An aberrant form of the genus Rattus collected from Iriomote-jima, the Yaeyama Group of the Ryukyu Islands

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An aberrant form of the genus *Rattus* collected from Iriomote-jima, the Yaéyama Group of the Ryukyu Islands*

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In the summer of 1962, the first expedition was made to the Yaéyama Group of the Ryukyu Islands situating about 200 **km east** of Formosa by the Committee on Foreign Scientific Research, Kyushu University. Two specimens of an abberrant form of the genus *Rattus* were collected by Dr. Yûiti Ono, a member of the party, in the primary school of Ôhara Village, southeast coast of Iriomote-jima (Lat. 24" 16' N., Long. 123" 52' E.), on August 12th 1962. Fortunately, these specimens were disposed to me for examination by the kindness of the Committee.

The rats appear to be coincided with *Rattus rattus* (Linnaeus) in general characters, but some peculiarities are disclosed by the detailed study. Two specimens provide equally indigenous external and cranial characters by which they can be separated from common rats and also from other species of rats in neighbouring districts (Taylor, 1934; Tate, 1935, 1936; Tate and Archbold, 1935 ; Chasen, 1940; Aoki and Tanaka, 1941; Tokuda, 1941; Ellerman, 1941, 1947a, b, 1949; Ellerman and Morrison-Scott, 1951). The most outstanding feature is found in the pattern of the crown surface of M^1. Namely, the fundamental enamel pattern of M^1 consists of four laminae instead of three in *R. rattus*. In older animal that extra front lamina comes up to the grinding surface and produces two definite accessory cusps.

Judging from the above characters I think that the rat from Iriomote-jima may be distinguished from the known species as an indigenous one. But the materials are too few to extend the taxonomical consideration at present, the descriptions will be confined to

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morphological points (Preliminary report was given in Japanese, 1964). Available specimens (skin and skull) consist of younger (Cat. No. 101, Zoological Laboratory, Faculty of Agriculture, Kyushu University) and older (ZLKU Cat. No. 102) ones, although they both belong to adult female; they are kept in the Zoological Laboratory, Faculty of Agriculture, Kyushu University.

DESCRIPTION

The most important characters are occurring on the first upper molar as mentioned above. Other measurements of these rats are shown in Table 1, in which the measurements of *R.* rattus are given together for the benefit of comparison. I will describe below the general characters of the aberrant rat as compared with those of *R.* ***rattus*** and *R.losea* (Swinhoe). The latter species is a resident of Formosa and known as a common field rat.

External *characters.*—In size and general appearance the rats resemble ***R. rattus*** except following peculiarities (Pl. 3, A, B).

Fur rather coarse, with long flattened spinous hairs which attain 11–15 mm in length; those hairs are tipped with dark yellowish brown (Sepia), based with pale yellowish brown (Malmaison). Ground hairs of the back fluctuate between 10 and 15 mm in length, tipped with dull yellow orange (Yellow Ochre), based with dark bluish gray (Slate). Bristles on the rump, about 20 mm in length, with tips of dark yellowish brown (Sepia), with bases of pale yellow (Ivory). Sides slightly lightened by shade of reddish yellow (Golden Rod) which gradually continue with still paler colour of belly. Belly hairs tipped with pale yellow (Ivory), based with pale yellow (Cream). Thus the fur apparently darker on the back than on the side and belly because of presence of dark tips of both spinous hairs and bristles (Pl. 3, B). If compared with the fur of ***R. rattus,*** the hairs of both side and belly apparently more brownish and the boundary lines between these two parts being obscure.

Tail far longer than head and body (tail coefficient: ***No.*** 101, 119.4 %; ***No.*** 102, 111.4 %), thicker, more robust and lightly unicoloured than in ***R. rattus*** ; width of scale rings on tail fairly broader as there exist nine or ten rings within one centimetre on the base of tail instead of twelve or thirteen in ***R.*** *rattus* and *losea*; shape of each scale rather roughly squarish ; blackish hairs on tail attaining nearly as long as width of two rings, therefore, these hairs slightly longer than those of ***R. rattus*** and *losea*; they are less densely dispersed over tail than in *R.rattus* (Pl. 4, A-D). Ears large and thin, with a few minute hairs; that can cover the eyes when laid forwards. Hands and feet large

relative to size of body as usual in *R. norvegicus*; upper surfaces of hands with brown (Russet Brown) except whitish margins, while feet with brownish gray (Drab) uniformly (Pl. 3, A. B); all palmar and plantar pads considerably larger than those of *R. rattus* and Zosea (Pl. 4, E, F). Specimen No. 102 provides eleven mammae arranged as follows: 3+1+2 on the left and 2+1+2 on the right. Specimen No. 101 with 2+1+2= 10 formula.

Cranial characters.—Skull, essentially as *R. rattus,* strong and large relative to size of body. But several points are distinctive from that of common rats. In dorsal view (Pl. 5, A-C), rostrum wider; zygomatic arches evenly bow laterally. Interorbital breadth rather wide and temporal ridges moderately developed on interorbital region and their posterior extensions strong but smoothly curve on outer margin of parietal. Width of parietal measured across parietal ridges is distinctly wider than parietal length measured along ridge, and the former of the present rat slightly superior to those of *R. rattus* and ***Zosea.*** Thus the cranium looks round when viewed from above as revealed in Pl. 5, A-C. Interparietal moderately large.

In ventral view (Pl. 6, A-C), foramen incisivum appears to be longer and considerably wider than those of *R. rattus* and *losea*, which extends posteriorly beyond a line drawn across anterior borders of M^1. Palate between molars slightly broader than in *R. rattus,* but nearly as in *R. losea*; its posterior termination extends decidedly over the level of last molars. Transverse margin of interpterygoid fossa is broader than in *R. rattus* and *Zosea,* and marginal line nearly heart-shaped. Corpus junction of presphenoid and basisphenoid rather broader and more robust than in *R. rattus* and Zosea. Withdrawal degree of nasioccipital at basion not so conspicuous as in *R. rattus* and Zosea.

When viewed from the side (Pl. 7, A-C), cranium evenly inflated from front to back, without flattended portion as seen usually in *R. rattus.* Nasals extended forwards slightly beyond the level of anterior surface of incisors. Masseteric plate of maxillary with well marked projection which forms distinct outer shield of infraorbital foramen, whereas it is slightly narrow in *R. rattus.* Auditory bullae rather small as compared with that of *R. rattus;* and its height nearly same as the level of paramastoid (jugular) process as in *R. norvegicus* and decidedly lower than those of *R. rattus* and *losea*; that character is especially evident in specimen No. 102 than in No. 101. Posterior edge of interparietal connected with occipital by a sharp angle. Height or depth of skull nearly same as in *R. rattus.*

In the occipital view (Pl. 8, A-C), occipital foramen likely appears to be round, although the fundamental construction of occipital portion is not different from those of *R. rattus* and *losea.* At any rate, the

shape of occipital foramen is considerably differing from those of *R. rattus* and *losea*. Distance between outer margins of both occipital condyles fairly wider than those of *R. rattus* and *Zosea*.

In mandible, broad coronoid process appears to be robust, in true, it is shoter than in *R. rattus*, but nearly as in *R. Zosea* (Pl. 9, A, B).

Dentition.—Dentition heavy relative to size of skull. Upper incisors nearly perpendicular (Pl. 7, A, B). Elemental constitution of molars more complete than in *R. rattus*, thus bringing forward more complicated pattern of grinding surface as shown in figures (Pl. 9, C-E; Pl. 10, A-C; Pl. 11, A-D and Pl. 12, A-C). Upper molars heavy and strong ; length of alveoli M^1—M^3 considerably surpassing that of *R. rattus*. Enamel pattern of the grinding surface of M^1 is especially peculiar, since it is composed of four laminae instead of three in *Rattus*. Because of an additional extra front lamina coming up to the grinding surface, the crown surface become to be elongated in marked degree (Pl. 9, C--E ; Pl. 10, A-C; Pl. 11, A-D). M^1 with *five* roots. Specimen No. 102 of rather old adult has pattern of extra lamina of M^1 furnished with two enamel rings, relatively large one on internal side and small one on external side (Pl. 10, B; Pl. 11, C, D). That pattern is apparently derived from the wearing of a single high tubercle such as seen in M^1 of specimen No. 101. In No. 101, the extra lamina of left M^1 is already bifurcated at least on top, while that of right side persists its unworn condition (Pl. 10, A ; Pl. 11, A, B). Next, in the aberrant rat (Pl. 11, A, B), cutting ridges on anterior lamina of M^1 are less evident, although the separation into internal (t'), middle (t^2) and external (t^3) cusps is recognizable. While in *R. rattus* (Pl. 10, C), these three cusps and cutting ridges are well indicated. Separation of t^3 from t^2 is fairly evident in the latter species.

M^2 has a minute antero-external cusp (t^3) as usual in *R. losea* and norvegicus ; that cusp is more distinctive in specimen No. 101 of junior adult than in No. 102 of older one (Pl. 9, C). M^3 with no trace of antero-external cusp (t^3) which is occasionally present in *R. losea*. Remaining cusps in each upper molar are similar to those of *R. rattus* or *Zosea* except their fast formation. M^3 never reduced in size and length, nearly attaining 50 % of length of M^1 (Pl. 10, A, B).

Enamel pattern of lower molars essentially as in rats of *rattus*-type, except M_3 having a well developed postero-external cusp as is especially well revealed in No. 101 (Pl. 12, A). That cusp either minute in *R. losea* or entirely devoid of in *R. rattus* and *norvegicus*. Internal large and external small cusps of anterior lamina of M_1 are separated by a deeper and longer groove between them than usual in *R. rattus* and *Zosea*. Accessory or posterior cusps of each lower molar apparently

Table 1. Comparison of external and cranial measurements between the aberrant form and *Rattus rattus* (in mm). External measurements of the aberrant rat are taken from specimens in formalin against most of *R. rattus* measured in flesh.

Species	Aberrant rat		*R. rattus*							
Relative age	No. 101♀ younger adult	No. 102♀ older adult	Younger adult (♂♀)				Older adult (♂♀)			
Portion			Range	M±S.E.	S.D.	N	Range	M±S.E.	S.D.	N
External measurements										
Head and body	165.0	175.0	150.0 — 185.0	161.6 ± 2.52	9.10	13	154.0 -208.0	177.0 ± 5.54	16.62	9
Tail	197.0	195.0	143.0 — 192.0	165.9 ± 5.06	15.19	9	173.0 -203.0	186.1 ± 3.86	10.21	7
Hind foot	36.0	37.0	26.0 — 34.0	30.1 ±0.63	2.26	13	30.5 — 34.5	32.6 ±0.53	1.59	9
Ear	22.0	21.0	20.5 — 25.0	21.9 ±0.46	1.67	13	21.0 — 23.5	22.4 ±0.30	0.84	8
Cranial measurements										
Greatest length	40.80	45.20	37.60— 40.90	39.25± 0.26	0.94	13	39.90— 44.00	42.07± 0.70	1.85	7
Condylobasilar length	36.00.	40.00	33.60 — 36.70	31.94 ± 0.26	0.98	14	35.90— 40.00	37.79 ± 0.58	1.63	8
Basal length	35.70	40.20	33.50— 36.70	35.17 ±0.25	0.94	14	35.50— 39.80	37.71 ±0.60	1.69	8
Palatilar length	20.00	22.40	18. 10— 20.10	19.12 ±0.16	0.63	15	19.40— 22.00	20.56±0.30	0.90	9
Diastema	10.90	12.90	9.80— 11.30	10.49±0.13	0.50	15	10.70— 12.50	11.48±0.21	0.61	9
Zygomatic breadth	(18.70)	21.40	18.00— 20. IO	19.30 ±0.15	0.58	15	19.90— 21.00	20.45±0.16	0.45	8
Nasal length	15.10	16.80	12.90 — 15.40	14.26 ± 0.22	0.81	14	14.20— 17.00	16.14 ±0.32	0.97	9
Interorbital breadth	6.70	7.00	4.90— 6.20	5.53 ±0.09	0.35	15	5.50— 6.50	6.03±0.11	0.34	9
Foramen incisivum	8.40	9.20	7.00— 8.10	7.64 ± 0.07	0.29	15	7.60— 8.90	8.13±0.13	0.38	9
Distance between condyles	9.40	9.40	7.80— 8.90	8.48 ± 0.09	0.32	14	8.20— 9.00	8.73±0.09	0.25	7
Alveoli M^1-M^3	8.30	8.10	6.80— 7.70	7.25 ± 0.07	0.26	15	6.90— 7.90	7.41 ±0.11	0.33	9
Breadth of M^1	2.10	2.00	1.80— 2.00	1.95±0.02	0.07	15	1.85— 2.00	1.95±0.02	0.06	9
Auditory bulla	7.20	7.40	6.80— 7.50	7.27 ± 0.05	0.19	14	7.40— 8.40	7.84 ±0.12	0.37	9
Breadth of rostrum	6.30	7.30	5.40— 6.20	5.77 ± 0.07	0.28	15	5.50— 6.40	6.07± 0.09	0.27	9
Height of skull	10.10	11.90	9.40— 10.80	10.20 + 0.10	0.40	15	10.20— 11.70	10.97 ± 0.18	0.53	9
Breadth of braincase	16.10	17.00	15.60 — 17.00	16.44 ±0.12	0.44	14	16.40— 17.50	16.96±0.14	0.39	8
Width across parietal ridges	14.90	15.10	13.30— 14.60	13.95 ± 0.09	0.35	14	13.80— 14.80	14.33±0.11	0.34	9
Depth of cranium	14.50	15.10	13.60— 15.00	14.15±0.13	0.47	14	14.40— 15.60	14.93 ±0.17	0.51	9

Younger adult represents the specimen having M^3 with the grinding surface worn moderately and older one considerably.

larger and more evident than those found in *R. rattus* (Pl. 12, A-C).

Measurements.—External and cranial measurements of the rat are shown in Table 1 as compared with those of *R. rattus*. As the present materials consist of two specimens, i. e., younger adult (No. 101) and older adult (No. 102), the examples of *R. rattus* were also divided into two groups in order to get a good correspondence.

The result of the present study indicates that the rats have indigenous characters on following points: Length of hind foot; interorbital breadth; length of foramen incisivum ; distance between outer margins of both occipital condyles; length of upper molar series (alveoli); breadth of rostrum ; width across parietal ridges ; auditory bulla.

BIOLOGICAL NOTES

The aberrant rat from Iriomote-jima is undoubtedly related to *R. rattus*, as mentioned above. However, the rat can be easily distinguished from it and also from any other known species by a conspicuous character, namely, the presence of an extra lamina situating immediately in front of anterior lamina (t^2) of M', besides several other characters.

Some authors have already paid attention to the presence of extra front lamina of M^1 in some forms of Murinae. According to Taylor (1934), in some specimens of *Rattus mindanensis mindanensis* from the Philippines, outer anterior cone of first molar rather well developed with a slight tubercle midway on outer anterior face of molar towards base of median anterior cone, but some specimens show a total absence of the accessory cones; some only a partial development. Ellerman (1941) also has paid attention to a well marked, extra and front lamina of M^1 found in some genera of Murinae. According to him, in Australian subgenus *Thetonzys* there is an extra front lamina in M'; but this is too variable a character for the group to be given generic rank, as has been done, since the same trend is observed not only in other Australian genera *(Leggadina* etc.), but also in *Rattus. He* really noticed the character on some specimen of *R. norvegicus* and Indian *Mus* (subgenus *Leggadilla*).

Notwithstanding the rats in question from Iriomote-jima are represented by only two specimens, it is worthy to note that each specimen equally provide the conspicuous extra front lamina in M^1. According to information of a Japanese mammalogist, Dr. Imaizumi, the specimens having M^1 with an inconspicuously or moderately developed extra front cusp are occasionally found in *Rattus* from Amami-ôshima of the Ryukyu Islands. I have only three specimens of *Rattus (rattus 2; norvegicus* 1) from Amami-ôshima, although the number of available specimens from the Okinawa Group are rather plenty, that is,

fifty-two (rattus *20 ; norvegicus 32)* from Okinawa-jima, four (*rattus*) from Tonaki-jima; and eleven (rattus 5; norvegicus 6) from Iriomote-jima. Besides, many specimens *(rattus* 65 *; norvegicus* 60) from Fukuoka, Kyushu are able to place under the examination.

As regard to the question whether the extra front lamina in M^1 exists or absents on specimens of R. *rattus* and norvegicus from several localities mentioned above, following results as shown in Table 2 are obtained. It becomes clear that the presence of the extra front lamina of M^1 which comes up to the grinding surface such as seen in the aberrant rat from Iriomote-jima is quite exceptional as far as the data obtained in this study show.

Table 2. Presence or absence of an extra front cusp in M^1 of *Rattus rattus* and norvegicus from various localities.

	Locality	Extra front cusp in M^{1*}			Total
		absent	inconspicuous	moderate	
R. rattus	Iriomote-jima	4†	1‡	—	5
	Okinawa-jima	12	7	1	20
	Tonaki-jima	2	2	—	4
	Amami-Bshima	1	1	—	2
	Fukuoka	65	—	—	65
R. norvegicus	Iriomote-jima	6	—	—	6
	Okinawa-jima	24	7	1	32
	Amami-oshima	—	1	—	1
	Fukuoka	54	5	1	60

* Extra front cusp of M^1 coming up to the grinding surface so as to be functional as in the case of aberrant rat does not occur in these specimens. However, its rudimentary conditions are observed in several specimens, so that they are indicated here as " moderate" or " inconspicuous." The former represents an existence of medium-sized extra cusp although it does not come up to the grinding surface, and the latter the true rudiment.

†‡ Specimens collected by the third expedition (1964) at Amitori and Sonai Village respectively.

A consideration should be paid on frequent occurrence of the inconspicuous or moderate extra cusp in M^1 in the rats of the Okinawa

Group, on one hand, and the fact that in the specimens from Fukuoka, the frequency is relatively high in *R. norvegicus,* on the contrary, there is none to show even the trace in *R. rattus.* It may be suggested that rats of *R. norvegicus* tend to furnish these extra cusps in a relatively high rate irrespective of the localities, whereas in rats of *R. rattus* there is a difinite geographic trend in regard to the development of extra cusp. The character has no special relation to age or sex in both species. It is generally believed that the ancestral forms of murine-mammals had more complicated set of laminae and cusps in molars, and their descendants evolved in association with the reduction of the number of these cusps (Aoki, 1915). *Rattus* is a typical genus embracing abundant species in which the most advanced species (house rats) are also included. High variability of *R. norvegicus* and *R. rattus* will probably be explained in this connection, but the difference in trend of variation between these rats is a matter of open question. The characteristic pattern of molars in the present rats seems to be possible, therefore, that they represent an atavistic form of *Rattus.*

So far as the present study goes, the aberrant rats are decidedly differing from ordinary rats of *R. rattus* in several external, cranial and dental characters. But, materials are too few to extend good taxonomical work. Further, the biogeographical evidence should be referred in taxonomical treatment. It is true that from the regions of southern Ryukyu no endemic mammal has been recorded except fossil deer and elephant. Besides, no murine-mammal has been reported from Iriomote-jima up to date. At any rate the present form of the rat should be carefully treated in regard to taxonomy as well as biogeography.

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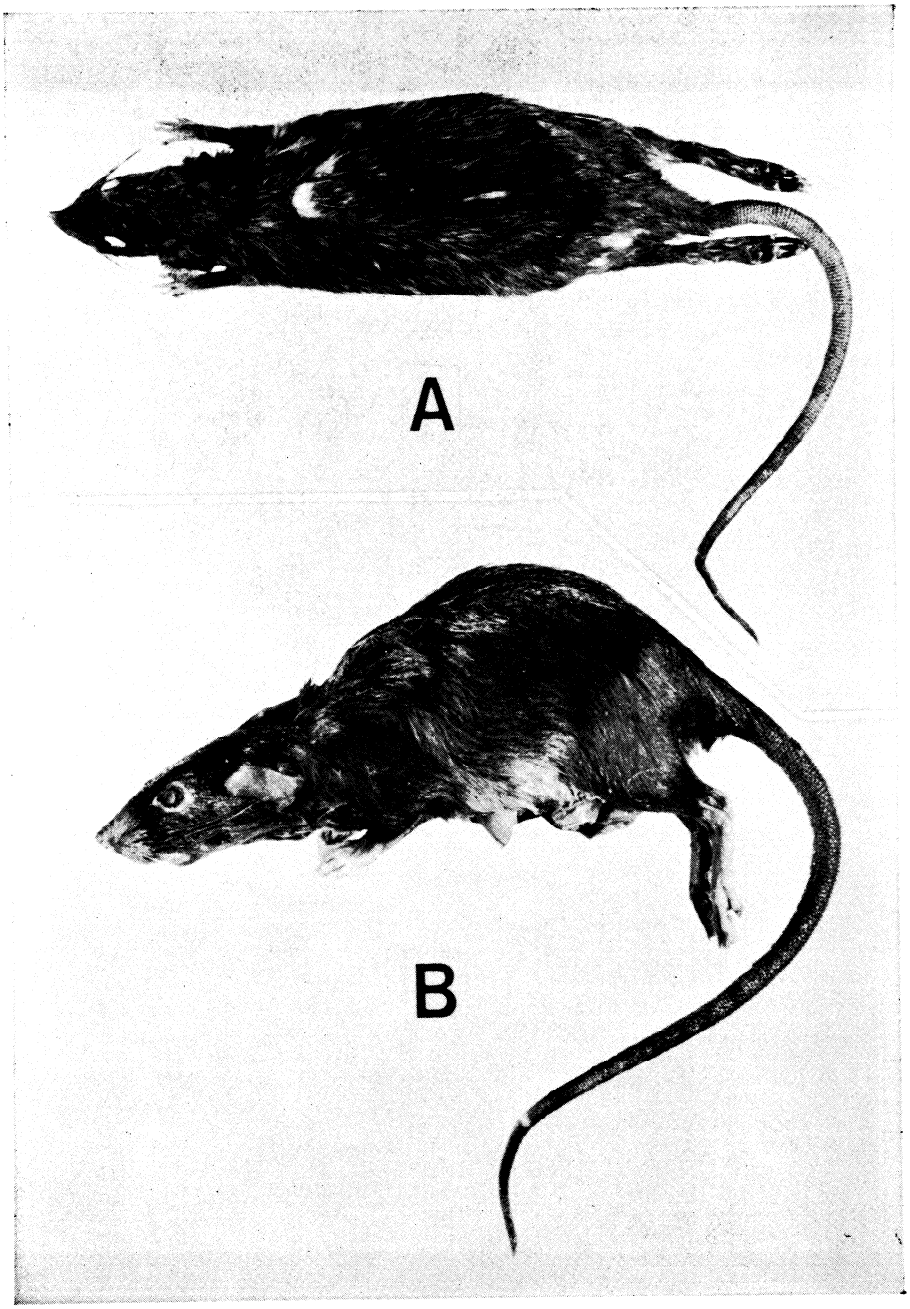
Explanation of Plate 3

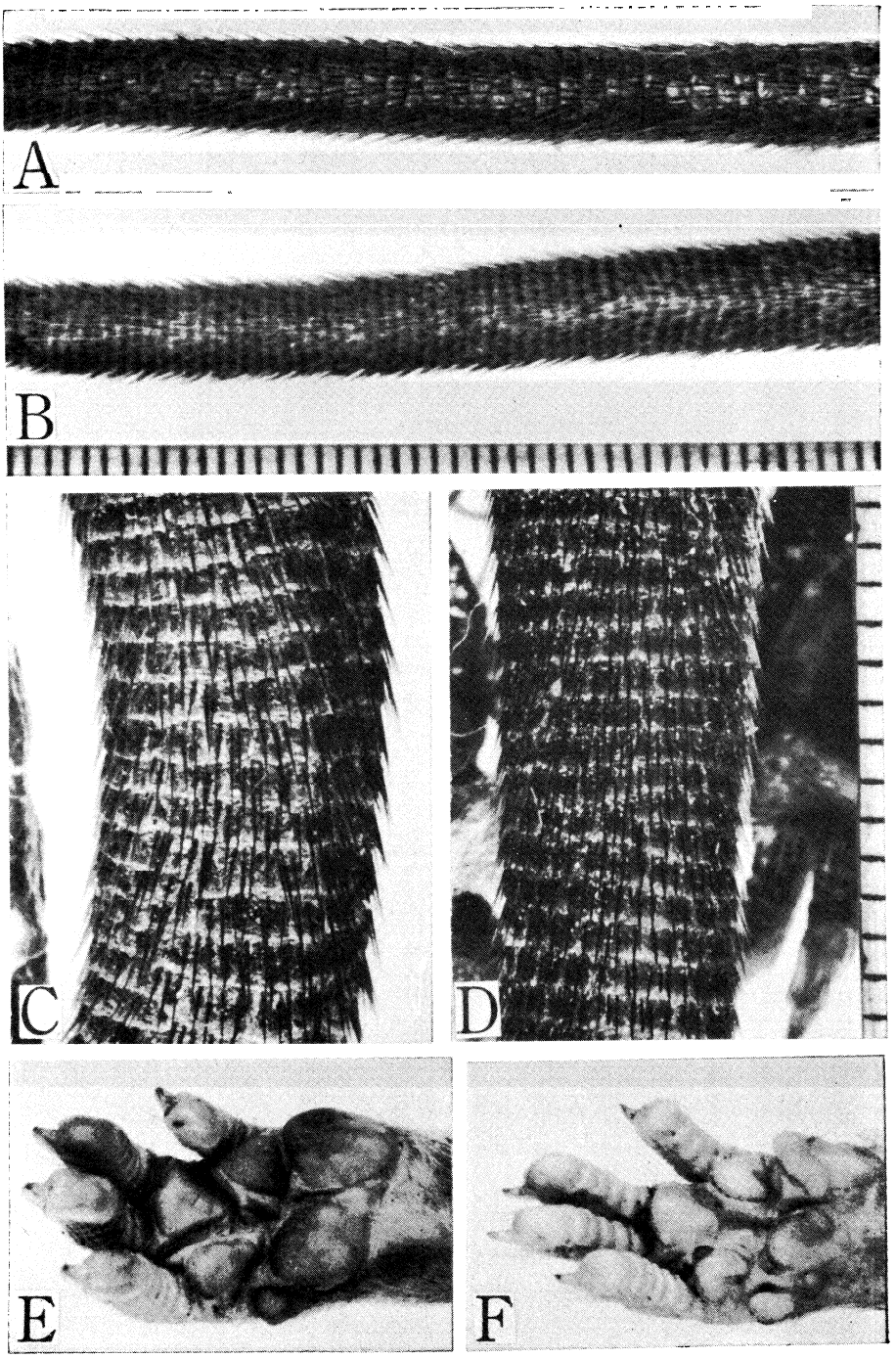
External appearance of the aberrant form of *Rattus (No. 101,* younger adult ♀) from Iriomote-jima, the Yaeyama Group of the Ryukyu Islands. Dorsal view of stuffed specimen (A). ×0.5 Lateral view of specimen preserved in formalin (B). ×0.6.



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 4

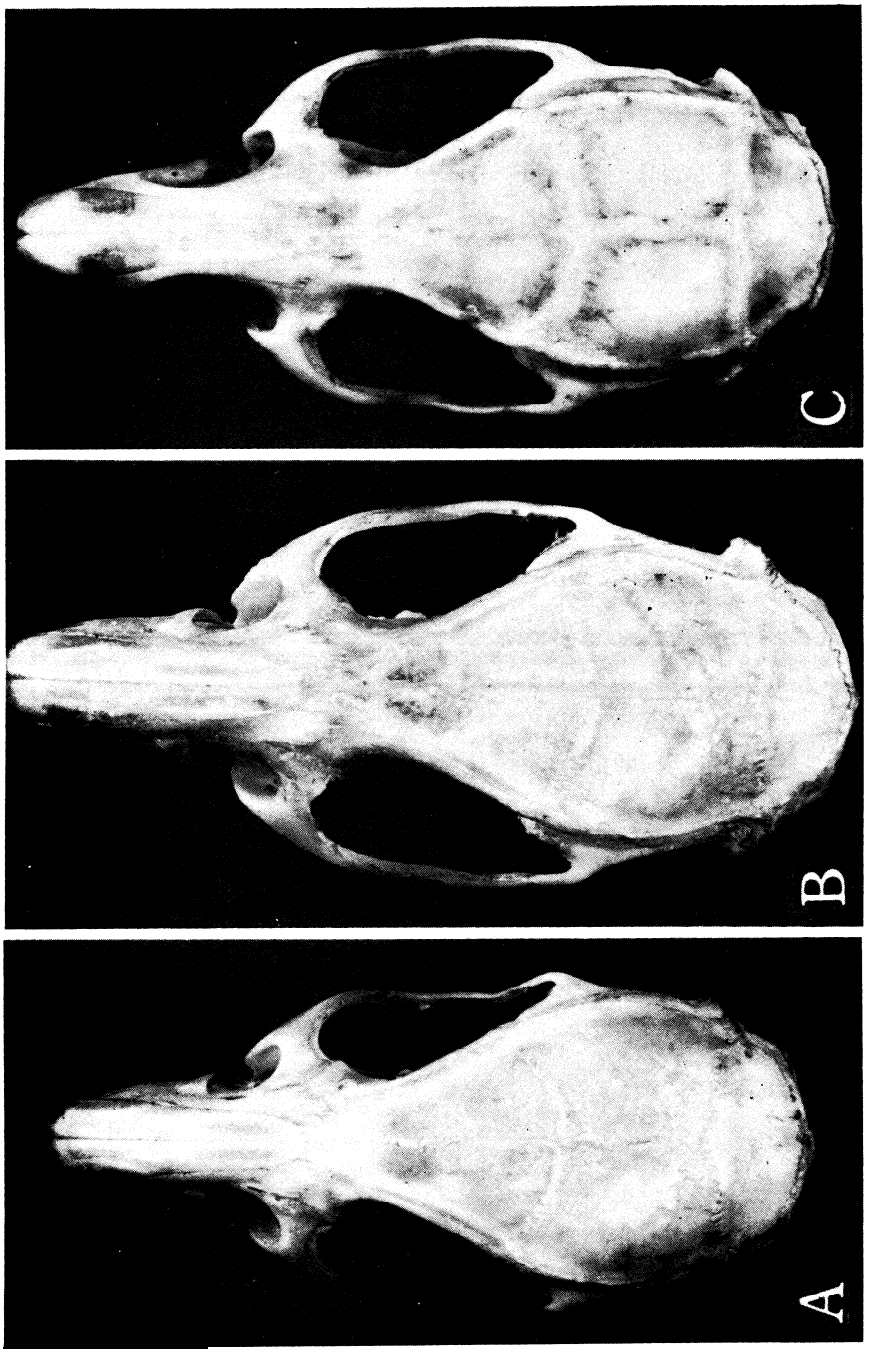
Comparison of tails and hands between the aberrant form and specimen of *R. **rattus.*** The tail is more robust and the scale rings are considerably wider in the aberrant form (A, No. 102, older adults ♀ in formalin) than in *R. **rattus*** (B, specimen in formalin). x 2.6. Scales are more roughly squarish and slightly longer hairs are less densely dispersed over the tail in the aberrant form (C, No. 101 in skin) than in *R. **rattus*** (D, specimen in skin). x5.3. The palmar pads are considerably larger in the aberrant form (E, No. 102 in formalin) than in *R. rattus* (F, specimen in formalin). x 3.2.



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 5

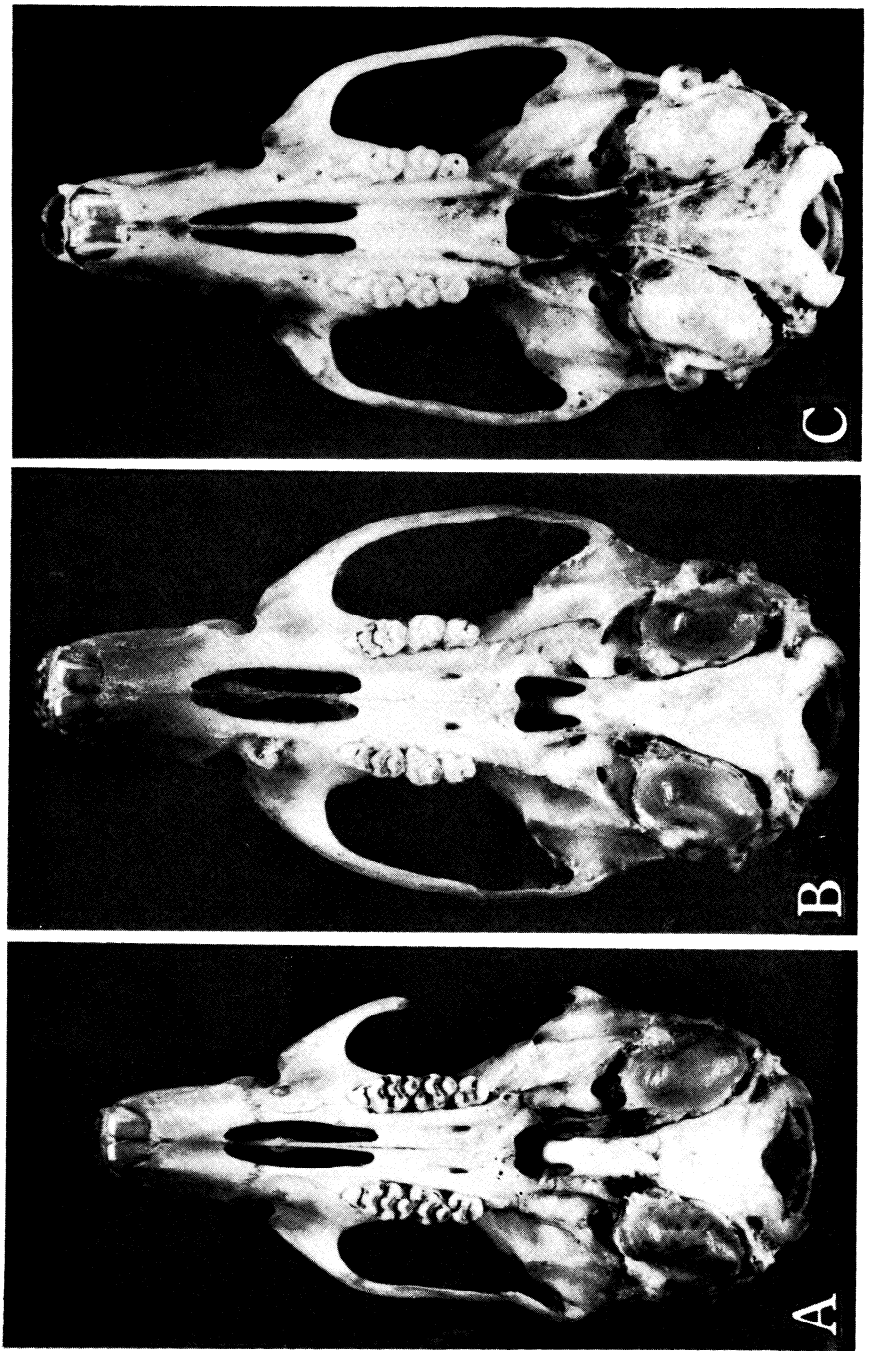
Comparison of skulls between the aberrant form (A, younger specimen *No. 101* ♀: B, older specimen No. 102 ♀) and *R. rattus (C,* older specimen No. HY 79 ♀), dorsal view. x2.5. Note the cranium is more round in the aberrant rat (A, B) than in *R. rattus (C).*



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 6

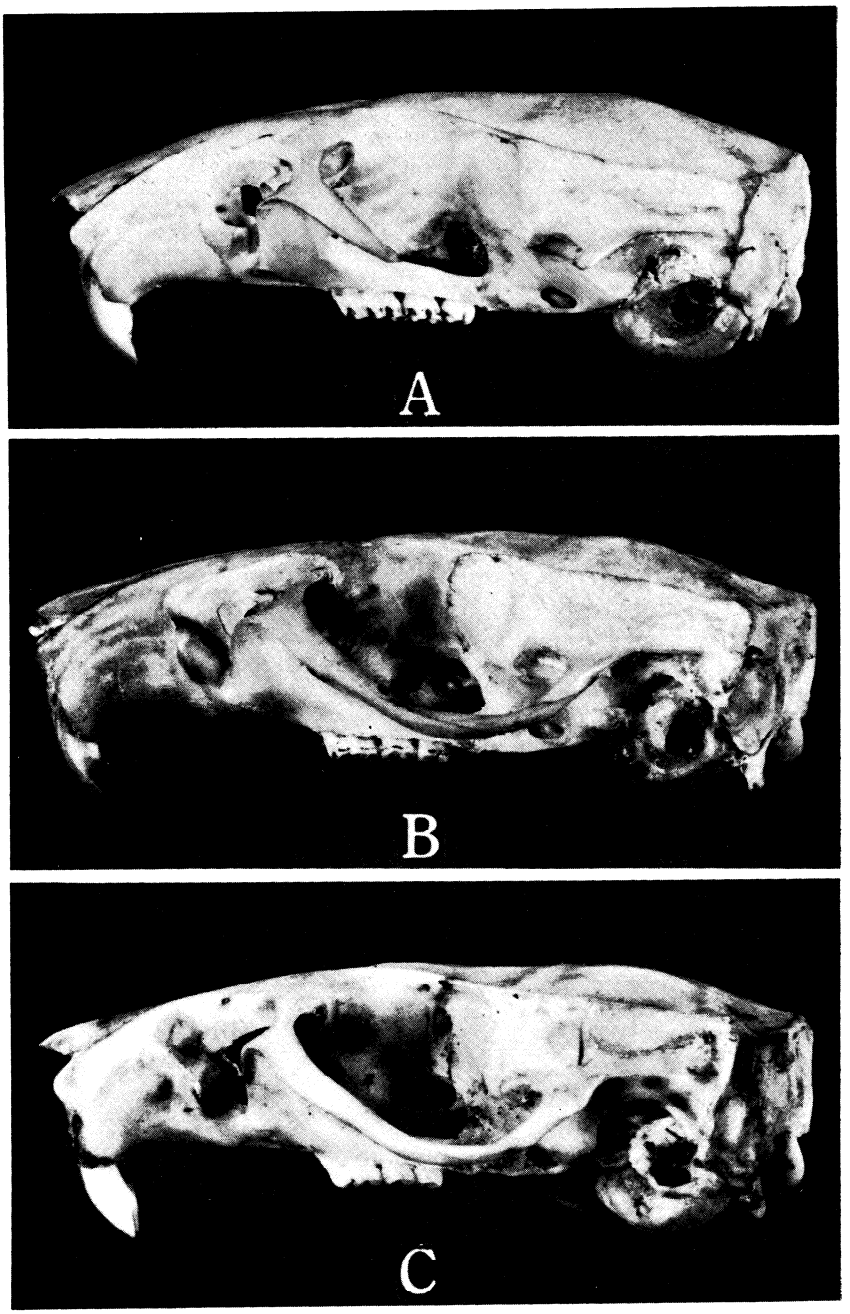
Comparison of skulls between the same specimens as in PI. 5, ventral view. x 2.5. The aberrant form (A, B) has relatively larger and wider foramen incisivum and slightly broader and more robust corpus junction of presphenoid and basisphenoid than in R. *rattus* **(C).**



An aberrant form cf the genus *Rattus* from Iriomote-jima

Explanation of Plate 7

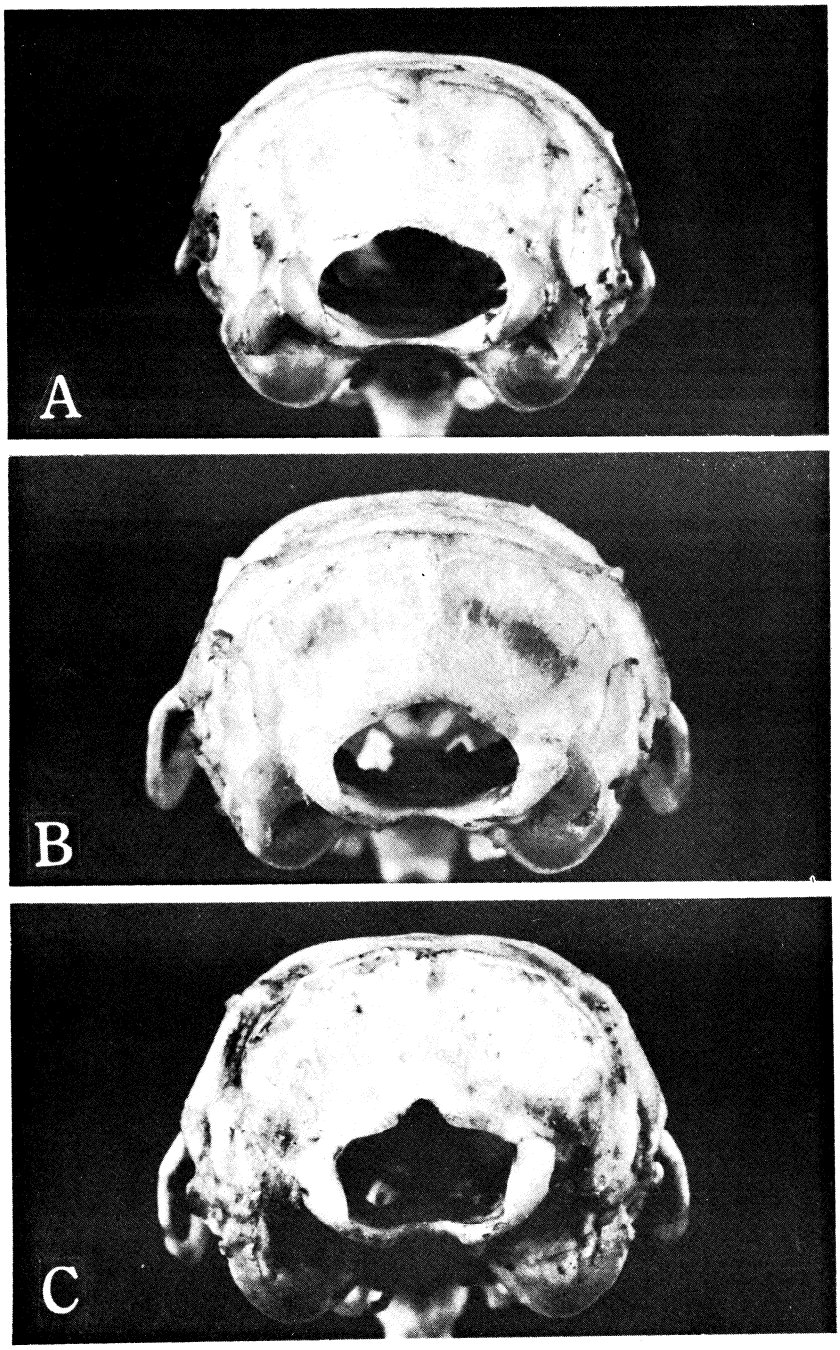
Comparison of skulls between the same specimens as in Pl. 5, lateral view. $\times 2.5$. Height of auditory bullae of the abberrant form (B) is nearly same as the level of paramastoid (jugular) process as in R. norvegicus, and lower than that of R. *rattus* **(C).** Extra front cusp of M^1 is clearly visible in each specimen of the aberrant form (A, B).



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 8

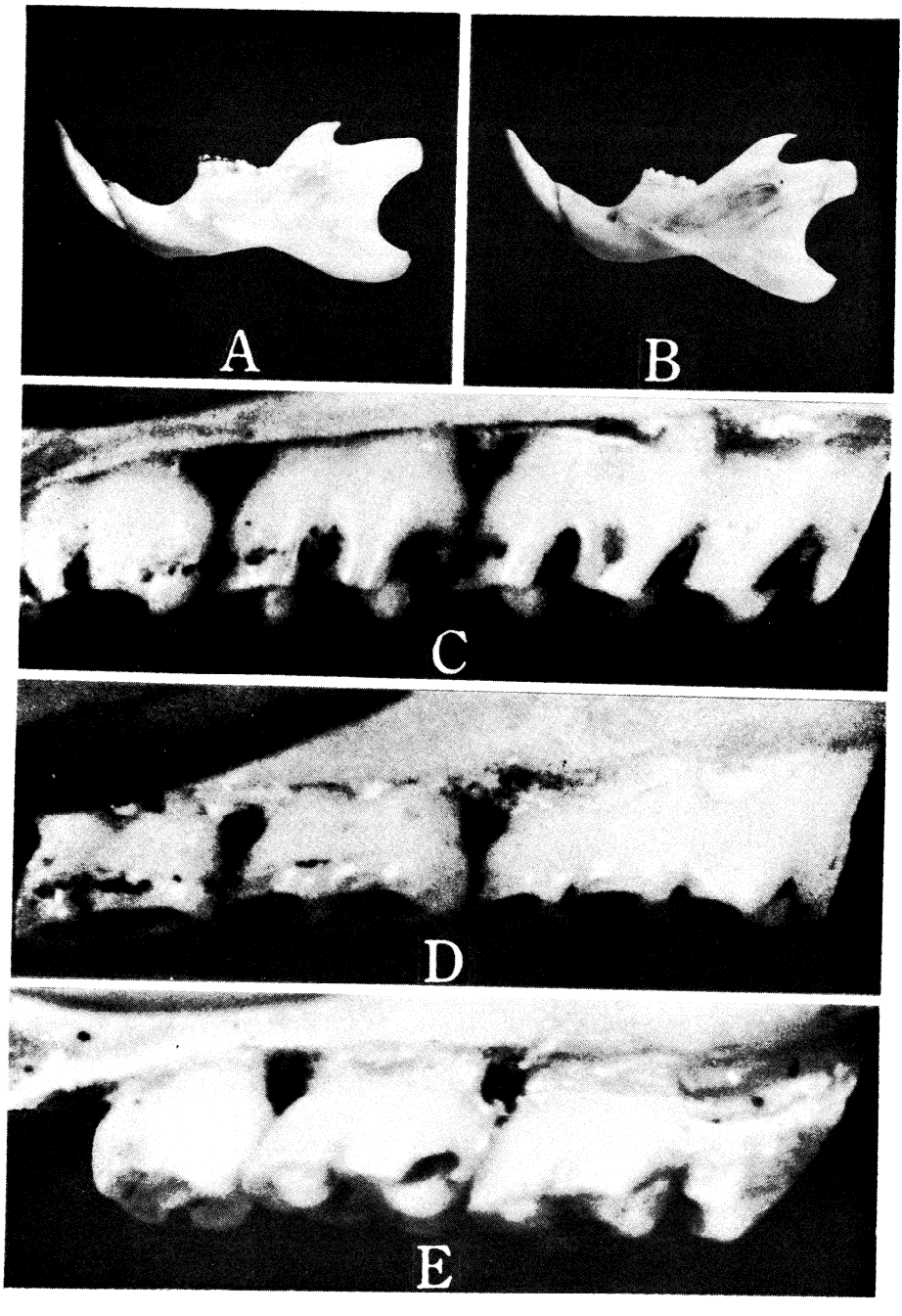
Comparison of skulls between the same specimens as in Pl. 5, occipital view. x 3.8. Occipital foramen is less angular in the aberrant form (A, B) than in R. *rattus* **(C).** Distance between the outer margins of both occipital condyles fairly wider in the aberrant rat than in R. *rattus*.



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 9

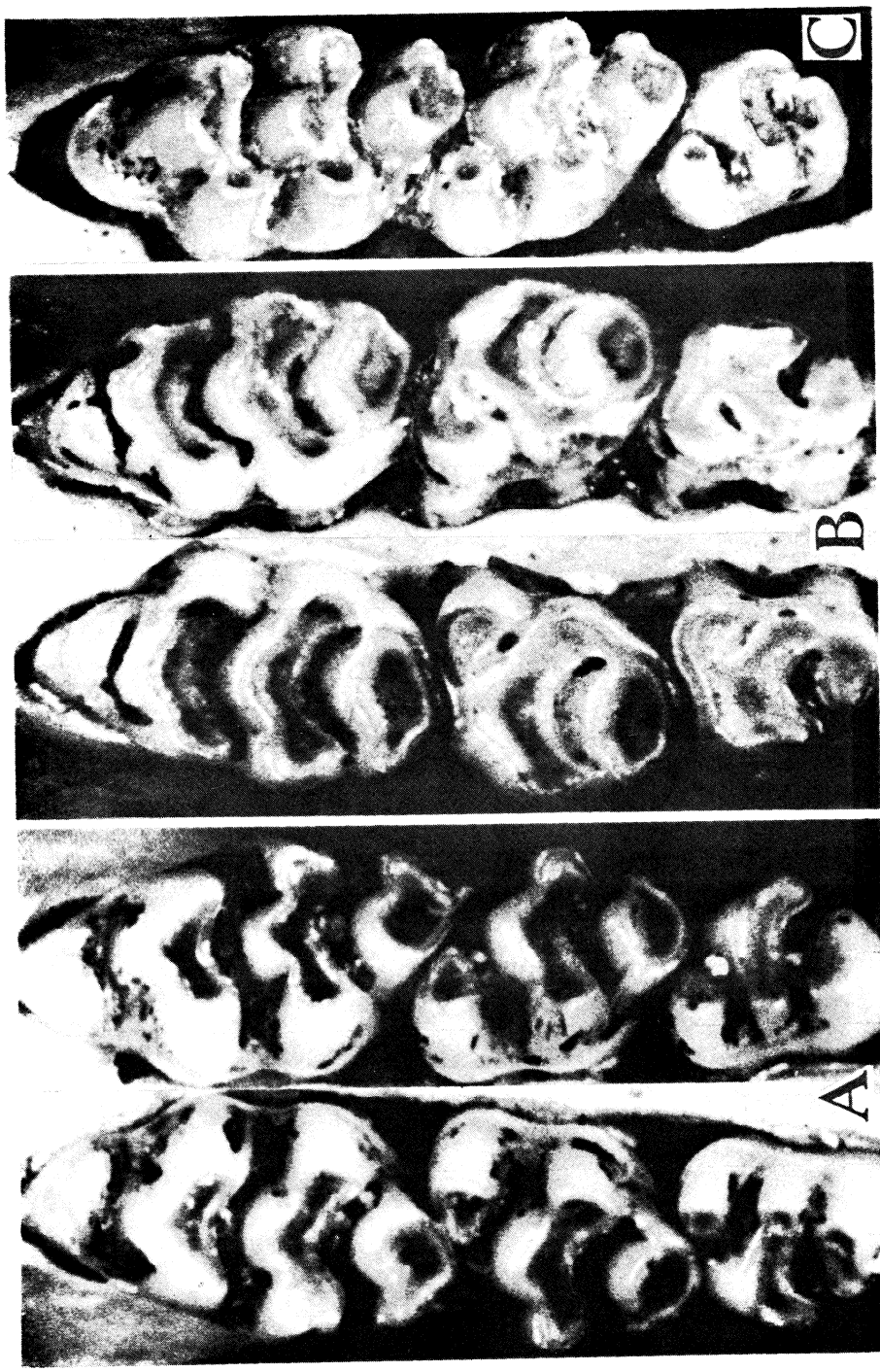
Comparison of mandibles and upper molars between the aberrant form and R. *rattus*. In the labial view of left mandibles the coronoid process fairly broader, more robust and shorter in the aberrant form (A, No. 102) than in R. *rattus* (B, No. HY 79). ×1.8. Labial sides of right upper molars, showing the constitution of enamel pattern of four laminae in M^1 of each specimen of the aberrant form (C, No. 101; D, No. 102), instead of three as usual in *Rattus* (E, *R. rattus*). Besides, M^2 of the aberrant form has a minute antero-external cusp (t^3) as clearly shown in specimen No. 101. x 14.5.



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 10

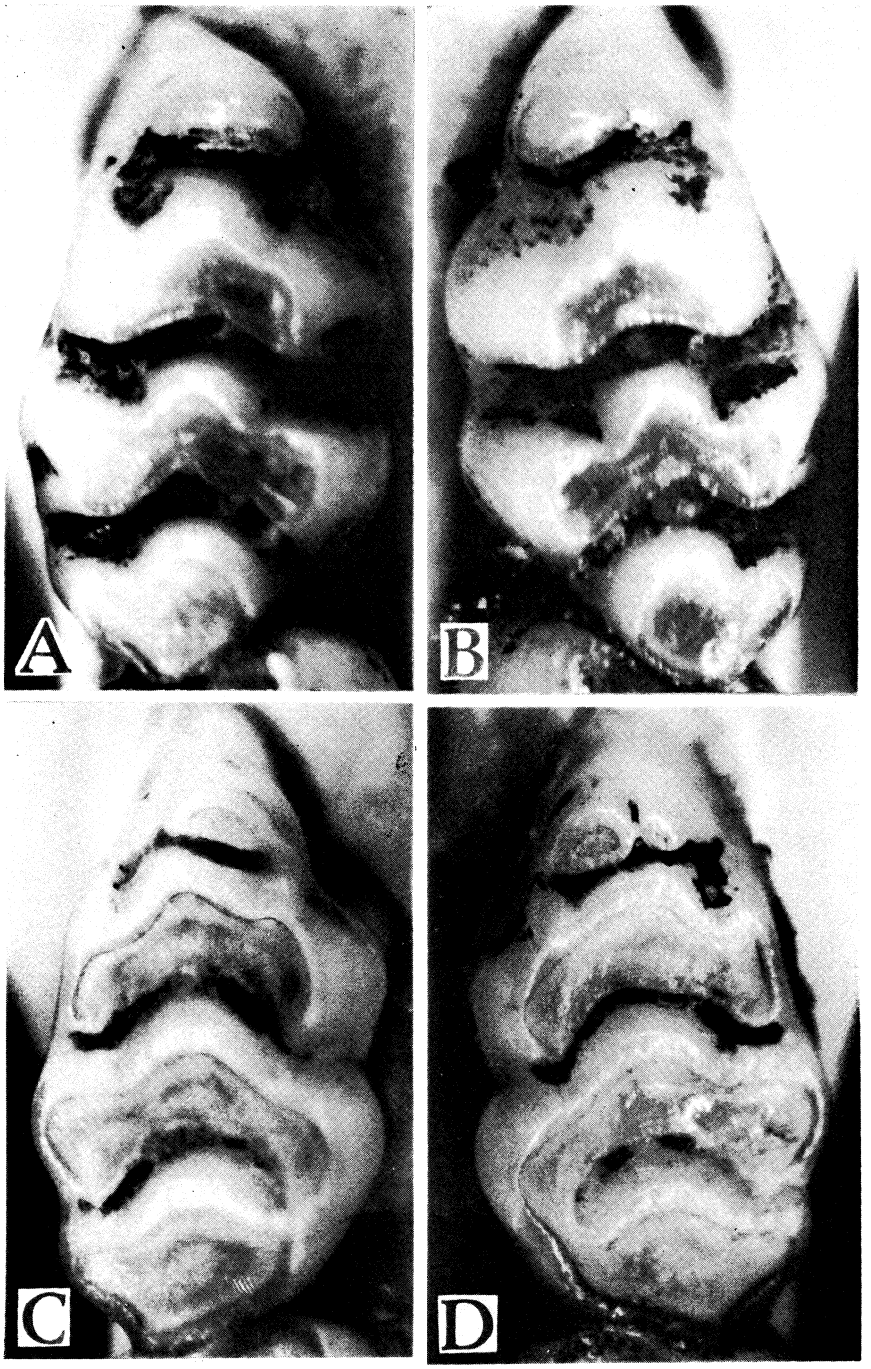
Comparison of construction in pattern of the crown surface of upper molars. x 14.5. Note the conspicuous extra front lamina in M^1 of the aberrant form (A, No. 101; B, No. 102), and lack of it in R. *rattus (C)*. M^3 never tend to be reduced, being nearly as large as 50% of length of M^1 in the aberrant form. Note right and left in figures (A, B) is reversed with each other.



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 11

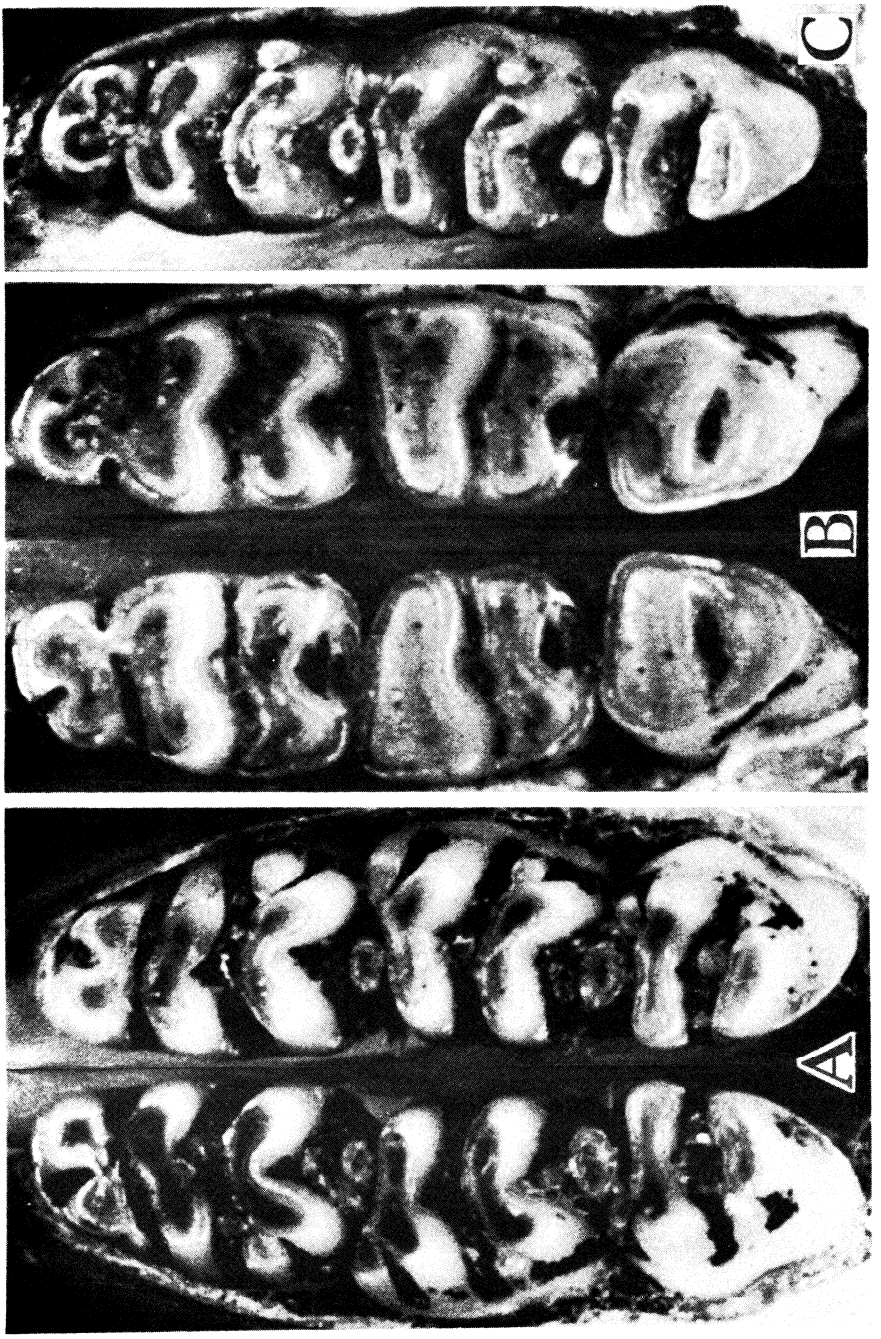
Enlarged view of enamel pattern of the grinding surfaces of M^1 in the aberrant rats (A and B, No. 101; C and D, No. 102). x 20. Well marked extra lamina is visible immediately in front of t? Presence of this extra lamina is the most important character by which these rats are separated from ordinary R. ***rattus.*** Moreover, the aberrant rat (A, B) provides the anterior lamina of M^1 less distinctly marked off by t^1, t^2 and t^3 cusps. While in R. ***rattus*** (Pl. 10, C) three cusps are very distinctive and t^3 is especially well marked. Note that in specimen No. 102 the pattern of extra lamina of M^1 consists of two enamel rings (C, D), which are derived from the wearing of a single high tubercle such as seen in M^1 of specimen No. 101 (A, B).



An aberrant form of the genus *Rattus* from Iriomote-jima

Explanation of Plate 12

Comparison of construction in pattern of the crown surface of lower molars. x 14.5. Note M_3 in the aberrant form being provided with a definite postero-external cusp (A, No. 101) though in specimen No. 102 (B) the cusp is worn out already, while it is entirely devoid of in R. *rattus* **(C).** Each lower molar tends to be enlarged considerably in the aberrant form.



An aberrant form of the genus *Rattus* from Iriomote-jima