

BIONOMICS AND SOME ANATOMICAL PECULIARITIES OF THE LIMBLESS LIZARD *BARKUDIA INSULARIS* ANNANDALE

By P. N. GANAPATI, M.A., D.Sc., and K. RAJYALAKSHMI, M.Sc.,
Department of Zoology, Andhra University, Waltair

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INTRODUCTION

Degeneration of the limbs is of widespread occurrence in some families of lizards such as the Scincidae, the Dibamidae and the Anguidae. Of these, the two families Scincidae and the Anguidae are represented in India while the distribution of Dibamidae extends from the southern Indo-China and the Philippines to the New Guinea Archipelago. The reduction of the limbs is accompanied by an elongation of the body with a corresponding increase in the number of body vertebrae. In India, three genera of limbless lizards have been reported, namely, *Nessia* Gray and *Barkudia* Annandale belonging to the family Scincidae and a third genus, *Ophisaurus* Daudin of the family Anguidae. Six species of *Nessia* have been recorded, differing from one another in the varying degree of reduction of the limbs, the most degenerate being *Nessia layardi* (Kelaart) in which the limbs are completely absent, the hind ones being represented by a pair of minute horny tubercles hidden by scales in a depression of the body on either side of the vent. In *Ophisaurus gracilis* (Gray) and *O. harti* Boulenger there are no external vestiges of the limbs.

The genus and the only species *Barkudia insularis* was described by Annandale¹ based on a single specimen which he dug out from loose earth from the root of a banyan tree on Barkuda Island in the Chilka lake. A second specimen was seen by Dr. F. H. Gravely in the same locality, in 1919, rapidly burrowing into the earth. The only specimen collected by Dr. Annandale has since been reported lost from the Indian Museum during the floods at Banaras². One of us recorded

¹ Annandale, N., *Rec. Indian Mus.* XIII, pp. 17-21 (1917).

² Personal communication to the senior author from the Director, Zoological Survey of India.

the occurrence¹ of a limbless lizard belonging to the genus *Barkudia* Annandale in the Andhra University campus. The first specimen was collected in July, 1949 and since then several specimens have been collected and an intensive study made of the bionomics and anatomy of this form. On a comparison of the local form with the description given by Annandale for the type species *B. insularis*, some minor differences are noticed but these do not appear to be of sufficient taxonomic value to warrant describing the present form as a new species of the genus. Unfortunately, the specimen collected by Annandale has since been lost and, as such, any comparison has to be made only with the description. We are, therefore, referring the local form as *Barkudia insularis* Annandale. A specimen of the lizard has been deposited in the Zoological Survey of India, Calcutta.

The present paper is an attempt to give the bionomics of the lizard based on our observations for the past five years. A detailed account of the anatomy will be published elsewhere shortly.

We are indebted to Dr. S. L. Hora, Director, Zoological Survey of India, for kindly confirming the identification of the lizard and for valuable suggestions in preparing this paper.

HABITAT, LOCOMOTION AND OCCURRENCE

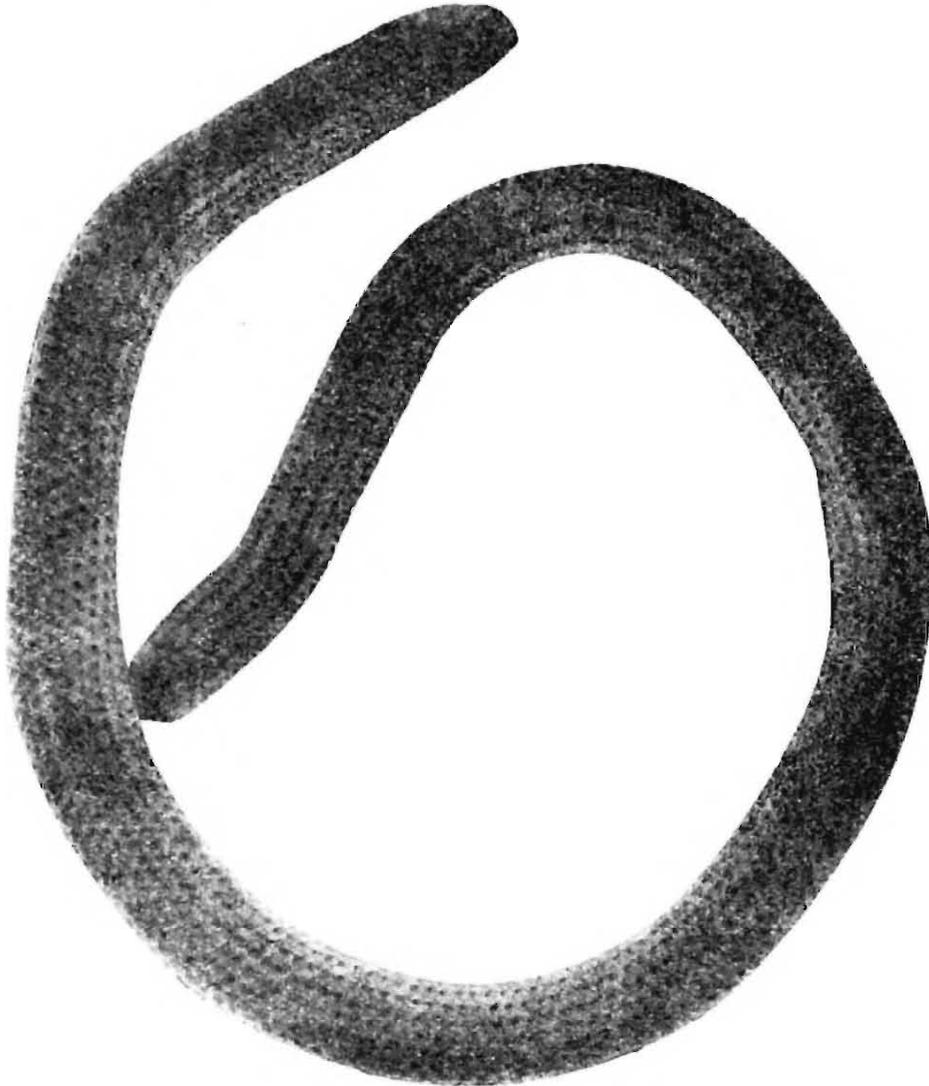
Waltair, where the University Campus is located, is a small hillock having an elevation of 157' above M. S. L. The soil is made up of loose red sand and the vegetation is mostly composed of low shrubs and cashewnut groves. *Barkudia* lives buried in the shady sub-soil amidst the cashewnut plantations, overlaid by a thick layer of decaying leaves. In the same habitat could be seen a variety of other animals like centipedes, millipedes, beetles and their larvae, termites, spiders, scorpions and the blind snake *Typhlops* sp.

The lizard has been dug out at various depths below the surface. They may be found a few inches below ground to a depth of a foot or more. We have never seen them above ground, at any time, in their natural habitat. They live in distinct burrows or tunnels which do not collapse in the damp soil. When the lizards were kept in damp soil inside rectangular boxes with sides made of glass, the animals readily constructed the tunnels and their movements could be observed from outside. The tunnels have a zig-zag tortuous course in response to its snake-like locomotion and the animal moves both forwards and backwards in the tunnel with the same agility. They do not seem to live permanently in any one tunnel and the tunnels are frequently made afresh with the result that the soil is always kept in a loose and well aerated condition. When the animal is dug out and released on the soil it burrows with extreme rapidity and in a few moments it disappears below ground. The animal first lifts up its head and immediately the wedge-shaped snout is struck into the soil and the body performs active undulatory movements pushing aside the loose dry surface sand on either side. Once the head and part of the body enters the soil the rest of the body

¹Ganapati, P. N. and Krishnan Nayar, K., *Current Science*, XXI, pp. 105-106 (1952).

is quickly drawn in and the animal disappears from sight, in a trice. When left on polished floor it is restless and its movements are very clumsy. It progresses by undulatory movements very much like that of a snake.

These lizards have been collected all through the year though they are seen in smaller numbers in the colder months of November, December, and January. They are also rare in the rainy months from June to October. They are fairly common in the summer months when the adult as well as juvenile forms are present.



TEXT-FIG. 1.—*Barkudia insularis* Annandale; entire.

External features.—The adult lizard (text-fig. 1) is long, slender and cylindrical with a short blunt tail. The head is dorso-ventrally flattened and narrowed anteriorly into an efficient burrowing wedge-shaped snout formed by the transversely elongated, rostral shield which projects beyond the lower jaw. The head is slightly broader than the trunk but there is no distinct neck. In a specimen measuring 22 cms. the following were the dimensions of the various regions:—

Snout-Vent Length		15.0 cms.
Tail-length		7.0 cms.
Snout-Orbit length	.	0.5 cm.
Head length	.	1.0 cm.
Mouth-orbital length	.	0.7 cm.
Inter-orbital length	.	0.5 cm.

The colour pattern has been found to vary to some extent from individual to individual. The common pattern is a glossy brown with a black spot in the middle of each scale. These spots form longitudinal rows which vary in number from 8 to 14 but ten of these rows are more conspicuous than the others. The ventral side is creamy white in colour. Towards the tail region the coloration gets more and more deep ending in a distinct uniformly dark pigmented cap over the tip of the tail. Some individuals instead of being glossy brown may be steel blue or orange brown in colour. The tip of the tail instead of being uniformly black may have a more diffuse pigmentation which increases in density gradually towards the tip. A number of individuals showing the two characteristic types of coloration of the tail were examined with a view to find out whether the difference has anything to do with the sex of the individual and it was found that both types occur in either sex. It is possible that the coloration may have something to do with the periodic shedding of the skin (Miller)¹, or it may be that there are two distinct varieties of the same species occurring locally.

The minute external narial openings are present on the dorso-lateral edges of the snout just above the rostral shield at the antero-lateral edge of distinct nasal shields.

The ear openings are also minute and are located on the dorso-lateral sides at the posterior end of the head at about the level of articulation of the lower jaw and behind the parietal shields.

The eyes are also small but quite functional. They are present on the dorso-lateral sides of the head, in between the external narial openings and the ear apertures. A well developed movable lower lid is present.

The tail is cylindrical and rounded at the tip. The relative length of the tail with the rest of the body is highly variable. In some cases the tail is nearly half as long as the body while in others it is less than a fourth the body length. As in many other lizards the tail is highly fragile and the animal is also capable of regenerating its broken tail.

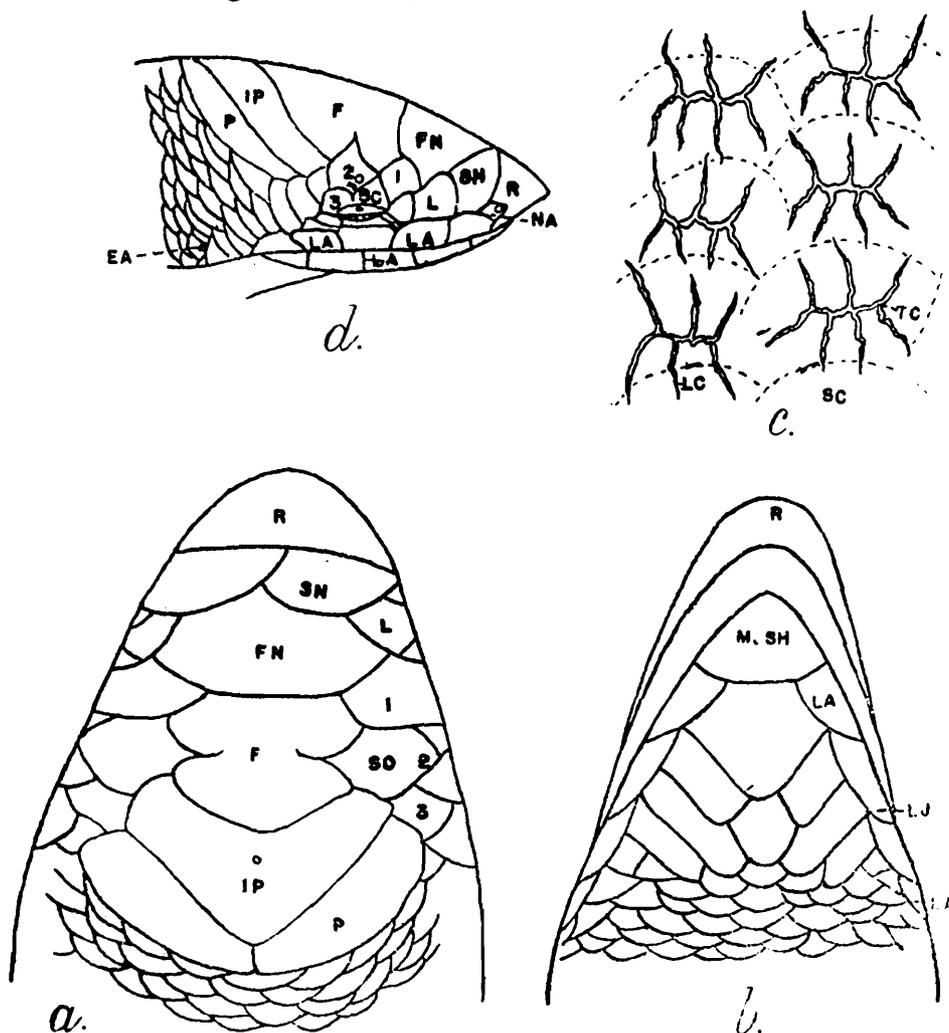
The head is covered by the shields and the body by the scales (text-fig. 2 *a, b, d*). The genus is characterised by three large azygous shields in the dorso-median side of the head and a number of smaller shields. Anteriorly is the rostral emarginate laterally to receive the nasals. The supra-nasals are large, in contact with one another behind the rostral and with the first labial. The first large azygous shield, fronto-nasal, is broader than long and larger than the frontal which follows. The middle azygous shield, frontal is longer than the fronto-nasal, strongly emarginate laterally to receive the first supraocular. The third shield, interparietal is much larger than the frontal. The parietals are narrow and obliquely placed, in contact with the fronto-nasal also. The third is small. There is a single loreal, a large single preocular, a single superciliary, a single subocular and two postoculars. The lower eyelid is composed of two or three scales while the upper eyelid is vestigial. There are four supralabials; the third largest, below the eye, and a single azygous postmental (text-fig. 2, *c*).

¹ Miller, C.R., *Ecol. monogr.* Durham N. C. XIV (3), pp. 71-289 (1944).

There are 140 scales between the postmental and the preanal scales. There are 20 to 22 scales round the middle of the trunk. The preanal scales are not enlarged.

The head is very small and consequently the gape of the mouth is small. The teeth are pleurodont, arranged in a row both along the upper and the lower jaw. They are small, conical and slightly curved. In addition to the teeth on the jaws there are also teeth on the palate. The pterygoid at its anterior end, where it meets the palatine, bears on each side a row of two or three conical teeth (text-fig. 3b) arranged in an oblique row along the flange of the bone. There are no teeth on the palatine or vomer. The new teeth arise at the base of the old ones as in Anguidae and not in the sockets of the old ones as in the Scincidae.

The tongue is long and slender and bifid at both ends. The animal shoots out the tongue at frequent intervals.



TEXT-FIG. 2.—*Barkudia insularis* Annandale.

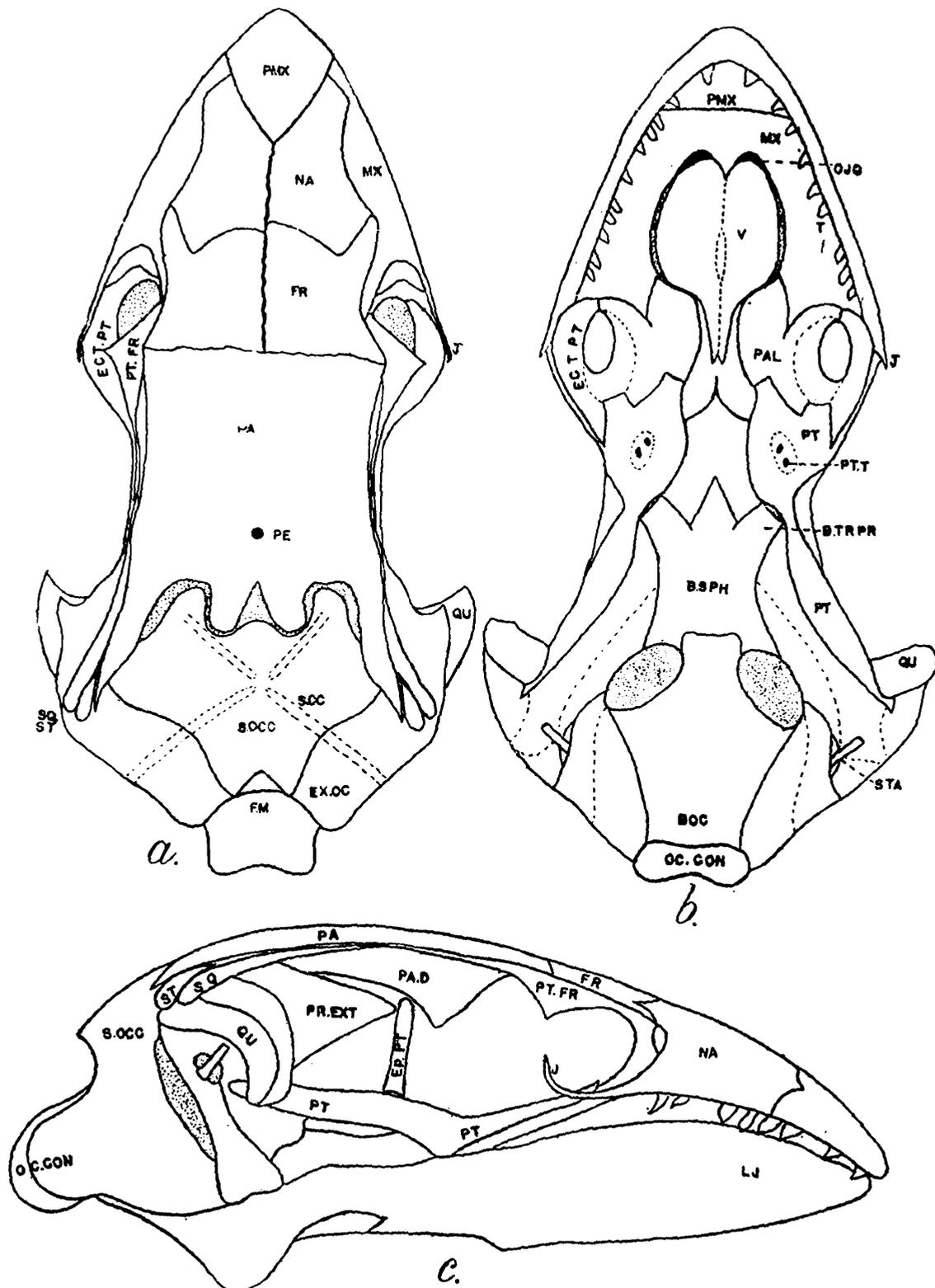
a. Dorsal view of head showing the arrangement of shields; b. Lateral view of head; c. Ventral view of head; d. Microscopic structure of scales.

EA., ear aperture; F., frontal shield; FN., fronto-nasal shield; IP., interparietal shield; L, loreal shield; LA., upper and lower labial shields; LC., longitudinal canal; LJ., lower jaw; M. SH., mental shield; NA., nasal shield; P., parietal shield; R, rostral; SC., scale; S.C., supraciliary; SO., supra-oculars 1, 2, and 3; SN., supranasal shield; TC., transverse canal.

FOOD AND FEEDING HABITS

Barkudia is mostly insectivorous in its diet. Examination of the gut contents of a large number of specimens has shown termites, adults

and larvae of beetles, insect's wings and appendages, centipedes, and occasionally remains of spiders and scorpions. As already mentioned in an earlier part of the paper these animals, which constitute the prey of the lizard, are found in large numbers in the natural habitat of the lizard.



TEXT-FIG. 3.—*Barkudia insularis* Annandale.

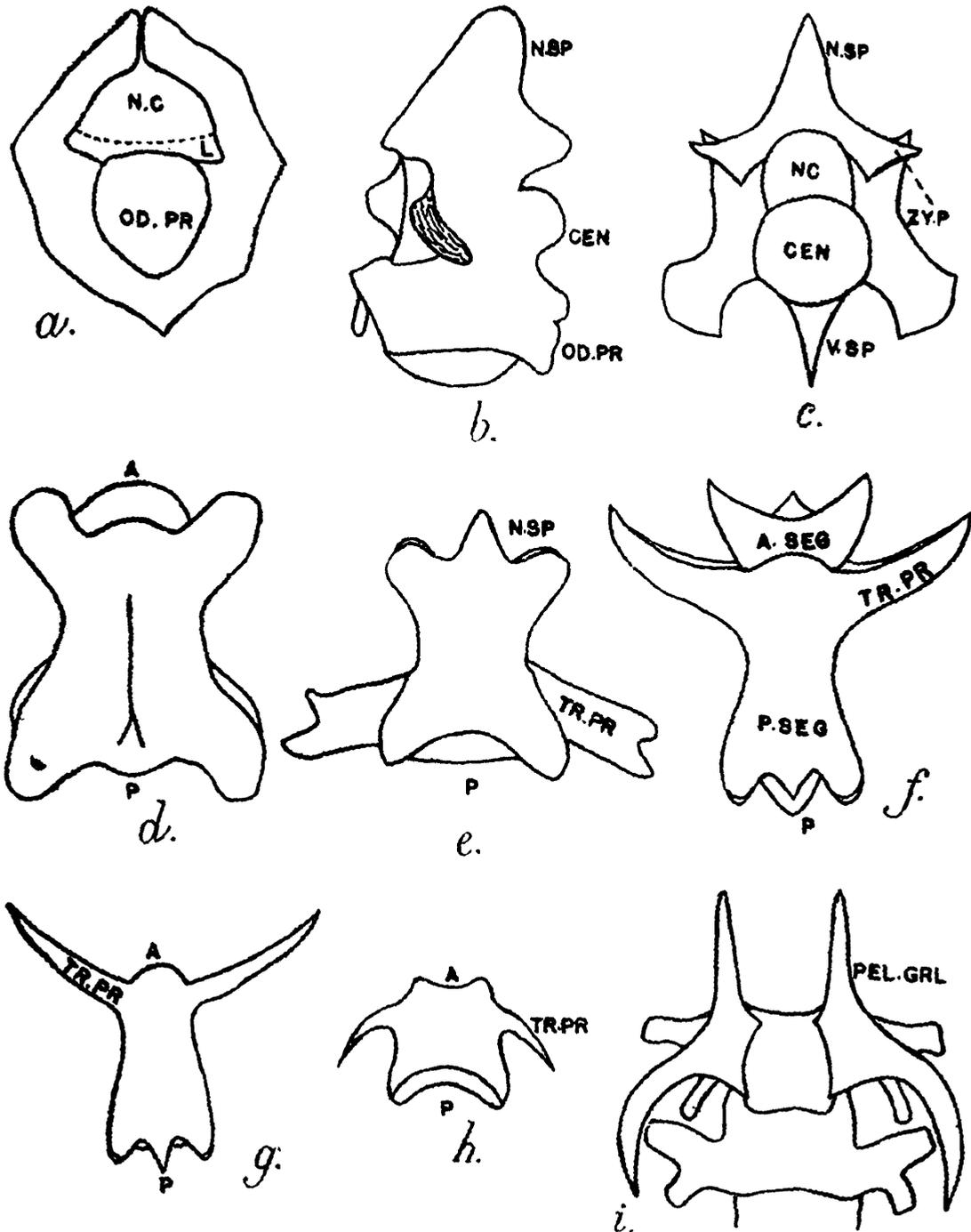
a. Dorsal view of skull; b. Ventral view of skull; c. Lateral view of skull.
 BOC., basioccipital; B. TR. PR., basitrabecular process; BSPH., basisphenoid; ECT. PT., ectopterygoid; EP. PT., epipterygoid; EX. OC. exoccipital; FR., frontal bone; F.M., foramen magnum; J., jugal; LJ., lower jaw; MX., maxilla; NA., nasal bone; OC. CON., occipital condyle; OJO., opening of the organ of Jacobson; PA., parietal bone; PE., pineal eye; PAL., palatine; PMX., premaxilla; PR. EXT., prootic extension; PT., pterygoid; PT. T., pterygoid teeth; PT., FR. post-frontal; QU., quadrate; S. CC., semicircular canals; S. OCC., supraoccipital; SQ., squamosal; ST., supratemporal; V., vomer.

We have observed the feeding habits of the lizard under laboratory conditions. A colony of termites was introduced into the terrarium where the lizards were kept. The termites soon started going in all directions and some of them burrowed into the earth. A few moments later, presumably owing to the disturbance caused, one of the *Barkudia* was seen to pop out its head, from the burrow, and to remain in that position for a while and when it noticed the presence of the termites it pushed out its head and a part of the body, waited for a few moments and with a sudden jerk it snapped the prey and immediately withdrew into the burrow. This operation was repeated several times before the lizard finally withdrew into its burrow. Apparently a small quantity of soil is also gulped in along with the prey as the stomach contents examined invariably showed an admixture of sand.

ANATOMICAL PECULIARITIES

Most of the specialisations and degeneration associated with the elongation of the body, disappearance of the limbs and assumption of a burrowing mode of life are to be found in the skeletal system. The skull is conical, tapering to a fine point anteriorly (text-fig. 3 *a, b, c*). The orbito-temporal region is specially elongated with a marked lengthening of the parietal above and the pterygoids below. The contour of the whole skull including the snout is remarkably smooth without any angles and projections, which are likely to impede a burrowing subterranean life. The frontals and the parietals have downward extensions which form the side walls of the cranium along with the well developed prootic extension. The frontal downgrowths separate the orbits in the median line. The elongation of the cranium up to the base of the nasal capsules, the absence of the lower temporal arcades and both the fossae, the extreme reduction of the temporal bones, the possession of strong membrane bones surrounding the olfactory capsules and the formation of an efficient burrowing tip by the premaxillae, maxillae, nasals and vomer are the other specialised features associated with the subterranean life of the lizard. While *Barkudia* shares the above degenerate features with other burrowing lizards, there are indications to show that in other respects degeneration has not completely set in. A superior temporal arcade formed by the meeting of the forward process of a tiny squamosal and a backward process of the post-frontal could be made out even though a fossa is not present. A very much reduced second temporal element, namely, the supratemporal is present. A well-developed but slender epipterygoid is present. The basitrabecular processes are also well developed. The line of flexion seems to be still metakinetic at the parieto-supraoccipital angle as evident by the presence of a wide gap between the two where the tendons from the body are attached. In other burrowing lizards this line has shifted either completely or to some extent to the fronto-parietal suture and the flexion is mesokinetic which is a specialised feature not seen in *Barkudia*. The hyoid apparatus is complex in *Barkudia* as in typical lizards, unlike the condition in *Anniella* where it is a simple rod which is bifurcate posteriorly with a simple branchiyl attached to the end of the branches,

The number of vertebrae is very large and the maximum number observed by us is 113 made up of 69 pre-caudals and 44 post-caudals. The vertebrae are procoelous (text-fig. 4, *a-f*). All the pre-caudals except the first three and the last three bear ribs and the caudal vertebrae have long transverse processes. All the caudal vertebrae possess complete chevrons at the posterior end of their centra. The transverse splitting of the vertebra commences from the third caudal. The split is in the anterior region (text-fig. 4, *f-h*) cutting off a small anterior segment



TEXT-FIG. 4.—*Barkudia insularis* Annandale.

a. Atlas; *b.* Axis, lateral view; *c.* A Cervical vertebra showing well-developed neural spine, ventral spine and transverse process; *d.* A typical vertebra; *e.* A sacral vertebra showing the forked transverse processes; *f.* A typical caudal vertebra showing the split in the anterior region; *g.* the posterior segment of the caudal vertebra; *h.* the anterior segment of the caudal vertebra; *i.* Sacral region showing the two halves of pelvic girdle.

A., ligament running across the atlas in its middle; N.C., neural canal; N.SP., neural spine; OD. PR., odontoid process; P., posterior end; P. SEG., posterior segment; PEL. GRL., pelvic girdle; TR. PR., Transverse process; V. SP., ventral spine; ZY.F., Zygapophyses.

and a large posterior segment. The number of body as well as tail vertebrae varies.

The pectoral girdle is completely absent and not even vestiges of it are left. The corresponding blood vessels supplying the limbs and girdle are also absent. The sternum is also totally absent.

Though not even vestiges of the hind limbs are present the pelvic girdle is represented by a pair of tri-radiate bones, one on either side, attached by ligaments to the vertebra immediately next to the last rib bearing vertebra (text-fig. 4, *i*). These two bones do not meet in the mid-ventral line.

In the internal anatomy of the soft parts also there are some characteristic changes. All the internal organs show a marked elongation, as in the snakes, corresponding to the elongation of the body. The alimentary canal is more or less a straight long tube without many coils as in the normal lizards. The liver has only a single well developed long lobe with a very small secondary lobe. The main lobe extends for a little distance behind the heart to the posterior end of the stomach.

There are two lungs, both functional, but asymmetrical in conformity with the elongated snake-like body. The right lung is very much elongated while the left is smaller and about half the length of the right one. The trachea is also very long:

In the circulatory system there are a few special features. The heart is shifted far backwards but it has the normal saurian structure. Consequent on the absence of the anterior limbs and girdles no trace of the blood vessels supplying these organs are seen. It is remarkable that there are many more than the normal number of arteries supplying the alimentary canal. There are as many as five or six branches of the dorsal aorta supplying the oesophagus, two gastrics, an anterior mesenteric and a posterior coeliaco-mesenteric. The two iliacs run backwards and end in the vestiges of the pelvic girdle.

In the nervous system the brain has a normal lacertilian structure but there are a few peculiarities connected with the sense organs. The external narial openings are very minute which prevent sand particles and other foreign bodies entering the nasal organs when the animal burrows. The Jacobson's organs are well developed and according to Pratt¹ this is associated with the ground living existence. It is more or less spherical lying beneath and lateral to the junction of the anterior and the olfactory chambers of the nasal organ. Posteriorly it opens by a slit-like aperture into the buccal cavity. The walls of the organ are much crenated. The choanal tube connecting the nasal sac with the pharynx is drawn out into a ductus naso-pharyngeus as in other burrowing lizards.

The eyes though very minute in size have a normal structure and are not in any way degenerate. There is no trace of the upper eyelid while the lower lid is well developed and movable. In some of the sections of the eye we have observed a vascular tissue extending from the

¹ Pratt, C. W. M., *Proc. zool. Soc. Lond. CXVIII*, pp. 171-201 (1948).

retina through the vitreous chamber to the base of the lens which corresponds to the pecten in lizards. The presence of a pecten has not been reported in any of the other burrowing lizards.

A tympanic membrane hidden by muscles is present below the external ear apertures. The middle ear has a normal structure with the columella auris and the internal ear has the semicircular canals and the calcareous otolith.

BREEDING HABITS

In the male the external genitalia consists of a pair of tubular hemipenis which, when withdrawn, are directed backwards and lie parallel to the vertebral column on the postero-lateral sides of the cloacal chamber.

We have not yet succeeded in getting the eggs of the lizard despite intensive search for them for the past five years. In one of the terraria where a female was kept in captivity an oblong egg measuring nearly 15mm. in length was collected. The egg was pure white covered by a leathery shell membrane. On opening the egg was found to be in a damaged condition. The lizard was dissected and a second egg similar to the one described above removed from the left oviduct. This also did not contain the embryo and apparently was unfertilised. Though large numbers of the lizard have been dissected we have not so far any evidence to show the existence of viviparity in the present form as has been reported in some of the Scincidae. The smallest specimens examined by us were about 12cms. in length and were very active like the adults. We are inclined to believe that *Barkudia*, like many other Scincidae, is oviparous. The search for the eggs from the natural habitat of the lizard is being continued.

DISCUSSION

It is interesting to compare the limbless burrowing *Barkudia* with similar lizards reported from other parts of the world. Excellent accounts are available of the African burrowing skink *Acontias meleagris* (Brock)¹, of the American limbless lizard *Anniella* (Coe and Kunkel²; Bellairs³; Miller⁴, and the Amphisbaenids of Africa and South America (Zangerl⁵; Bellairs⁶). Besides the above, brief scattered reports of other burrowing lizards are also available.

From Brock's account of the skull of *Acontias meleagris* many of the features described for the form seem similar to those of *Barkudia*. The prootic bone has a prootic extension which forms part of the side wall in the orbito-temporal region. A large epipterygoid widely separated from the quadrate is present. The features in which it differs

¹ Brock, G. T., *J. Linn. Soc. (Zool.)* XLI, pp. 71-88 (1941).

² Coe, W. R. and Kunkel, B. W., *Trans. Conn. Acad.*, XII, pp. 349-403 (1906).

³ Bellairs, A., *Proc. Zool. Soc. Lond.* CXIX, pp. 73-83 (1950).

⁴ Miller, C.R., *Ecol. monogr.* Durham N.C., XIV (3), pp. 71-289 (1944).

⁵ Zangerl, R., *Amer. Midland Nat.*, Notredame, XXXI (3), pp. 417-454 (1944) *Amer. Midland Nat.*, Notredame, XXXIII (3), pp. 764-780 (1945).

⁶ Bellairs A., *J. Linn. Soc. (Zool.)*, XLI, pp. 482-512 (1949); *Proc. Zool. Soc. Lond.*, CXIX, pp.73-83 (1950).

from *Barkudia* are the absence of a superior temporal arcade, the palatal bones being large and scroll-like, open as a groove all along the ventral median line and the tube containing an elongation of the nasal passage with the internal nares situated at the posterior end of the palatines. The skull is mesokinetic instead of the metakinetic condition of *Barkudia*.

In *Acontias niger* (Peters)¹ and *A. plumbens* (Bellairs) the squamosal and post-orbital form a complete superior temporal arch as in *Anguis* and *Ophisaurus*. The same condition is seen in *Barkudia* except that the elements concerned in the formation are post-frontal and squamosal.

From Bellairs' account of *Nessia* a burrowing skink from Ceylon, the anatomy of the skull seems to be similar to that of *Barkudia*, *Anniella* and *Acontias*. Here too the temporal region of the skull is elongated, the fronto-parietal downgrowths are present, the temporal arches have been lost, squamosal and jugal are reduced, and the post-orbital absent.

Brock gives the characters of *Typhlosaurus auranticus* (Anelytropsidae) based on Peters' figures and says that all the features are very similar to *Acontias meleagris* except that instead of the one vestigial temporal bone in *T. auranticus*, both *Acontias* and *Barkudia* have two.

Feylinidae and Anelytropsidae also conform to the features characterising burrowing forms in that they are stated to lack temporal arcades (Boulenger²; Cope³; Camp⁴). The epipterygoid and basitrabecular processes are well-developed (Bellairs), as in *Barkudia*, *Anniella* and *Acontias*. In *Feylinia* the parieto-occipital angle does not seem to be much reduced as is the case in *Barkudia*.

The various accounts on *Anniella* (Bellairs, Coe and Kunkel⁵; Miller, confirm the similarity of features of this form and *Barkudia*. A few in which it differs are that the posterior margin of the parietal is unusual in possessing a triangular median process which projects backward over the processus ascendens. Bellairs states "It seems likely that in *Anniella* the transference from the primitive metakinetic condition to the mesokinetic state has largely taken place" There is no superior temporal arcade in *Anniella*.

Anguis fragilis (Anguidae) according to Bellairs serves to illustrate an early stage in burrowing adaptation. Here there are frontal downgrowths, a feature not restricted to burrowing forms alone. Parietal downgrowths, the presence of which is associated with burrowing existence, are absent in *Anguis*. Moreover the skull shows metakinetic line of flexion as in *Barkudia*.

A comparison of *Barkudia* to Amphisbaenidae reveals a few interesting points. The general morphology of the skull is similar, and in *Amphisbaena vilacea*, Brock states that "it is even more slender and

¹ Peters, W.C.H., *Naturwissenschaftliche Reise nach Mossambique. Zoolog'e Amphibien*. G. Reimer, Berlin (1882).

² Boulenger, G. A., *Catalogue of the lizards in the British Museum (Natural History)* (1887).

³ Cope, E. D., *Ann. Rept. U. S. Nation. Mus.* (1889), pp. 151-1294 (1900).

⁴ Camp, C. L., *Bull. Amer. Mus. Nat. Hist.* XLVIII, pp. 289-482 (1923).

⁵ Coe, U. R. and Kunkel, B. W., *Amer. Nat.* XXXVII, pp. 487-490 (1904), *Anal. Anz.*, XXVI, pp. 219-222 (1905).

lacking in angles and projections calculated to impede a subterranean existence. The downgrowths of parietals and frontals have formed a solid cranial box extending to the skull floor and entirely obliterating the inter-orbital septum. There is no trace of an epipterygoid nor of any temporal arcade bones. The lower jaw is foreshortened and the quadrate relatively lengthened which has the effect of lessening the gape of the jaws in a manner one might expect to be favourable to a burrowing mode of life" Versluys¹ pointed out that Amphisbaenidae possessed mesokinetic skulls. He also reports that a basitrabecular process is lacking in *Amphisbaena*. According to Bellairs Amphisbaenidae 'presents a combination of highly adaptive features with certain others, less obviously adaptive'. From Zangerl's account, it is clear that vestigial sternum and shoulder girdle elements are present in all genera of Amphisbaenidae. The pelvis and hind limbs are highly vestigial. In his words 'the numerically varying position of the cloacal region in different Amphisbaenidae and the variable qualitative and quantitative development of the ribs transverse and ventral processes at the end of the cloacal series suggest a phylogenetic displacement of this region towards the tail' The eyes are reduced in varying degrees.

Brock referring to Peters' account of the burrowing snakes *Typhlops* and *Glauconia* finds a close similarity between the skull of *Glauconia* and *Amphisbaena*. She, moreover, states that 'the typical ophidian skull has a very unique appearance, but its peculiarities are all modifications to provide the wide gape of the specialised snake. When we discount these modifications we find that the remaining ophidian characters are those described for *Glauconia*, features which are all associated with a subterranean existence'.

She further adds that "In this comparative study of *Acontias* with other burrowing lizards and snakes, I have detected no features in skull structures which differentiate the Ophidia from the Lacertileae. The burrowing lizards and burrowing snakes form an intermediate series which completely bridge the gap between the typical lizards and the specialized snakes"

SUMMARY

The paper deals with the bionomics and some aspects of the anatomy of a limbless lizard, *Barkudia insularis* Annandale occurring in the University Campus, Waltair.

The lizard is an efficient burrower and lives in underground tunnels. It is mainly insectivorous in diet. Its food and feeding habits are briefly described. The eyes are normal and functional, unlike the degenerate condition found in some of the Amphisbaenidae. Minute external ear openings are present. The internal organisation shows the usual asymmetrical condition in some of the organ systems, such as the lungs, liver, etc. which is associated with the elongation of the body and the assumption of a snake-like condition. In the blood vascular system there is no trace of the vessels supplying the anterior limbs and the pectoral girdle, in conformity with the total absence of the pectoral

¹ Versluys, *Zool. Jahrb. Suppl.* XV (2), pp. 545-716(1912).

girdle and the anterior limbs. The iliacs are represented supplying the vestiges of the pelvic girdle.

In the skull the important specialised features are the elongation of the cranium up to the base of the nasal capsules, the absence of the lower temporal arcades and their fossae, the presence of the downgrowths of frontals and parietals which along with the prootic extension form a side wall to the cranium, the presence of strong membrane bones surrounding the olfactory capsules and the formation of an efficient burrowing tip by the premaxillae, maxillae, nasals and vomer.

The pectoral girdle and the anterior limbs are totally absent while the pelvic girdle is represented by vestiges.

The anatomical peculiarities of *Barkudia insularis* are compared with those of other burrowing lizards recorded from other parts of the world and a general discussion made about the evolutionary trend of these limbless lizards in the light of our present knowledge of the subject.