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Article XXVIII.—THE SKELETAL CHARACTERS OF *SCUTISOREX* THOMAS.[1]

By J. A. Allen.

Plates LXXXIX–XCII; Text Figs. 1–8.

The genus *Scutisorex* Thomas was founded in 1913 [2] for a large species of African shrew, previously described by him as *Sylvisorex somereni*,[3] based on a single specimen (skin and skull) from Uganda. A second species of the genus was described by the same author five years later as *Scutisorex congicus*,[4] based also on a single specimen (skin and skull) collected at Medje, Upper Ituri River, Belgian Congo. Thirty-seven topotypes of this species, collected by Lang and Chapin on the American Museum of Natural History Congo Expedition, were recently recorded by Hollister in this 'Bulletin.' [5]

The "chief characters" of *Scutisorex* are given as "the long thick fur, quite different from the short velvety coat of *Sylvisorex*, and the great development of the cranial ridges, as compared with the practically smooth unridged skull of *Sylvisorex*." Fortunately in addition to the large series of skins and skulls mentioned above, the Lang-Chapin collection contains a specimen in alcohol, one complete skeleton and six other skeletons more or less incomplete. This material shows that the external and cranial characters fail to reveal the existence in *Scutisorex* of an extremely specialized vertebral column, differing surprisingly in structure from that of *Sylvisorex* or *Crocidura*, and even from that of any known insectivore.

The skull and limb bones are not essentially different from those of other Crocidurinæ. The teeth, in comparison with those of the larger species of *Crocidura* (as, *e. g.*, the *C. nyansæ* group) are markedly reduced in size but not otherwise essentially modified. The skull, however, is differently proportioned, the preorbital portion being narrowed and the postorbital greatly broadened in comparison with that of *Crocidura*, in which the maxillar breadth is about 32 per cent. and the mastoid breadth 36 per cent. of the condylobasal length, while these proportions in *Scuti-*

[1] Scientific Results of the American Museum of Natural History Congo Expedition. Mammalogy, No. 3.

[2] Ann. and Mag. Nat. Hist. (8), XI, pp. 320–321, March, 1913.

[3] *Ibid.*, VI, p. 113, July, 1910.

[4] *Ibid.*, XVI, p. 470, Dec., 1915.

[5] Bull. Amer. Mus. Nat. Hist., XXXV, pp. 663–680, pll. vii–xi, Oct. 21, 1916. *Scutisorex congicus* Thomas, pp. 673–674, pl. xi, fig. 2 (half-tone of animal, about ½ nat. size).

sorex are respectively 30 and 46 per cent. In *Crocidura* the dorsal outline of the skull is straight, the depth of the skull at the beginning of the molariform series being the same as at the mastoid region. In *Scutisorex* the depth of the rostrum is much less than in *Crocidura,* and at the mastoid region much greater. In *Scutisorex* the braincase is strongly roughened, the lambdoid crest is heavily produced and the mastoid region greatly expanded. In *Crocidura* the braincase is smooth, the lambdoid rather weakly developed, and the mastoid breadth of the skull is but little greater than the maxillar breadth. (Compare Figs. 1–3.)

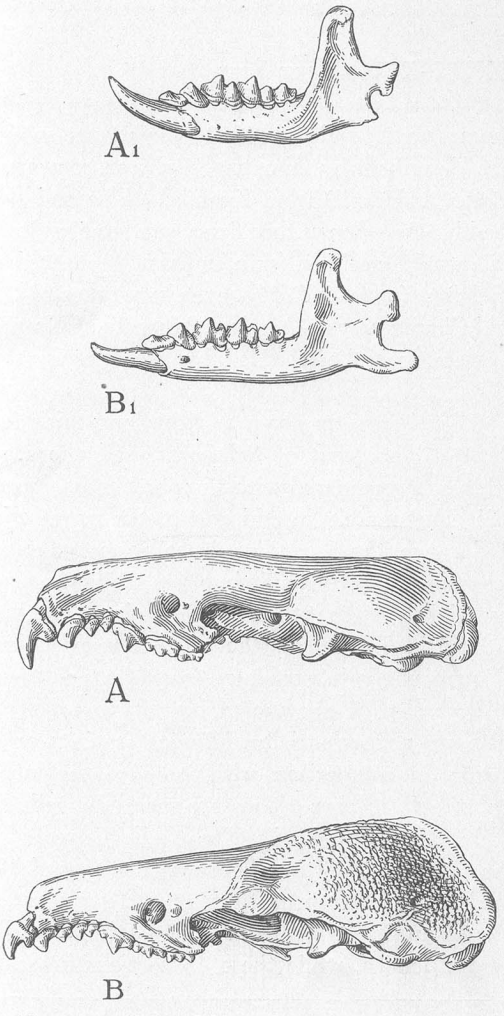


Fig. 1. Skulls and lower jaws (side view) of *Crocidura* and *Scutisorex*. All $\frac{2}{1}$.

A and A^1, *Crocidura nyansæ kivu* (♂ No. 48497, Medje, April 8, 1910); *B* and B^1, *Scutisorex congicus* (♂ No. 51311, Medje, April, 1910).

The measurements of the skull (No. 51311) of the skeleton constituting the principal basis of the description of the axial skeleton given below are as follows: Condylobasal length (to front of incisors) 32 mm.; total length, 32.4; interorbital breadth, 8.4; mastoid breadth, 13.7; maxillar breadth, 9.8; breadth at base of incisors, 3.1; breadth across occipital condyles, 8; breadth outside to outside of zygomatic processes of squamosal, 10.2; transverse breadth of foramen magnum, 4.7; axial breadth of foramen magnum, 3.3; upper toothrow (including canines), 14.1; maxillar

series (first unicuspid to m^3), 10; molar series, 5.3; mandible to tip of incisors, 22, to base of incisors, 18.4; angle to condyle, 5.5; depth at coronoid, 8; toothrow to tip of incisors, 13.1, excluding incisors, 9.6.

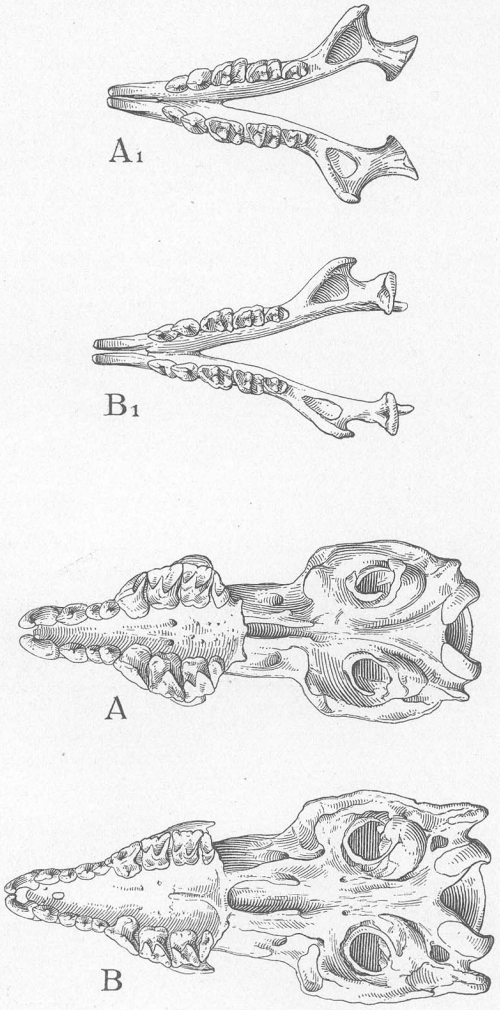


Fig. 2. Skulls (ventral view) and lower jaws (dorsal view) of *Crocidura* and *Scutisorex*. All $\frac{2}{1}$. *A* and A^1, *Crocidura nyansæ kivu:* *B* and B^1, *Scutisorex congicus*. Same specimens as in Figs. 1 and 3.

Axial skeleton, total length, 232 mm., made up as follows: skull, 32; cervical vertebræ, 14; thoracic vertebræ, 25; lumbar vertebræ, 33; sacral vertebræ, 17; caudal vertebræ, 111.

Scutisorex has, in comparison with *Crocidura*, a much heavier body and

correspondingly more strongly developed limbs. While the length of the skull in *Scutisorex* is practically the same as in *Crocidura nyansæ*, it is more massively built, the body is several times greater in bulk than in *C. nyansæ*,

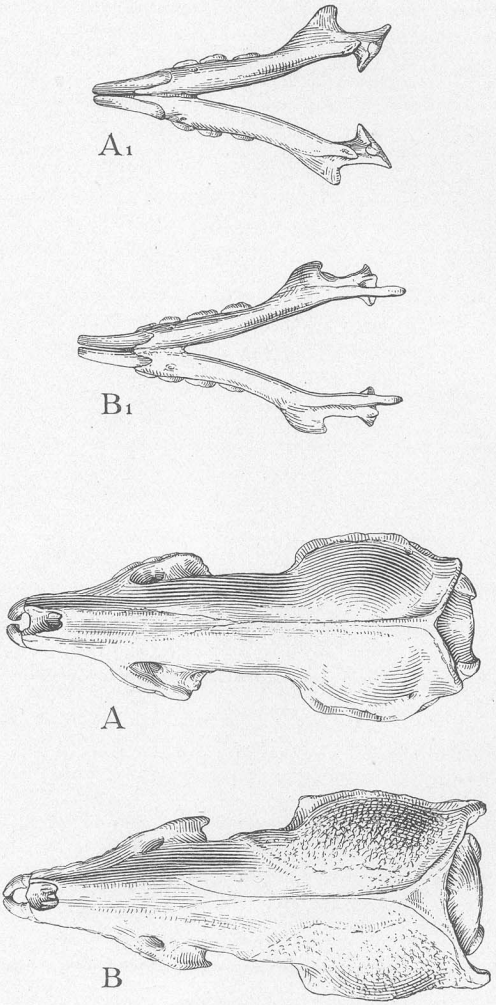


Fig. 3. Skulls (dorsal view) and lower jaws (ventral view) of *Crocidura* and *Scutisorex*. All $\frac{2}{1}$. *A* and *A*^{1}, *Crocidura nyansæ kivu; B* and *B*^{1}, *Scutisorex congicus*. Same specimens as in Figs. 1 and 2.

and the limbs are proportionally similarly developed, the limb bones being about one-fourth longer and correspondingly more robust. The details of structure, however, are essentially the same, developed on a much larger scale.

Vertebral Column.

For convenience in preparing the present account of the principal characters of the axial skeleton in *Scutisorex congicus*, the skeleton of one of the larger species of *Crocidura* (*C. nyansæ*) has been taken as a suitable standard for comparison.

Vertebral formula.— The vertebral formula of *Scutisorex* differs strikingly from that of *Crocidura*, and also from that of insectivores in general, through the lengthening of the lumbar series from 6 (sometimes 5) to 11[1], which latter has been found to be the constant number in five skeletons of *Scutisorex congicus*, or nearly twice the usual number in the Soricidæ and allied families. This in itself is a surprising and noteworthy feature; but it is combined with an unique specialization of the vertebræ themselves of the whole dorso-lumbar series. The vertebral formula of *Scutisorex*, in comparison with that of *Crocidura nyansæ*, is as follows:

	Cervical	Dorsal	Lumbar	Sacral	Precaudal	Caudal
S. congicus	7	14	11	5	37	23?
C. nyansæ	7	15[2]	6	5	33	19

General features.— As shown in the accompanying illustrations (Figs. 1–8), the vertebral column in *Crocidura* is typically soricine — slender and lightly constructed, with slight development of the apophysial elements, and nearly uniform in the transverse and vertical diameters of the vertebræ from the anterior cervical to the end of the lumbar series. In *Scutisorex* the vertebral column is heavily built, the vertebræ rapidly increase in both diameters from about the middle of the dorsal series to the middle of the lumbar, and decline in size only slightly thence to the end of the lumbar series, as shown in the following table of measurements and in Text Figs. 5–8 and Plates LXXXIX and XC.

The unique feature of the vertebræ in *Scutisorex* is the profuse development of interlocking spines, arising mainly from their lateral aspects, but also present on the dorsal and ventral, apparently as yet unrecorded for any mammal. The latero-ventral borders of the vertebræ from about the 7th dorsal to the last lumbar are so enormously produced that this part of the vertebral column, as seen from below, is deeply concave or trough-shaped, suggesting the simile of a canoe. These spines are directed hori-

[1] Five skeletons have each 11, one has only 10, but in this one the last two thoracics are somewhat abnormal, apparently through injury in life. The other skeleton has the dorso-lumbar series of vertebræ incomplete.

[2] In two specimens; given as 14 in some of the other species of *Crocidura*.

Comparative Measurements[1] *of Vertebræ in Scutisorex and Crocidura.*

	Scutisorex congicus No. 51311		Crocidura nyansæ kivu No. 48947	
	Transverse	Vertical	Transverse	Vertical
4th Cervical	6.6	5.0		
1st	7.5	4.5	5.1	5.0
7th "	7.5	3.5	4.5	3.3
14th "	9.5	6.4	4.1	3.5
4th Lumbar	11.0	7.5	4.6	3.0
11th "	8.2	7.5	—	—
1st Caudal	5.0	4.5	3.8	3.8

zontally, those of one vertebra interlocking closely with those of the next adjoining vertebræ. They seem not to be morphologically homologous with any of the ordinary vertebral elements; they suggest the exostosis often present in vertebrates as a senile or pathological condition. Possibly in the present case they may be construed as a normal exostosis, the function of which is to add strength and rigidity to the dorso-lumbar portion of the vertebral column. The function or purpose served can be determined only by full knowledge of the habits of the animal and study of its movements in life.

Cervical Vertebræ.— Except in their relatively much larger size, and the stronger development of the transverse processes, this series agrees very closely with the cervicals in the genus *Crocidura,* and consequently do not require consideration in detail. The ventral surface of the centrum, however, is flat, with a low median spine (hypapophysis) on the 2d, 3d and 4th, directed backward, but absent on the 5th, 6th and 7th. The enlarged transverse process of the 6th is similar in form to the same process in *Crocidura* but developed to a greater degree.

Dorso-lumbar series.— These can best be considered together, since the peculiar conditions which reach their maximum development in the lumbar series begin near the middle of the dorsal series.

The spinous process is rudimentary on the 1st dorsal, becomes a little larger on the 2d, and reaches its maximum size on the 3d; it decreases in size on the 4th, 5th and 6th, and is rudimentary from the 7th to the 14th, on which it is seen as a small point at the posterior border of the vertebra, horizontal in direction and imbricating the front border of the succeeding

[1] Measurements are in millimeters.

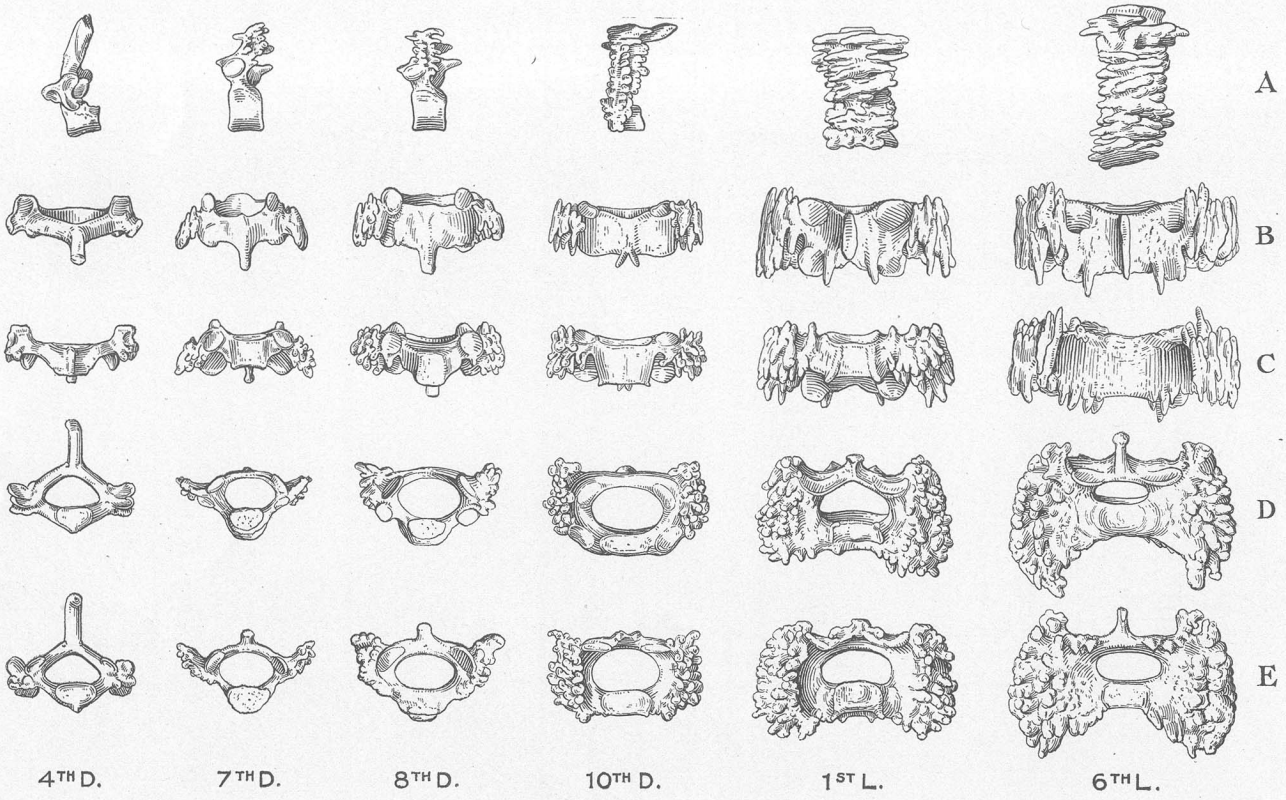


Fig. 4. Vertebræ of *Scutisorex congicus*. From a disarticulated skeleton (No. 48452, Bafwabaka, Jan. 5, 1910). All $\frac{2}{1}$.
From left to right, 4th, 7th, 8th and 10th dorsals, and 1st and 6th lumbars. *A*, lateral, *B*, dorsal, *C*, ventral, *D*, anterior, *E*, posterior views.

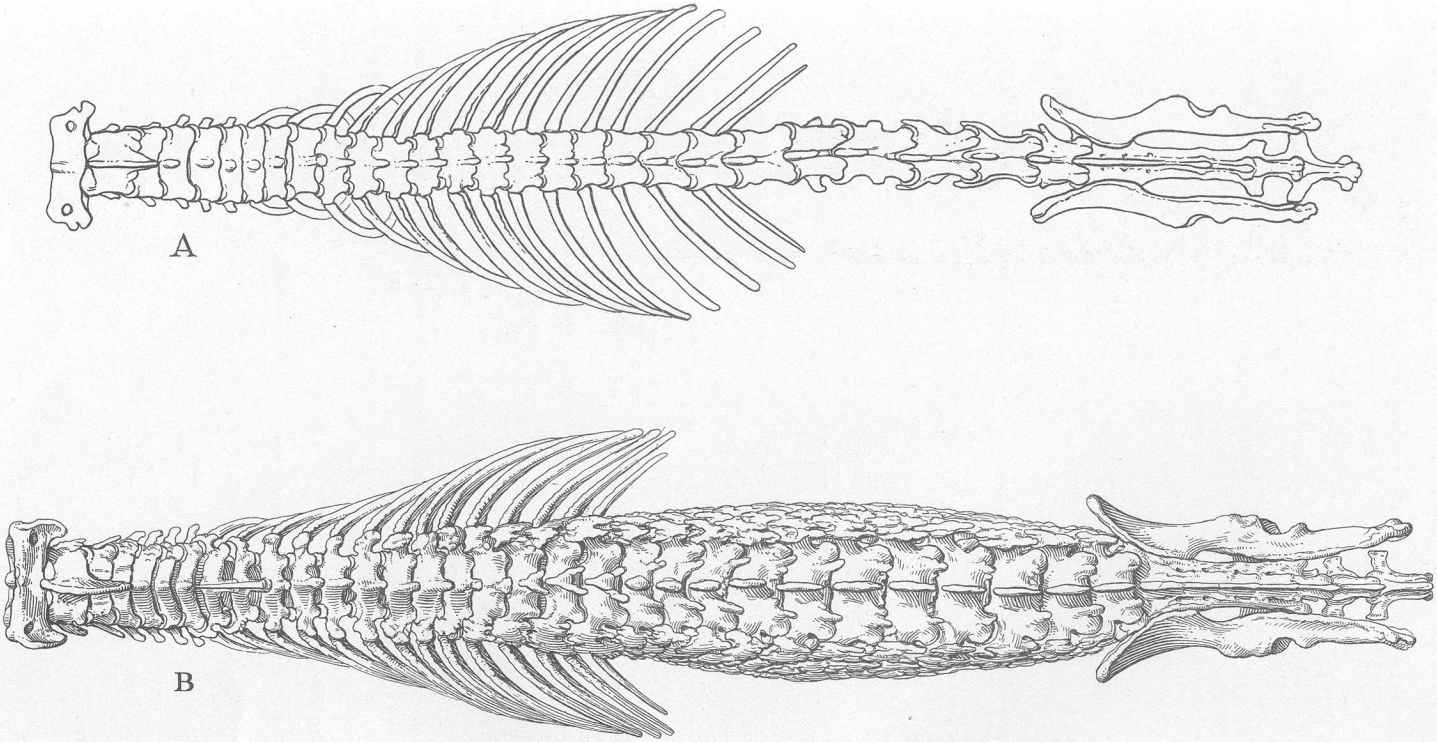


Fig. 5. Vertebral columns, dorsal view; *A*, *Crocidura nyansæ kivu*, *B*, *Scutisorex congicus*. Same specimens as skulls (Figs. 1–3). $\frac{2}{1}$.

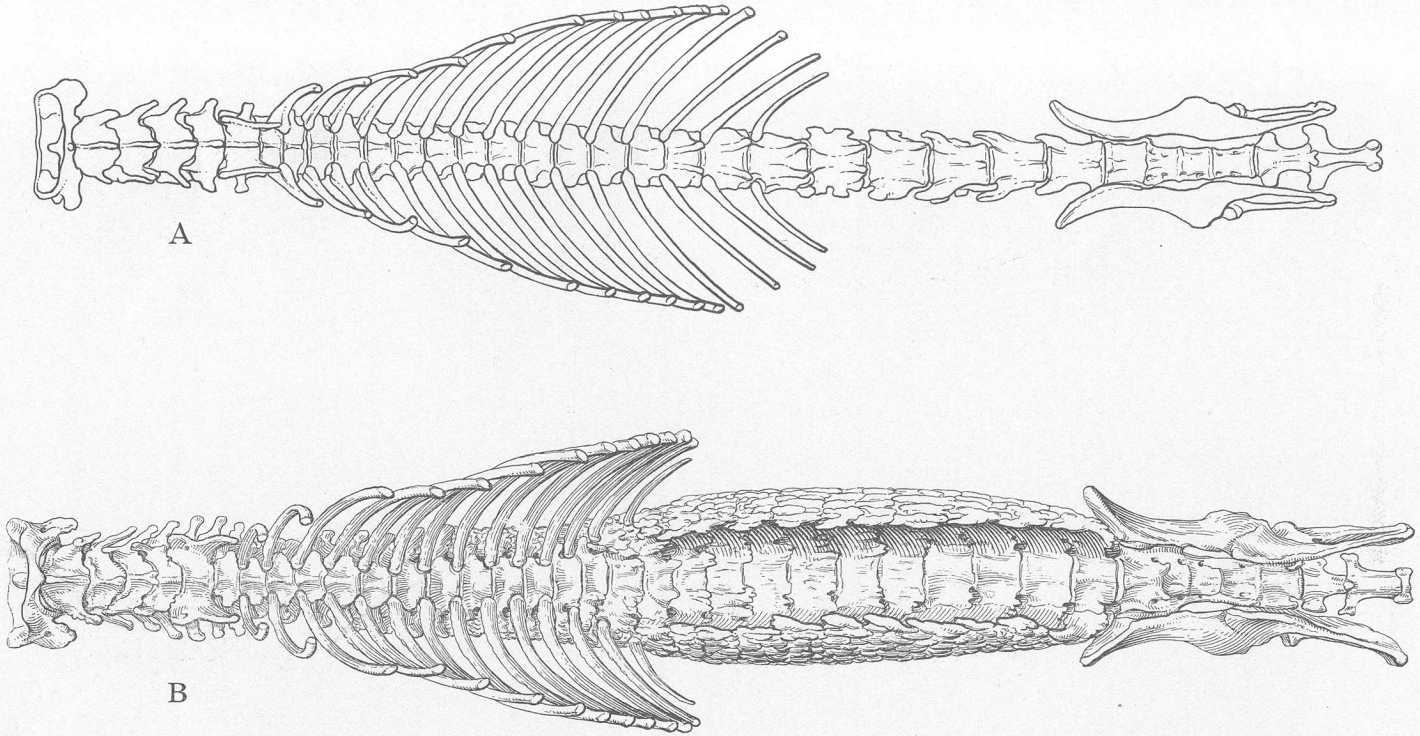


Fig. 6. Vertebral columns, ventral view, of (*A*) *Crocidura* and (*B*) *Scutisorex*. Same specimens as Fig. 5. $\frac{2}{1}$.

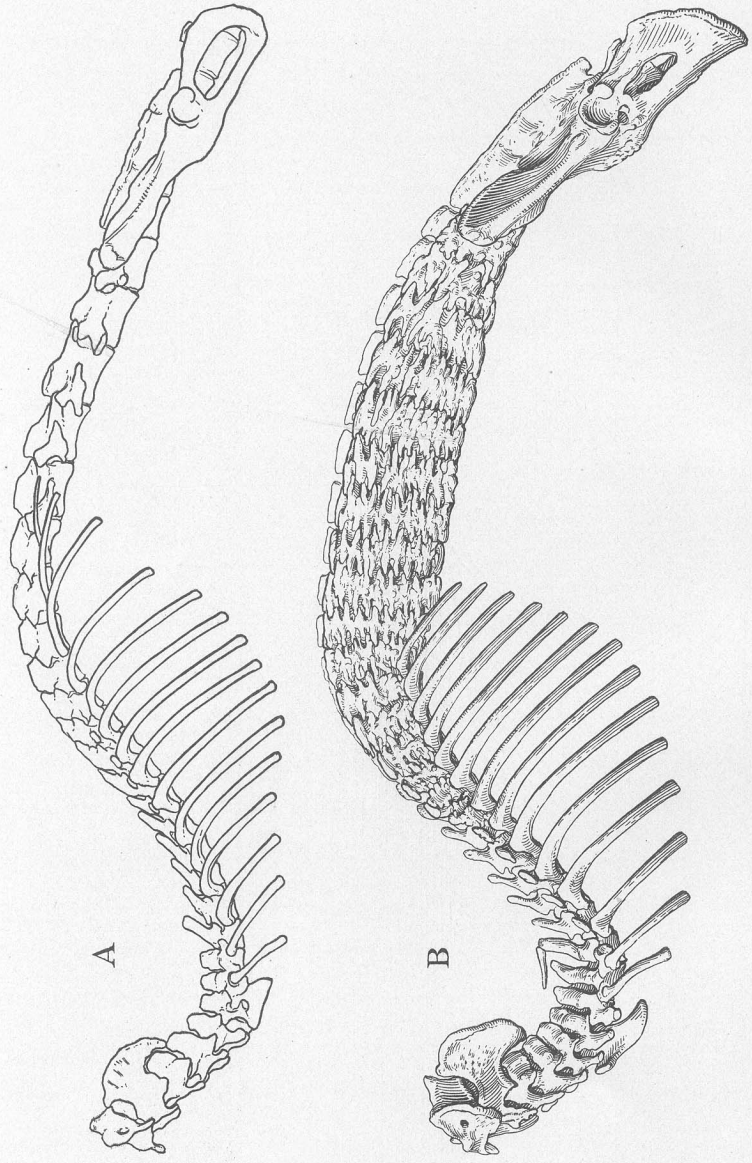


Fig. 7. Vertebral columns, lateral view, of (*A*) *Crocidura* and (*B*) *Scalisorex*. Same specimens as Figs. 5 and 6. $\frac{2}{1}$.

vertebral segment. On the 12th, 13th, and 14th, it is forked or v-shaped at the caudal end.

In the lumbar series the spinous process of the 1st is a low oval knob; on the rest of the series it is strongly developed as a subquadrate vertical lamina, the superior border straight, so that the series forms a low, nearly even median crest, with a slight vacuity between the processes at the junctions of the vertebral segments. The small accessory spines, or 'anapophyses,' described above as appearing on the last three dorsals, continue on

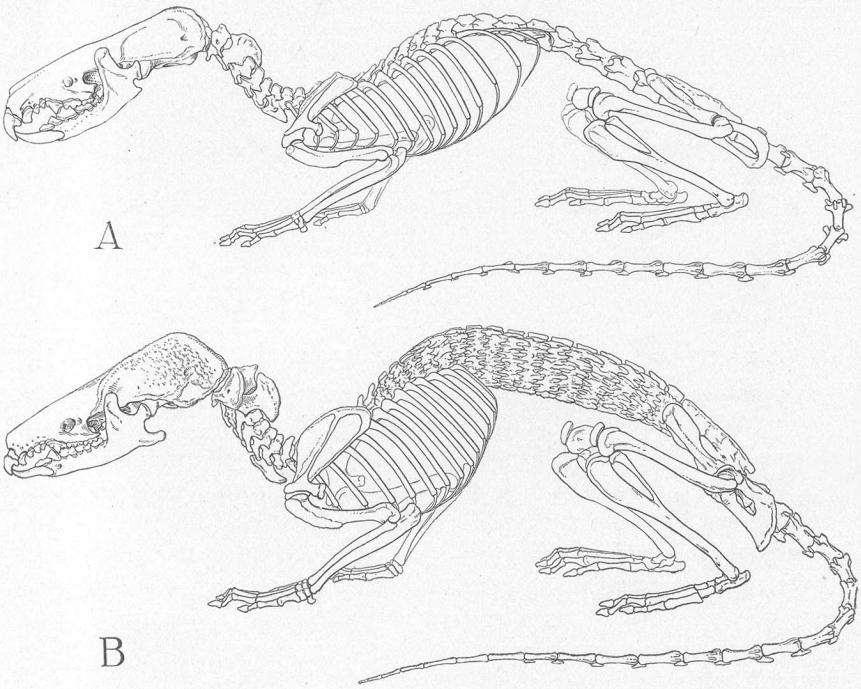


Fig. 8. Skeletons of (*A*) *Crocidura nyansæ kivu* and (*B*) *Scutisorex congicus*. Same specimens as Figs. 5–7. $\frac{1}{1}$.

either side of the spinous processes as low spicules directed horizontally backward, and slightly overlap the front border of the succeeding vertebra. From about the 5th or 6th of the series they tend, at the posterior end, to become double, through the development of a smaller spine external to the main 'anapophysis.'

The anterior articular facets are broadly expanded and cup-shaped, for the reception of the convex posterior articular facets of the preceding vertebra. The lateral edge of the anterior zygapophysis is vertically ex-

tended, its dorsal face expanded, forked in front and posteriorly prolonged into a long spine which interlocks with the fork on the front border of the anterior zygapophysis of the succeeding vertebra.

Rudimentary 'anapophyses' begin, as stated above, at about the 12th dorsal and become fully developed on the 1st lumbar, continuing thence posteriorly on each vertebra to the end of the lumbar series. They arise from the posterior half of the lamina midway between the neural spines and the posterior zygapophyses, and extend backward from the posterior third of the vertebra nearly to the base of the 'anapophysis' of the succeeding vertebra.

The ventral face of the anterior seven centra of the dorsals is convex and distinctly keeled, rather sharply so on the first three of the series, the keel flattening and the surface becoming more evenly convex posteriorly and quite flat on the last six; the last three have a low ridge, axially directed, on each side of the median line.

In the lumbar vertebræ the ventral face is transversely and deeply concave, the median third of each centrum flat or slightly concave, the lateral borders greatly thickened at base and narrowing apically to a high crest, the whole mass appearing on the outer surface as a complex of interlocking horizontal spines through excessive specialization, as shown in Figs. 4–7. Three horizontally directed spines arise from near the posterolateral border of each side of the centrum and overlap the frontolateral border of the next, upon which they are closely imbricated. They are apparently *sui generis*, without homologues. Functionally they appear to represent the anapophysis of the dorsal side of the neural arch of the same vertebræ, but instead of the single spine of the dorsal face, they form groups of two or three, and occasionally four.[1] The extreme crest of the lateral border, as seen from below, consists, for each vertebra, of a horizontal three-pointed spine, its anterior termination forming a single point, the posterior two nearly equal points, interlocking with the single point of the preceding vertebra.

The transverse processes of the dorsal and lumbar vertebræ are heavily developed and of normal form (nearly obsolete throughout both series in *Crocidura*) as far as the 7th dorsal; a change begins at the 8th dorsal, which, with the 9th, has the transverse process shortened and transversely thickened; the broadening is increased from the 10th dorsal thence to the posterior lumbar, gradually narrowing to about 5 mm. at the 11th (the last) lumbar. At the anterior end of this tract the spines are thickly massed without

[1] The number is variable in different individuals, on different vertebræ of the same skeleton, and even on the two sides of the same vertebra, ranging in number from 1 to 4.

definite order, and their points are directed more or less outward. As the tract they occupy attains greater width they are arranged approximately in axial rows, varying in number at different points from five to seven. Those of each vertebra (as seen from the articular faces of disarticulated vertebræ) form two vertical rows of spines, an outer and an inner, which coalesce at the middle; those arising from the anterior border of the pedicle wall point forward, those on the posterior border backward; in this way the spines of each of two adjoining vertebræ so closely interlock that at the point of junction the spines conceal the less superficial portions of the vertebræ and also the vertebral articulations. (See Figs. 4–7.)

Sacral Vertebræ.— The spinous processes are fused as usual into a continuous lamina. The 'anapophyses' are rudimentary, and tend to form a slight low ridge at the base of the spinous process. In other respects they resemble the sacrals in *Crocidura*.

The Taxonomic Status of Scutisorex.

While the external and cranial characters of *Scutisorex* sufficiently indicate the propriety of its generic separation from *Crocidura* and *Sylvisorex*, the extreme specialization of the vertebral column, as shown above, should apparently be further emphasized, and it is here proposed to raise the *Scutisorex* group to the rank of a subfamily of the Soricidæ, under the name **Scutisoricinæ**.

Field Notes on Scutisorex.

The following field notes on *Scutisorex* are kindly furnished by Herbert Lang, leader of the American Museum of Natural History Congo Expedition, and furnish interesting proof of the great strength of the vertebral column.

"In the northern Ituri forest the 'hero shrew' (*Scutisorex congicus*) is the largest of the twelve species we found in this region. It can be easily recognized by its more clumsy appearance and its longer, denser pelage. Fully adult specimens measure 8.6 to 9.6 inches (218 mm. to 243 mm.) from nose to tip of tail, the latter accounting for about two-fifths of the total length. The largest individual recorded is a female.

"At present *Scutisorex congicus* is only known from two localities, Medje (2° 20′ N., 27° 30′ E.) and Bafwabaka (2° 3′ N., 27° 5′ E.), both situated near the borders of the tropical rain-forest and only about 30 miles distant one from the other. We never succeeded in securing speci-

mens anywhere northward, though on inquiry we found, by the stories about the strength of its vertebral column, that the people as far as 100 miles northward knew the animal.

"The natives of these regions, especially the Mangbetu, who are well acquainted with this shrew, first called our attention to its abnormally strengthened back-bone by their performances upon captive specimens. These people feel convinced that its charred body or even its heart, when prepared by their medicine-men, transmit truly invincible qualities, if worn as a talisman or taken like a medicine. Perhaps this mystic reputation has often contributed to make of a brave man a real hero, wherefore the Mangbetu gave it a name meaning 'hero shrew.' Those engaging in warfare or setting out upon an equally dangerous enterprise such as hunting elephants are anxious to carry along even a fraction of the ashes of this shrew. Though only worn somewhere about their body, they believe that neither spears nor arrows, nor any kind of an attack can seriously injure them, much less bear them down. One can easily imagine that by the removal of the inhibitory influence of fear their courage, cunning and cleverness are set free for the best possible achievements.

"Whenever they have a chance they take great delight in showing to the easily fascinated crowd its extraordinary resistance to weight and pressure. After the usual hubbub of various invocations, a full-grown man weighing some 160 pounds steps barefooted upon the shrew. Steadily trying to balance himself upon one leg, he continues to vociferate several minutes. The poor creature seems certainly to be doomed. But as soon as his tormentor jumps off, the shrew after a few shivering movements tries to escape, none the worse for this mad experience and apparently in no need of the wild applause and exhortations of the throng.

"During this demonstration the head is always left free. The strength of the vertebral column, together with the strong convex curve behind the shoulder (Text Fig. 8, B), evidently protects the heart and other viscera from being crushed and this is undoubtedly the reason why this shrew can submit to such rough treatment that instantly kills, as we have convinced ourselves, any other shrew or small rodent."

"We found most stomachs to be empty, but a few contained portions of various adult insects, caterpillars and also earthworms; meat, skins and terminal phalanges of tiny frogs were recognized. This diet is practically the same as that of its closer relatives and contains only creatures easily killed by a shrew of its size and fairly abundant all over the floor of these tropical rain-forests. Its feeding-habits therefore offer no explanation of the usefulness or necessity of its enormously strengthened vertebral column.

In spite of the curious structural condition of its vertebral column,

Scutisorex congicus can bend its back dorso-ventrally and laterally much more than any one would expect from the study of the skeletonized vertebral column that appears completely rigid. The much broadened, closely and laterally serrated articulations together with the interlocking action of the 'anapophyses' of course exclude rotation, but such a restriction is not apparent in the live specimen. In fact in their native haunts *Scutisorex congicus* and *Crocidura nyansæ kivu* in respect to the possibility of movements show hardly any differences for which the more sluggish temper of the former could not easily account.

"*Scutisorex congicus* is to a very great extent diurnal. Many specimens have been caught during the daytime, a few even at noon in bright sunlight when crossing pathways. Others have been trapped during the night, attracted by the bodies of winged termites that were used as bait.

"Being extremely shy it can seldom be discovered in its native haunts. Indeed the leafstrewn ground of the chaotic, luxuriant maze of the sombre undergrowth to such a small animal offers manifold and easy opportunities to elude an intruding observer. Captured specimens, set at liberty on the open ground, scurry along rapidly, usually making for the darkest spot in sight. Yet they go about in a more deliberate manner and do not rely upon the effectiveness of short and sudden dashes by which so many of the smaller mammals try to escape.

"One let loose in the early morning would busily lick off dewdrops from the margin of the leaves. But whenever it came to small tufts of grass, it would press down the blades with the fore limbs starting near the base until it could easily reach the glittering drops that had gathered at the tips.

"In watching them, it soon becomes clear that scent prevails over sight. The deeply grooved nose is moved in every direction, and continually quivering, it explores actively the objects in view. The under side of leaves and even stones are thus inspected. Fair-sized pebbles, pieces of bark and decayed wood are turned over or pulled away with the assistance of the incisors. When looking for insects or worms they squat resting the sole of the hind foot on the ground. Though their fatal, unyielding grab between the sharp row of teeth quickly finishes their prey, they never show the aggressive boldness of other related species. Neither are their attacks distinguished by the nervous display of rapid, jerking movements that help so many insectivores not only to overawe instantly their quarry but also to protect themselves from any possible defensive attack.

"Its more sluggish temper was especially apparent when in a cage together with other species of shrews. Though they might annoy it, it never killed any of them as *Crocidura nyansæ kivu* invariably did."— HERBERT LANG.

In the following paper (Art. XXIX) Dr. H. von W. Schulte considers the specialization of the dorso-lumbar series of vertebræ in *Scutisorex* from the morphogenetic side, and also the relation of the spicules to the enclosing ligamentous tissue based on studies made by him of a somewhat mutilated wet specimen. The skiagraphs (Plates LXXXIX and XC), giving comparative views of *Scutisorex congicus* and *Crocidura turba nilotica*, were taken for him during these investigations by Dr. Archibald Evans, of New York; for the opportunity to reproduce them here I am indebted to the greatly appreciated courtesy of Dr. Schulte.

The excellent text illustrations are mainly the work of Mr. Erwin S. Christman, under the superintendence of Mr. Herbert Lang in my behalf. Mr. Lang's work in the Belgian Congo made possible the preparation of this paper, and the following one by Dr. Schulte, on a unique and previously unknown specialization of the vertebral column in mammals.

The text illustrations and measurements of *Scutisorex congicus* are based on specimen No. 51311, an adult from Medje, except the figures of the separate vertebræ which are from No. 48452, a disarticulated vertebral column from a specimen taken at Bafwabaka. The skeleton of *Crocidura* used for comparison with *Scutisorex* is No. 48490, a male *C. nyanzæ kivu*, from Medje.

EXPLANATION OF PLATES.

Plate LXXXIX.

Skiagraphs of skeletons of (*A*) *Scutisorex congicus* (Thomas) (No. 48489, ♂, Medje, Aug. 13, 1910), and (*B*) *Crocidura turba nilotica* Heller (No. 48578, ♂, Faradje, Feb. 20, 1912). Dorsal views. $\frac{1}{1}$. Courtesy of Dr. H. von W. Schulte. $\frac{1}{1}$.

Plate XC.

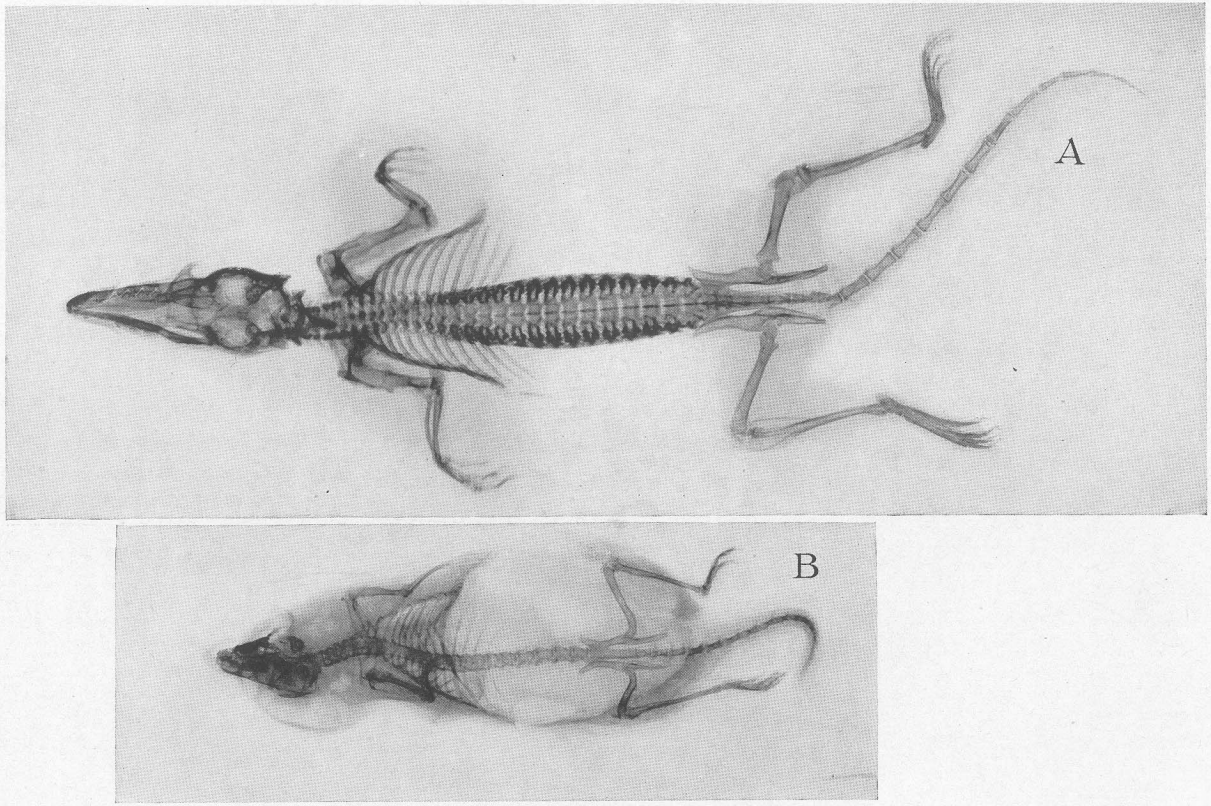
Skiagraphs of skeletons of (*A*) *Scutisorex congicus* and (*B*) *Crocidura turba nilotica*. Same specimens as in Plate LXXXIX. Lateral views. $\frac{1}{1}$. Courtesy of Dr. H. von W. Schulte.

Plate XCI.

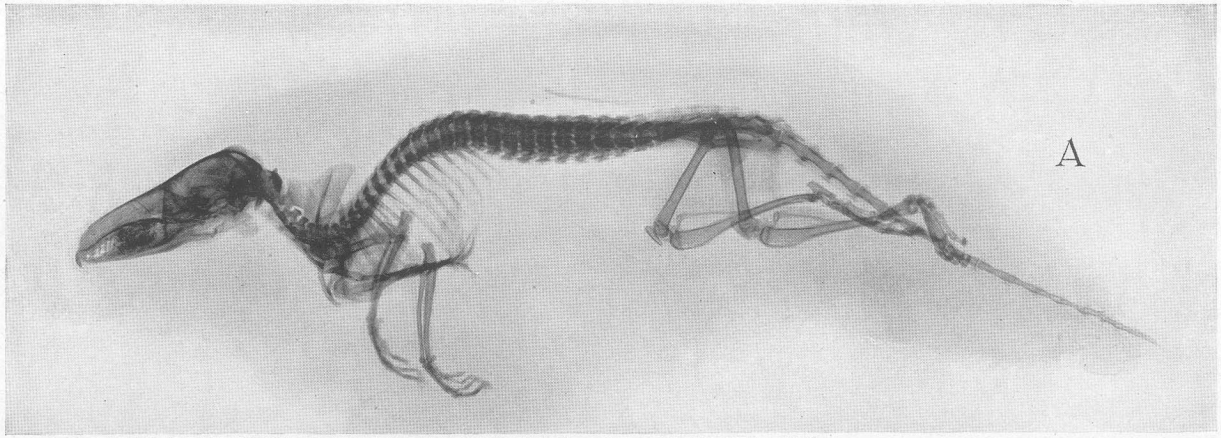
Scutisorex congicus (No. 48475, ♂, Medje, May 30, 1914), lateral view. $\frac{1}{1}$. From photograph of specimen in the flesh, by Herbert Lang.

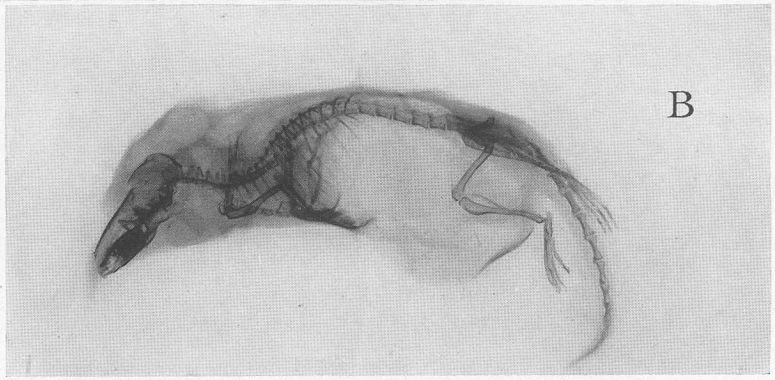
Plate XCII.

Crocidura nyansæ kivu (No. 48501, ♂, Medje, June 13, 1914), lateral view. $\frac{1}{1}$ From photograph of specimen in the flesh, by Herbert Lang.

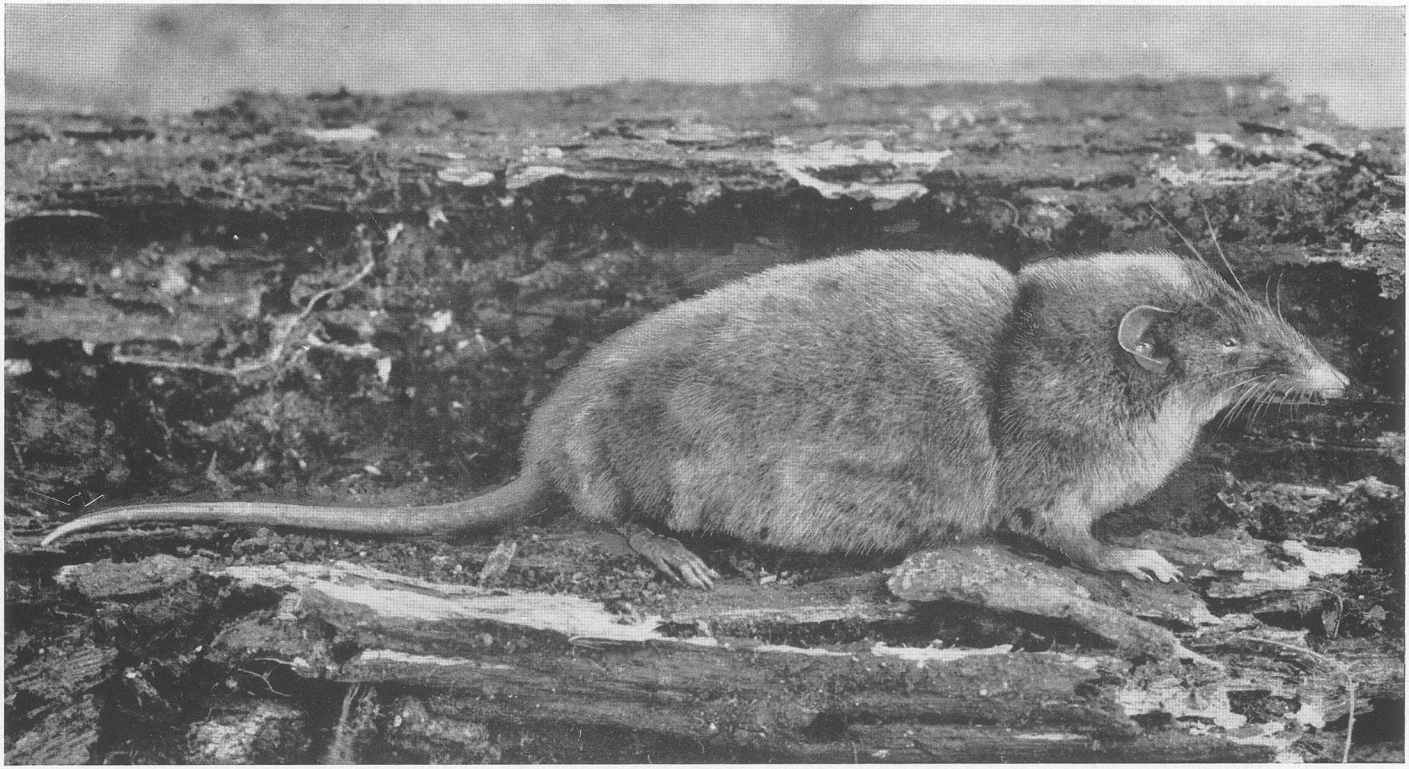


A, Scutisorex congicus; *B*, Crocidura turba nilotica. $\frac{1}{1}$.

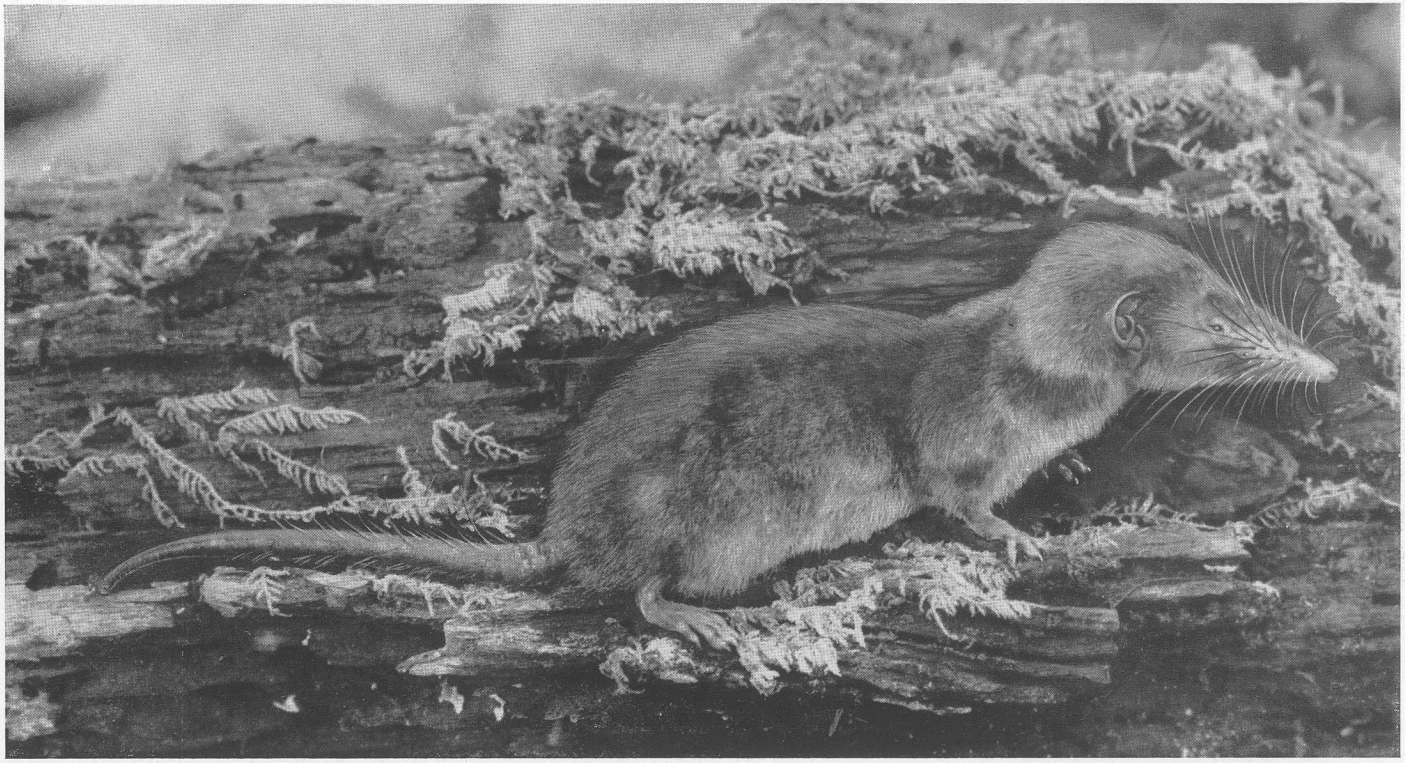




A, Scutisorex congicus; *B*, Crocidura turba nilotica. $\frac{1}{1}$.



Scutisorex congicus. $\frac{1}{1}$.



Crocidura nyansæ kivu. $\frac{1}{1}$.