Article IX.—CRANIAL VARIATIONS IN NEOTOMA MICROPUS DUE TO GROWTH AND INDIVIDUAL DIFFERENTIATION.

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PLATE IV.

In view of the stress naturally, and very properly, laid upon the importance of cranial characters in the discrimination of species in groups of closely-allied forms, it seems desirable to ascertain the character and amount of change in not only the general form of the skull but in the form of its separate bones due to growth, and also to determine the amount and kind of individual variation that may be expected to occur in skulls unquestionably of the same species. Having of late had occasion to examine a large amount of material relating to the genus *Neotoma*, the subject has been forcibly brought to my attention, and some of the results of a careful examination of a large series of skulls pertaining to several species of this genus are here presented. No attempt is made to treat the subject exhaustively, only a few special points being here presented.

As is well known to all experienced workers in mammalogy, the general contour of the brain-case, the relative size and form of individual bones, notably the interparietal, and the condition of the supraorbital and other ridges for muscular attachment, alter materially after the animal reaches sexual maturity; the deposition of osseus matter, the closing of sutures, the building out of crests and rugosities continuing throughout life, so that a skull of a very old animal may differ notably from that of an individual of the same species in middle life, and this latter from one just reaching sexual maturity.

The Museum has at present a large series of specimens of *Neotoma micropus* Baird, including ages ranging from nursling young to very old adults. They are mainly from three localities in the eastern coast district of Texas, namely, Brownsville, Corpus Christi, and Rockport. In order to avoid any complications that

might arise through geographic variation, only the specimens from Rockport and Corpus Christi—localities less than twenty-five miles apart, and similar in physical conditions—are here considered. There is not the slightest reason for questioning their conspecific relationship. The series selected to illustrate variations due to age are, with one exception, from Rockport; those figured to show individual variation are all from Corpus Christi.

Variations due to Age.

General Contour.—The variation in the general form of the skull resulting from growth is due mainly to the lengthening of the several skull segments without a corresponding relative increase in the breadth of the skull. Hence in the young skull, in comparison with an adult skull of the same species, the brain-case is disproportionately large in comparison with the anteorbital and basal portions of the skull. This is well shown in Plate IV, and in the subjoined table of measurements of three

Measurements and Ratios showing Cranial Variations due to Age in *Neotoma micropus*.

	No. 5834, ♀ juv.	Ratio[1]	No. 4480, ♂ juv.	Ratio[1]	No. 4478, ♂ very old.	Ratio[1]
Occipito-nasal length	31	100	41	100	53	100
Length of nasals	10	32.3	14.5	35.4	22	41.5
Length of frontals	13	42	15	36.6	18	34
Length of parietals on median line	5	19.4	6	14.6	8	15
Greatest length of parietals	12	39	15	36.6	16	30.2
Length of interparietal	4.5	14.5	5.5	13.4	7	13.2
Length of brain-case	14	45.2	17	41.5	21	39.6
Greatest rostral breadth	5.5	17.7	6.3	15.4	6.5	12.3
Least interorbital breadth	6	19.4	6	14.6	6	11.3
Breadth of brain-case	16	51.6	19.5	45	20	38
Breadth of interparietal	11	35.5	10	24.4	7.5	14.2
Greatest zygomatic breadth	20?	64.6	23	56.1	30	56.6
Depth of skull at middle of palate	8	26	11	26.8	15	28.5
Depth of skull at front of basisphenoid	11	35.5	12	29.3	14	26.4
Length of tooth-row (crown surface)	8[2]	25.8	8	19.5	9	17
Length of incisive foramina	6	19.3	8.5	20.7	11.5	21.7
Width of incisive foramina	3	9.7	3	7.3	3.5	6.6
Length of palatal floor	5	16.1	7	17	7	13.2

[1] Ratio to occipito-nasal length.
[2] From No. 4482, ♀ juv., in which the last molar has just come into use.

specimens of *N. micropus* from Rockport, Texas. No. 5834, ♀ juv., is a nursling so young that the last molar is still wholly enclosed in the jaw;[1] No. 4480, ♂ juv., though not quite full-grown, would pass as a 'young adult'; No. 4478, ♂ ad., is a very old male, with the teeth well worn down, and the fangs visible at the alveolar border. Other specimens in the series furnish a complete series of gradations between the two extremes (Nos. 5834 and 4478).

In general contour (Figs. 1–11, Pl. IV), the young skull, in comparison with adults, is much more convex in dorsal outline,[2] very broad posteriorly, and very narrow anteriorly. In comparing the relative length of the several skull segments the occipito-nasal length is taken as the basis, and the skulls will be referred to as *A* (=No. 5834), *B* (=No. 4480), and *C* (=No. 4478).

Rostral Segment.—In *A* the ratio of the rostral segment to the total length is 32.3 per cent.; in *B*, 35.4; in *C*, 41.5—giving a rapid *increase* in the ratio with age.

Frontal Segment.—In *A* the ratio of the frontal segment—*i. e.*, the distance between the naso-frontal and fronto-parietal sutures—to the total length is 42 per cent.; in *B*, 36.6; in *C*, 34—a considerable *decrease* in the ratio with age.

Parietal Segment.—In *A* the ratio of the parietal segment—*i. e.*, the distance from the latero-anterior angle of the parietal bone on either side to the occipito-parietal suture—to the total length is 39 per cent.; in *B*, 36.6; in *C*, 30.2—again a rapid decrease in the ratio.

Brain-case.—The length of the brain-case in *A* is 51.6 per cent. of the total length of the skull; in *B*, 45; in *C*, 38.

In each case the change in ratio is due to the disproportionate growth of the rostral portion of the skull. Thus in *A* the nasals have a length of only 10 mm.; in *B* they have increased to 14.5 mm., and in *C* to 22 mm., while the total occipito-nasal length of

[1] The length of the tooth-row given in the table is taken from an older specimen (No. 4482, ♀ juv.), in which the last molar has reached the level of the others and is just beginning to show traces of wear.

[2] In Figs. 10 and 11 it should be noted that the greater flatness of the skull interorbitally, as compared with Fig. 6, is masked by the raised supraorbital borders in the older skulls when viewed in profile.

the skull has increased only from 31 mm. in *A* to 53 mm. in *C*. In other words, the nasal bones have increased in length 120 per cent., while the total length has increased only 77 per cent.

Transverse Breadth.—In respect to the breadth of the skull the variations with growth are much less than in its length. Thus the greatest diameter of the rostrum varies only from 5.5 mm. in *A* to 6.5 in *C*—an increase of about 20 per cent. in the breadth of the rostrum, against an increase of 120 per cent. in its length. The interorbital breadth remains nearly constant, being 6 mm. in all three of the skulls here compared. The width of the brain-case shows an increase of 25 per cent. against an increase in the total length of the skull of 77 per cent. The zygomatic breadth shows an increase of about 50 per cent., due almost wholly to the thickening and increased convexity of the zygomatic arches.

Vertical Depth.—In respect to the depth of the skull, the variations with age prove especially interesting, although only such as would be expected from the facts already given. For present purposes the depth of the skull is taken at two points, namely, (*a*) at the middle of the palatal region, and (*b*) at the posterior border of the basisphenoid (basisphenoid-basioccipital suture). The palatal depth increases markedly with age, correlatively with the growth of the rostrum ; the basisphenoidal depth changes but slightly after the molars have attained to functional development. Thus in *A* the basisphenoidal depth is 11 mm. ; in *B*, 12 mm. ; in *C*, 14 mm.—an increase of about 28 per cent. The palatal depth in *A* is 8 mm. ; in *B*, 11 mm. ; in *C*, 15 mm.—an increase of nearly 88 per cent.

Tooth-row.—The length of the upper tooth-row varies about 12 per cent., due almost wholly to the wearing down of the teeth, the length of the crown surface being much less, in slightly worn teeth, than the length taken at the alveolar border.

Interparietal.—The interparietal shows surprising modification with age, both as to size and form, but especially in respect to the latter. At early stages, as in *A*, this bone is more or less crescentic in shape, with the transverse diameter more than twice

the antero-posterior diameter. Thus in *A* the two diameters are respectively 11 and 4.5 mm.; in *B*, 10 and 5.5 mm.; in *C*, 7.5 and 7 mm. In other words, the short, broad, convex sub-crescentic interparietal in *A* becomes transformed in *C* into a squarish, flat bone in which the two diameters are nearly equal, instead of the transverse being twice as great as the antero-posterior, as in *A*. This would be almost incredible were not the proof so abundantly furnished by the material in hand, where every stage of transition is shown. (Figs. 1–8, Pl. IV.) This change is coincident with the development of the raised supra-orbital borders and their prolongation backward as ridges to the parieto-occipital suture, and the flattening of the whole dorsal aspect of the post-rostral portion of the skull. In old age these ridges become confluent with the lateral edges of the interparietal which has now lost its postero-lateral moieties, partly apparently by absorption and partly by their being overgrown by the mediad posterior angle of the parietals. A sharp thin ridge for muscular attachment also extends back from the posterior base of the zygomatic arch. The interparietal at the same time develops a more or less prominent median angular projection at its posterior border, confluent with the median ridge of the supraoccipital. The contrast between these conditions, obtaining only in very old skulls, and their almost entire absence in skulls which have just reached sexual maturity, is strikingly great.

Supraoccipital.—The supraoccipital changes from a posteriorly convex, thin lamina of bone, in early life, to a thick, nearly vertical plate, with a strongly-developed median ridge produced into an angular spine at its superior border, and with a lateral ridge on either side about midway between the median line and its lateral borders; these lateral ridges also each develop an angular rugosity or process about midway their length. The superior border is also produced into an incipient occipital crest.

Basioccipital.—The basioccipital becomes greatly altered by growth, as in fact is the case with the whole postpalatal region. In comparing stages *A* and *C* it is found that the distance across the occipital condyles increases only about 15 per cent., while the breadth of the anterior border increases 100 per cent., and the length about 50 per cent. (Figs. 12-14, Pl. IV.)

Basisphenoid.—The basisphenoid doubles in length, and its anterior third becomes differentiated into a narrow projecting neck. The presphenoid at stage *A* is nearly hidden by the palatal floor. (Figs. 12-14, Pl. IV.)

Postpalatal Region as a whole.—This doubles its length with an increase in breadth of only about 50 per cent. At stage *A* the postpalatal border terminates slightly behind the posterior edge of M.2 ; in stage 3 it holds very nearly the same position. The distance between the postpalatal border and the front border of the auditory bullæ, compared with the total length of the skull, is as 1 to 9 in *A*, and as 1 to 5 in *C*. In *A* the pterygoid hamuli reach the second fourth of the bullæ ; in *C* they terminate slightly in advance of the bullæ. The bullæ themselves in *A* are more obliquely placed than in *C*, in relation to the axis of the skull, and are quite differently shaped. Also the form of the foramen magnum has undergone much change. These points are all well shown in Figs. 12-14 of the accompanying plate.

Incisive Foramina.—Consequent upon the growth of the rostral portion of the skull, the incisive foramina undergo marked change in form, and somewhat in position, as regards both their anterior and posterior borders. In the stage designated as *A* they are short and broad, and extend relatively further both anteriorly and posteriorly than in stage *B* or *C*, their anterior border being nearer the base of the incisors, and their posterior border being carried back to or slightly behind the front border of the first molar. Thus in *A* the length of the incisive foramina is 6 mm., with a maximum breadth of 3 mm., while in *C* the dimensions are respectively 11.5 and 3.5 mm.—a great increase in length with only slight increase in breadth. At the same time the anterior border is considerably further from the base of the incisors, and the posterior border is slightly in advance, instead of slightly behind, the front border of the molars.

Spheno-palatine Vacuities.—In adults of *Neotoma micropus*, as in other species of the 'round-tailed' section of the genus, there is a long, broad vacuity on each side of the presphenoid and anterior third of the basisphenoid, which Dr. Merriam has recently

named[1] the '*spheno-palatine vacuities*,' and he has also called attention to the fact that they are not present in some forms of the 'bushy-tailed' section of the genus. It is therefore of interest in the present connection to note that these vacuities are absent at stage *A*, and are only partially developed at later stages (Figs. 12-14, Pl. IV). My attention was called to the matter by finding several nearly fully-grown skulls from Texas and northeastern Mexico with these vacuities either quite absent or represented by an exceedingly narrow slit, while I could find no differences in the skins or in other cranial characters that gave the slightest hint that the animals were not referable to *N. micropus*. Further examination of young skulls of undoubted *N. micropus* from Rockport and Corpus Christi, Texas, showed that the closed condition was in this species a feature of juvenility. It is thus of interest to find that a feature which proves to be merely a character of immaturity (and quite inconstant as well) in *N. micropus* is a permanent condition in *N. cinerea occidentalis*.[2]

In the development of these vacuities it appears that as the presphenoid increases in length it becomes reduced in width; at the same time, as the skull broadens, the edges of the ascending wings of the palatine bones become slightly incised. There is, however, much individual variation in this respect, as will be shown later.

Molars.—When the molars first cut the gum they have nearly the entire crown-surface capped with enamel. Very soon, even before the tooth has attained its full height, the enamel begins to disappear from the centers of the enamel loops, the capping remaining longer over the narrower loops than over the broader ones; it quickly disappears from all as soon as the crown-surface becomes subject to wear. In stage *A*, in which only M.1 and M.2 have appeared, and are less than one-third grown, the enamel walls of the loops nearly meet over the dentinal areas—quite meeting over the narrower portions, especially in the case of the middle transverse loop of each tooth. Some time before the age represented by *B* is reached, the crown-surface is worn to an

[1] Proc. Biol. Soc. Wash., VIII, p. 112, July, 1893.

[2] Unfortunately the outline figures here given (Figs. 12–15, Pl. IV,) fail to show clearly the points at issue.

even plane; the tooth has reached its normal length, but the fluting of the sides still extends to the alveolar border. As attrition goes on, with the advance of the animal in age, the crown-surface wears down, and the neck of the tooth appears above the alveolar border, till, especially in the upper molars, the fluted terminal and the smooth basal portions are of nearly equal extent; but in old age (as in *C*) the smooth basal portion is the longer and the division of the root into fangs is clearly shown. With this wearing down the tooth increases somewhat in both width and length, but the pattern of the enamel folds undergoes but slight change until nearly the whole crown is worn away, except that the angles become gradually more rounded.

Résumé.—As already stated the change with age in the general form of the skull is due to the relatively disproportionate increase in length of the pre- over the post-orbital region, and the same disproportionate increase of the basal region as compared with the frontoparietal elements. In the first case the rostrum becomes relatively greatly produced; in the second the basioccipital and adjoining parts become so greatly enlarged as to change the entire aspect of the basal region of the skull. Thus the occipital condyles, which in *A* terminate slightly in advance of the most convex portion of the supraoccipital, and are crowded up very close to the bullæ, form in *C* the most posterior part of the skull, with a considerable interval between them and the bullæ. (Figs. 12–14, Pl. IV.)

Individual Variation.

In comparing a large series of skulls of the same species it quickly becomes apparent that no element of even the adult skull is constant, either as to form or relative size. There is also much variation in the size of skulls of the same sex and approximately the same age.

Variation in Size.—Thus in *Neotoma micropus*, from the same locality, there are dwarfs and giants. While the females average smaller than the males, size is by no means a safe criterion of sex. Thus two old females, not appreciably different in age, from Corpus Christi, Texas, vary as follows: No. 2948, total

length 51 mm., zygomatic breadth 26 mm.; the corresponding dimensions in No. 2955 are 45 mm. and 24 mm. These are merely the extremes of a series of six specimens; with a much larger series doubtless the difference would be considerably increased. A series of six old males, from the same locality and indistinguishable as to age, vary as follows: No. 2952, total length 50.5 mm., zygomatic breadth 27 mm.; the corresponding dimensions in No. 2956 are 45 mm. and 25 mm.

Nasals and ascending branches of the Premaxillæ.—Ordinarily in *N. micropus* the nasals terminate in a gradually narrowed evenly rounded point, a little less than 2 mm. in front of the posterior termination of the ascending branches of the premaxillæ. The distance between the points of termination of the nasals and premaxillæ, however, frequently varies between 1.5 and 2.5 mm.; more rarely from 1 to 3 mm. These extremes each occur in the ratio of about 10 per cent. of the whole, while probably 60 per cent. would not vary much from the normal average of about 2 mm. (See Figs. 1–8 and 16, 17, Pl. IV.)

The nasals, as already said, usually terminate in an evenly rounded point, but in several of the 50 skulls of *N. micropus* before me their posterior border forms a double point, *each* nasal terminating in a distinctly rounded point; in one or two the posterior border is squarely truncate; in others it is irregularly uneven. The ascending branches of the premaxillæ usually terminate in an obtusely V-shaped point, with a uniformly even outline, their breadth, however, being subject to variation; in some specimens they terminate in a brush of irregular spiculæ. (Figs. 1–8 and 16, 17, Pl. IV.)

Frontals.—The posterior border of the frontals is subject to great irregularity, varying from a nearly transverse line (rounded slightly at the outer corners) to a gentle, rather even convexity, and thence to an acute angle, involving the whole posterior border. It is difficult to decide what outline is the most frequent, though the tendency seems to be greatest toward a well-pronounced rather even convexity. Figures 1–8 and 18, 19, Plate V, well show the variation in the position and direction of the fronto-parietal suture.

Parietals.—The anterior outline of the parietals of course conforms to the posterior outline of the frontals, and must be equally variable. It hence follows that their length on the median line is also variable. Their posterior border is also subject to much variation in consequence of the great diversity in the form of the interparietal.

Interparietal.—In middle-aged specimens the interparietal tends strongly to a quadrate form, varying from quadrate to diamond shape, through a more or less marked median angular extension of both its anterior and posterior borders, and occasionally of its lateral borders as well. Often it forms a quadrate figure, in which each of its four sides is slightly convex; again the corners are so much rounded, and the lateral breadth so much in excess of the antero-posterior, as to give a lozenge-shaped figure. In other cases it is distinctly shield-shaped; in others it is hexagonal. In size the variation is fully 50 per cent. of what may be regarded as the average dimensions. These remarks have strict reference to fully adult specimens, and as nearly as can be judged these variations are not at all due to differences of age, which, as already shown, has so great an influence upon the size and form of this exceedingly variable element of the skull.[1] (Figs. 20–23, Pl. IV. Compare also the interparietal, as shown in Figs. 1–8.)

Ventral aspect.—The ventral aspect of the skull presents numerous points of variability, only a few of which will be here mentioned. The palate varies more or less in breadth, and especially in the development of the anterior palatal spine, which is sometimes slight, and sometimes so strongly produced anteriorly as to touch the vomer. The postpalatal border may be evenly concave, or present a slight median process. The presphenoid is very variable in size, being often an exceedingly slender rod of bone, and at other times very stout, the variation in thickness being nearly or quite 100 per cent. The anterior third of the basisphenoid shares in the same variability. As the

[1] As regards variation with age in the form of the interparietal, *Neotoma micropus* is only an example of what doubtless prevails throughout the genus, and even in many other genera as well. Yet in adult animals the form of this bone seems, as a rule, to be sufficiently constant to be of more or less taxonomic value. Thus in the *N. cinerea* group it may be said to be normally quadrate; in the *N. fuscipes* group it is quite constantly shield-shaped. In *N. floridana*, however, and in the *N. mexicana* group, it seems to be nearly or quite as variable as in *N. micropus*, both as to size and shape.

ascending borders of the palatals are also variable in respect to the extent of their development, it follows that there is, even among adults, a wide range of variation in the size of the sphenopalatine vacuities.

Teeth.—Aside from differences due to age and attrition, the teeth vary in size to a considerable extent among individuals strictly comparable as to sex and age, some having a much heavier dental armature than others. But more particularly noteworthy in this connection is the variation in the color of the teeth, which seems strongly a matter of individuality. Although Dr. Merriam has recently placed *N. micropus* in his "*Neotoma leucodon* group,"[1] which has, among other alleged characters, "color of teeth white or nearly white," the teeth in *N. micropus* average blacker than in any other species of the genus known to me. Were this all it might be considered that *N. micropus* was erroneously referred to the '*leucodon* group'; but unfortunately the range of individual variation in the color of the teeth in the large series at hand covers also the whole range of variation for the genus. Thus in some instances the molar teeth are intensely black from base to crown, while the crown-surface itself is strongly blackish, even the enamel loops, as well as the enclosed dentine being tinged with blackish; in other cases the teeth are merely slightly tinged with brownish near the base and at the bottom of the sulci. These extremes are connected by a series of very gradual intergradations. In other words, among hundreds of skulls of *Neotoma*, those with the blackest teeth occur in *N. micropus*, as well as those in which the teeth are practically white.

In the suckling young the teeth are pure white; before M.3 has come to wear, M.1 and M.2 have become more or less blackened; in young adults, and in middle aged specimens, the teeth are often intensely black; in old specimens, with the teeth much worn, the teeth average lighter than in the younger individuals. There is, however, a wide range of variation in the color of the teeth in specimens of corresponding age, whether old or young. The black coloring consists to a large extent of a

[1] Proc. Biol. Soc. Wash., IX, p. 118, July 2, 1894.

superficial incrustation which tends to scale off in flakes in the prepared skull, and its absence apparently may be due sometimes to removal in the process of cleaning the skull for the cabinet. In other words, the blackness is to some extent an accidental or pathological condition, due probably more or less to the particular character of the food or to the health of the animal.

General Remarks.

The bearing of what has been stated above respecting variations in the form of the skull and of its principal elements due to age is of course obvious, the inference being that in animals which have reached sexual maturity variations due wholly to growth, in passing through adolescence to senility, may readily be mistaken, when working with very small series or with single specimens, for differences of subspecific or even specific importance. Not only do the individual bones vary in their outlines and proportions and in relative size, but the skull varies as a whole in its relative dimensions, including depth as well as length and breadth. There is beside this a wide range of purely individual variation, affecting every character that can be used in a diagnostic sense. Thus in a series of fifty skulls of *Neotoma micropus* it would be easy to select extremes, of even individual variation, that depart so widely from the average, in one or more characters, as to deceive even an expert, on considering these alone, into the belief that they must represent very distinct species; yet in the present instance the proof that such is not the case is overwhelming. In *N. micropus* the coloration is remarkably constant, for a member of this genus, at all seasons and ages, so that the case is less complicated than it would be in many other species of the group, where the color of the pelage varies radically with season and age.

Personal criticism is not the purpose of the present paper, and it was not my intention at the outset to refer specifically to the work of any of my *confrères*. Since its preparation was begun, however, its *raison d'être* has perhaps been emphasized by the publication of two brochures of 'preliminary descriptions' of species and subspecies of the genus *Neotoma*, numbering altogether 10 species and 8 subspecies, which added to the 22 species and sub-

species previously standing practically unchallenged, makes, at the present writing, a total of 40 forms of the genus *Neotoma*. Of these no less than 26 have been described within the last nine months.[1] Without the material before me used by the original describers of these forms it would be presumptive to give an opinion respecting the merits of many of them. While the greater part may have some real basis, it is evident that others are almost unquestionably synonyms of previously-described forms, judging by 'topotypes' in this Museum, the brief diagnoses accompanying the names affording in these cases no characters that are in the least degree distinctive.

The genus *Neotoma* was chosen for treatment in this connection in preference to some other almost solely by chance, as the facts of variation above presented are not at all exceptional. In fact the common muskrat (*Fiber zibethicus*) would have shown a still more striking case of variability, as would also various species of many other genera. Yet describers of new species are constantly laying stress upon cranial differences that have not necessarily the slightest specific or even subspecific importance; and, so far as can be judged from their descriptions, they are entirely unconscious that such can be the case.

On the other hand, it is equally certain that such alleged characters may have the value assigned them; since it is now a well known fact that the extremes of purely individual variation in any character, external or internal, may exceed in amount the average differences that serve to satisfactorily distinguish not only well-marked subspecies, but even forms that are unquestionably specifically distinct. Hence it must often happen that the determination of the status of a species or subspecies originally described from one or two specimens, in groups especially susceptible to variation, must depend upon the subsequent examination of a large amount of material bearing upon this and its closely-related forms.

[1] For a list of the species and subspecies of *Neotoma* described prior to July 6, 1894, see Abstr. Proc. Linn. Soc. New York, No. 6, pp. 34, 35, July, 1894.

EXPLANATION OF PLATE IV.

Figures all Natural size.

Neotoma micropus *Baird.* Showing cranial variations due to age and individualism. (Unless otherwise stated, the specimens are from Rockport, Texas.)

Figs. 1–8. Dorsal aspect of skull, showing gradual change in form with age, and especially in the form and relative size of the interparietal. Fig. 1, No. 5834, ♀ juv. (suckling). Fig. 2, No. 2975, ♀ juv. (nearly sexually adult), Corpus Christi, Texas. Fig. 3, No. 5841, ♀ ad. Fig. 4, No. 4480, ♂ ad. Fig. 5, No. 2958, ♂ ad., Corpus Christi. Fig. 6, No. 4479, ♂ ad. Fig. 7, No. 4477, ♀ ad. Fig. 8, No. 4478, ♂ ad.

Figs. 9–11. Skull in profile, to show change of form with growth. Fig. 9, No. 5834, ♀ juv. (nursling). Fig. 10, No. 4480, ♂ ad. (rather young). Fig. 11, No. 4478, ♂ ad. (very old).

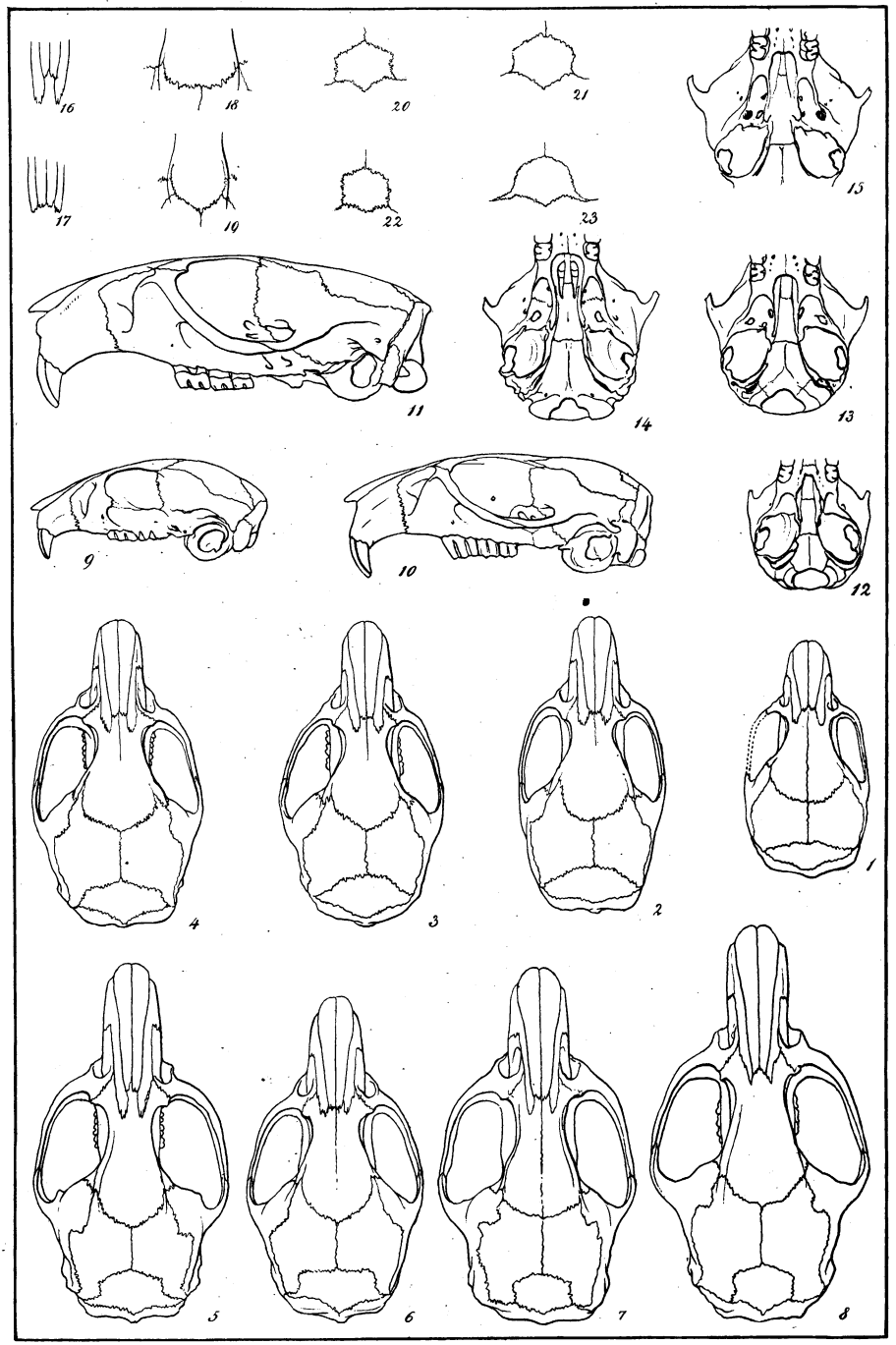
Figs. 12–15. Ventral aspect, showing variations in postpalatal region due to age. Fig. 12, No. 5834, ♀ juv. (nursling). Fig. 13, No. 5841, ♀ ad. (young adult). Fig. 14, No. 2958, Corpus Christi, ♂ ad. (very old). Fig. 15, No. 1456, *Neotoma cinerea occidentalis*, ♂ ad., Ducks, B. C. (for comparison with *N. micropus*).

Figs. 16, 17. To show extremes of individual variation in relative posterior extension of nasals and ascending branches of premaxillæ. Locality, Corpus Christi, Texas. Fig. 16, No. 2958, ♂ ad. Fig. 17, No. 2948, ♀ ad.

Figs. 18, 19. To show extremes of individual variation in posterior border of frontals. Locality, Corpus Christi, Texas. Fig. 18, No. 2949, ♂ ad. Fig. 19, No. 2951, ♂ ad.

Figs. 20–23. To show individual variation in the size and form of the interparietal. Specimens all from Corpus Christi, Texas. Fig. 20, No. 2949, ♂ ad. Fig. 21, No. 2948, ♀ ad. Fig. 22, No. 2952, ♂ ad. Fig. 23, No. 2945, ♀ ad.

NOTE.—If the Brownsville, Texas, series of specimens had also been included, the range of individual variation would have been considerably increased.



Neotoma micropus.

Figures nat. size.