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Skull and Dental Characters, and Skull Measurements of *Microtus kikuchii* Kuroda, 1920 from Taiwan

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Abstract. Skull character and dental pattern were described and 16 skull measurements were given in 14 specimens of *Microtus kikuchii*. The skull was rather large but less ridgy and angular. The number of re-entrant folds varied greatly at both sides in $M\underline{3}$: three inner and outer folds are most frequent among the specimens examined. The number of closed dental spaces of $M\underline{3}$ varied from four to six, and five ones were most common. The antero-external concavity of the anterior loop of $M\bar{1}$ varied from indistinct to distinct type. A prominant first outer fold of $M\bar{3}$ is observed in all specimens studied, and it suggests that the fold is a characteristic of the vole. The re-entrant fold of the second loop of $M\bar{3}$ did not appear consistently. Significant regression coefficients of seven skull measurements on zygomatic width (ZW) were shown except for interorbital width. By a regression line of condylobasal length (CBL) on ZW, the 95% confidence interval for CBL of the holotype specimen, whose basal part of braincase is damaged, was estimated as 30.97–31.99 mm, which is longest among the specimens examined and reported.

Key words: *Microtus kikuchii*; Skull; Dental pattern; Variation; Taiwan.

Introduction

The kikuchi's field vole *Microtus kikuchii*, an endemic Taiwan species, was first described by Kuroda (1920) on the basis of one adult female collected from Mt. Morrison. Afterwards, very few details of the literature have been reported based on a few specimens: on skull character (Tokuda, 1941; Aoki & Tanaka, 1941), on dental pattern (Kuroda, 1920; Tokuda & Kano, 1938; Tokuda, 1941; Aoki & Tanaka, 1941), on some external measurements (Kuroda, 1920, 1935; Horikawa, 1932; Tokuda & Kano, 1938; Tokuda, 1941; Aoki & Tanaka, 1941), and on some skull measurements (Kuroda, 1920, 1935; Tokuda, 1941; Aoki & Tanaka, 1941).

This paper presents skull character, dental pattern, and skull measurements of 14 specimens of the Kikuchi's field vole and discusses on the variation of the vole.

I wish to thank the late Dr. M. Tokuda, Kyoto University, for providing me 11 specimens. Institute of Yamashina Ornithology, Abiko, Chiba Prefecture, very kindly allowed me to examine three specimens. I should like to thank Prof. E. W. Jameson, Jr., University of California, for his reading and commenting on the

early draft.

Materials and Methods

Nine crania with lower jaws, one cranium, and one lower jaw were presented by the late Dr. M. Tokuda (K4943 to K4953) (Table 2). Among the specimens dental pattern of three specimens was figured by Tokuda & Kano (1938) and external and skull measurements of four specimens were given by Tokuda (1941). The locality, the date of collection, sex and external measurements of K4946 and K4952 were identified by the Tokuda's field note: the two specimens were collected from Mt. Arisan (now Mt. Alishan) (23°31′N, 121°47′E, alt. 2270 m). Other specimens studied have not been identified by the author. Some skulls or molars are damaged or lost.

Three specimens collected from Mt. Taiheisan (now Mt. Taipingshan) (24°32′N, 121°33′E, alt. 1922 m) and kept in the Institute of Yamashina Ornithology (I. Y. O.) were examined and measured (609 to 611) (Table 2). Kuroda (1935) reported the locality, the date of collection, and the range of external and a few cranial measurements of the specimens. Certain skull measurements and dental pattern of the two specimens cannot be taken, because muscles have not been removed from skulls.

The following 16 skull measurements were taken to the nearest 0.1 mm with a dial caliper by the author; paired structures were principally measured on the left side except for some parts of skull damaged or missing: condylobasal length (CBL)…distance between occipital condyle and anterior point of premaxillae; basal length (BL)…distance from mid point of lower margin of foramen magnum to the anterior point of premaxillae; condylo-zygomatic length (C-Z)…distance between occipital condyle and antero-superior edge of premaxillae; condylo-molar 1 length (C-M1)…distance between occipital condyle and anterior edge of M1; incisive-molar 3 length (I-M3)…distance from the most anterior point of incisor to the most posterior edge of M3; length of diastema (Dias)…distance from the posterior edge of incisive alveolus to anterior edge of alveolar space of molar row; palatilar length (PL)…distance from the posterior edge of incisive alveolus to the foremost point on the hind margin of the palate; upper molar length (ML) …distance from the most anterior edge of M1 to the most posterior edge of M3; lower molar length (ML)…distance from the most anterior edge of M1 to the most posterior edge of M3; length of incisive foramen (IFL)…maximum length of palatine slit; length of nasal (NL)…maximum length of nasal bone; zygomatic width (ZW)…maximum spread of zygomatic arches; interorbital width (IOW)…least diameter of frontal bones between orbits; molar width (M1W)… maximum distance between lateral borders of M1; breadth of M1 (BM1)… greatest breadth of M1; rostrum width (RW)…maximum distance between across lateral faces of rostrum at roots of incisors.

Skull and dental pattern were drawn by the Stereoscopic Microscope (SMZ-10) produced by Nippon Kōgaku with an accessory drawing apparatus by 35 magnifier. The apparatus was not used for three specimens (610 to 611) kept

in I. Y. O.

The scientific names used in Honacki *et al.* (1982) were followed here. The current name, latitude, and longitude of the mountain where specimens were collected were obtained from Sanseido (1984) except for Mt. Taiheisan, whose current name was based on Chinese pronunciation and whose location was estimated from a map (Anonymous, 1930).

Results and Discussion

Skull character (Fig. 1)

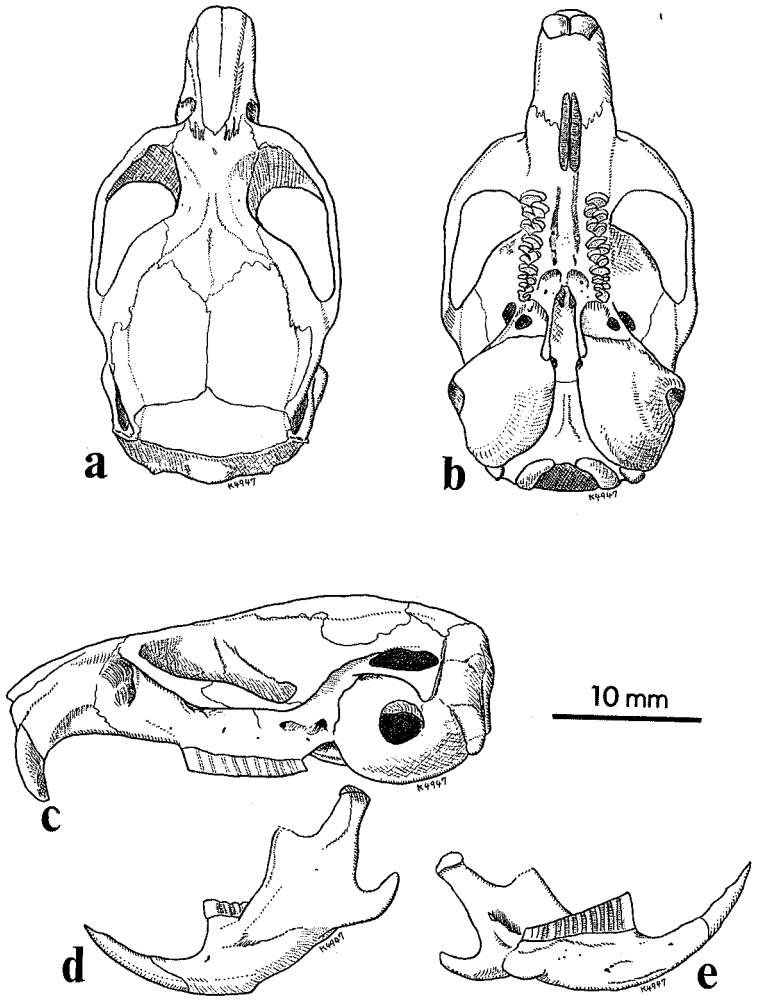

Fig. 1. Dorsal (a), ventral (b), and lateral (c, d and e) views of skull of *Microtus kikuchii* (K4947).

The cranium is rather large but less angular in *M. kikuchii*. The lateral profile is rather round and there is much less pronounced declivity at the rostrum. Squamosal and interorbital ridges are not well developed. The weakly developed ridges on the frontal bones do not fuse, and to form two separate interorbital crests. Incisive foramen is medium in length without posterior constriction except for one specimen (K4950). The posterior palatal shelf terminates in a median projection, which is bordered by slightly shallow lateral pits on either side. External auditory meatus is larger. Auditory bullae are larger also with weekly developed spongy tissue. Paroccipital process attaches to the bullae and is not well developed even in the largest specimen (K4947). Pterygoid fossae are deep. Infraorbital foramen is large and wide. Zygomata are not well spread out from the sides of the skull. Lambdoidal crest is not well developed. Mandibular foramen is situated labially at the base of articular process of lower

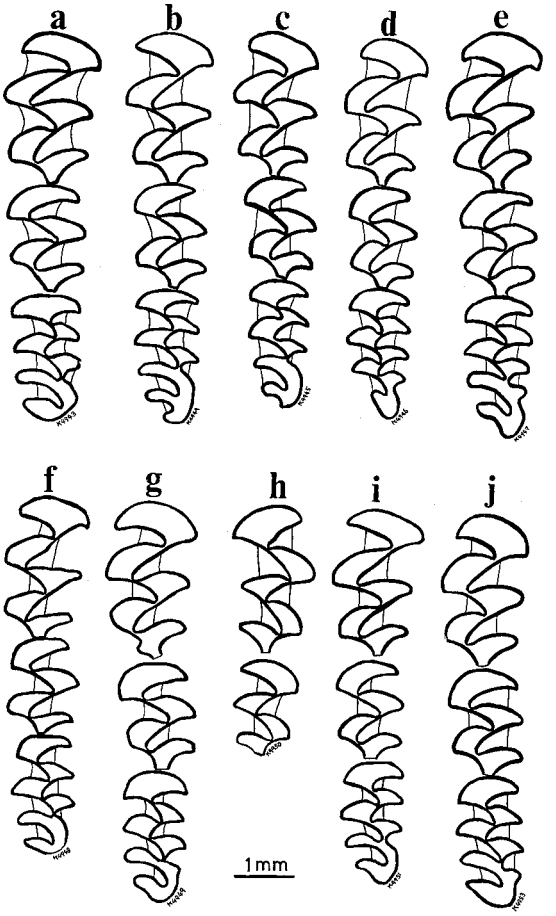

Fig. 2. Upper molar patterns of 10 specimens of *M. kikuchii*. a, K4943; b, K4944; c, K4945; d, K4946; e, K4947; f, K4948; g, K4949; h, K4950; i, K4951; j, K4953.

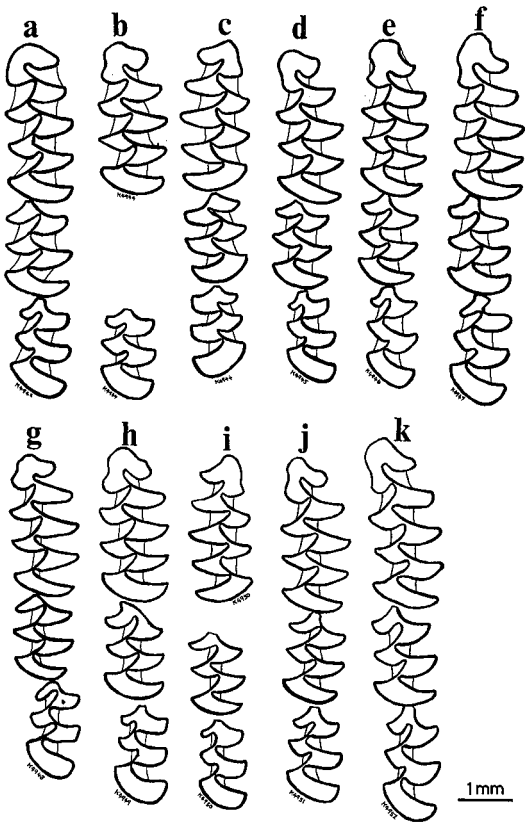

Fig. 3. Lower molar pattern of 10 specimens of *M. kikuchii*. a, K4943; b, K4944; c, K4944; d, K4945; e, K4946 ; f, K4947 ; g, 4948 ; h, K4949 ; i, K4950 ; j, K4951 ; k, K4952.

jaw, where the posterior end of incisive pulp capsule terminates. The position of the foramen is on the anterior border of the capsule.

Kuroda (1920) has not described the skull characters of the holotype specimen collected from Mt. Morrison (now Mt. Yushanch'ienfeng) (23°28′N, 120°54′E, alt. 3050 m). Tokuda (1941) wrote that the ridges and angles of the skull showed rather feebly, whereas Aoki & Tanaka (1941) stated that the skull was rather angular and ridged. Tokuda's (1940) description is well agreed with the present specimens investigated, compared with the skull of other four species of *Microtus*: namely *fortis* (Kirin Prov. and Anhwei Prov., China), *oeconomus* (Kol'sky Peninsula and the Kuriles, USSR), *maximowiczii* (Heilungkiang Prov., China), and *montebelli* (Kyoto, Japan).

Dental pattern (Fig. 2 and 3)

Frontal surfaces of upper incisors are orange in colour. M1 has an anterior loop and four alternating closed triangles. Following an anterior loop, M2 has

three alternating closed triangles without postero-internal heel.

M3 has an anterior loop with three closed triangles and a posterior loop, which shows some variations. Table 1 gives the variation of the number of re-entrant folds at each side of the molar: three inner and outer re-entrant folds with or without the forth small concavity were observed in seven specimens among ten.

Kuroda (1920) has described the number of re-entrant folds of M3 in the holotype specimen as three at the inner side and four at the outer side. Tokuda & Kano (1938) figured two molars of M3 with four inner and outer re-entrant folds, and with four inner and three outer folds. Aoki & Tanaka (1941) reported five specimens with four inner and three outer folds, six specimens with five inner and three outer folds, and four specimens with five inner and four outer

Table 1. The number of re-entrant folds on either side of M3 in *Microtus kikuchii*.

Side	Inner fold—Outer fold					
Left	3–3	3+s*–3	3–3+s*	3–4	3–3+s*	3+s*–3+s*
Right	3–3	3+s*–3	3+s*–3+s*	3+s*–4	3–3+s*	3+s*–3+s*
Registered number	K4943 K4948 610	K4945 K4949 K4951	K4946	K4944	K4953	K4947

*3+s, The forth small concave was found as figured in c, e, g and i of Fig. 2.

folds. Table 1 shows that the number of inner and outer folds varies greatly in M3 of *M. kikuchii*, and three inner and outer folds are most common, and there are some specimens with four inner and three outer, and with three inner and four outer folds, which have not been described by Kuroda (1920) and Aoki & Tanaka (1941).

In M3 five closed dental spaces were observed in both sides of seven specimens (K4944, K4947, K4948, K4949, K4951, K4953, and 610), in the right side of K4946, and in the left side of K4943. Furthermore, because the second and third dental spaces of the molar are confluent at the right side of K4943 and both sides of K4945, these three molars have four closed dental spaces.

Kuroda (1920) has reported that the holotype specimen has five closed dental spaces in M3. Tokuda & Kano (1938), however, noted that there were five to six closed spaces in this vole. Aoki & Tanaka (1941) figured one specimen with five spaces. Thus, the number of the spaces varies from four to six, and five ones are most common.

M1 has a posterior loop with five closed triangles and an anterior loop. The first inner re-entrant angle of the anterior loop forms a deeper fold anteriorly: the dental space of the loop shows a reverse V-letter or U-letter. Two specimens (K4946 and K4949) have a distinct antero-external concavity in the loop, whereas other two specimens (K4943 and 610) lack the concavity in the loop.

Kuroda (1920) has described an indistinct external concavity of the anterior

loop of $\overline{M1}$ in the holotype specimen. The present study, however, indicates that this vole varies from indistinct to distinct concavity.

$\overline{M2}$ has a posterior loop with four alternating closed triangles without variation. $\overline{M3}$ has three transverse loops. A prominent antero-external re-entrant fold of the first transverse loop was observed in both sides of the molar in all specimens examined. Furthermore, the fold sometimes forms a small anterior closed dental space in the loop (K4947 in both sides and K4952 in the right side) (Fig. 3–f). The same condition was figured by Aoki & Tanaka (1941). Therefore, as Tokuda (1941) has already pointed out, it appears that the prominent first fold of $\overline{M3}$ is a characteristic of this vole.

The re-entrant fold of the second loop in $\overline{M3}$ was not developed in the left side of K4943, K4945, and K4946, and in the right side of K4953, whereas the fold was found clearly in other specimens. Therefore, the fold does not appear consistently, though Tokuda & Kano (1938) noted the second outer fold was characteristically deep.

Measurements

Skull measurements of 14 specimens are given in Table 2. Fig. 4 shows scatter diagrams and regression lines of eight skull measurements against ZW, based on Table 2. Because specimens with the dimension of ZW are greatest in number, ZW was used as a standard dimension. Regression coefficients were

Table 2. Skull measurements (mm) of *Microtus kikuchii.*

Registered number	K4943	K4944	K4945	K4946*	K4947	K4948	K4949	K4950	K4951	K4952*	K4953	609†	610†	611†
Sex	–	–	–	♀	–	–	–	–	–	♀	–	♂	♂	♂
CBL	28.8	29.2	—	28.9	29.8	26.3	—	—	—	—	—	29.3	30.8	—
BL	27.2	27.3	—	27.1	28.0	24.7	—	—	—	—	—	—	—	—
C–Z	22.5	22.3	—	22.5	23.4	20.9	—	—	—	—	—	22.6	23.8	23.1
C–M1	18.2	18.4	—	18.2	19.0	17.1	—	—	—	—	—	—	19.0	—
I–M3	17.7	18.0	17.1	17.5	18.4	15.9	18.0	16.5	17.0	—	17.5	—	18.7	—
Dias	8.7	8.8	8.3	8.7	9.1	7.2	9.2	8.4	8.5	—	8.4	—	9.3	—
PL	14.4	14.3	13.4	14.1	15.4	12.1	14.7	13.9	14.2	—	14.1	—	—	—
$\underline{ML}$	6.6	6.8	6.4	6.5	7.0	6.2	7.0	—	6.3	—	6.8	—	6.6	—
ML	6.5	6.4	6.4	6.5	7.0	6.2	6.8	—	6.5	7.1	—	—	7.0	—
IFL	5.1	5.1	4.8	4.7	4.8	4.1	5.5	4.9	4.7	—	4.8	—	5.1	—
NL	8.0	8.9	7.7	8.3	8.9	—	8.7	7.9	8.6	—	8.2	8.9	9.3	9.0
ZW	15.6	15.9	15.5	15.4	16.4	13.8	16.2	14.8	15.7	—	16.1	16.2	16.9	16.8
IOW	4.0	4.1	4.2	4.1	4.2	3.9	4.5	4.1	3.7	—	4.3	4.5	4.2	4.2
MW	5.5	5.5	5.1	5.5	5.5	5.2	5.4	—	5.1	—	5.1	—	6.0	—
$\underline{BM1}$	1.4	1.3	1.2	1.3	1.4	1.2	1.4	1.2	1.2	—	1.3	—	1.4	—
RW	4.9	5.1	4.9	4.7	4.8	4.0	4.9	4.6	4.9	—	5.0	—	5.3	—

*, The two specimens were collected from Mt. Alishan on 17 February 1939. The external measurements recorded (mm) are as follows in the order of head and body length (HBL), tail length (TL), hind foot length (HFL) and ear length (EL) : 99, 73, 22, and 13.7 in K4946 ; 122, 89, 23, and 13.7 in K4952. †, The three specimens were collected from Mt. Taipingshan on 17 November (609), 6 December (610), and 20 December (611), 1932. The external measurements recorded (g or mm) are as follows in the order of body weight, HBL, TL, HFL, and EL : 41.3, 114, 66, 24, and 18 in 609 ; 45.1, 120, 77, 23, and 16 in 610 ; 45.1, 122, 73, 24, and 16 in 611.

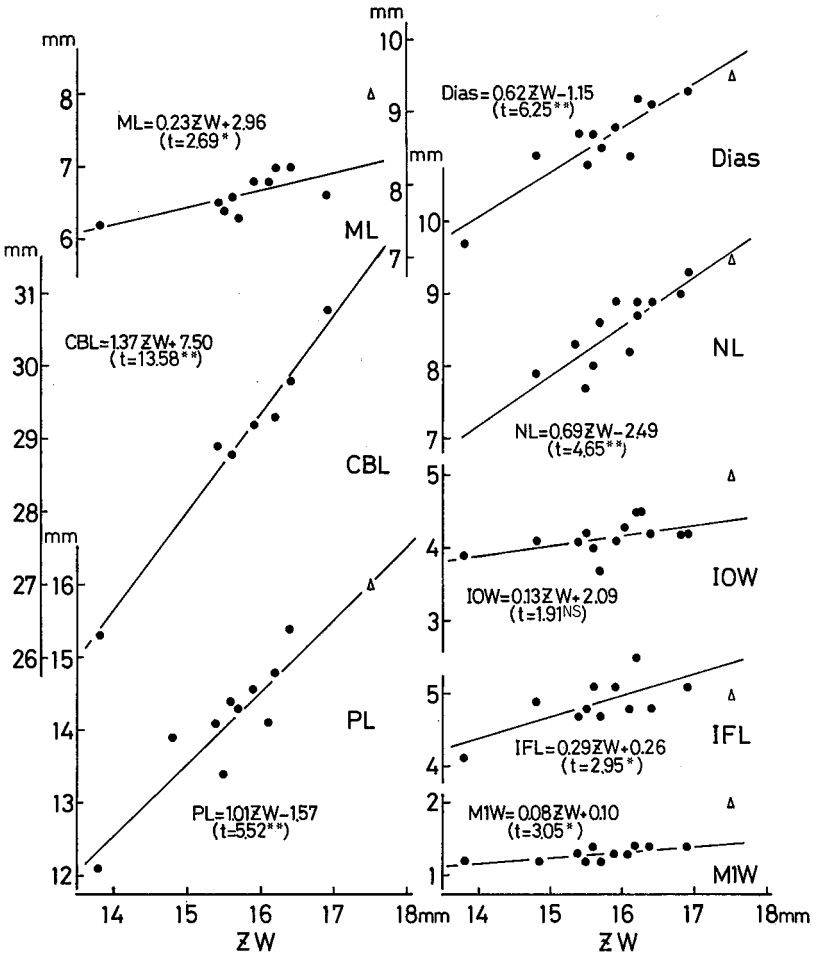

Fig. 4. Scatter diagrams and regression lines of skull measurements against zygomatic width (ZW) in *M. kikuchii*. Hollow triangles indicate the values of measurements of the holotype specimen described by Kuroda (1920). *, $0.001<p<0.05$; **, $p<0.001$.

statistically significant except for a relationship between ZW and IOW.

The skull measurements of the holotype specimen (Kuroda, 1920) are included in the 95% confidence interval for PL(15.23–16.99 mm), for NL (9.04–10.14 mm), and for Dias (9.25–10.15 mm) but deviate from the interval for ML (6.61–7.33 mm), for M1W (1.39–1.61 mm), and for IFL (4.89–5.79 mm). These intervals are estimated by the regression lines mentioned above because ZW of the holotype is 17.5 mm (Kuroda, 1920). One of the reasons why these three measurements of the holotype deviate from the intervals may be a lower significant figure (Kuroda, 1920) than those in the present study. Because the basal part of braincase of the holotype specimen was damaged and not measured (Kuroda, 1920), the 95% confidence interval for CBL of the specimen can be predicted as 30.97–31.99 mm. Because Aoki & Tanaka (1941) measured ZW of

one specimen (no.3368) as 16.3 mm, the confidence interval for CBL can be estimated as 29.55–30.11 mm. These intervals suggest that the overall skull size of the type specimen described by Kuroda (1920) is longest among the specimens examined and reported.

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