagoshima C. 17.

Distribution. India, Ceylon, Malay, Anambas, Sumatra, Java, Bali, Borneo, Indo-china, Southern China, Hainan, Formosa, and Japan (Riu Kiu Islands and Kyûshû).

Remarks. The house shrew is common in tropical and subtropical regions of Asia. From these regions this shrew frequently travels in company with man toward the neighboring districts (ALLEN 1938, PETERSON 1956, and others). It is also well known that this shrew was introduced to Nagasaki and Kagoshima in Kyûshû probably by ships in the eighteenth century (KISHIDA 1924).

To the Japanese representatives, KURODA assigned the name of *riukiuanus* as a subspecies, owing to the slightly smaller size. This shrew, however, is likewise hightly variable in size. Actually the author has failed to find out any tangible differences between the specimens from Japan and the typical form as far as can be judged from the literature. Therefore, the author is of the opinion that the Japanese house shrew should be referred to the typical subspecies from Java, Ceylon, and India.

Genus ***Crocidura*** WAGLER

1832. *Crocidura* WAGLER, Isis, 275, *Sorex leucodon* HERMANN.

General features are similar to those of *Sorex* but evidently differ in the tapering tail with scattered bristle hairs and in the prominent ears. Scent glands of body sides remarkable. Mammae: $0+1+2=6$ or $0+0+3=6$.

Skull with a broader and massive facial portion, the sagittal and the occipital crests usually prominent. Dorsal outline of skull nearly straight in profile. Teeth white, unpigmented. Anterior upper incisor large, hook-like, the posterior cusp not well marked; lower incisor large and long. The number of upper unicuspids: three. Dental formula: $I\frac{3}{1}+C\frac{1}{1}+Pm\frac{1}{1}+M\frac{3}{3}=28$.

Distribution. Tropical and subtropical regions of the old world. Some species extend into temperate Europe and Asia.

Key to the Japanese species of *Crocidura*.

1. Body small; tail relatively short, usually less than 70 per cent of head

and body; underparts of body pale mouse gray or whitish; paracone of upper premolar well developed, higher than the line connecting the tips of second and third unicuspids; greatest length of skull less than 17.1 mm.
. . . . *C. suaveolens.*

2. Body medium; tail long, averaging 70 per cent of head and body; underparts of body mouse gray or hair brown; paracone of upper premolar less developed, much lower than the line connecting the tips of second and third unicuspids; greatest length of skull less than 17.9 mm.
. . . . *C. horsfieldi.*

3. Body large; tail short, averaging 64 per cent of head and body; underparts of body hair brown or drab; paracone of upper premolar usually lower than the line connecting the tips of second and third unicuspids; greatest length of skull usually more than 17.0 mm.
. . . . *C. dsinezumi.*

9. *Crocidura suaveolens shantungensis* MILLER.

1901. *Crocidura shantungensis* MILLER, Proc. Biol. Soc. Washington, 14: 158.
1940. *Crocidura ilensis shantungensis* KURODA, Monogr. Jap. Mamm. 182.
1949. *Crocidura ilensis coreae* IMAIZUMI, Nat. Hist. Jap. Mamm. 80.
1951. *Crocidura suaveolens shantungensis* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 77; IMAIZUMI, Col. Illust. Mamm. Jap. 21.

Type. *Crocidura shantungensis* MILLER, from Chimeh, Shantung, China.

Size small. Tail short, usually less than 70 per cent of head and body, with short hairs concealing the annulations and with long bristle hairs scattering along almost the entire length of tail except for the terminal portion.

Color in winter pelage, pale grayish bister above, pale mouse gray or dull white below. The demarkation line between them obscure. On close inspection there is seen a slight metallic reflection on the upper surface. Tail bicolored, similar to but slightly paler than back above, dull white under. Summer pelage seal brown above, dull white under.

Skull retains broad interorbital constriction, but breadth across molars and rostrum narrow, proportions of latter to the greatest length of skull 23.1, 29.5, and 12.4 per cent in average. Upper unicuspid teeth very conspicuous in the small size of second and third ones; in lateral view, both the unicuspids lower than half the height of first large unicuspid; third slightly larger than or subequal to second. Upper unicuspid row relatively short, the proportion to the greatest length of skull 12.3 per cent in average. Paracone of upper premolar well developed, usually exceeding in height the line connecting the tips of second and third unicuspids.

Measurements. Body weight 4.0–5.5 ; head & body 60.0–69.0 ; tail 40.0–42.0 ; fore foot (s. u.) 7.0–7.5 ; hind foot (s. u.) 11.2–12.0 ; ear 7.5–8.3 ; greatest length of skull 16.2–17.1, 17.0–17.9 (with I) ; basal length 14.3–15.0, 15.0–15.8 (with I) ; breadth of braincase 7.8–8.1 ; depth of braincase 4.7–4.9 ; interorbital breadth 3.7–4.0 ; breadth across molars 4.8–5.2 ; rostral breadth 2.0–2.2 ; upper tooth row 7.4–7.7 ; upper unicuspid row 2.0–2.2 ; mandible 8.5–9.2 ; lower tooth row 6.8–7.0.

Specimens examined. Shitomi, Izuhara T., Tsushima 5.

Distribution. Central and northern China, Korea, and Tsushima in Japan.

Remarks. This species is easily distinguishable by its smaller size, the tail with bristle hairs along almost the entire length, the less developed second and third upper unicuspids, and the well developed paracone of upper premolar.

10. *Crocidura horsfieldi watasei* KURODA.

1909. *Sorex* sp. NAMIE, Zool. Mag. Tokyo, 21: 453.

1924. *Crocidura watasei* KURODA, New Mamm. Riu Kiu Is. 1 ; KISHIDA, Honyûdôbutsu Zukai 1924, 73 ; KURODA, Trans. Biogeogr. Soc. Jap. 1933, 3, 1: 66.

1951. *Crocidura horsfieldi watasei* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 76 ; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 23.

Type. *Crocidura watasei* KURODA, from Komi, Amami-Ôshima, Riu Kiu Islands.

Size medium, head and body usually 61–76 mm. Tail long, averaging about 70 per cent, with range from 63.4 to 75 per cent, of head and body. Short hairs of tail concealing the annulations in young, reduced in old adult. Bristles scattered along basal half or basal one-third of tail.

Color in winter pelage a uniform fuscuous or clove brown above (similar to that of *C. suaveolens shantungensis* but more grayish), mouse gray below, Tail indistinctly bicolored, concolors with back above, wood brown below. Summer pelage chaetura drab above, hair brown below.

Skull small, the greatest length usually 16.4–17.9 mm. Interorbital portion conspicuously constricted, and palatal and rostral portions broad, their proportions to the greatest length of skull 22.8, 30.3, and 13.1 per cent in average, respectively.

Second and third upper unicuspids relatively large, usually exceeding about half the height of first one ; third larger than second. Upper unicuspid row relatively long, the proportion to the greatest length of skull 13.3 per cent in average. Paracone of upper premolar less developed, usually much lower than the line connecting the tips of second and third unicuspids. Of forty-three specimens examined, thirty-seven (young and subadults) with the paracone being lower than the level, four (subadults) with the paracone being on the same level, and two (subadult and adult) with the paracone being higher than the level.

Measurements. Body weight 3.7–7.3 ; head & body 57.0–76.0 ; tail 37.0–53.0 ; fore foot (s. u.) 6.5–7.8 ; hind foot (s. u.) 10.7–12.5 ; ear 7.4–9.0 ; greatest length of skull 16.0–17.9, 16.9–18.6 (with I); basal length 14.3–16.0, 14.9–16.7 (with I): breadth of braincase 7.5–8.4 ; depth of braincase 4.7–5.4 ; interorbital breadth 3.7–4.1 ; breadth across molars 4.8–5.4 ; rostral breadth 2.2–2.4 ; upper tooth row 7.2–8.0 ; upper unicuspid row 2.2–2.4 ; mandible 8.6–9.6 ; lower tooth row 6.7–7.5.

Specimens examined. Amami-Ôshima : Nishinakama, Sumiyô V. 42 ; Kasari V. 1. Total 43.

Distribution. Amami-Ôshima, Tokunoshima, and Iejima, Riu Kiu Islands.

Remarks. General characters of this species are very similar to those of *C. suaveolens* but readily distinguishable from the latter by the longer tail with very sparse bristles along its basal half only, by the larger second and third upper unicuspids, and by the small paracone of premolar.

Amami Islands are situated on the northern border in the distribution of this species, and the subspecies from these islands retains the largest body size and relatively short tail in *C. horsfieldi*.

11. *Crocidura dsinezumi dsinezumi* (TEMMINCK).

1844. *Sorex dsinezumi* TEMMINCK, in SIEBOLD's Fauna Jap. Mamm. 26.

1844. *Sorex kinezumi* TEMMINCK, ibid. 26 (foot note); TEMMINCK, ibid. 4, Tab. iv, figs. 6–11 c.

1906. *Crocidura dsinezumi* THOMAS, Proc. Zool. Soc. London, 1905, 2 : 340; KISHIDA, Honyûdôbutsu Zukai 1924, 69; KURODA, Monagr. Jap. Mamm. 1940, 180 ; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 78 ; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 27.

1906. *Crocidura dsinezumi chisai* THOMAS, Proc. Zool. Soc. London, 1905, 2: 340; KISHIDA, Honyûdôbutsu Zukai 1924, 70; KURODA, Monogr. Jap. Mamm. 1940, 179; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 78; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 27.

1924. *Crocidura dsinezumi intermedia* KURODA, New Mamm. Riu Kiu Islands, Tokyo, 2; KISHIDA, Honyûdôbutsu Zukai 1924, 72 ; KURODA, Monogr. Jap. Mamm. 1940, 180; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 78; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 30.

1951. *Crocidura russula dsinezumi* ELLERMAN & MORRISON-SCOTT. Checklist of Palaearctic and Indian Mamm. 79.

1951. *Crocidura russula chisai* ELLERMAN & MORRISON-SCOTT, ibid. 80.

1951. *Crocidura russula intermedia* ELLERMAN & MORRISON-SCOTT, ibid. 81.

1956. *Crocidura russula* subsp. KINOSHITA, Rep. Hokkaido Branch Gov. Forest Exp.

St. (Spec. Rep.), 5: 57.

1959. *Crocidura suaveolens okinoshimae* KURODA & UCHIDA, Annot. Zool. Jap. 32: 43.

1960. *Crocidura dsinezumi okinoshimae* IMAIZUMI, Col. Illust. Mamm. Jap. 28.

Type. *Sorex disnezumi* TEMMINCK, from Kyûshû, Japan.

Size large, head and body usually 65–80 mm. Specimens from southern regions are usually larger than those from northern regions. Tail short, usually less than 70 per cent of head and body, the bristle hairs scattering along the basal half of tail.

Color of pelage is very variable geographically. Winter pelage, between grayish pale bister and clove brown on back; belly, between drab and hair brown. Summer pelage, snuff brown or clove brown above, buffy brown or hair brown under.

Skull with broad and robust facial portion, the greatest length 17.3–19.3 mm. Upper tooth row short; second and third upper unicuspids half as low as the height of first one or slightly higher; third unicuspid slightly larger than, or subequal to, second one. Paracone of upper premolar (in unworn tooth) usually not exceeding the line connecting the tips of second and third unicuspids. Of fifty-four specimens examined, thirty-two (young and subadults) with paracone being lower than the level, six (subadults and adults) with paracone being on the same level, sixteen (subadults and adults) with paracone being higher than the level.

Measurements. Body weight 5.0–12.5; head & body 61.0–84.0; tail 39.0–54.0; fore foot (s. u.) 7.0–9.0; hind foot (s. u.) 11.5–15.0; ear 7.1–9.1; greatest length of skull 16.5–19.3, 17.5–19.6 (with I); basal length 14.5–17.0, 15.2–17.4 (with I); breadth of braincase 8.1–9.2; depth of braincase 5.0–5.8; interorbital breadth 4.0–4.5; breadth across molars 5.2–6.0; rostral breadth 2.0–2.5; upper tooth row 7.5–8.5; upper unicuspid row 2.2–2.5; mandible 9.1–10.4; lower tooth row 7.0–7.7.

Specimens examined. Honshû: Iwate Pref.: Kamiyonai, Morioka C. 2; Fukushima Pref.: Tadami, Tadami T. 6; Nagano Pref.: Agematsu, Agematsu T. 1; Ôdaira, Iida C. 1; Gifu Pref.: Natsumaya, Kiyomi V. 2; Hiroshima Pref.: Shibaki, Togouchi T. 1; Tottori Pref.: Daisei V. 1. Shikoku: Tokushima Pref.: Jingo, Kawashima T. 13; Nishioe, Kamojima T. 7; Mt. Nakatsumine 3; Ehime Pref.: Mt. Takanawa 1; Matsuyama C. 1; Kôchi Pref.: Mori V. 2; Yoshiwara V. 2; Mononobe V. 1; Kawase V. 1; Ôsugi V. 1; Nishi-Shinyashiki, Kochi C. 1. Kyûshû: Fukuoka Pref.: Zendôji T. 2; Kagoshima Pref.: Kogashira, Kagoshima C. 4; Tane Is.: Kawamukai, Nishinoomote C. 8. Hokkaido: Ashibetsu C. 3. Total 64.

Distribution. Hokkaido, Honshû, Sado Is., Oki Is., Niijima, Shikoku, Kyûshû, and Tane Is.

Remarks. As stated above, the size and the color of this shrew are very variable geographically. The characters, however, change gradually from one locality to another. Studying a series of samples coming from various regions, the author has been quite unable to find any reasonable distinction among *C. dsinezumi chisai*, *C. dsinezumi intermedia*, *C. disnezumi okinoshimae*, and typical *C. dsinezumi dsinezumi*. It is, therefore, the author's opinion that these forms must be a mere geographic variation of *typicus*.

The specimens obtained by KINOSHITA (1956) in Hokkaido possess relatively small body and skull. The general characters, however, fit well with those of the specimens from northern Honshû. Consequently the author has identified these specimens with the present subspecies.

12. *Crocidura dsinezumi umbrina* (TEMMINCK)

1844. *Sorex umbrinus* TEMMINCK, in SIEBOLD's Fauna Japon. Mamm. 27; THOMAS, Proc. Zool. Soc. London, 1906, 2: 340.

1924. *Crocidura dsinezumi umbrina* KISHIDA, Honyûdôbutsu Zukai 71; KURODA, Monogr. Jap. Mamm. 1940, 180; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 78; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 30.

1951. *Crocidura russula umbrina* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 79.

Type. *Sorex umbrinus* TEMMINCK, from Miyanoura, Yaku Is.

External and cranial characters quite similar to those of the specimens from Tane Is., except for the larger size. Tail length as in typical subspecies in proportion to head and body length. Winter pelage dark mars brown above, olive brown below; summer pelage clove brown above, hair brown below.

The only character claimed is the supposedly slightly greater size: males of this subspecies are slightly larger than those from more northern subspecies, females subequal to males from Tane Is. or from more northern regions.

Measurements. Body weight 7.5–8.0; head & body 78.0–82.0; tail 48.0–54.0; fore foot (s. u.) 8.0–8.5; hind foot (s. u.) 13.1–13.5; ear 8.5–8.9; greatest length of skull 18.5–18.9, 19.5–19.7 (with I); basal length 16.3–16.8, 17.3–17.6 (with I); breadth of braincase 8.8–9.0; depth of braincase 5.5–5.8; interorbital breadth 4.3–4.5; breadth across molars 5.7–5.8; rostral breadth 2.3–2.4; upper tooth row 8.5–8.7; upper unicuspid row 2.4–2.5; mandible 10.2–10.4; lower tooth row 7.8–8.0.

Specimens examined. Yaku Is.: Anbô, Shimoyaku V. 2; Miyanoura, Kamiyaku V. 2. Total 4.

Distribution. Confined to Yaku Is.

13. *Crocidura orii* KURODA

1924. *Crocidura dsinezumi orii* KURODA, New Mamm. Riu Kiu Islands 3; KISHIDA, Honyûdôbutsu Zukai 1924, 73; KURODA, Monogr. Jap. Mamm. 1940, 181; IMAIZUMI, Col. Illust Mamm. Jap. 1960, 30.

1951. *Crocidura russula orii* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 81.

1961. *Crocidura orii* IMAIZUMI, Jour. Mamm. Soc. Jap. 2; 17.

Type. *Crocidura dsinezumi orii* KURODA, from Komi, Amami-Ôshima.

This is a relative of *C. dsinezumi* but easily distinguished from the latter and others by the relatively long fur of the back (6.0–6.5 mm.), the decidedly larger claws of manus (2.7 mm.), the much shorter braincase, and the posteriorly located posterior border of infraorbital foramen and anterior extremity of orbit (from IMAIZUMI 1961).

Color of pelage, light seal brown above, pale mouse gray below.

Measurements. Head & body 78.0–90.0; tail 51; hind foot 15.0; ear 8.5–9.0; greatest length of skull (with I) 20.7; breadth of braincase 9.8; breadth across molars 6.3–7.0; upper tooth row 9.1–10.0; mandible 13.5; lower tooth row 8.6–9.0 (from KURODA 1924 and IMAIZUMI 1960).

Specimens examined. None.

Distribution. Amami-Oshima.

Genus *Chimarrogale* ANDERSON

1877. *Chimarrogale* ANDERSON, Jour. Asiat. Soc. Bengal, 46, 2: 262. *Crossopus himalayanus* GRAY.

This is an aquatic form of the crocidurine shrews and well differentiated to life in water. Feet have a fringe of flattened, stiff hairs on both lateral edges of each toe, acting as a web in water. Ears concealed in the fur, with a valvular antitragus closing the opening. Tail relatively long, subequal to, but slightly shorter than, the length of head and body, and with hairs being longer on the under side. Fur soft and dense, the guard hairs with silvery tips scattering along the upper and lateral surface of body, especially dense on the rump. Mammae: 0+0+3=6.

Skull with broad and flattened braincase, the profile of the latter making a flat angle with that of the rostrum. Lambdoidal crest less marked. The upper outline of rostrum nearly parallel with the alveolar margin. Teeth white, first upper incisor slender and long hook-like, with a lower posterior cusp; three upper unicuspids subequal in size to one another, about as high as the anterior cusp of premolar; lower incisor blade-like, with nearly straight cutting edge. Dental formula : $I\frac{3}{1}+C\frac{1}{1}+Pm\frac{1}{1}+M\frac{3}{3}=28$

Distribution. Himalaya, Burma, Indo-china, Southern China, and Japan (Honshû, Shikoku, and Kyûshû).

14. *Chimarrogale platycephala platycephala* (TEMMINCK)

1842. *Sarex platycephala* TEMMINCK, in SIEBOLD's Fauna Japon. Mamm. 23.

1906. *Chimarrogale platycephala* THOMAS Proc. Zool. Soc. London, 1905, 2; 340: KISHIDA, Honyûdôbutsu Zukai 1924, 75: KURODA, Monogr. Jap. Mamm. 1940, 188; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 80; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 88; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 35.

Type. *Sorex platycephala* TEMMINCK, from near Nagasaki and Bungo, Kyûshû, Japan.

Size larger than any other subspecies, head and body usually 103–133 mm., hind foot 24.5–27.7 mm.

Color of pelage variable, summer pelage chaetura black or chaetura drab above, deep olive buff or mouse gray (young) below; winter pelage blackish chaetura brown above, whitish below. Tail dark brown above, usually white below.

Skull larger, as a whole, than that of other subspecies.

Measurements. Body weight 24.0–56.0; head & body 103.0–133.0; tail 94.0–105.0; fore foot (s. u.) 15.0–16.7; hind foot (s. u.) 24.5–27.7; ear 7.2–8.5; greatest length of skull 26.2–28.2, 27.4–29.0 (with I); basal length 23.2–24.8, 24.3–25.6 (with I); breadth of braincase 14.5–15.5; depth of braincase 7.7–8.6; interorbital breadth 6.1–6.8; breadth across molars 8.7–9.2; rostral breadth 3.3–3.7; upper tooth row 12.3–12.9; upper unicuspid row 2.7–3.9; mandible 14.9–16.2; lower tooth row 11.2–11.9.

Specimens examined. Honshû: Nagano Pref.: Akagawara, Miwa V. 1; Gifu Pref.: Natsumaya, Kiyomi V. 1; Tottori Pref.: Nishidomari T. 9: Kyûshû: Fukuoka Pref.: Hikosan, 1. Total 12.

Distribution. Honshû, Shikoku, and Kyûshû, Japan.

Family *Talpidae*

Insectivores of this family have many peculiarities in the anterior part of the body, which is modified for a fossorial life. The fore feet are enlarged and provided with stout claws. The head is tapering forward, the external ears usually absent, the muscles of neck, shoulder, and arms are well developed.

The zygomatic arches of skull are present but slender; the tympanic bone forms a rounded bulla. The teeth are primitive in form and the upper molars have sharp cusps forming a W-pattern.

This group is holarctic in distribution, and two subfamilies including four genera occur in Japan.

Key to the Japanese subfamilies and genera of Talpidae.

1. Tail long; rhinarium rather cylindrical, the nostrils directed outward; the length of manus longer than the width; first upper incisors larger than canines . . . . Subfamily Scalopinae.
   2. Tail slender, more than 45.8 per cent of head and body; teeth 38, first upper incisors with a flat tip in anterior view . . . . *Dymecodon.*
   2'. Tail clavate in form, less than 39.0 per cent of head and body; teeth 36, first upper incisors large, with pointed tip . . . . *Urotrichus.*

1'. Tail short; fore foot broadened, the length subequal to the width; rhinarium semicircular; incisors smaller than canines . . . . Subfamily Talpinae.
   3. Body small, naked portion on upper side of muzzle long triangular in outline; nostriles directed somewhat outward; teeth 44 . . . . *Euroscaptor.*
   3'. Body large; naked portion on upper side of muzzle long rectangular in outline; nostrils directed forward; teeth 42 . . . . *Mogera*

Genus ***Dymecodon*** TRUE

1887. *Dymecodon* TRUE, Proc. U. S. Nat. Mus. 1886, 97.
   Dymecodon pilirostris TRUE.

1951. *Urotrichus* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 33 (in part).

External characters somewhat shrew-like. Snout very long, slender and hairy. Rhinarium nearly cylindrical, with a shallow longitudinal groove along the upper mid-line; the nostrils opening outward; triangular scale situated on the posterior portion of the nostrils subequal to, or larger than, nostrils. Auricles lacking. Fore feet slightly broadened, the length longer than the width; toes with slightly flattened and nearly straight claws; back of feet scaly and dark. Tail relatively long, with the tail ratio ranging from 43 to 60 per cent and with relatively short hairs: 5–7 mm at the middle, 8–15 mm at the tip; the thickness subequal in its entire length except for the constricted base, Fur somewhat plushlike. Mammae: 1+0+2=6 or 1+1+1=6.

Skull similar to that of *Urotrichus* but lighter and more delicate; rostrum slender, longer; interorbital portion broader. First upper incisor very large, about one and half as high as second, the tip broad and flat when viewed from front. Upper canine and first premolar subequal in size, lower than half the height of second incisor; subequal second and third upper premolars, with two roots, much larger than first (Plate 1–H). The tip of lower incisor as in first upper one. Lower canine much larger than anterior three premolars. Lower tooth row with four premolars. Dental formula, therefore:

$$I\frac{2}{1}+C\frac{1}{1}+Pm\frac{4}{4}+M\frac{3}{3}=38.$$

This is a genus endemic to Japan and only one species is known.

Distribution. Honshû and Shikoku, Japan.

15. *Dymecodon pilirostris* TRUE.

1887. *Dymecodon pilirostris* TRUE, Proc. U.S. Nat. Mus. 1886, 97; THOMAS, Proc. Zool. Soc. London, 1908, 51; AOKI, Zool. Mag. Tokyo, 1911, 23: 102; KISHIDA, Honyû-dôbutsu Zukai 1924, 65; KURODA, Monogr. Jap. Mamm. 1940, 194; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 55; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 37.

1951. *Urotrichus pilirostris* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 34.

Type. *Dymecodon pilirostris* TRUE, from Enoshima, Honshû, Japan.

Principal characters as described for genus.

Color in summer pelage, chaetura black above, slightly paler below in the specimens from northern localities, but in those from southern localities usually more brownish: blackish brown above; winter pelage darker than summer.

Measurements. Body weight 8.0–14.5; head & body 70.0–84.0; tail 32.0–44.0; fore foot 8.0–10.0 (s. u.), 10.7–13.5 (c. u.); breadth of fore foot 4.0–5.4; hind foot (s. u.) 12.8–15.2; greatest length of skull 20.8–23.0; basal length with I. 16.3–18.5; palatal length with I. 8.6–10.0; breadth of braincase 10.0–11.1; depth of braincase 6.5–7.4; greatest interorbital breadth 5.0–5.9; rostral breadth 2.3–3.0; breadth across molars 5.3–6.4; upper tooth row 8.5–9.7; $Pm\underline{4}$–$M\underline{3}$ 5.0–5.8; zygomatic breadth 7.4–8.6; mandible 12.4–14.4; lower tooth row 7.8–8.9.

Specimens examined. Honshû: Aomori Pref.: Mt. Hakkoda (770–1050 m. alt.), 5; Yamagata Pref.: Yunodai, Mt. Chôkai 1; Nagano Pref.: Shiroumajiri, Shirouma-dake, 1; Yokoo, Kamikôchi, 8; Akagawara, Miwa V. 2; Kai-komagadake, 2; Yabusawa, Senjogadake, 4; Kitazawatôge, Miwa V. 6; Shikoku: Ehime Pref.: Mt. Ishizuchi 2; Mt. Sazareo (800 m. alt.), Iyo-mishima C. 3; Mt. Shimokabuto (1000 m. alt.), Niihama C. 2. Total 36.

Distribution. Honshû and Shikoku, Japan.

Genus *Urotrichus* TEMMINCK

1839. *Urotrichus* TEMMINCK, Tijdschr. Natuur. Gesch. 5: 286. *Urotrichus talpoides* TEMMINCK, nom. nud.

1841. *Urotrichus* TEMMINCK, Het. Instit. K. Ned. Inst. 212. *Urotrichus talpoides* TEMMINCK

External characters similar to those of *Dymecodon*, except the larger size, slightly less hairy but thicker snout, broader fore feet, relatively shorter but thicker tail which is clavate in form and about a third of head and body in length, and the tail with relatively longer coarse hairs (6–9 mm. at the middle, 10–20 mm. at the tip). Mammae: $1+0+2=6$ or $1+1+1=6$.

Skull more robust than that of *Dymecodon*. Rostrum usually broad and short; interorbital portion relatively narrow. First upper incisor very large, sharply pointed at the tip; second as low as half the height of first; upper canine very small; upper unicuspid premolars with one root gradually increase in size from first to third; the tip of lower incisor pointed and curved antero-upward; lower canine and anterior two premolars subequal in size and form (Plate 1–I). Teeth reduced in number; the formula:

$$I\frac{2}{1}+C\frac{1}{1}+Pm\frac{4}{3}+M\frac{3}{3}=36.$$

Distribution. Honshû, Shikoku, Kyûshû, Oki Is., and Tsushima, Japan.

Remarks. This is also a genus endemic to Japan; only one species is known.

16. *Urotrichus talpoides talpoides* TEMMINCK

1841. *Urotrichus talpoides* TEMMINCK, Het. Instit. K. Ned. Inst. 215; TEMMINCK, In SIEBOLD's Fauna Japon. Mamm. 1842, 22, pl. 4, fig. 2–11; THOMAS, Proc. Zool. Soc. London, 1906, 341; THOMAS, ibid. 1908, 50; AOKI, Zool. Mag. Tokyo, 1911, 23: 101; KISHIDA, Honyûdôbutsu Zukai 1924, 60; KURODA, Monogr. Jap. Mamm. 1940, 192; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 53; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 34; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 40.

1906. *Urotrichus talpoides pilirostris* THOMAS, Proc. Zool. Soc. London, 1905, 2: 342. not of TRUE, 1886.

1908. *Urotrichus talpoides centralis* THOMAS, Proc. Zool. Soc. London, 50; KISHIDA, Honyûdôbutsu Zukai 1924, 62; KURODA, Monogr. Jap. Mamm. 1940, 192; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 53; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 34; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 41.

1908. *Urotrichus talpoides hondonis* THOMAS, Proc. Zool. Soc. London, 51; AOKI, Zool. Mag. Tokyo, 1911, 23: 49; KISHIDA, Honyûdôbutsu Zukai 1924, 63: KURODA, Monogr. Jap. Mamm. 1940, 190; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 53; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 34; IMAIZUMI, Col. Illust Mamm. Jap. 1960, 42.

1929. *Urotrichus talpoides yokohamanis* KANDA, Zool. Mag. Tokyo, 41: 147.

1932. *Urotrichus talpoides minutus* TOKUDA, Annot. Zool. Japon 13: 580; KURODA, Monogr. Jap. Mamm. 1940, 192; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 53: ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 34; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 44.

Type. *Urotrichus talpoides* TEMMINCK, from Nagasaki, Kyûshû, Japan.

General characters as described for genus.

Color of pelage gradually varies from near black in small local forms of northern localities to dark chestnut brown in large local form of southern ones: summer pelage of the former near black or blackish brown above, slightly paler than back below, whereas in that of the latter much dark chestnut brown above, slightly paler than back below. Specimens from intermediate localities usually represent entire intermediate colorations between both the extremes, though there are some exceptions. Pelages of the specimens from Oki Is. are very similar to those of the specimens from Mt. Daisen, Tottori Pref. Winter pelage darker than summer one.

Measurements. Body weight 14.5–25.5; head & body 89.0–104.0; tail 27.0–37.0; fore foot 9.5–12.0 (s. u.), 12.0–15.5 (c. u.); breadth of fore foot 5.0–7.0; hind foot (s. u.) 13.8–16.0; greatest length of skull 23.8–27.5; basal length with I. 19.3–22.6; palatal length with I. 9.7–11.8; breadth of braincase 11.3–13.8; depth of braincase 7.2–8.6; greatest interorbital breadth 5.6–6.7; rostral breadth 3.0–3.9; breadth across molars 6.7–8.5; upper tooth row 9.7–11.6; Pm $\underline{4}$–M $\underline{3}$ 5.9–7.2; zygomatic breadth 8.8–10.6; mandible 14.6–17.6; lower tooth row 8.7–10.2.

(Measurements of the animals in the "a–1" class of age are omitted from the above data).

Specimens examined. Honshû: Aomori Pref.: Sukayu, Mt. Hakkoda, 2; Akita Pref.: Ôyu T. 2; Iwate Pref.: Kuroishino, Kamiyonai, and Asagishi, Morioka C. 33; Fukushima Pref.: Ketanomiya, Bange T. 17; Yanaizu T. 2; Tadami T. 12; Nagano Pref.: Sarukura, Shirouma V. 1; Futamata, Shirouma V. 2; Hideshio, Soga V. 3; Yabuhara, Kiso V. 1; Ogawa, Agematsu T. 3; Ôdaira, Iida C. 10; Konashidaira, Kamikôchi 26; Gifu Pref.: Natsumaya, Kiyomi V. 17; Hiroshima Pref.: Shibaki, Togouchi T. 24; Tottori Pref.: Mt. Daisen 14. Shikoku: Ehime Pref.: Mt. Sazareo, Iyo-mishima C. 9; Mt. Shimokabuto, Niihama C. 5; Saragamine 18; Tokushima Pref.: Mt. Kôtsu, Kawata T. 5;

Yokose T. 2; Jingo, Kawashima T. 2. Kyûshû: Fukuoka Pref.: Hikosan 32; Ôita Pref.: Yoake, Hita C. 1; Kagoshima Pref.: Kogashira, Kagoshima C. 15; Taniyama, Kagoshima C. 1. Oki Is.: Saigo T. 13. Total 272.

Distribution. Honshû, Shikoku, Kyûshû, Oki Is. and Gotô Is., Japan.

Remarks. As stated previously the examination of a large series of specimens collected from various regions led the author to conclude that geographical variations of this species are usually continuous from one local population to another. Therefore all the subspecies which have been so far recognized, except *U. talpoides adversus*, are no more than mere variations of the typical subspecies.

17. *Urotrichus talpoides adversus* THOMAS.

1908. *Urotrichus talpoides adversus* THOMAS, Proc. Zool. Soc. London, 49; ANDERSON, ibid. 1908, 50; AOKI, Zool. Mag. Tokyo, 1911, 23: 102; KISHIDA, Honyûdôbutsu Zukai 1924, 61; KURODA, Monogr. Jap. Mamm. 1940, 193; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 53; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 43; IMAIZUMI, Col. Illust. Mamm. Jap. 1960,

Type. *Urotrichus talpoides adversus* THOMAS, from Sasuna, North Island, Tsushima, Japan.

Size large. Tail relatively long, the proportion to the head and body about 36.7 per cent in average, with ranges from 33.7 per cent to 39.2 per cent (the samples in the "a-1" stage of age are omitted). Color of pelage paler than any other local variation: between bister and clove brown above, hair brown below even in winter pelage.

Skull relatively large but slender: the proportion of palatal length to greatest length of skull large, reversely the proportion of breadth of braincase small.

Measurements. Body weight 16.5–23.0; head & body 89.0–100.5; tail 31.0–38.0; fore foot 10.5–12.2 (s. u.), 13.2–15.5 (c. u.); breadth of fore foot 5.7–7.0; hind foot (s. u.) 14.6–16.8; greatest length of skull 25.0–27.1; basal length with I. 20.3–22.2; palatal length with I. 11.0–12.0; breadth of braincase 12.3–13.2; depth of braincase 7.4–8.2; greatest interorbital breadth 5.8–6.4; rostral breadth 3.2–3.6; breadth across molars 7.3–8.0; upper tooth row 10.5–11.6; Pm $\underline{4}$–M $\underline{3}$ 6.4–7.2; zygomatic breadth 9.3–10.2; mandible 15.7–17.2; lower tooth row 8.9–10.3.

Specimens examined. Tsushima: Shitomi, Izuhara T. 29.

Distribution. Tsushima Islands, Japan.

Remarks. This is the most diversified local form of *U. talpoides* and is distinguishable from the typical form by its relatively longer tail, paler coloration, and relatively longer but slender skull.

Genus ***Euroscaptor*** MILLER

1940. *Euroscaptor* MILLER, Jour. Mamm. 21 : 443.
Talpa klossi THOMAS

External characters closely resemble those of *Talpa*: head tapering, neck and arms shortened and muscular, fore feet enlarged and broadened, the five claws long, stout and flattened; auricles lacking; eyes much reduced; tail clavate and short. Fur soft, plush-like. Rhinarium semicircular, the median pad strongly projecting forward; therefore, the nostrils directed outward. Glans short but thick.

Skull and teeth also similar to those of *Talpa*: three incisors above and below subequal in size and small, upper canines large, lower canines small and similar in size and shape to last incisor, anterior three premolars of upper jaw subequal in size, fourth premolar large and molariform. Dental formula with the full number of placental mammals: $I\frac{3}{3}+C\frac{1}{1}+Pm\frac{4}{4}+M\frac{3}{3}=44$

Ear bones very much resembling those of *Mogera*: lamina of malleus does not form a hollow cone but a thin broad plate, the cavum lamina broad and long triangular. Pelvis similar to, but more sender than, that of *Talpa*.

Distribution. Himalaya, Indo-china, South-western China, and Japan.

18. *Euroscaptor mizura* (GÜNTHER)

1880. *Talpa mizura* GÜNTHER, Proc. Zool. Soc. London, 441.
1948. *Euroscaptor mizura* KURODA, Mamm. Japan, 111; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 56.
1948. *Talpa micrura wogura* SCHWARZ, Proc. Zool. Soc. London, 118: 36 (in part); ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 39 (in part).
1955. *Talpa mizura* IMAIZUMI, Bull. Nat. Sci. Mus. Tokyo. I, 1: 32.
1955. *Talpa mizura hiwaensis* IMAIZUMI, ibid. I, 1: 33.
1955. *Talpa mizura ohtai* IMAIZUMI, ibid. I, 1: 34.
1960. *Euroscaptor mizura mizura* IMAIZUMI, Col. Illust. Mamm. Jap. 46.
1960. *Euroscaptor mizura hiwaensis* IMAIZUMI, ibid. 47.
1960. *Euroscaptor mizura ohtai* IMAIZUMI, ibid. 47.

Type. *Talpa mizura* GÜNTHER, from the neighborhood of Yokohama, Honshû, Japan.

Size very small, head and body about 79–107 mm. Tail relatively long, usually more than one and a half the length of hind foot (s. u.). Rhinarium semicircular, the forward-projecting median pad separated from a lower lip-like transverse pad by a deep horizontal groove; posterior border of upper surface of the rhinarium strongly concave, V-like, as in *Mogera*. Muzzle with a long triangular naked portion on the upper side.

Color of pelage varies from hair brown to almost black.

General characters of skull similar to those of small mountain forms of *Mogera wogura* but much smaller in size; rostrum more slender; interorbital portion much broader, braincase longer proportionately. Teeth quite similar to those of *Tapla europaea.* Incisors arranged in clearly V-shaped row. Ear bones closely resemble those of the small local forms of *Mogera wogura* and *M. kobeae*: lamina of malleus thin broad plate-like, the cavum lamina broad and long-triangular in form. Apophysis orbicularis present, the neck markedly constricted, manubrium cone-like and short; processus cephalicus present; processus longus of incus very short in length, processus brevis of a small cone shape.

Pelvis retains two pairs of foramina on the dorsal surface, the tips of ischia curving outward; the fissure between ischia relatively shallower than in *Euroscaptor longirostris* and *E. micrura*, resultiong from the fusion of their inner sides by which is formed a extra pair of small posterior foramina as in *Mogera*.

Measurements. Body weight 26.0–35.5; head & body 97.0–106.5; tail 23.0–26.0; fore foot 14.5–16.0 (s. u.), 19.0–21.0 (c. u.); breadth of fore foot 14.3–15.3; hind foot (s. u.) 14.0–15.4; greatest length of skull 26.9–28.0; condylobasal length 26.0–27.1; palatal length 11.0–11.4; breadth of braincase 13.3–14.0; depth of braincase 8.1–8.4; greatest interorbital breadth 6.9–7.4; rostral breadth 3.4–3.8; breadth across molars 6.6–7.2; mandible 16.6–17.4; upper tooth row 11.4–11.9; lower tooth row 10.7–11.2; C $\underline{1}$–M $\underline{3}$ 10.1–10.5; Pm $\underline{4}$–M $\underline{3}$ 6.3–6.4; zygomatic breadth 9.4–9.9; length of posterior braincase 8.0–8.3: projection degree of incisor row 20.3–37.6%; ratio of length of posterior braincase to breadth of it 57.9–60.8%; ratio of rostral breadth to greatest interorbital breadth 48.9–52.1%.

Specimens examined. Honshû: Nagano Pref.: Yokoo, kamikochi, 1; Kitazawatoge, Miwa V. 2. Total 3.

Distribution. Mountain regions of central and southern Honshû, Japan.

Remarks. *Euroscaptor* closely resembles *Talpa*, except for the glans penis, rhinarium, ear bones, and pelvis, all of which fit in general characteristics with those of *Mogera*, though the former two and the lattter differ from each other in dental formulae. Thus *Euroscaptor* appears to be a genus which approaches *Mogera* in phylogenetic relations. Especially, the present species may be the most advanced form in the genus, for the pelvis shows a progressed differentiation.

IMAIZUMI (1955) recognized two local subspecies by the differences in body size and color of the coat. As the author has pointed out above, these characters are very variable geographically and are not good taxonomic criteria. The author has examined only three specimens: one (♀) from Kamikochi, Nagano Pref., corresponds well to *E. mizura ohtai* in size and color; in the other two (♀♀) from Kitazawa-tôge, Miwa V., Nagano Pref., the size is subequal to that of *E. m. mizura* (of IMAIZUMI), but the color is decidedly different from that of the latter, being nearly black. Thus, these specimens and above subspecies seem to be no more than mere variations of the typical form.

Genus ***Mogera*** POMEL

1848. *Mogera* POMEL, Arch. Sci. Phys. Nat. Genéve, 9: 246.
Talpa wogura TEMMINCK,
1948. *Talpa* SCHWARZ, Proc Zool. Soc. London, 118: 36 (in part).
1951. *Talpa* ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 35 (in part).

External characters closely resemble those of *Euroscaptor*, but animal is larger and more robust, the tail shorter. Rhinarium with a forward-projecting median pad which is not separated by a horizontal groove from a transverse lip-like pad but smoothly connected with it; dorso-posterior border of rhinarium strongly concave at middle: V-shaped; muzzle with a long rectangular naked portion on the upper side. Glans penis short but thick. Mammae: $2+1+1=8$ or $1+2+1=8$.

Skull and teeth are also similar to those of *Euroscaptor*, except for the relatively slender interorbital portion, the relatively small braincase, and the dental formula characterized by the loss of the third lower incisors: $I\frac{3}{2}+C\frac{1}{1}+Pm\frac{4}{4}+M\frac{3}{3}=42$. Teeth stronger as a whole than in *Euroscaptor* and *Talpa*.

Ear bones essentially very similar to those of *Euroscaptor*: apophysis orbicularis of malleus usually present but ill defined; lamina forms a thin externally convex plate, cavum lamina broad and long triangular; capitulum mallei not a globular formation but rather only a well developed thikening of the articular surface. Processus longus of incus relatively very short.

Pelvis slender and simple, with two pairs of foramina on the upper surface, and with a shallow concave portion between ischia instead of a deep fissure as in *Talpa*.

Distribution. Ussuri, Manchria, China, Formosa, Korea, Hainan, and Japan.

Key to the Japanese species of *Mogera*.

1. Arrangement of upper incisors V-shaped; interorbital portion broad; rostrum relatively narrow.
   2. Body large; greatest length of skull more than 38.0 mm; braincase broad but short; postero-lower angle of infraorbital foramen usually obtuse and round. *M. tokudae.*
   2′. Body medium or small; greatest length of skull usually less than 38.5 mm.; braincase narrow but long; postero-lower angle of infraorbital foramen usually acute . . . . *M. wogura.*

1′. Body medium or large; arrangement of upper incisors round arc-like; interorbital portion narrow and nearly cylindrical; rostrum broad; posterolower angle of infraorbital foramen usually obtuse and round . . . . *M. kobeae.*

19. *Mogera wogura* (TEMMINCK)

1842. *Talpa wogura* TEMMINCK, in SIEBOLD's Fauna Japon. Mamm. 1: 19.
1845. *Talpa woogura* (sic.) TEMMINCK, ibid. 4: tab. 4, fig. 1–5.
1848. *Mogera wogura* POMEL, Arch. Sci. Phys. Nat. Genève, 9: 246; THOMAS, Proc. Zool. Soc. London, 1906, 341; KISHIDA, Honyûdôbutsu Zukai 1924, 57; KURODA, Monogr. Jap. Mamm. 1940, 196; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 59; IMAIZUMI, Col. Illust. Mamm. Jap. 1960, 50.
1936. *Mogera wogura minor* KURODA, Botany and Zoology, Tokyo, 4, 1: 74; KURODA, Monogr. Jap. Mamm. 1940, 195; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 59.
1936. *Mogera wogura gracilis* KISHIDA, Animls and Plants of Nikko, Japan, 261 (nom. nud.).
1948. *Talpa micrura wogura* SCHWARZ, Proc. Zool. Soc. London, 118: 36 (in part); ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 39 (in part).
1953. *Talpa micrura minor* KURODA, Col. Illust. Jap. Mamm. 98.
1957. *Talpa micrura imaizumii* KURODA, Jour. Mamm. Soc. Jap. 74 (renaming for *Talpa micrura minor* KURODA)
1960. *Mogera wogura imaizumii* IMAIZUMI, Col. Illust Mamm. Jap. 52.

Type. *Talpa wogura* TEMMINCK, from Yokohama, Honshû, Japan.

Body small or medium, the size very variable, usually larger in wide plains than it is in mountain regions or narrow valleys. Rhinarium with a forward-projecting median pad which is not divided by a horizontal groove from a transverse pad.

Color of pelage variable; usually darker in small forms from mountain regions, more brownish in large forms from plains. Summer pelages of large local forms, between mars brown and clove brown above, near cinnamon brown below. Head, throat, upper chest and central abdomen brown or near orange in adult. Back of small local forms near clove brown, belly slightly paler than back. Winter pelage usually darker than summer pelage.

Skull with relatively narrow rostrum and swollen interorbital region; braincase smooth, less angular. The postero-lower angle of infraorbital foramen usually acute. Incisor row usually much projected forward and markedly V-shaped in small local forms but this changes to a broad V-shape in large local ones. Anterior three upper premolars usually not so crowded together as in *M. kobeae*, but this is variable geographically; second smaller than the other two, which are subequal in height to each other. Three upper incisors gradually diminish from the largest first to the smallest third in small local forms whereas they are subequal in height to one another in large local ones.

Principal characters of ear bones as described for genus, but slightly variable with the change of skull size: the neck of apophysis orbicularis usually more constricted in small local forms than in large local ones, resulting in a more defined formation of apophysis orbicularis in the former.

Measurements. Body weight 48.0–127.0; head & body 121.0–159.0; tail 14.0–22.0; fore foot 15.5–22.5 (s. u.), 21.5–27.5 (c. u.); breadth of fore foot 16.5–23.0; hind foot (s. u.) 16.0–21.5; greatest length of skull 31.5–38.5; condylobasal length 30.7–37.7; palatal length 12.0–15.5; breadth of braincase 14.7–17.9; depth of braincase 9.3–11.7; greatest interorbital breadth 7.1–9.1; rostral breadth 3.7–5.5; breadth across molars 7.6–10.4; mandible 19.4–25.0; upper tooth row 12.7–16.3; lower tooth row 11.3–15.2; C $\underline{1}$–M $\underline{3}$ 11.5–15.0; Pm $\underline{4}$–M $\underline{3}$ 7.0–9.5; zygomatic breadth 10.6–13.6; length of posterior braincase 8.6–10.4: projection degree of incisor row 20.4–42.5%; ratio of length of posterior braincase to breadth of it 54.3–64.8%; ratio of rostral breadth to greatest interorbital breadth 49.7–67.6%.

Specimens examined. Honshû: Aomori Pref.: Noheji T. 3; Iwate Pref.: Kuroishino, Kamiyonai, and Asagishi, Morioka C. 20; Hanaizumi T. 14; Maezawa T. 1; Miyagi Pref.: Semine T. 20; Fukushima Pref.: Bange T. 14; Funado and Kubo, Takazato V. 15; Yanaizu, Yanaizu T. 10; Hinohara, Mishima V. 4; Tadami, Tadami T. 14; Niigata Pref.: Shibata, Shibata C. 9; Kakizaki T. 1; Nagano Pref.: Hiraide, Kanai, and Ueda, Shiojiri C. 16; Hideshio, Soga V. 5; Yabuhara, Kiso V. 4; Kiso-fukushima T. 2; Ogawa, Agematsu T. 10; Gifu Pref.: Natsumaya, Kiyomi V. 1. Shikoku: Tokushima Pref.: the top of Mt. Tsurugi (1955 m. alt.) 4. Total 167.

Distribution. Mountain regions of Chûgoku, Shikoku, and Kii Peninsula; northern Honshû more than the line connecting northern Shizuoka, Nagano, and Ishikawa Prefs., except the lower basins of the Shinano River and the

Agano River in Niigata Pref.

Remarks. *Mogera wogura imaizumii* KURODA is no more than a mountain form of the present species, for the external and cranial characters of the former gradually change and approach those of lowland moles with descent to lowlands.

20. *Mogera tokudae* KURODA

1933. *Mogera wogura* subsp. TOKUDA, Annot. Zool. Japon. 14, 2: 238, pl. 11.
1940. *Mogera wogura tokudae* KURODA, Monogr. Jap. Mamm. 196; IMAIZUMI, Nat. Hist Jap. Mamm. 1949, 59.
1960. *Mogera kobeae tokudae* IMAIZUMI, Col. Illust. Mamm. Jap. 57.

Type. *Mogera wogura tokudae*, from Sado Is., Japan.

Body very large but essentially quite similar in external characters to *M. wogura* except for the relatively longer tail.

Color in summer pelage, mars brown or near clove brown or darker above, near cinnamon brown below.

Skull essentially similar to that of *M. wogura* except the wider but shorter braincase, the clearly V-shaped and forward-projected upper incisor row despite the very large skull, the relatively longer upper tooth row, and the obtuse, rounded posterior-lower angle of infraorbital foramen. Rostrum relatively narrow, reversely interorbital portion broad, Upper incisors gradually diminishing from largest first to smallest third in frontal view.

Ear bones usually different from those of the other two species in the larger angle formed with manubrium and collum mallei, and in the ill-defined smooth apophysis orbicularis as in *Euroscaptor micrura*.

Measurements. Body weight 95.0–164.0 ; head and body 153.0–182.0 ; tail 19.0–30.0 ; fore foot 19.0–24.5 (s. u.), 25.7–32.5 (c. u.) ; breadth of fore foot 20.0–25.5 ; hind foot (s. u.) 20.0–25.5 ; greatest length of skull 38.0–43.3 ; condylobasal length 37.0–42.0 ; palatal length 16.0–18.4 ; breadth of braincase 18.0–19.8 ; depth of braincase 11.2–12.8 ; greatest interorbital breadth 8.2–9.4 ; rostral breadth 4.8–6.1 ; breadth across molars 10.2–12.0 ; mandible 24.6–27.9 ; upper tooth row 16.9–19.0 ; lower tooth row 15.7–17.9 ; C $\underline{1}$–M $\underline{3}$ 15.4–16.5 ; Pm $\underline{4}$–M $\underline{3}$ 9.8–11.3 ; zygomatic breadth 14.0–15.5 ; length of posterior braincase 9.5–11.3 ; projection degree of incisor row 21.8–35.8% ; ratio of length to breadth of posterior braincase 51.3–57.0% ; ratio of rostral breadth to greatest interorbital breadth 57.5–67.4%.

Specimens examined. Honshû : Niigata Pref. : Niitsu, Niitsu C. 3 ; Kameta, Kameta T. 4 ; Shibata, Shibata T. 9. Sado Is. : Umezu, Ryôzu C. 17. Total 33.

Distribution. Sado Island and the lower basins of the Shinano River and the Agano River, Niigata Pref., Japan,

Remarks. As pointed out previously this species seems to have differentiated on Sado Is. from the original stock of *Mogera wogura* probably during the glacial age, and to have reinvaded the lower plain of Niigata after this speciation. This species appears to be a close relative of *M. wogura* rather than *M. kobeae.* Actually *M. tokudae* is very similar in many respects to the former, in spite of the slight modifications in skull which occur with relation to the increase in the skull size. For example, similarities of the facial portion of skull and of the shape of upper incisor row are very important in the morphology of this group.

At Shibata T., Niigata Pref., which is situated on the peripheral area of the distribution of *M. tokudae* in Honshû, the species is confronted with *M. wogura* but segregates into micro-ranges even in the area of overlap, and no intermediate has been found. From these facts *M. tokudae* seems to be well established species.

21. *Mogera kobeae* THOMAS

1905. *Mogera wogura kobeae* THOMAS, Ann. Mag. Nat. Hist. 15: 487; THOMAS, Proc. Zool. Soc. London, 1905, 341, 358; THOMAS, ibid. 1907, 463; KISHIDA, Honyûdôbutsu Zukai 1924, 58; KURODA, Monogr. Jap. Mamm. 1940, 198; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 59.

1906. *Mogera wogura kanai* THOMAS, Proc. Zool. Soc. London, 1905, 2: 361; THOMAS, ibid. 1907, 463; KISHIDA, Honyûdôbutsu Zukai, 1924, 58; TOKUDA, Bull. Biogeogr. Soc. Jap. 1933, 3, 3: 170; KURODA, List Jap. Mamm. 1938, 89, 114; KURODA, Monogr. Jap. Mamm. 1940, 200; IMAIZUMI, Nat. Hist. Jap. Mamm. 1949, 59; IMAIZUMI, Col. Illust Mamm. Jap. 1960, 52.

1907. *Mogera wogura coreana* THOMAS, Proc. Zool. Soc. London, 463; KURODA, Zool. Mag. Tokyo, 1917, 29: 356; KURODA, Jour. Mamm. 1934, 15: 238; KURODA, Monogr. Jap. Mamm. 1940, 201.

1938. *Mogera wogura kiusiuana* "KISHIDA", KURODA, List Jap. Mamm. 1940, 199.

1948. *Talpa micrura kobeae* SCHWARZ, Proc. Zool. Soc. London, 118: 44; ELLERMAN & MORRISON-SCOTT, 1951, Checklist of Palaearctic and Indian Mamm. 40.

1948. *Talpa micrura kanai* SCHWARZ, Proc. Zool. Soc. London, 118: 44; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 41.

1948. *Talpa. micrura coreana* SCHWARZ, Proc. Zool. Soc. London, 118: 44; ELLERMAN & MORRISON-SCOTT, Checklist of Palaearctic and Indian Mamm. 1951, 41.

1960. *Mogera kobeae kobeae* IMAIZUMI, Col. Illust. Mamm. Jap. 55.

1960. *Mogera kobeae kiusiuana* IMAIZUMI, Col. Illust. Mamm. Jap. 56.

Type. *Mogera wogura kobeae* THOMAS, from Kobe, Honshû Japan.

External characters quite similar to those of *M. wogura,* but body is usually larger ; body size very variable geographically, usually larger in individuals from wide, humid plains than in those from mountain regions.

Color in summer pelage, bister or mars brown above, slightly paler than back or near prout's brown below, throat and upper chest ochraceous tawny or orange in adult. Winter pelage much darker than the summer one. Specimens from Oki Is. are usually more reddish, as a whole, than are other local forms.

Skull usually distinguishable from those of the other two species by the broader rostrum, the narrow and nearly cylindrical interorbital portion, and the angular and shorter braincase. Postero-lower angle of the infraorbital foramen obtuse and rounded. Upper incisor row rounded arc-like in arrangement, less projected forward in relatively young animals or even in small local forms. The bridge bone between infraorbital foramen and orbit frequently reduced in thickness ; in such individuals it is extremely slender and string-like or entirely absent. Anterior three premolars usually crowded together ; three incisors subequal in height.

General characters and variations of ear bones resemble those of *M. wogura*.

Measurements. Body weight 48.5–175.0 ; head & body 125.0–185.0 ; tail 14.5–27.0 ; fore foot 16.8–25.5 (s. u.), 22.0–33.0 (c. u.) ; breadth of fore foot 16.0–25.0 ; hind foot (s. u.) 16.5–24.0 ; greatest length of skull 33.0–42.1 ; condylobasal length 32.3–41.6 ; palatal length 12.8–17.1 ; breadth of braincase 15.6–19.8 ; depth of braincase 9.9–12.5 ; greatest interobrital breadth 7.5–9.3 ; rostral breadth 4.5–6.5 ; breadth across molars 8.3–11.6 ; mandible 20.7–27.9 ; upper tooth row 13.7–17.8 ; lower tooth row 12.6–16.8 ; C $\underline{1}$–M $\underline{3}$ 12.5–16.3 ; Pm $\underline{4}$–M $\underline{3}$ 7.7–10.4 ; zygomatic breadth 11.9–15.8 ; length of posterior braincase 8.8–11.2 ; projection degree of incisor row 14.1–29.2% ; ratio of length to breadth of posterior braincase 50.5–62.7%; ratio of rostral breadth to greatest interorbital breadth 56.1–72.9%.

Specimens examined. Honshû : Nagano Pref. : Ueda, Shiojiri C. 8 ; Kawashima, Tatsuno T. 5 ; Yonekawa, Chiyo V. 10 ; Tachimachi, Agematsu T. 1 ; Kamisato and Suhara, Ôkuwa V. 13 ; Midono, Yomikaki V. 12 ; Ôdaira, Iida C. 4 ; Todaiguchi, Miwa V. 1 : Tottori Pref. : Nishidomari T. 1 ; Hiroshima Pref. : Shibaki, Togouchi T. 15 ; Akoichi T. 16. Shikoku : Tokushima Pref. : Jingo, Kawashima T. 20 ; Nishioe, Kamojima T. 3 ; Kamiakui, Tokushima C. 3 ; Ehime Pref. : Ryûjindaira, Saragamine, 1. Kyûshû : Fukuoka Pref. : Hikosan (670 m. alt.) and Soeda, Soeda T. 3 : Ôishi, Ukiwa T. 12 ; Zendoji T. 9 ; Izumi, Chikugo C. 4 ; Kumamoto Pref. : Takata, Yatsushiro C. 9 ; Sajiki, Ashikita T. 9 ; Kagoshima Pref. : Kogashira and Taniyama, Kagoshima C. 11.

Oki Is. : Saigo T. 30. Tsushima : Shitomi, Izuhara T. 8. Yaku Is. : Shimoyaku V. 15 ; Miyanoura, Kamiyaku V. 2. Tane Is. : Ishidera, Nishino-omote C. 17 ; Noma, Nakatane T. 1. Korea ; Mt. Kongo, Chian Zen 2. Total 245.

Distribution. Southern Honshû more than the line connecting Shizuoka, Nagano, and Ishikawa Prefs. ; Shikoku, Kyûshû, Tane Is., Yaku Is., Goto Is., Oki Is., and Tsushima ; Japan and Korea.

Remarks. "*Mogera wogura kanai*" is a mere geographic variation of *M. kobeae* rather than of *M. wogura*, for the former has an arc-like and less projected upper incisor row despite its general similarity to *wogura*.

"*M. kobeae kiusiuana*" (of IMAIZUMI) is also a mere local variation of *M. kobeae*. Since the moles represent a perfect gradation in the geographic variations from one locality to another, *M. kobeae* should not be separated into any local subspecies.

It has been found that *M. kobeae* and *M. wogura* co-exist in part on the range between Ueda, Shiojiri City and Nakanohashi, Tatsuno Town, Nagano Pref., and at Nezame, Agematsu Town, Nagano Pref. However, the ranges of colonies are usually segregated, even where they overlap. and no intermediate has been found. *Mogera kobeae*, therefore, seems to be a well established species.

Literature*

1) ABE, H. 1958. Mem. Fac. Agr. Hokkaido Univ. 3: 201.
2) ALLEN, G. M. 1938. The mammals of China and Mongolia. Pt. 1. New York.
3) BOLOWSKI, S. 1958. Acta. Theriol. II. 14: 286.
4) CLOTHIER, R. R. 1955. J. Mamm. 36: 214.
5) CONAWAY, C. H. 1952. Amer. Midl. Nat. 48: 219.
6) CROWCROFT, P. and J. M. INGLES 1959. Nature 183: 907.
7) DOBSON, G. E. 1890. Ann. Mag. Nat. Hist. Ser. 6. V: 155.
8) EADIE, W. 1939. J. Mamm. 20: 150.
9) ELLERMAN, J. R. and T. C. S. MORRISON-SCOTT, 1951. Checklist of palaearctic and Indian mammals. London.
10) GÜNTHER, A. 1880. Proc. Zool. Soc. London 440.
11) HUBBS, C. L. 1940. Amer. Nat. 74: 198.
12) IMAIZUMI, Y. 1949. The natural history of Japanese mammals. Tokyo. In Jap.
13) ———— 1954. Bull. Nat. Sci. Mus. TOKYO 1: 94.
14) ———— 1955. *Ibid.* 2: 26.
15) ———— 1960. Coloured illustrations of the mammals of Japan. Osaka. In Jap.
16) KISHIDA, K. 1924. Zool. Mag. Tokyo 36: 156. In Jap.
17) ———— 1924. Nihon-Honyûdôbutsu-Zukai (Illustrated Japanese mammals). Tokyo. In Jap.
18) KURODA, N. 1917. Zool. Mag. Tokyo 29: 356.
19) ———— 1924. On new mammals from the Riu Kiu Islands and the vicinity. Publ. by the author. Tokyo
20) ———— 1925. Zool. Mag. Tokyo 37: 435.
21) ———— 1928. J. Mamm. 9: 222.
22) ———— 1933. Bull. Biogeogr. Soc. Japan 3: 152.
23) ———— 1936. Bot. Zool. 4(1): 74.
24) ———— 1940. A monograph of the Japanese mammals. Tokyo. In Jap.
25) ———— and T. UCHIDA 1959. Annot. Zool. Japon. 32: 43.
26) LACK, D. 1947. Darwin's finches. Cambrindge
27) MILLER, G. S. 1912. Catalogue of the mammals of western Europe.
28) MINATO, M. and S. IJIRI 1958. Nihonrettô (The Japanese Islands). Tokyo. In Jap.
29) NAKANO, T. and K. KOBAYASHI 1959. Nihon no shizen (The nature of Japan). Tokyo. In Jap.
30) NAORA, N. 1944. Nihon-honyûdôbutsu-shi (A history of the Japanese mammals). Tokyo. In Jap.
31) PALMER, F. G. 1937. J. Mamm. 18: 280.
32) PETERSON, G. D. 1956. J. Mamm. 37: 278.
33) PRUITT, W. O. Jr. 1954. J. Mamm. 35: 35.
34) RIDGWAY, R. 1912. Color standards and color nomenclature. Washington.

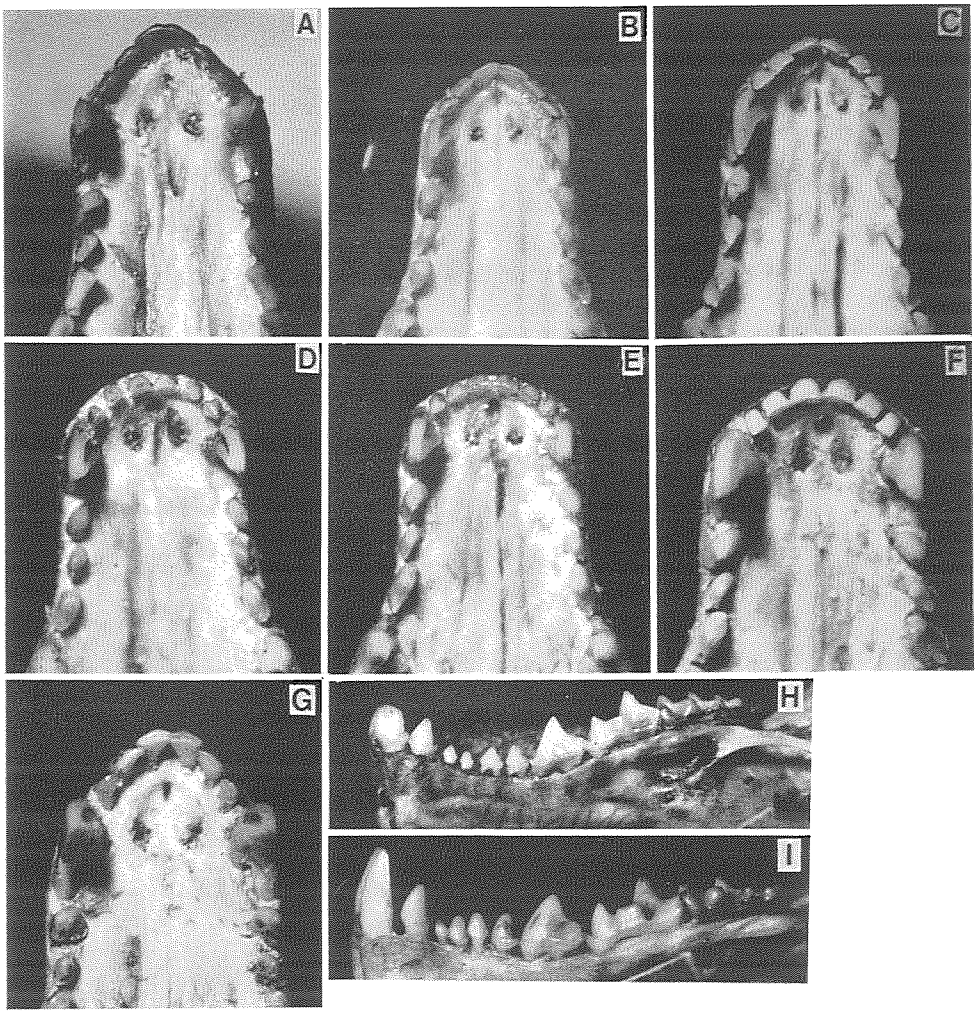
* Literature quoted in the synonymic list of each species are omitted from this list.

35) RUDD, R. L. 1955. J. Mamm. 36: 323.
36) SERAFINSKI, W. 1955. Acta Theriol. 1: 27.
37) SHIKAMA, T., Y. HASEGAWA, and G. OKAFUJI 1958. J. Mamm. Soc. Jap. 1: 97.
38) SOWERBY, C. 1923. The naturalist in Manchuria. Tientsin
39) СтрогАнов, С. У. 1957. Звери Сибири, Насекомоядные. Москва
40) TEMMINCK, 1842–1844. Fauna Japonica, Mammalia
41) THOMAS, O. 1905. Ann. Mag. Nat. Hist. 15: 487.
42) ———— 1905. Proc. Zool. Soc. London 331
43) ———— 1906. *Ibid.* 858.
44) ———— 1907. *Ibid.* 404
45) ———— 1908. *Ibid.* 47
46) TOKUDA, M. 1932. Annot. Zool. Japon. 13: 580.
47) ———— 1941. Nihon-seibutsu-chiri (Biogeography of Japan). Tokyo. In Jap.
48) ———— 1954. Two types in geographic variations. in "The variability of organisms" Tokyo 14. In Jap.
49) True, F. W. 1886. Proc. U. S. Nat. Mus. 9: 97.
50) VAURIE, C. 1951. Adaptive differences between two sympatric species of nuthatches (*Sitta*). Proc. Xth Intern. Ornith. Congr., Uppsala, 1950, 163 (From E. MAYR Animal species and evolution. Harvard).

Plate 1. The incisor rows of moles (A–G), and the upper tooth rows of shrew–moles (H–I).

A. Euroscaptor mizura from Kitazawa-tôge, Miwa. Nagano (young). B–D. *Mogera wogura*: B. Small local form from Tadami, Fukushima (young); C and D. Large local form from Semine, Miyagi (C: young, D: adult). E and F. *M. kobeae*: E. Small local form from Tane Is. (young); F. Large local form from Ueda, Shiojiri, Nagano (young). G. *M. tokudae* from Kameda, Niigata (adult). H. *Dymecodon pilirostris*. I. *Urotrichus talpoides*.

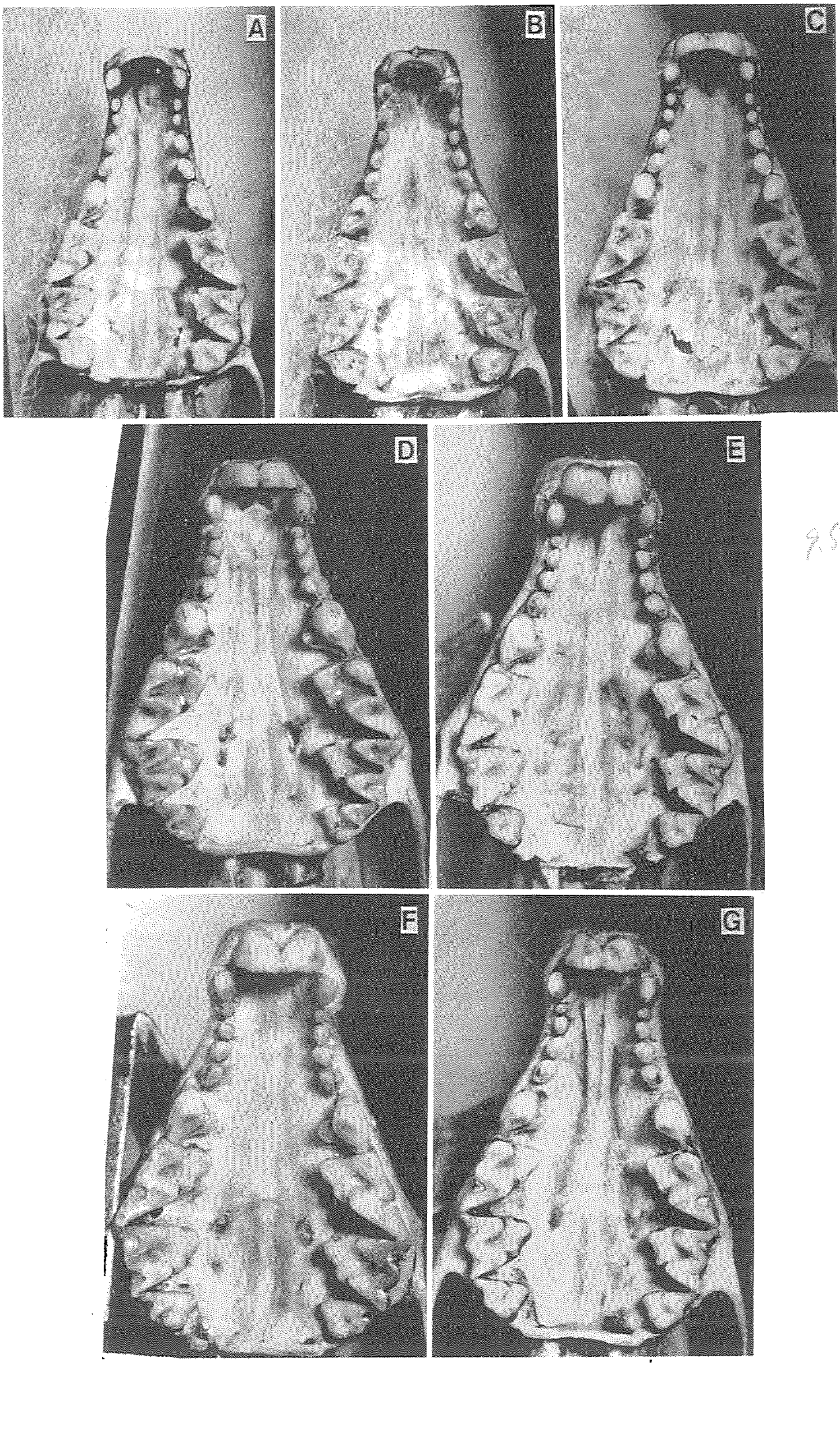
8.8×12.8 1/2.64



4×4.3 6.3×4

Plate 2. Geographic variation of the palatal portion of the skull.

Dymecodon pilirostris (A–C): A. Mt. Hakkoda, Aomori. B. Kitazawa-toge, Miwa, Nagano. C. Mt. Shimokabuto, Ehime. *Urotrichus talpoides* (D–G): D. Morioka, Iwate. E. Mt Sazareo, Ehime. F. Kagoshima. G. Izuhara Tsushima.


A
B
C
D
E
F
G