

May 29, 1906.

FREDERICK GILLETT, Esq., Vice-President, in the Chair.

Mr. R. H. Burne, F.Z.S., exhibited, on behalf of Prof. Stewart, some dissections prepared for the Museum of the Royal College of Surgeons from material derived from the Society's Gardens. The specimens included the head of a Ki-wi (*Apteryx mantelli*) in sagittal section, showing the relatively large size of the olfactory parts of the brain and the complexity of the olfactory chamber; the head of a Crowned Crane (*Balearica regulorum*), showing the dilatable pharynx, which by its inflation when the bird crows causes a sudden distension of the gular wattle, and apparently acts as a resonating-chamber; preparations of the cheek-pouches of a Spotted Cavy (*Coelogenys paca*) and the stomach of a foetal Giraffe (*Giraffa camelopardalis antiquorum* ♂ × *G. c. wardi* ♀).

Dr. L. W. Sambon exhibited a series of diagrams illustrating the transmission of diseases by Insects and Ticks.

Prof. Robert T. Jackson exhibited a photograph of the Champey collection of eggs of the Great Auk taken before the collection was dispersed, and made remarks on specimens of the bird that had lately come under his notice. He also exhibited a long-focus lens for museum work and dissections.

The Secretary exhibited the skull of a Wild Boar that had lately been dug up during building operations in James Street, Oxford Street, W.

Mr. R. E. Holding exhibited and made remarks upon the skull and horns of a fine male so-called Wild Irish Goat. He stated that these animals existed in considerable numbers in the mountainous district of the West of Ireland, and were undoubtedly domesticated Goats which had taken to a wild life and had so become to all intents and purposes feral; that they were of wary disposition and sure-footed, and difficult to get a shot at. At times, however, during the breeding-season the males came into the lowlands to the she-goats and so were occasionally shot. The age of the specimen exhibited was probably 7 or 8 years.

Mr. Holding also exhibited the skull of a male domestic Cat, in which the posterior border of the orbit was complete. In the majority of the existing *Felidae* this portion of the orbit remained open throughout life. There were, however, about four or five existing species, viz. *Felis viverrina*, *F. subrugosa*, *F. planiceps*, in which the orbit was complete; there was also a figure in de Blainville's 'Ostéographie' called *F. longicaudata* in which this condition was also

characteristic. Whether the specimen was a reversion to those existing species which had a complete orbit, or whether it was simply a case of individual variation, it was difficult to ascertain.

Mr. Holding also exhibited a large calculus weighing 5 lb. 6 oz., taken from the descending colon of a Horse, and remarked that calculi were fairly common amongst older horses bred and reared in towns, where there was a preponderance of dry and impure food, and where, as in London, the water was largely impregnated with impurities; the composition of these calculi being usually 50 p. c. ammonio-phos. of magnesium, 20 p. c. of calcic phosphates, with soluble salts and fatty material—as shown in the concentric rings.

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The following papers were read:—

1. The Rudd Exploration of South Africa.—V. List of Mammals obtained by Mr. Grant in N.E. Transvaal. By OLDFIELD THOMAS, F.R.S., and HAROLD SCHWANN, F.Z.S.

[Received May 11, 1906.]

After completing the work at Knysna, of which we gave an account in our last paper\*, Mr. Grant journeyed by way of Delagoa Bay and Pretoria to the Zoutpansberg District of the Transvaal, a region hitherto practically untouched, so far as the collections in the National Museum are concerned. Indeed, the whole drainage-area of the Limpopo had been remarkably little worked, such few collections as had been sent from within it having been from its northern part in Matabililand or the western in Bechuanaland, the Limpopo part of the Transvaal having been quite neglected.

In this interesting region Mr. Grant has worked with his usual energy and success, and his collection includes 250 specimens belonging to 51 species. This fine series, by Mr. Rudd's generosity, is, as before, added to the treasures of our National Museum.

The localities at which the collection was made were two—Klein Letaba on the low veldt, and Woodbush on the high veldt; and these localities are so distinct from each other both geographically and zoologically, that we have thought it advisable to separate altogether the collections received from them and to write two distinct lists as follows:—

#### I. KLEIN LETABA.

Klein Letaba is situated in about 23° 21' S. and 30° 40' E., on a branch of the Letaba River, which runs south-eastwards to join the Olifants River, uniting again still further eastwards with the main stream of the Lower Limpopo. It is at an altitude of about 1000 feet to the east of and below the high range of the Drakensberg.

\* P. Z. S. 1906, p. 159.

Its mammal fauna proves to be more like that of the high veldt than one would have expected from the difference in altitude, so that we are disappointed to find fewer of the coast and tropical forms than we had hoped, and it is evident that to get the true coast fauna a still lower level must be visited.

Even here, however, several interesting northern forms have been added to the South African list, the most notable being a representative of the Nyasan *Raphicerus sharpei*, an Antelope so strikingly different from any South African species that the tardiness of its discovery is somewhat surprising. Other interesting forms are a new *Helogale* and two new Genets.

Mr. Grant's notes on the Klein Letaba district are as follows:— "The low veldt, that is the country under the Berg, is mainly undulating grass country with long stony rises and some few kopjes and mountains.

"It is thickly timbered, principally with Mopani (Shinatsi of the Tchangaan); a large, fine-growing tree called Ntuma, which bears a small green fruit; the Marula, on the berries of which *Funisciurus cepapi* feeds and from which the natives make beer; 'wait-a-bit' thorns ("Ikaya"); and wild fig and cream-of-tartar trees.

"Water is scarce in the dry season and only to be found in the main rivers that intersect the country, except for some few pools left in the rocks in some of the spruits. The soil is sandy and very fertile in good rainy seasons. The climate is not healthy, and the weather generally very warm. The thermometer frequently records 106° and seldom less than 90° in the shade.

"The natives are a tribe called the Tchangaan, and are an offshoot of the Zulu nation. They have a language of their own, but all understand Zulu and speak it readily. Though very keen on hunting big game, they gave but little assistance in securing small mammals."

#### 1. *MINIOPTERUS NATALENSIS* Smith.

♀. 1275, 1299, 1300.

As already noted in our Knysna paper, the *Miniopterus* of South Africa generally, apart from the extreme southern coast region, is a brown species, very uniformly coloured, its head quite like its body. The forearms of these examples measure 44, 44.5, and 45 mm.

To this species, of which the type is still in the British Museum, we refer Sundevall's *Vesperugo scotinus*, kept separate by Dobson because of its much smaller size. But in so distinguishing it he only took account of the Madagascar specimens he referred to it, with forearm 38–39 mm., and ignored the fact that Sundevall himself gave the forearm measurement as 44 mm., a size quite similar to that of other examples of *M. natalensis*. One of Sundevall's typical specimens, collected by Wahlberg, is also in the Museum collection.

Of the *Miniopteri* previously sent home by Mr. Grant, those

from Klipfontein, Namaqualand, and Ngoye Hills, Zululand, referred by us on Dobson's authority to *M. schreibersi*, now both prove to be referable to the present species.

"This species, which is not very common, does not appear until it is quite dark."—C. H. B. G.

## 2. SCOTOPHILUS NIGRITA Schr.

♂. 1272, 1285, 1289, 1311. ♀. 1271, 1293.

These specimens are rather paler than a Zululand skin which may be taken as representing *S. n. dingani* Smith, described from the country "between Natal and Delagoa Bay." Perhaps they will prove to be similar to *S. n. planirostris* Peters, the Zambesi form, of which we have as yet no good specimens available.

"Fairly common, but apparently confined to the low country. Makes its appearance soon after sundown, and is strong and rapid on the wing."—C. H. B. G.

## 3. NASILIO BRACHYRHYNCHUS Smith.

♂. 1315. ♀. 1224, 1247, 1280, 1309, 1318.

Two of the females were pregnant, with one foetus each. One of Mr. Darling's specimens from Mazoe, however, "gave birth to two very large young after capture," so that these animals do not always have only one young.

With regard to the generic position of this animal, we are of opinion that it is fully time that the three very distinct groups contained in "*Macroscelides*" should be recognised as genera.

These may be briefly distinguished as follows:—

### I. MACROSCELIDES.

Type.

*Macroscelides* Smith, Zool. Journ. iv. p. 435

(1829) ..... *M. proboscideus*.

*Rhinomys* Licht. Darst. Säug., text to  
pl. xxxviii. (1834) ..... *M. proboscideus*.

A. a. of W. Sclater's synopsis of *Macroscelides* \*.

Lower molars two. Bullæ much enlarged.

*Macroscelides*, as thus restricted, would contain only two species, *M. proboscideus* and *M. melanotis*.

### II. ELEPHANTULUS.

Type.

*Elephantulus* Thos. & Schw. Abst. P. Z. S.

No. 33, p. 10, June 5, 1906..... *E. rupestris*.

A. b. of Sclater's synopsis.

Lower molars two. Bullæ normal, not specially enlarged.

This genus would contain the great mass of the Elephant-Shrews, and its range extend from Algeria (*E. rozeti*) to the Cape.

\* Mamm. S. Afr. ii. p. 146 (1901).

## III. NASILIO.

Type.

*Nasilio* Thos. & Schw. Abstr. P. Z. S.No. 33, p. 10, June 5, 1906..... *N. brachyrhynchus*.

B. of Selater's synopsis.

Lower molars three in number, a small cylindrical  $m_3$  being present behind the large  $m_1$  and  $m_2$ . Bullæ normal.

To this genus there belong the forms described as *brachyrhynchus*, *fuscus*, *schinzi*, and *malosa*, but the specific or subspecific standing of each of them is as yet by no means settled.

"Tchangaan name 'Madauri.'

"Common and inhabiting all stony places on the flats, hillsides, or mountains. When pursued they take cover under any available object, even the old piping lying on the veldt. They are diurnal only and were not observed in pairs."—C. H. B. G.

4. *FELIS OCREATA* CAFRA Desm.

♂. 1295.

"Tchangaan name 'Goye.'

"The specimen sent was the only Wild Cat seen at Klein Letaba and was shot while sunning itself in the daytime on the open veldt. It is considered a great delicacy by the natives."—C. H. B. G.

5. *GENETTA LETABÆ*, sp. n.

♂. 1242.

A Genet of the *G. tigrina* group, but with the tail longer than the head and body, and the skull much constricted and heavily ridged.

Size rather greater than in Cape specimens of *tigrina*, hind feet considerably longer.

Fur comparatively short, rather finer in texture than in *G. ludia* (*infra*), rather coarser than in *G. tigrina*; long hairs about 20 mm. in length, underfur about 15.

General ground-colour of upper surface including flanks rather greyer than "cream-buff"; dorsal crest not so marked as in *G. ludia*, extending from the anterior point of the lumbar region to the root of the tail; spots edged with black, centres varying from dark tawny to chestnut, mostly of oblong shape, about one inch in length, smaller, darker, and rounder on the flanks. Underfur slate-grey. Long hairs of the light ground-colour grey for the basal third, middle third white, distal third black. Under surface of body light buffy, the sternal region marked with a few faint brownish spots, bases of the hair slate-grey. Head considerably darker than ground-colour of body, cheeks smoke-grey; forehead rather darker, tips of hairs tawny. Ears of medium length rounded, darker than in *G. ludia*. Inter-ramia, throat, and chest light yellowish grey, the last speckled with a few light reddish spots; fore limbs coloured like ground-colour of back, not black as in *G. tigrina* or *G. ludia*; posterior surface of hind limbs blackish owing to the dark underfur, remainder of hind limbs and feet coloured like back. Tail

longer than head and body, covered with long fine hair; about ten black rings, alternating with narrower ones, yellowish above, creamy white below, the last two not complete above, leaving a black streak on the upper surface.

Skull of the same general size as in Cape specimens of *G. tigrina*, but more delicately built, more constricted over the frontals, and more heavily crested. Nasals narrow and running to a point posteriorly, their lateral edges not roughly parallel as in *tigrina*; ascending processes of the maxillaries produced considerably behind the posterior limit of the nasals, postorbital constriction elongated; sagittal crest unusually developed, commencing immediately behind the postorbital processes and running the whole length of the brain-case. Teeth as in *G. tigrina*, the third upper premolar with no internal cusp.

Dimensions of the type (measured in the flesh):—Head and body 487 mm.; tail 519; hind foot 90; ear 48.

Skull—greatest length 90 mm.; basal length 83; zygomatic breadth 44; nasals  $20 \times 5$ ; interorbital breadth 10.5; brain-case breadth 31.8; palatal length 40.5; length of bullæ (including paraoccipital process) 17.1; greatest diameter of  $p^4$  9.4; outer diameter of  $p^4$  8; transverse diameter of  $m^1$  7.5; length of  $p_4$  6.3, of  $m_1$  7.3.

*Hab.* Klein Letaba.

*Type.* Male. B.M. no. 5.12.9.15. Original number 1242. Collected 24 July, 1905.

This very interesting species appears to be the Zoutpansberg representative of *G. tigrina*, and is, as might be expected, rather more thickly and coarsely haired. It may be distinguished from that animal by the rufous centres to the spots, by the absence of black on the under surface of the body and on the fore and hind limbs, and by the tail being longer than the head and body. The skull is chiefly remarkable for the very conspicuous constriction of the postorbital region and the greatly developed sagittal crest. It might have been supposed that these skull-characters, varying during life and only present in an advanced state in extreme age, as is certainly the case in most genera, are worthless as specific characters. But it is to be noted that in the British Museum's large series of skulls of *G. tigrina* no other specimen shows these peculiarities to anything like the same extent, although many are obviously older than the type of *G. letabæ*, which has its basilar suture still unclosed.

"Tchangaan names 'Ngauny' (for the large brown-spotted species) and 'Tisimba' (for the smaller dark-spotted species). Both species are apparently uncommon. They frequent the kloofs, river-banks, and open bush veldt, are nocturnal in their habits, and feed principally on beetles."—C. H. B. G.

#### 6. GENETTA LUDIA, sp. n.

♂. 1276, 1297.

A Genet of the *G. dongolana* type, with black dorsal stripe and small rusty-red spots.

Size considerably larger than in Cape specimens of *G. tigrina*, tail longer than head and body. Fur of medium length, stiff and rather coarse, about 50 mm. long on the median crest, about 30 mm. on flanks.

Ground-colour on back and flanks pale sandy, whiter than cream; dorsal crest strongly marked, jet-black, extending from neck to base of tail; spots tawny, becoming darker on flanks, small, numerous, arranged in five or six rows. Underfur grey basally, pale sandy yellow terminally. Light ground-colour hairs white for their proximal two-thirds, distal third black, occasionally with a faint intermediate tawny ring. Under surface of body rather lighter than cream-buff. Underfur fine, thick, grey (no. 7) basally, sandy terminally. Head sandy grey lighter than body, the long hairs with white tips; infraorbital spot, not defined posteriorly, merging into the grey of the cheeks; ears rounded, covered with short whitish-grey hairs; lips and interramia dark brownish black; throat and chest white with faint yellow suffusion. Upper surface of forearm rather yellower than back, speckled with small black spots; feet yellowish white or buffy; under surface of upper arm smoky grey suffused with creamy white, forearm brownish black, sharply contrasting with it. Hind limbs below the knee jet-black, with the exception of a line of the ordinary ground-colour passing down the front of the limb to the ankle-joint; feet dirty white with a few black hairs interspersed. Tail longer than head and body, thickly covered with long coarse hair, having about ten black rings, broadest towards the tip and narrowest at the base; upper surface of the white rings conspicuously yellow owing to the presence of tawny hairs.

Skull decidedly larger than in *G. tigrina*, more heavily built, the anterior wing of the squamosal more widely curved, postorbital breadth greater, bullae more noticeably constricted in the middle; third upper premolar with a very well-marked internal cusp.

Dimensions of the type (measured in the flesh):—

Head and body 486 mm.; tail 496; hind foot 99; ear 59.

The corresponding measurements of a *G. tigrina* (B.M. no. 5.5.7.41.) from Knysna are as follows:—

Head and body 443; tail 397; hind foot 81; ear 49.

Skull—greatest length 93 mm.; basal length 85.5; zygomatic breadth 46.4; nasals  $18.8 \times 7$ ; interorbital breadth 16; brain-case breadth 31.6; palatal length 44; length of bullae 19.5; greatest diameter of  $p^4$  9.1; outer diameter of  $p^4$  8; transverse diameter of  $m^1$  7.5; length of  $p_4$  6.5; of  $m_1$  7.2.

*Hab.* Klein Letaba.

*Type.* ♂. B.M. no. 5.12.9.17. Original number 1276. Collected 5 Aug., 1905.

This species may be distinguished from *G. tigrina* by its very different external proportions and by the whole of the under surface of the body and fore limbs being dark brown or black in *tigrina* and only the forearm black in *G. ludia*.

The close resemblance this species bears to *G. dongolana*,

*H. & E.*, is very remarkable, though it may be easily distinguished by its larger size.

7. *HERPESTES GRACILIS PUNCTULATUS* Gray.

♂. 1307. ♀. 1288.

"Tchangaan name 'Mungauba.'

"This species is not common. It frequents the open bush veldt and lives in holes or in hollow trees and feeds chiefly on insects."—C. H. B. G.

8. *HELOGALE BRUNNULA*\* Thos. & Schw.

Abstr. P. Z. S. No. 33, p. 10, June 5, 1906.

♂. 1218, 1219, 1262, 1263, 1264. ♀. 1229, 1265, 1274.

A brown species, not so black on head and limbs as *H. parvula*.

Colour above uniform brown finely ticked with buffy whitish, the general effect between "bistre" and "vandyke brown," with a certain warmth in the tone not present in *H. parvula*, which more approaches 'seal-brown.' This warmth is due to the under-fur being broadly dull buffy or clay-colour for its terminal half, while in *H. parvula* it is smoky grey. Under surface not conspicuously different from upper. Head greyer than back, with a slightly olive tone; in *H. parvula*, on the other hand, the head is if anything more blackish than the back. Limbs like body, grizzled and ticked, not darkening terminally to black as in *H. parvula*. Tail of the same general colour, evenly tapering, the terminal pencil inconspicuously blacker.

Skull much as in *H. parvula*, except that the bullæ are decidedly larger and more evenly inflated, the increase being particularly noticeable in their posterior, mastoid portion.

Dimensions of the type (measured in the flesh):—

Head and body 207 mm.; tail 165; hind foot 42; ear 21.

Skull—basal length 44 mm.; greatest breadth 29.3; inter-orbital breadth 8.2; breadth of brain-case 22; palatal length 24; breadth between outer corners of p<sup>4</sup> 16.8; greatest horizontal diameter of p<sup>4</sup> 5.6; of m<sup>2</sup> 3.5.

*Hab.* Klein Letaba, Zoutpansberg District. Alt. 1050'.

*Type.* Male. B.M. no. 5.12.9.22. Original number 1263. Collected 30 July, 1905.

The eight specimens of this *Helogale* are all precisely similar in colour, and all equally different from a co-type of *H. parvula* in the Museum Collection. Unfortunately the locality of *H. parvula* is not known, though from the general account of Wahlberg's localities given by Sundevall in his paper on the birds, the present region might have been the "Caffraria superior, juxta tropicum." However, since the Letaba *Helogale* does not agree

\* [The complete account of this new species appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' it is distinguished by the name being underlined.—EDITOR.]



with *H. parvula*, the latter must have been obtained further south, perhaps on the Crocodile River.

*H. brunula* may readily be distinguished from *H. parvula* by its head being paler instead of darker than the body, by its buffy-tipped underfur, and by its head and feet not darkening terminally.

"Tchangaan name 'Mashli.'

"Fairly common in the low country. They were observed in parties of from four to eight, and live and take refuge in the deserted ant-heaps. They become commoner towards the Portuguese frontier."—C. H. B. G.

#### 9. FUNISCIURUS CEPAPI Smith.

♂. 1223, 1228, 1237, 1261, 1281, 1283, 1286, 1287, 1291, 1293, 1302, 1303, 1317. ♀. 1227, 1232, 1244, 1268, 1277, 1282, 1292.

"Shot in tree" is on most of the specimens, so the species is evidently an arboreal one.

"Tchangaan name 'Mashinyane.'

"Very common on the low veldt, to which it is confined. These Squirrels breed and sleep in a hollow tree, in which they take refuge when pursued. They are easily captured, and form an article of food with the natives."—C. H. B. G.

#### 10. GRAPHIURUS MURINUS Desm.

♂. 1269.

This example shows strongly the peculiar staining of the chest-hairs, on which Smith's name of *erythrobronchus* was based.

"Tchangaan name 'Ndabidabi.'

"The specimen sent was found asleep in the woodwork of an outbuilding and was very fat. This species is not easy to obtain as it hibernates during the winter."—C. H. B. G.

#### 11. TATERA BRANTSII Smith.

♂ ♀. 1305.

"Tchangaan name 'Masingaan.'

"Common and gregarious in habits. Forms burrows in sandy places but never of any great size."—C. H. B. G.

#### 12. TATERA MILIARIA SALSA Wrought.

♂. 1255. ♀. 1233, 1301.

#### 13. ARVICANTHIS DORSALIS Smith.

♂. 1260, 1284, 1312. ♀. 1241, 1290, 1316.

"Tchangaan name 'Matsutsa.'

"This species is fairly common on the low veldt, where it apparently replaces *A. pumilio*, to which its habits are similar. It frequents the grassy flats and thick undergrowth in the kloofs. Diurnal only and a vegetarian."—C. H. B. G.

14. *STEATOMYS PRATENSIS* Peters.

♂. 1217, 1238, 1254, 1270. ♀. 1221, 1222, 1230, 1239, 1248, 1252.

Specimen 1270, a male, is immensely larger than any of the other individuals of the series, but it is very old, its teeth being quite worn down. Its skull is 26·5 mm. in total length, thus equalling the typical skull of *S. bocagei*, but the latter belonged to a much younger individual. The two equally old female skulls measure 25 mm. in length.

"Tchangaan name 'Ntenyane.'

"Common and confined to the low country. They sleep throughout the winter, roughly from April to October, in a grass nest at the end of their burrow. All the specimens were dug out and were excessively fat and unable to move fast. The natives, who consider them a great delicacy, say they cannot find them in the summer, and firmly believe they turn into bats."—C. H. B. G.

15. *MUS CHRYSOPHILUS* de Wint.

♂. 1245, 1267, 1304. ♀. 1256.

"Tchangaan name 'Magundane.'

"Common everywhere, especially so in the undergrowth in kloofs and in outbuildings. Nocturnal only."—C. H. B. G.

16. *MUS COUCHA* Smith.

♂. 1220, 1225, 1226, 1237, 1250, 1306. ♀. 1234.

"Tchangaan names 'Mkundlo' or 'Magundane' (a rat). Very common."—C. H. B. G.

17. *LEPUS ZULUENSIS* Thos. & Schw.

♂. 1266. ♀. 1294, 1313.

In our paper dealing with the mammals obtained by Mr. Grant in Zululand a Hare, belonging to the *saxatilis*-group, was described as a new subspecies under the name of *Lepus saxatilis zuluensis*\*. On the receipt of the material with which the present paper deals a careful examination of the whole group was undertaken, and we are led to the conclusion that no intergrading takes place between the large-eared Hare, *Lepus saxatilis*, and its eastern representative. We therefore consider the small-eared one to be worthy of specific rank.

"Tchangaan name 'Nfundla.'

"This species is fairly common in stony places and on the sandy flats, especially round old mealie-patches. They move about only at night and spend the day under a bush or in the long grass."—C. H. B. G.

18. *RAPHICERUS SHARPEI COLONICUS*, subp. n.

♂. 1278, 1279.

Similar in all essential characters to the true *sharpei* of Nyasa,

\* P. Z. S. 1905, i. p. 270.

but the feet decidedly longer, though both the specimens are immature. In three fully adult specimens of *sharpei* the hind feet, including hoofs, measure 196–198 mm., while in the two Letaba individuals, which still retain their milk-dentition, this dimension is 208 and 215 mm.

General colour slightly richer and more purplish than in true *sharpei*, the intermixed white hairs more numerous. Throat, chest, and belly purplish buff, the line of demarcation on sides of belly little marked; in *sharpei* the under surface is white or whitish with but little tinge of buffy.

Skull much as in *sharpei*, but the bullæ appear to be slightly larger.

Dimensions of the type, taken in flesh :—

Head and body 722 mm.; tail 76; hind foot, without hoof 195; ear 89.

Skull—greatest length 126 mm.; basal length 112; greatest breadth 64; nasals 35 and 15; muzzle to orbit 59; muzzle to front of mp<sup>2</sup> 30.

Horns, length 38 mm.; diameter at base 12.

*Type.* Immature male. B.M. no. 5.12.9.81. Original number 1279. Collected 10 August, 1905.

“Shot on grass-covered hillside, dotted with trees.”—C. H. B. G.

The discovery of the peculiar Nyasan Steinbuck *Raphicerus sharpei* south of the Zambezi makes an important addition to the known fauna of S. Africa. Possibly it has been obtained before, but sportsmen might easily have confounded it with the Grysbok, which it resembles by its hoary-mixed coat, though its short horns, even when adult, and the absence of supplementary hoofs, show that it is really quite distinct from that animal.

The British Museum owes to the kindness of Col. Manning several specimens of *R. sharpei* from Mpimbi, Nyasa, and these, though fully adult, are so uniformly smaller than the two obtained by Mr. Grant, that we think it advisable to give a subspecific name to the Transvaal form.

#### 19. *RAPHICERUS NEUMANNI CAPRICORNIS*, subsp. n.

♂. 1258. ♀. 1314.

Similar to the East African Steinbuck in all respects, except that the bullæ are very markedly larger, and the nasals are rather smaller and narrower.

Dimensions of the type, measured in the flesh :—

Head and body 814 mm.; tail 65; hind foot 236; ear 102. Fore-hoofs, length anteriorly 26·5, transverse breadth 19.

Skull—greatest length 147 mm.; basal length 128; zygomatic breadth 72·5; nasals 43 × 17; muzzle to orbit 71; muzzle to anterior premolar 36; palatal length 74; length of upper molar series (alveoli) 45; bullæ, greatest diameter on inflated part 24·5, height below level of glenoid surface 20, greatest breadth between inflated parts of opposite sides 49·5.

Horns, length 92 mm.; diameter at base 13·5.

*Type.* Adult male. B.M. no. 5.12.9.78. Original number 1250. Collected 27 July, 1905.

On a comparison of the numerous beautiful specimens of *Raphicerus* obtained during the Rudd exploration with such East African examples as are available, we find that the latter are readily distinguishable from the Cape forms by their paler general colour and by the greater extent of their white facial markings. Their eyes are completely ringed with white, their lips are white, the edges of the ears are more broadly whitened, and there is a considerable increase in the extent and brightness of the white chin, throat, and limb-markings. Their skulls are rather larger.

In all these respects the Letaba Steinbucks absolutely agree with the East African specimens, and differ from the Cape ones, not being in any way intermediate; and we therefore think we should recognize *neumanni* as a distinct species, and consider the Transvaal form of it—characterized by its very large bullæ—as a special subspecies.

The dark coronal horseshoe-mark is absent in the male, slight in the female.

## 20. CEPHALOPHUS GRIMMII L.

♀. 1259, 1300.

“Tchangaan name ‘Munti.’

“Very common everywhere, especially in long grass and patches of bush. They vary a great deal in colour and size.”—C. H. B. G.

## 21. CERVICAPRA ARUNDINUM Bodd.

♂. 1296, 1298.

“Tchangaan name ‘Mhlangu.’

“Fairly common, observed singly or in pairs, occasionally even three together. This species feeds during the night and drinks at sundown and between dawn and sunrise.”—C. H. B. G.

## II. WOODBUSH.

Woodbush lies on the slopes of the Drakensberg Range, about 30 miles to the north-east of Pietersburg, at an altitude of about 4500 feet. Its fauna is therefore that of the high veldt in general, and the collection gives us valuable information as to the north-eastern range of the high-veldt animals. New forms are less numerous than in the Letaba collection, but we have found occasion to describe a new Elephant-Shrew and a new *Crocidura*, while several rarities, notably *Myosorex tenuis* and *Cynictis selousi*, are added to our series.

Mr. Grant has sent us the following notes on the Woodbush District and the High Veldt:—

“The high open veldt which extends round Pietersburg for

many miles consists of grass-covered flats and undulating country dotted with kopjes and long stony ridges, with here and there patches of cactus and thorn trees. Euphorbias (Naboom) and milk-bush are common in the kopjes, though water is by no means plentiful. When the country is dry and grass is scarce, the country is very 'karoo'-like and most monotonous to travel over.

"The Woodbush Hills are part of the northern spurs of the Drakensberg, and very similar to the high veldt of Zululand both in vegetation and climate.

"Woodbush village lies in the hills of the same name, but at a rather lower elevation than the hills proper. It is surrounded by rocky country fairly well timbered, but not nearly so thickly as the 'bush-veldt.' The vegetation consists chiefly of mimosa-thorn (Acacia), large specimens of Euphorbias, fig-trees (Moga) along the streams, and Ntuma trees on the warmer sides of the large kloofs.

"The natives throughout the high veldt are Basuto, and, except in a few instances, gave no assistance in collecting specimens."

## 22. CERCOPITHECUS ALBIGULARIS Sykes.

♀. 1340.

This is the second record of this East African species in South Africa proper. Selater\* mentions the capture of the first specimen at Umtali in Mashonaland.

"Basuto name 'Duru.'

"Common, but difficult to obtain on account of its wariness. This species inhabits the deep kloofs in the depths of the forests, seldom visiting the open parts."—C. H. B. G.

## 23. ELEPHANTULUS RUPESTRIS MYURUS, subsp. n.

♀. 1137.

Similar to the typical *rupestris* from Namaqualand in general colour and proportions, but with a much more closely-haired and untufted tail.

Fur soft and silky, about 10 mm. in length on middle of back. General colour of upper surface between drab and fawn-colour, passing into yellowish drab on flanks; under surface pure white, bases of hairs blackish slate. Eyes not so conspicuously ringed with white as in the typical subspecies, the white line partially interrupted posteriorly. Ears of medium length, light drab externally, not rufous-brown as in *rupestris*, and with no rufous hairs internally, only white. Nuchal region light rufous in colour, not so markedly so as in the typical Namaqualand race. Upper surface of hands and feet pure white. Tail long, closely covered with minute hairs, reddish brown above, white below, not tufted at the tip.

Dimensions of the type (measured in the flesh):—

Head and body 127 mm.; tail 154; hind foot 34; ear 26.

\* Mammals of South Africa, vol. i. p. 12 (1900).

Skull (damaged)—nasals, length 15; length of upper tooth-row 20·2, of lower tooth-row 18·8.

*Hab.* Woodbush, North-eastern Transvaal.

*Type.* Female. B.M. no. 6.4.3.2. Original number 1137. Collected 17 May, 1905.

This subspecies can be easily distinguished from the typical one by its much lighter-coloured tail and by the absence of a tuft.

"Basuto name 'Umsiti.'

"This species is undoubtedly very rare on the high veldt."—C. H. B. G.

24. *CROCIDURA ARGENTATA* Sund.

♂. 1186.

"Basuto name 'Mezitri.'

"This species was not observed in the low country, and the specimen sent home was the only one seen."—C. H. B. G.

25. *CROCIDURA SYLVIA*, sp. n.

♂. 1114, 1134, 1143, 1148, 1153, 1156, 1199, 1200, 1210.  
♀. 1203, 1352.

A dark-coloured Shrew, probably allied to *C. fumosa* Thos., but with a less hairy tail and narrower skull.

Fur long and velvety, about 6 mm. in length on the middle of back. General colour of upper surface between "seal-brown" and "clove-brown," darker on the rump. Under surface paler and browner. Hands and feet brown. Tail more than half the length of head and body, not incrassated; bristle-hairs present only at the base, much fewer than in *fumosa*; dark brown, almost black, above and below.

Skull finer, narrower, and more slenderly built than in *fumosa*, but i' stronger and larger.

Dimensions of the type (measured in the flesh):—

Head and body 81 mm.; tail 43; hind foot 15; ear 8·5.

Skull—condylo-incisive length 21·5 mm.; basal length 19·5; greatest breadth 9·0; length of upper tooth-row 9·0; i' to p' 4·8.

*Hab.* Woodbush, Zoutpansberg District. Alt. 4500 ft.

*Type.* Male. B.M. no. 6.4.3.10. Original number 1200. Collected 14 June, 1905.

This species may be distinguished from any other South-African *Crocidura* by its very dark colour and the scarcity of the bristle-hairs on the tail—characters that might lead to its confusion with *Myosorex sclateri* unless a comparison of the skulls were made.

"Very common on the high veldt, not observed in the low country. Inhabits vleis and thick grass by the river-banks."—C. H. B. G.

26. *CROCIDURA* sp.

♂. 1147.

27. *MYOSOREX TENUIS* Thos. & Schw.

♂. 1109, 1113, 1121, 1126, 1140, 1144, 1149, 1157, 1158, 1160, 1209, 1327, 1329, 1330, 1336. ♀. 1110, 1325, 1326.

The present series was obtained in the Woodbush Hills at a height of 4900 feet, and the single specimen on which the species was founded was caught by Mr. Grant at Zuurbron in the Wakkerstroom District of the Transvaal at an altitude of 4600 feet. It is therefore probable that *tenuis* is the high-veldt representative of *M. varius*, to which it is certainly more allied than to *M. sclateri*, the latter differing from it very considerably in external measurements and skull-characters. Its only point of agreement with *sclateri* is in its general colour, and not, as we stated in the second account of Mr. Rudd's exploration of South Africa\*, in the length of its tail. Although the difference between the types of *sclateri* and *tenuis* in this measurement is only 8 mm., extreme specimens show a difference of nearly twice this, and the average may be considered as about 12 mm.

"Very common on the kopjes, cultivated lands, and the vegetation on the banks of streams."—C. H. B. G.

28. *GENETTA LETABÆ* Thos. & Schw.

♂. 1159, 1177.

These specimens are practically identical with the type of this species described in the first part of the paper. No. 1177 is young and naturally proportionately smaller, and both specimens have slightly redder spots, but the difference is so slight as to be negligible.

"Basuto name 'Chipa.'

"Rather uncommon. Inhabits the kopjes and bush-covered hillsides. Nocturnal only."—C. H. B. G.

29. *HERPESTES GALERA* Erxl.

♀. 1139, 1142, 1155.

"Basuto name 'Muliza.'

"Uncommon. Inhabiting vleis and thick reed-beds by the rivers. Apparently feeds on tadpoles, frogs, crabs, &c. Nocturnal only."—C. H. B. G.

30. *HERPESTES GRACILIS PUNCTULATUS* Gray.

♂. 1173, 1198, 1212, 1356, 1357. ♀. 1125, 1130, 1138, 1346.

"Basuto name 'Kanu.'

"This species was observed in the forest on the Woodbush hills, though it is common everywhere, especially by the rivers. Its food consists principally of insects."—C. H. B. G.

31. *CYNICTIS SELOUSI* de Wint.

♂. 1178. ♀ 1361.

The only specimens of this remarkable species hitherto received

\* P. Z. S. 1905, i, p. 132.

are the skull obtained by Mr. Selous, on which the species was founded, and an example collected by Mr. P. C. Reid at Linyati, and figured in our 'Proceedings'\*,

"Basuto name 'Manhauta.'

"Rare everywhere. Nocturnal only."—C. H. B. G.

32. *CANIS MESOMELAS* Ehrenb.

♀. 1348.

"Basuto name 'Pugure.'

"Not uncommon, but seldom seen and very difficult to trap. A considerable source of annoyance to the farmers, who persecute them at all times and seasons."—C. H. B. G.

33. *ICTONYX CAPENSIS* Kaup.

♂. 1193.

"Basuto name 'Kopani.'

"Not uncommon, frequenting the kopjes and open country at night in search of food."—C. H. B. G.

34. *TATERA BRANTSII* Smith.

♀. 1171, 1196.

"Basuto name 'Leboka'."—C. H. B. G.

35. *TATERA MILIARIA SALSA* Wrought.

♂. 1172, 1175, 1176, 1187, 1188, 1211. ♀. 1164.

This is the series on which Mr. Wroughton founded the subspecies†.

36. *OTOMYS IRRORATUS* Bts.

♂. 1131, 1132, 1158. ♀. 1133, 1134, 1135.

These specimens approximate in colour to the *Otomys laminatus* described by us in an earlier paper on Mr. Rudd's mammals, though their laminal formula shows them to be true *irroratus*.

"Basuto names 'Beba' and 'Ibuka.'

"In the Woodbush hills they were found on the steep grass-covered hillsides some considerable distance from water."—C. H. B. G.

37. *DENDROMUS MESOMELAS* Bts.

♂. 1338.

This specimen has the black dorsal stripe less prominent than appears to be usual.

38. *MUS CHRYSOPHILUS* de Wint.

♂. 1181, 1191. ♀. 1124, 1128, 1154, 1165, 1169, 1205, 1208, 1339.

"Basuto name 'Lohauto' (a rat).

"Common everywhere, especially in the cultivated lands."—C. H. B. G.

\* P. Z. S. 1901, i. p. 2, pl. i.

† Ann. Mag. N. H. (7) xvii. p. 485 (1906).



39. *MUS COUCHA* Smith.

♂. 1116, 1131, 1204, 1319. ♀. 1111, 1112, 1127, 1132, 1179, 1207, 1323, 1349, 1350.

Specimens nos. 1204, 1111, and 1127 are slightly lighter in colour than the remainder of the series, which is otherwise very uniform. No. 1127 shows the multimammate character very clearly, which is the only character that in many cases serves to distinguish the members of this very difficult group from *Mus colonus* Bts.

40. *MUS DOLICHURUS* Smuts.

♀. No number.

41. *ARVICANTHIS PUMILIO DILECTUS* de Wint.

♂. 1115, 1117, 1135, 1150. ♀. 1118, 1122, 1123, 1146.

"Basuto name 'Dari.'

"Common on the high veldt, but not observed in the low country. Diurnal only."—C. H. B. G.

42. *DASYMYS INCOMTUS* Sund.

♀. 1353.

"Basuto names 'Beba' and 'Ibuka.'

"Apparently very rare, as the specimen sent was the only one seen."—C. H. B. G.

43. *SACCOSTOMUS CAMPESTRIS* Pet.

♂. 1337.

"Basuto name 'Lohauto.'

"Rather rare and apparently confined to the high veldt. The pouches contained seeds of various plants."—C. H. B. G.

44. *GEORYCHUS* sp.

♂. 1163, 1170, 1185, 1189, 1201, 1202, 1321, 1324. ♀. 1161, 1322.

Until this group has been monographed we are not prepared to commit ourselves to an exact specific determination.

"Basuto name 'Puga.'

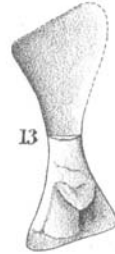
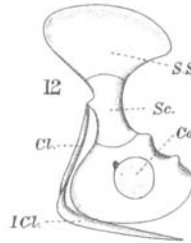
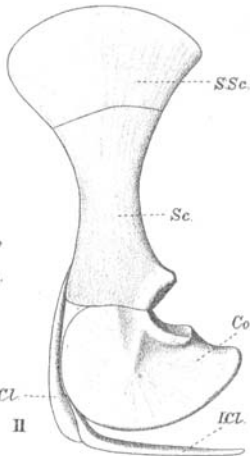
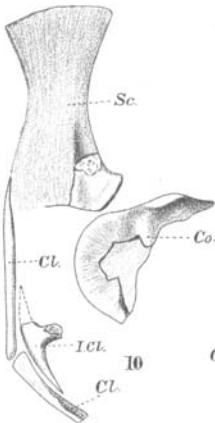
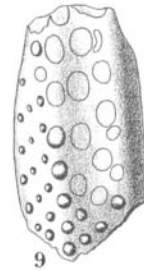
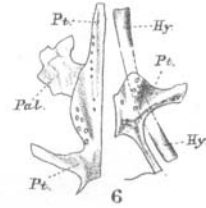
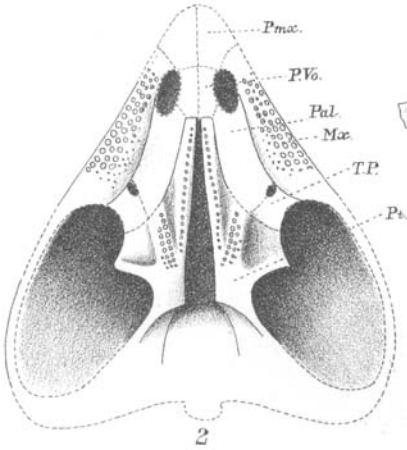
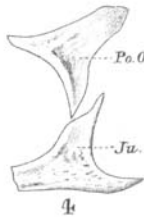
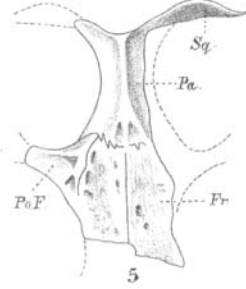
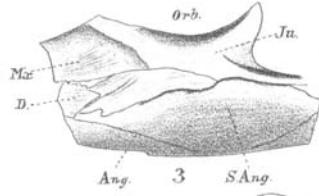
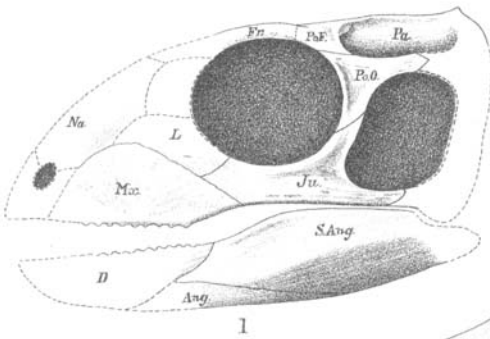
"Common, especially in cultivated lands, where it forms runs. In the low country the scarcity of rain during my stay prevented their working, and so none were trapped."—C. H. B. G.

45. *PEDETES CAFER* Pall.

♂. 1347. ♀. 1345, 1360.

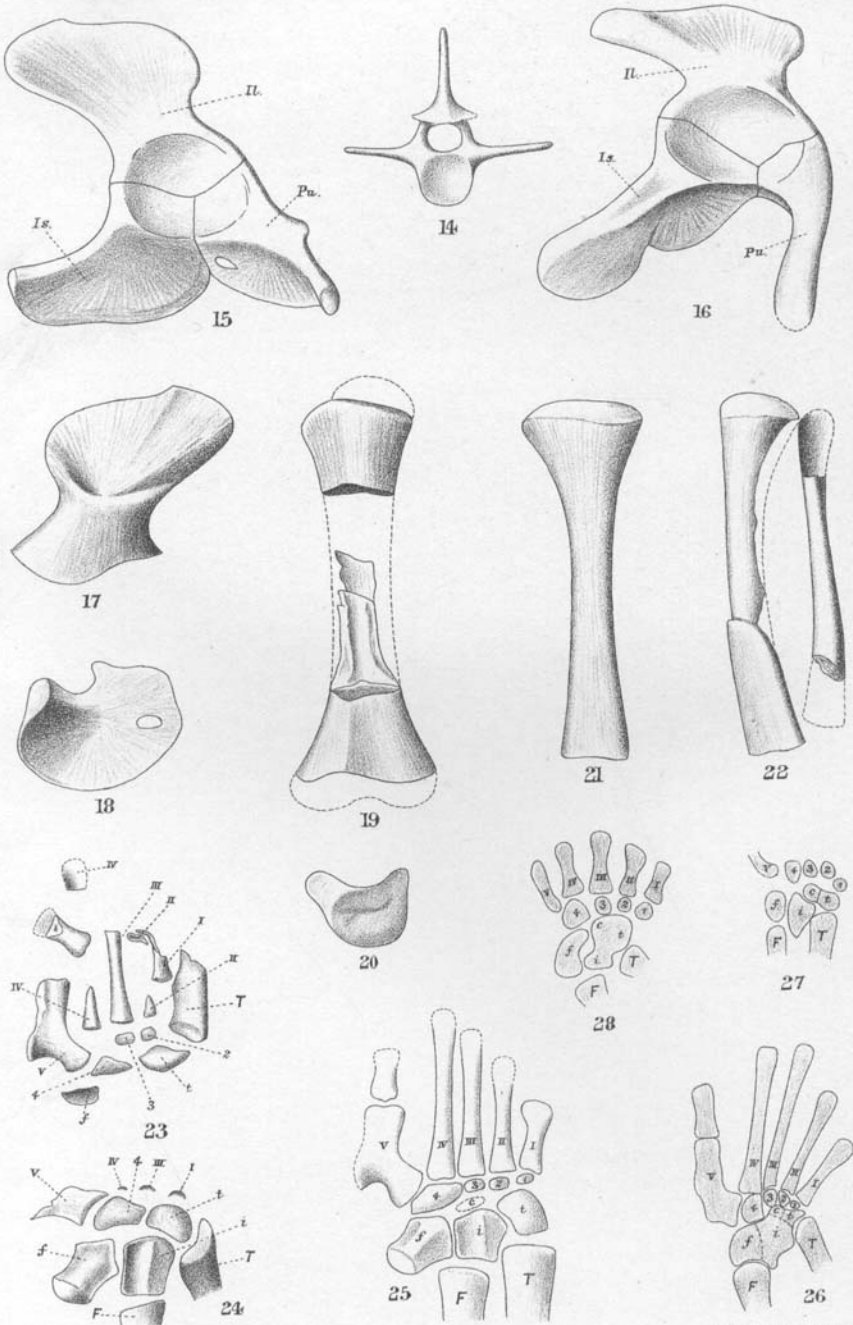
"Basuto name 'Sidula.' Tchangaan name 'Jengwy.'

"Fairly common on the high veldt. The natives reported them to be in the low country, and though I found some of their holes at Klein Letaba, none were recent. They do great damage to the mealies."—C. H. B. G.



R. Broom del.

M. P. Parker lith.  
Parker & West imp.



R. Broom del.

HOWESIA BROWNI.

M. P. Parker lith.  
Parker & West imp.

46. *LEPUS ZULUENSIS* Thos. & Schw.

♂. 1151, 1166, 1174, 1355. ♀. 1152, 1180, 1206, 1213.

"Basuto name 'Muda.'

"Very common in all stony places. It is not found on the flat open country round Pietersburg, where it is replaced by *Lepus ochropus*."—C. H. B. G.

47. *LEPUS OCHROPUS* Wagn.

♀. 1215. Pietersburg.

"Common, but confined to the high veldt round Pietersburg."—C. H. B. G.

48. *PRONOLAGUS CRASSICAUDATUS* Geoff.

♂ juv. 1328.

"Guriously uncommon, considering the great stretches of country suited to its habits. I only observed two of these Hares during my stay here."—C. H. B. G.

49. *PROCAVIA CAPENSIS* Pall.

♂. 1182. ♀. 1194, 1344.

"Basuto name 'Imbile.'

"Not nearly so common as *P. brucei*, with which it inhabits the same kopjes and krantzies. Diurnal only."—C. H. B. G.

50. *PROCAVIA BRUCEI* Gray.

♂. 1133, 1342. ♀. 1184, 1193, 1354, 1359.

"Basuto name 'Imbile.'

"This species is much commoner than *P. capensis*, but is much more difficult to secure, being more wary."—C. H. B. G.

51. *CEPHALOPHUS GRIMMII* L.

♂. 1214. ♀. 1129, 1167, 1341, 1351.

"Basuto name 'Imputi.'

"Common at Woodbush, but scarcer on the flats round Pietersburg. It feeds during the night and spends the day lying on the kopjes".—C. H. B. G.

2. On the South African Diaptosaurian Reptile *Howesia*.

By R. BROOM, M.D., D.Sc., C.M.Z.S., Victoria College, Stellenbosch.

[Received May 15, 1906.]

(Plates XL. &amp; XLI.\*)

About a year ago I published in the Records of the Albany Museum† a preliminary notice of a very interesting small

\* For explanation of the Plates, see p. 600.

† "Preliminary Notice of some new Fossil Reptiles collected by Mr. Alfred Brown at Aliwal North, S. Africa." Rec. Alb. Mus. Grahamstown, vol. i. pt. iv. p. 269 (1905).

fossil reptile, remains of which had been discovered by Mr. Alfred Brown near Aliwal North. As the animal somewhat resembles *Sphenodon* in size and general appearance and is evidently a Rhynchocephaloid reptile, I thought it befitting to name the genus *Howesia*, in honour of the late Prof. G. B. Howes, who has done such brilliant work on the osteology of *Sphenodon*, and whose early death has left such a serious gap in the ranks of morphologists.

In Mr. Brown's collection there are three specimens which I regard as belonging to *Howesia*. Specimen A, which I take as the type, is a very badly crushed and imperfect skull. The middle parts of both mandibles are preserved, including portions of both dentaries, the right jugal, much of both maxillaries, a large part of both pterygoids, parts of the hyoid, and a few other crushed and fragmentary bones. Specimen B, which there is little doubt belongs to the same genus and species, consists of a number of bones of the skull, crushed and much displaced, parts of most of the cervical vertebræ, the left shoulder-girdle and the left humerus. Among the cranial bones the following can be identified with some degree of certainty—frontals, parietals, postfrontal, postorbital, squamosal, jugal, maxillary, and pterygoid. Specimen C consists of the pelvis, most of the bones of the hind limbs including the tarsus, and a considerable number of caudal vertebræ of a Rhynchocephaloid reptile which may provisionally be regarded as belonging to the same genus and species as specimens A and B. In the absence of head there is of course an element of doubt, but as all the specimens are from the same horizon, and as the pelvis in specimen C is such as we should expect to find in *Howesia* from the size and characters of the skull and shoulder-girdle, I shall assume that it belongs to the same species as the others.

#### *Skull.*

Though both specimens of the skull are in a very unsatisfactory condition, it is nevertheless possible to make out most of the principal points in the cranial anatomy. In the main the skull resembles fairly closely that of *Sphenodon*, though there is a marked difference in the dentition. At the time the preliminary note was written I was unable to determine with certainty whether the rows of *Hyperodapedon*-like teeth were borne by the maxilla or by the palatine or by both. As the result of the further development of specimen A, it would appear that the teeth are on the maxilla, and on the maxilla only.

The maxilla is shaped as in the better known Diaptosaurian reptiles *Procolophon* and *Palæohatteria*. The facial portion is flat and triangular, and probably about 25 mm. in length and 12 mm. in depth. The inferior or tooth-bearing portion is thick and rounded. In specimen A one of the maxillæ measures 5 mm. in thickness; in specimen B a maxillary fragment is 5.5 mm. in thickness. In front the tooth-bearing portion is considerably thinner—at least as thin as 3 mm. In the middle portion of the maxilla there are three rows of obtusely pointed teeth, but

perhaps in front there may be only one or two rows. Behind, there are four rows of similar-sized obtusely pointed teeth, and on the inner side of the bone three additional rows of more minute teeth, which apparently do not meet the dentary and are unworn. The teeth seem to have a thin layer of enamel and to be implanted in the bone rather than ankylosed to it. When the jaw is worn, the teeth and bone together form a grinding-surface. The exact relations of the teeth to the jaw could be certainly determined only by sectioning one of the fragments, and this I do not feel at liberty to do.

A large part of the jugal is preserved in specimen B, and in specimen A the cast of almost the whole bone. It forms practically the whole of the lower border of the orbit. In its relations to the maxilla, to the postorbital, and to the quadrato-jugal it is almost identical with that in *Palæohatteria*. There is clear evidence of a lower temporal fossa bounded below by the posterior process of the jugal. Pl. XL. fig. 3 represents the cast of the jugal in specimen A and fig. 4 part of the jugal in specimen B.

The postorbital bone is preserved in perfect condition in specimen B. It is triangular, and strikingly like the corresponding bone in *Sphenodon*. It divides the upper from the lower temporal fossa and, in part, both from the orbit. It is represented in fig. 4.

The postfrontal is preserved in specimen B. It is a small triangular bone not unlike that of *Sphenodon*. It articulates by a long suture with the frontal and by a short one with the parietal. It is shown in fig. 5.

The frontals are broad and rather flat. They form only a short part of the supraorbital margins between the prefrontals and the postfrontals. The whole of the supraorbital ridge is slightly elevated, owing to there being a depression along the frontal bone and on to the postfrontal. On the whole of the upper surface of these bones, but chiefly in the depression, are a number of shallow pits, which suggest the possibility of their having lodged glands in connection with the skin. The narrowest part of the interorbital region measures 10.5 mm., and the greatest measurement across the frontals is 14 mm.

The parietals are well preserved in specimen B. They are ankylosed, and like those of *Sphenodon* form, in their posterior two-thirds, a low median ridge. In the anterior third this median ridge divides into two feeble ridges, which pass forwards and outwards and end at the suture between the parietal and the frontal. To the naked eye there appears to be no parietal foramen, but when the bone is examined microscopically there is seen to be a small median foramen about as large as a pin-point. I think there can be little doubt that this is a rudimentary parietal foramen. It measures about .5 mm. in greatest length. Posteriorly the parietals pass outwards to meet the squamosals as in *Sphenodon*.

Though portions of the squamosal and probably quadrato-jugal, exoccipitals, and a few other bones are present, they are either too

imperfect or insufficiently displayed, or the determination too uncertain to warrant description.

A portion of the nasal preserved shows that the bone was of considerable size, as in *Palaeohatteria*.

In specimen A a number of bones of the palate are preserved. Though these are imperfect, yet as the pterygoids are fairly complete it is possible to make an approximate restoration of the palate.

The pterygoids are of the triradiate type found in most early reptiles, such as *Dimetrodon*, *Proterosuchus*, *Procolophon*, &c., and, as in these genera, are dentigerous. The anterior process is long and narrow, and along apparently its whole length is a single row of small teeth, which must lie almost parallel with the corresponding row on the pterygoid of the opposite side. The posterior half of the anterior process is about twice as broad as the anterior, and on it is a second dental ridge with at least two rows of fairly well-developed teeth passing forwards and slightly outwards from near the back end of the inner dental ridge. The anterior ridge articulates by much of its outer side with the palatine. From the posterior part of the toothed portion of the bone the median process passes outwards and slightly forwards. It appears to be devoid of teeth. From about the same point the posterior process is sent backwards and outwards, doubtless to meet the quadrate. This process is broad, fan-shaped, and concave, and recalls rather forcibly the posterior process of the pterygoid in *Procolophon* and *Dimetrodon*.

The palatine is very imperfect, but it appears to be moderately flat and devoid of teeth.

A considerable portion of each mandible is preserved, but not in a very satisfactory condition. The dentary carries four rows of small obtusely pointed teeth almost exactly similar to those of the maxilla. Unfortunately, only the back part of one dentary is preserved, and the cast of the back part of the other. The preserved portion is 4 mm. wide. The post-dentary portion of the jaw has a swollen appearance, recalling that of *Procolophon*, but it is much larger in *Howesia*. The bone which forms the greater part of the outer side I believe to be the surangular. In situation it quite agrees with the supposed surangular in *Procolophon*, but in the latter genus it is much smaller. In *Proterosuchus* the surangular is also of very large size. There appears to be a small but distinct coronoid bone. The angular seems to form nearly the whole of the lower border of the posterior two-thirds of the jaw. In the middle of the jaw there is a very large cavity as in *Procolophon*.

Lying on the pterygoids were two long, rounded, slightly curved rods of bone at least 22 mm. in length. These are probably hyoid bones.

#### *Vertebrae.*

Though portions of many cervical and caudal vertebrae are preserved as well as parts of a few others, they are for the most part not

sufficiently well displayed or preserved to permit of a satisfactory examination. The cervical vertebræ are about seven in number, and from the position of the shoulder-girdle we may infer that *Howesia* had a neck of about the same length as the skull. The axis has a large spine almost of mammalian type. Of the other cervical vertebræ, only the zygapophyses are displayed. There are no dorsal or lumbar vertebræ preserved. There appear to have been two sacral vertebræ, as in *Erythrosuchus*. Twelve caudal vertebræ are preserved, but not well displayed. The first of these is probably the 3rd caudal. It has well-developed transverse processes and spine. Across the transverse processes it measures 26 mm., and the total height of the vertebra as preserved is 24 mm. There is probably not much of the spine missing. The body is much constricted, as in *Phytosaurs*, *Pelycosaurs*, and most primitive reptiles, and appears to be amphiplatyan or amphicoelian. It is certainly not distinctly notochordal. A well-developed intercentrum lies between this vertebra and the next. The second preserved vertebra (probably 4th) has a small chevron, and the succeeding vertebræ have very long double-headed chevrons. In the case of the supposed 5th caudal, the chevron as preserved is 24 mm. long, and in the 6th it is probably even longer. Except in being slightly smaller, the posterior caudals are very similar to the anterior; they have the same slender transverse processes and similar long chevrons.

#### *Shoulder-girdle.*

Though the shoulder-girdle is rather badly preserved, sufficient remains to show all the principal features. The scapula is comparatively short and moderately flat. Its greatest length is 29 mm. The upper end is 16 mm. wide, and has evidently supported a large cartilaginous suprascapula. The posterior border curves gently and uniformly to the glenoid cavity. The anterior border is badly preserved, there being only indications of the cast. In fig. 10 (Pl. XL.) a view is given of the shoulder-girdle as preserved, and in fig. 11 a restoration of the whole girdle. The lower end of the scapula is probably 14 mm. wide, and there is no evidence of any notch. The coracoid is very imperfect, but the whole of the anterior half and the glenoid portion are preserved. It has evidently been a large flat rounded bone. There is no coracoid foramen seen in the specimen so far as preserved. Perhaps the foramen was in the cartilage at the anterior and upper corner of the bone. There is no precoracoid. The interclavicle is a slender T-shaped bone, but only a part of the upper end is preserved. The clavicles are long, fairly straight bones which meet each other above the interclavicle. The length of the one which is fully preserved is 23 mm.

#### *Humerus.*

The humerus is in bad preservation, the upper half being represented only by a much weathered impression. The length



of the bone is about 34 mm. Both the upper and lower ends are broad, and they make with each other an angle of about  $60^{\circ}$ . The delto-pectoral ridge is fairly well developed, but the imperfect impression does not show very clearly its relations to the shaft. There is apparently no epicondylar foramen. The lower end of the bone measures about 10 mm. It has evidently been capped by a large pad of cartilage.

#### *Pelvis.*

The remains in specimen C are much better preserved than in either A or B. All the pelvic bones are preserved and in almost true apposition. The under and outer sides of both pubes and ischia have been displayed, and the inner side of the right ilium.

The pelvis is a slightly modified variety of the well-known plate-like type found in all primitive Diaptosaurian reptiles. The ilium is broad and flat, and its axis is directed upwards and backwards from the acetabulum. It is presumed that the acetabulum is of large size from the shape of the lower part of the ilium, and probably it had a thick coating of cartilage. The acetabular portion of the ilium measures 19 mm. across. Above the acetabulum the bone becomes constricted and measures only 12 mm. across. From this point the upper part forms a fan-like expansion, which measures 25.5 mm. from front to back. The greatest length of the ilium is 34 mm., and the least, measuring from the surface for articulation with the ischium to the anterior part of the crest, 22 mm. On the inner side of the ilium is a hollow depression just above the constricted portion, with a second slight depression behind it and separated from it by a low ridge. These depressions are for articulation with the two sacral ribs.

The ischium is a flat semicircular bone not unlike the flat bone in *Procolophon* or *Stereosternum*. Though the acetabular portion is not displayed in *Howesia*, it is probably of much larger size than in these other genera. It seems probable that the ischium sloped downwards and inwards at an angle of about  $45^{\circ}$ . The whole margin of the bone has manifestly been bordered by cartilage except the margin which is directed upwards. The lower margin for about 17 mm. is fairly straight, and forms, with the bone of the opposite side, a symphysis with probably comparatively little cartilage between. Anteriorly there is another fairly straight margin of 10 mm., which served as an articulation with the pubis, probably again with but little cartilage between the bones. Between the two ischia and the two pubes there is left a lozenge-shaped gap, like the anterior fontanelle in the head of a babe. This may have formed an obturator foramen, but I am of opinion that it was completely covered by cartilage.

The pubis, though of the plate-like type, does not resemble at all closely the flat pubes of *Procolophon*, *Stereosternum*, or *Palæohatteria*. This is owing to the fact of the anterior third of the bone being bent rather abruptly down so as to form an angle of about  $75^{\circ}$  with the posterior part. The deflected portion has its outer and inferior end terminated by a thick margin, which seems

to have been covered by cartilage. Whether this cartilage has, only been a narrow border round the front of the bone, or a well-developed prepubic cartilage, the evidence does not conclusively show. About the middle of the outer side of the pubis is a well-marked bony process. There is a large pubic foramen in the bone near its posterior and upper corner. The greatest length of the pubis is 25 mm., and the greatest breadth 19 mm.

In fig. 15 (Pl. XLI.) is shown a side view of the pelvis slightly restored as regards the acetabulum. All the bones are shown in what is believed to be true side view. In fig. 16 there is given for comparison a view of the pelvis of the large South-African Phytosaur *Erythrosuchus*. Here the pubis and ischium are also of the plate-like type, but the modification is carried further than in *Howesia*. The pubis is bent down still further and the lower part stouter. The symphyseal portions of both pubis and ischium are directed more inwards. Fig. 18 shows the left pubis as viewed from below and slightly from behind and the outer side.

#### *Femur.*

Portions of both femora are preserved, and both the upper and lower ends of the left are in good condition. The bone is slightly curved downwards towards its lower end, as is the case in the femur of the Crocodile. Both ends have been largely cartilaginous. Pl. XLI. fig. 20 represents the appearance of the proximal end. There is a large trochanter which has probably been devoid of cartilage, and a large, flat, semicircular surface which has supported the cartilaginous head. The lower end of the bone is broad and powerful, and has doubtless had large cartilaginous condyles.

#### *Tibia and Fibula.*

The left tibia is practically complete, but the lower third is slightly displaced, owing to a fracture which occurred during the animal's life and united with the fragments in a slightly false position. The bone is much expanded at the proximal end, which has a rounded upper surface and had probably little cartilage on it. Its greatest width is 16 mm. The bone is much constricted in the middle, measuring only 5 mm. across. The lower end is not much expanded, and probably had a well-developed pad of cartilage. The total length of the bone is 50 mm.

The fibula is slender in the middle and considerably expanded at both ends. It has a slight double curve. It is probably a little shorter than the tibia.

In fig. 21 a view is given of the front of the tibia restored so far as the correction of the slight displacement of the lower fragment. Fig. 22 shows the tibia and fibula as preserved in the specimen.

#### *Pes.*

A considerable portion of the right foot is preserved, and though some of the bones are displaced it is possible to make a fairly satisfactory restoration of both the tarsus and metatarsus.

Figs. 23 and 24 show two views of the tarsus as preserved. There are seen to be three large bones in the proximal part of the tarsus, and the tibia seems to be in connection with the inner and the fibula with the middle one. These three bones we may fairly confidently regard as tibiale, intermedium, and fibulare. On the outer side of the foot is a large curved bone which is manifestly the 5th metatarsal. This is supported by a large tarsale which we may regard as the 4th. The other tarsal elements are small. If these determinations are correct, then it would appear that the foot has been folded on the leg and the sides crushed together. Making allowance for the crushing the foot may be restored as in fig. 25.

The tibiale is an irregularly oval-shaped bone and is the smallest of the elements of the proximal row. The intermedium is a large rectangular bone. On its under or posterior surface there is a large groove. The fibulare forms a well-marked heel process. There is no centrale displayed, but it is probable that one existed though it may have been cartilaginous. Of the distal tarsal bones the 1st, 2nd, and 3rd are of small size, each supporting a single metatarsal. The 4th tarsale is about as large as the tibiale and supports both the 4th and 5th metatarsals. The 1st metatarsal is rather short and stout. The 2nd, 3rd, and 4th are all imperfect at their distal ends, but the 2nd is considerably longer than the 1st, and the 3rd and 4th much longer than the 2nd. It is not certain whether the 3rd or 4th is the longer, but the little evidence available points to the 4th being the longest of the metatarsals.

#### *Affinities of Howesia.*

The only animals with which it seems necessary to compare *Howesia* are *Sphenodon*, the Gnathodonts *Hyperodapedon*, *Stenometopon*, and *Rhynchosaurus*, the Phytosaurs, and the Proterosaurs such as *Palaeohatteria*. The jugal, postorbital, and post frontal bones bear considerable resemblance to the corresponding bones in *Sphenodon*, but almost quite as much to those of the much more primitive Diapsosaurians, the Pelycosaurs, and of *Palaeohatteria*. There is also considerable resemblance to the facial bones of *Rhynchosaurus*. In the other Gnathodonts the resemblances are obscured by the specialisations. The frontals and parietals are more like those of *Rhynchosaurus* and even of *Stenometopon* than of *Sphenodon*, and the resemblance is increased by the fact of the parietal foramen being practically absent in *Howesia*. The maxillary and dentary dentition is unlike that of any other reptile hitherto known except *Hyperodapedon*; and though this latter genus is extremely specialised, the mode of implantation of the teeth in the bone is so essentially similar to that in *Howesia*, as to suggest a relationship between the genera. The palate is more primitive than in either *Sphenodon* or *Hyperodapedon*, and resembles more that of the Pelycosaurs. It also bears some resemblance to the palate of the Rhynchocephaloid reptile, *Proterosuchus*.

The shoulder-girdle differs from the earlier types in having no precoracoid. In many respects the girdle resembles that of

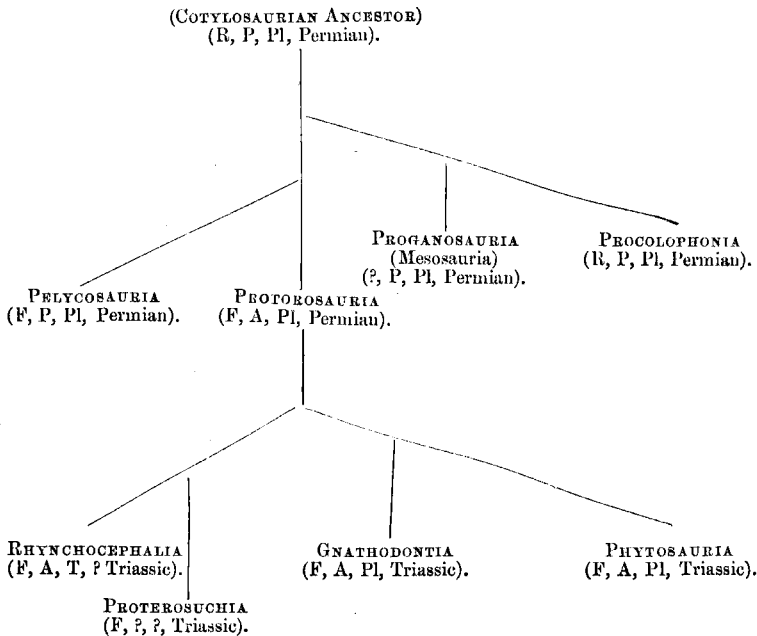
*Sphenodon*, but the imperforate condition of the coracoid is a feature found in a few Diaptosaurians.

The pelvis is not much modified from the type found in most Diaptosaurians. The plate-like pubis and ischium are found in *Rhynchosaurus*. In the Phytosaur *Erythrosuchus* the pelvis is very similar in structure; in *Sphenodon* the pelvic structure is very different.

It is impossible to compare the tarsus with that of most allied forms, as little is known of the tarsus in the Gnathodonts or Phytosaurs. There is, however, an undoubted resemblance between the tarsus of *Howesia* and that of *Sphenodon*, and this is more marked when that of the embryo is considered. The similarity is so close, that it is difficult to doubt that it indicates a relationship. In *Procolophon* we also see some affinity. It is interesting to note the similarity of the mode of articulation of the 5th metatarsal.

Taking the various points into consideration, I conclude that *Howesia* is a very slightly specialised Gnathodont. It seems to show, moreover, that the Gnathodonts are not true Rhynchocephalians, but are probably more nearly related to the Phytosaurs. I incline to agree with Osborn in placing them in a distinct order, no doubt showing some points of resemblance to the Rhynchocephalians, but not so nearly related to them as is generally held.

In the following table an attempt is made to indicate the phylogenetic relationships of the Diaptosaurian orders:—



In the above table the first letter of the formula, R or F, indi-

cates that the skull has the temporal region roofed or fenestrated; the second letter, P or A, indicates that a precoracoid is present or absent; and the third, Pl or T, that the pelvis is plate-like or triradiating. It will be observed that all the orders occurring in the Permian have the pelvis plate-like, all have notochordal vertebræ, and most have retained the precoracoid, while all those that first appear in the Trias show no trace of a precoracoid. I have included among the Diaptosaurians a new suborder, or possibly order, Proterosuchia, of which *Proterosuchus* may be taken as the type. Boulenger is inclined to place it near to *Ornithosuchus*, but the palate is very different in the two genera, and the presence of rows of teeth on the pterygoids of the African genus seems of sufficient importance to remove it from the Phytosauria. It seems to me worthy of being placed in at least a distinct suborder. The Phytosauria might, I think, be included among the Diaptosaurians. Further research in the Permian and Triassic rocks is pretty certain to reveal a large number of new groups—groups which are ancestral to the Plesiosaurs, the Chelonians, the Lizards, and the Ichthyosaurs at least.

## EXPLANATION OF THE PLATES.

*Ang.*, Angular; *c.*, centrale; *Cl.*, clavicle; *Co.*, coracoid; *D.*, dentary; *F.*, fibula; *f.*, fibulare; *Fr.*, frontal; *Hy.*, hyoid; *i.*, intermedium; *I.cl.*, interclavicle; *Il.*, ilium; *Is.*, ischium; *Ju.*, jugal; *L.*, lachrymal; *Mr.*, maxilla; *Na.*, nasal; *Orb.*, orbit; *Pa.*, parietal; *Pal.*, palatine; *Pmx.*, premaxilla; *Pof.*, postfrontal; *Pos.*, postorbital; *Pt.*, pterygoid; *P.Vo.*, prevomer; *Pa.*, pubis; *S.Ang.*, surangular; *Sc.*, scapula; *Sq.*, squamosal; *S.Sc.*, suprascapular; *T.*, tibia; *t.*, tibiale; *T.P.*, transpalatine; 1, 2, 3, 4, tarsalia; I, II, III, IV, V, metatarsalia.

## PLATE XL.

- Fig. 1. Restoration of skull of *Howesia browni*. Nat. size.
2. Restoration of palate of *Howesia browni*. Nat. size.
3. Specimen A showing portion of mandible and cast of jugal and other bones. Nat. size.
4. Jugal and postorbital bones of *Howesia browni* (specimen B). Nat. size.
5. Portion of upper surface of skull of *Howesia browni* (specimen B). Nat. size.
6. Remains of palate as shown in specimen A. Nat. size.
7. Portion of left dentary showing teeth (specimen A).  $\times 3$ .
8. Middle portion of left maxilla showing teeth (specimen A).  $\times 3$ .
9. Posterior part of left maxilla showing teeth (specimen B).  $\times 3$ .
10. Shoulder-girdle as preserved (specimen B). Nat. size.
11. Restoration of shoulder-girdle of *Howesia browni*. Nat. size.
12. Shoulder-girdle of young *Sphenodon*, after Howes & Swinerton.
13. Humerus of *Howesia browni*. Nat. size.

## PLATE XLI.

- Fig. 14. Anterior caudal vertebra of *Howesia browni*. Nat. size.
15. Side view of pelvis of *Howesia browni*. Nat. size.
16. Side view of pelvis of *Erythrosuchus africanus*.  $\times \frac{1}{10}$ .
17. Inner view of right ilium of *Howesia browni*. Nat. size.
18. Under view of left pubis of " " "
19. Front view of left femur of " " "
20. Proximal end of left femur of " " "
21. Front view of left tibia of " " "
22. Side view of left tibia and fibula of *Howesia browni*. Nat. size.
23. View of the foot as preserved. Nat. size.
24. A second view of the foot as preserved. Nat. size.
25. Restoration of the tarsus and metatarsus of *Howesia*. Nat. size.
26. Foot of *Sphenodon punctatus*. Stage R. Magnified.
27. " " " " Stage Q. Magnified, after Howes & Swinerton.
28. Foot of *Procolophon trigoniceps*. Nat. size.

3. On the Vascular System of *Heloderma*, with Notes on that of the Monitors and Crocodiles. By FRANK E. BEDDARD, M.A., F.R.S., &c., Prosector to the Society.

[Received May 11, 1906.]

(Text-figures 99-106.)

Although much work has been done upon the blood-system of the Lacertilia, especially by Rathke and Hochstetter\*, there remain a number of important genera of which we have at present either no knowledge whatever, or the very slightest only. Among these is the genus *Heloderma*, with the general anatomy of which the recent investigations of Boulenger, Stewart, and particularly Shufeldt† have made us well acquainted. In the present communication I bring before the Society some facts concerning the blood-vessels of this Lizard in continuation of former contributions to the anatomy of this Order of Reptiles‡.

Having had the opportunity, during the last year or two, of dissecting several examples, comprising several species, of *Varanus*, I incorporate these notes into the present communication for the reason that *Heloderma* is in some respects not very remote from *Varanus*§, and indeed shows certain apparent resemblances to that genus in the arrangement of the blood-vessels, as will be pointed out in the course of the following pages.

Since both in *Heloderma* and *Varanus* there is a departure in many directions from the arrangement of the blood-vessels found in other Lacertilia (e. g. *Iguana*, Skinks, Geckos, *Ophisaurus*, *Amphisbæna*, *Anguis*), and on the whole in the direction of greater complication, it seemed to me important to compare the ascertained facts with those relating to the Crocodilia, since the vascular system of the Crocodilia is perhaps the most advanced among the Reptilia. In this department I am able to add some details to the classical treatise of Rathke, in addition to the facts accumulated by Jacquart and Hochstetter, whose contributions will be referred to on a later page. Of the Crocodilia I have been able to dissect several species belonging to more than one genus.

(1) *On some Veins and Arteries in Heloderma suspectum.*

In a specimen of *Heloderma suspectum* which died in the Society's Gardens in January of the present year, the veins were turgid with blood, and therefore in an excellent state for anatomical observation. I had the arterial system injected, and am therefore able to give, as I trust, some reliable notices of various

\* Morph. Jahrb. xix. 1893, were earlier papers are referred to.

† Boulenger, P. Z. S. 1891, p. 109; Stewart, *ibid.* 1891, p. 119; Shufeldt, *ibid.* 1890, p. 148.

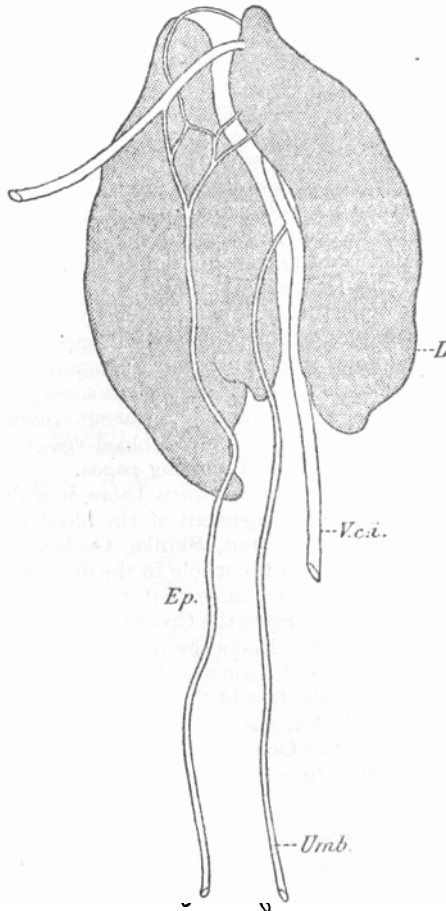
‡ In P. Z. S. 1904 and 1905.

§ This is not a prevalent view though adopted by Baur. See Boulenger (P. Z. S. 1891, p. 116) for discussion of the subject.

arteries and veins in this genus, of which we have at present no knowledge save a few notes by Dr. Shufeldt\*.

*Umbilical Vein.*—It is extremely interesting to find in *Heloderma* very considerable vestiges of the umbilical vein of the

Text-fig. 99.



Ventral surface of liver and related veins in *Heloderma suspectum*.

*Ep.* Epigastric vein; *L.* Liver; *Umb.* Umbilical vein; *V.c.i.* Postcaval

fœtus. This vein ends off somewhat obscurely posteriorly, gradually fading away without being connected, so far as I could

\* "Contributions to the Study of *Heloderma suspectum*," P. Z. S. 1890, p. 148. This paper concludes with a full bibliography.

ascertain, with any veins in the posterior region of the abdomen. It runs, of course, upon the ventral side of the abdominal cavity lying to the left of the anterior abdominal vein. This position at first led me to think that the vein in question was a left anterior abdominal vein, such as is met with in addition to a right in the Crocodilia invariably and in the Chelonia generally. I think, however, that the facts which I have to state about this vein disprove the idea that it is a second anterior abdominal vein and prove it to be a persistent umbilical. This vein is by no means a ligamentous rudiment such as Hochstetter has described and figured \* the umbilical to be in *Anguis fragilis*. It contains plenty of blood; but it looks rather like an artery owing to its pink colour—due, I imagine, to thickish walls. It is, however, not an artery; for anteriorly it could be followed between the lobes of the liver ventrally, and perhaps about halfway along the length of the liver was traced into communication with the vena cava posterior, which latter, on separating the lobes of the liver, can be seen lying between them. It could be distinctly observed at the same time that various branches of the epigastric vein (see p. 609) which enter the liver near the entry of the umbilical did not communicate with the vena cava but entered the liver-substance. There can be no confusion therefore of this presumed persistent umbilical vein with a branch of the epigastric system of veins. It is further to be noted that the umbilical vein is in its relations to adjoining viscera more like that of birds than of the Boidæ, where alone among existing Sauropsida—so far as we know at present—this vein persists in the adult. That is to say, the vein is lost to sight until the two lobes are separated at about the middle of the liver as in the Class Aves, instead of extending beyond the liver as in the Python † for example, and joining the vena cava in front of that organ. On another page ‡ I call attention to the possible persistence of the umbilical vein in the Monitor lizards, which vein, however, shows certain differences from that which I describe in *Heloderma* as an umbilical. There is no doubt, however, that the vein in *Heloderma* corresponds to what is clearly the persistent umbilical in the Anaconda, &c. in bearing no part in the circulation, *i. e.* in not being furnished with branches.

*Anterior Abdominal Vein.*—This vein is, as is universal among the Lacertilia §, a single median vein, and was very full of blood in the specimen which I dissected. The origin of the vein in the pelvic region seems to me to be more like that of *Varanus* than of such other Lizards as have been examined. Of *Varanus arenarius* (= *V. griseus*) Hochstetter || has written :—"Ein zweiter wichtiger Differenzpunkt betrifft die Lage der Wurzel der Abdominalvene,

\* Morph. Jahrb. xix.

† Beddard, "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 28.

‡ Below, p. 611.

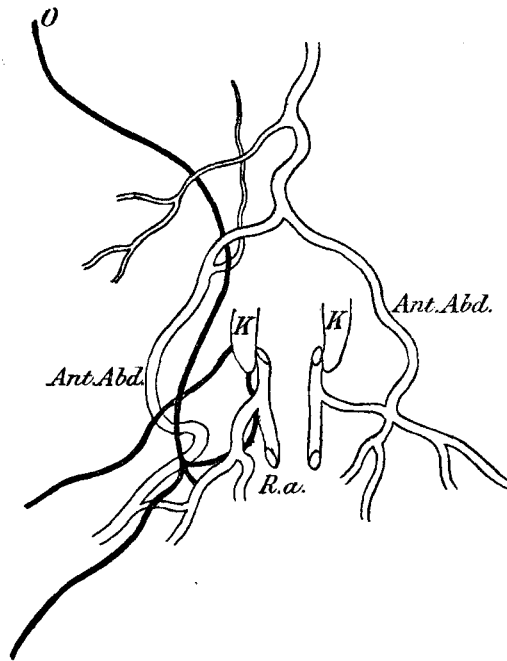
§ Excepting possibly *Varanus* (see below, p. 611).

|| Morph. Jahrb. xix. p. 467.



die sich bei *Varanus* als unmittelbare Fortsetzung der V. ischiadica präsentirt." The accompanying figure given by Hochstetter\* shows this point clearly, the vein in question merely giving off a branch in passing to the afferent renal behind the kidney. In *Lacerta*, &c., on the other hand, it is rather that the ischiadic vein joins the afferent renal and gives off the anterior abdominal as a branch before doing so, and that this junction takes place at or near the middle of the kidney. *Iguana*† and some other lizards agree with *Lacerta* in these points; but hitherto *Varanus* has stood alone among the Lacertilia, though showing resemblances, in the arrangement of the vein under discussion, to the Crocodiles.

Text-fig. 100.

Origin of anterior abdominal vein in *Heloderma suspectum*.

*Ant. Abd.* Two roots of anterior abdominal vein; *K*. Kidneys; *R.a.* Renal afferent veins; *O*. Fat-body artery (this and others, *i.e.* femoral and sciatic arteries, indicated in black).

In *Heloderma*, however, there is a distinct likeness to the Varanidæ which cannot be overlooked. In the accompanying illustration the roots of the anterior abdominal are shown upon both sides of the body (text-fig. 100), and it will be observed that

\* *Loc. cit.* Taf. xvi. fig. 17.

† Beddard, P. Z. S. 1904, vol. i. p. 442.

they are somewhat asymmetrical; a fact which does not disguise the resemblance which they bear in details to the corresponding veins of *Varanus*. On the right side, the two veins which issue from the leg are connected below the pelvic region by an anastomosis whose calibre is as great or nearly so as that of the two veins which it joins. The junction lies to the dorsal side of the femoral artery which crosses it below. The more anterior of the two veins, which I presume to be the sciatic, then bends upon itself, but passes directly into the anterior abdominal vein, of which it forms the right root. The other vein, the femoral, receives the usual lateral caudal vein and joins the right branch of the caudal, forming with it the renal afferent vein of the right kidney. This junction takes place behind the kidney. The ischiadic artery lies dorsal of this vein, and is crossed ventrally by the conjoined femoral and lateral caudal. It appears from Hochstetter's figure that the relative positions of these blood-vessels is exactly the reverse in *Varanus*, that the artery is ventral of the vein. On the left side of the body, the likeness to *Varanus* is exhibited in a more striking way, since the junction of the veins in the leg is more normal. The two veins of the leg unite with each other, and shortly thereafter divide into the left root of the anterior abdominal vein and a branch joining the left renal afferent vein behind its point of contact with the corresponding kidney. Just before this division the common trunk from the leg receives the lateral caudal. The arrangement of these various veins is therefore exactly as in *Varanus*, and thus differs equally from that prevalent among the Lacertilia. The anterior abdominal is chiefly concerned with the blood returned from the fat-body, from which it receives a considerable number of affluents. I noticed only one branch from the fat-body to join the right root of the anterior abdominal, the rest poured their contents into the common trunk.

The hepatic portal system of this Lizard is more complex than that of many other Lizards. In addition to the usual veins, derived from the parietes and viscera, common to the Lacertilia as a whole, there are, as will be seen from the following account, certain veins which are not represented, or are rarely represented, in other genera of the Lacertilia.

*System of Vertebral Veins and branches to Liver.*—It is the rule among the Lacertilia for the azygos and the vertebral veins and their branches to the liver to be mainly developed upon the right side of the body, and for the separate gastro-hepatic affluents of the portal system to be independent not only of the main portal vein, but also of the dorsal parieto-hepatic veins running from the body-wall to the liver-substance. In these various particulars the venous system of *Heloderma* is rather different from that of other Lizards.

The *Azygos Vein* in *Heloderma* is short and to be found only

upon the right side of the body, its usual position not so much in the Lacertilia as in the Ophidia generally.

It is of very limited extent in the present lizard, and after reaching the neighbourhood of the vertebral column plunges at once into the thickness of the parietes. It appears on the surface for a brief interval between the two following intercostal arteries. Five intercostal arteries then intervene before the next appearance superficially of the vertebral vein, which is here developed upon both sides of the vertebral column. The longitudinally running vein of the left side is the more important of the two and draws blood from six intercostal spaces; the right-hand vein is shorter but developed in the same region of the vertebral column as the left. The two vessels join and enter the liver near to its anterior end together by a common trunk. This trunk receives before it reaches the liver a branch from the stomach, the *gastro-hepatic*, which is in its turn composed of two vessels, one of which runs along the stomach forwards and the other passes along the stomach towards its posterior end. This posterior *gastro-hepatic vein* has other rather unusual relations with the portal system. It gives off a small branch which goes at once to the liver. Posteriorly it does not communicate with the general portal system of the alimentary tract as in other Lizards, but ends by joining the anterior abdominal vein behind the point where the latter receives the intestinal portal. The somewhat complicated relations of these several veins will perhaps be rendered clearer by an inspection of the accompanying diagram of their course (text-fig. 101). In possessing that anterior system of parieto-hepatic veins which are connected with the gastro-hepatic veins, *Heloderma* does not merely differ from the more typical Lacertilia, but agrees with the Boine snakes, the snake-like Lizard *Ophisaurus*\*, with *Hatteria*, and, as will be seen presently †, with the Varanidæ, though to a less extent with these also aberrant Lizards. The entire separation of the gastric from the intestinal portal system is also noteworthy; and it will be obvious that, in spite of the points of resemblance with other Squamata insisted upon, the details of this part of the venous system are peculiar to *Heloderma* and distinguish it from other Lacertilia.

*Heloderma* possesses, as do all other Lacertilia which have been examined, a series of veins entering the right lobe of the liver close to its posterior extremity, the *posterior dorsal parieto-hepatic veins*.

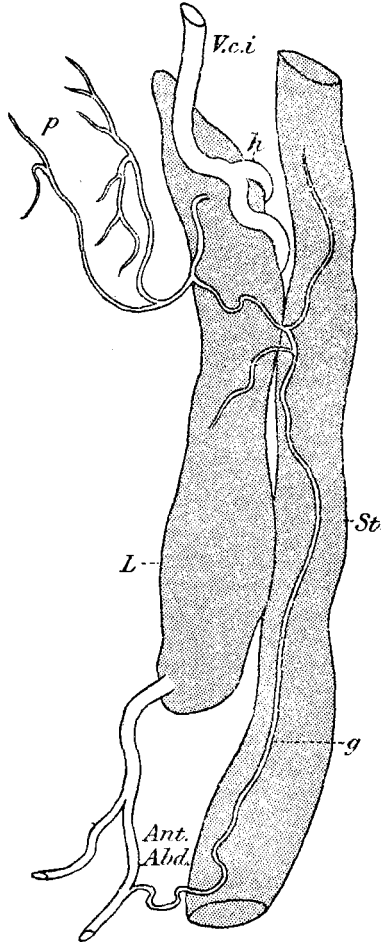
These vessels originate by several roots, which unite to form one trunk as in *Varanus*. There are four separate roots, which arise from the parietes on the right side of the body and lie between three intercostal arteries. The single trunk formed by their union enters the right lobe of the liver close to the postcaval vein, and by the aid of a fold of membrane which, as in so many

\* Beddard, P. Z. S. 1905, vol. ii. p. 474.

† *Infra*, p. 616.

Lacertilia including *Varanus*, attaches the extremity of the liver to the lateral parietes. Two of the four roots lie between two intercostal arteries, each close to an artery. These do not join

Text-fig. 101.



Certain hepatic veins of *Heloderma suspectum*.

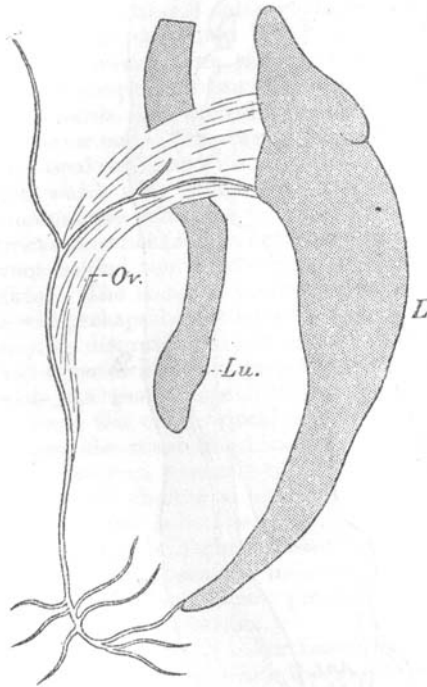
*Ant. Abd.* Anterior abdominal vein; *g*, Gastro-hepatic vein; *h*, Hepatic vein joining postcaval (*V.c.i.*); *L*, Liver (viewed laterally); *p*, Parieto-hepatic veins from right and left of mid-dorsal line; *St*, Stomach.

for some distance from their point of origin from the parietes. The second pair of roots lie between the second of the two inter-

costal arteries just referred to and the next; they join immediately to form one stem. The conjoint stem receives branches from the fat-body. The following intercostal is embraced by the two roots of a vein belonging to the same series, which, however, belongs to the suprarenal portal system.

*Oviducal Vein.*—The oviduct is borne by a membrane which is attached to the lateral parietes and anteriorly passes over the lung, becoming attached to its proximal section in its passage, and is inserted on to the liver. Anteriorly, therefore, this membrane is transversely disposed to the longitudinal axis of the body

Text-fig. 102.



Oviducal membrane in *Heloderma suspectum* showing attachment to liver.

*L.* Liver (pushed over to left and viewed laterally); *Lu.* Right lung;  
*Or.* Oviducal membrane bearing vein.

and arches over the distal part of the lung. This membrane bears a vein which follows its edge. Anteriorly, the oviducal vein gives off a branch just at the funnel of the oviduct, and another where the oviducal membrane arches over the lung, which runs towards the line along which the oviducal membrane is attached to the lung. It ends by entering the liver-substance,

and thus forms a part of the hepatic portal system. On the right side of the liver, a little process of liver-substance juts out to meet the vein. This does not occur in the case of the left-hand vein. The arrangement of oviducal membrane and the vein which it bears appears to me to be exactly the same as a corresponding series of structures which I described some time ago in the *Chamæleon* \*.

*Epigastric Veins.*—These veins in *Heloderma* (text-fig. 99, p. 602) form a median unpaired system unlike the corresponding veins of *Varanus*. The principal vein of the system enters the liver very anteriorly quite close to the end of that organ. The epigastric generally, it is to be observed, is connected with the liver well in front of the entrance of the umbilical vein. The main stem of the epigastric was broken off, and a corresponding break on the largest branch of the abdominal vein may perhaps indicate the junction of the two. The main stem, whose actual course I am thus unable to map, gives off a backwardly running branch which extends beyond the liver. This latter stem is also connected directly with the liver itself by two branches which it gives off just before ending in the main stem of the epigastric. These form an anastomosis with each other, and there are altogether formed three exits into the liver, in addition, of course, to the main epigastric stem.

*Arterial System.*—Dr. Shufeldt, in his memoir already referred to †, has made a few comments upon the arteries arising from the aorta behind the heart. He has not, however, dealt in any way with the arteries at their point of origin from the heart. The general arrangement of the exits of the arteries does not seem to me to differ from what is found in the *Lacertilia* generally. The heart also is bound to the pericardium by the tag which is so general in the group. On the right side, the systemic trunk and the carotid run side by side for a long distance after their emergence from the common trunk by which they originate from the ventricle. The systemic trunk then doubles upon itself to pass back towards its point of junction with the aorta of the opposite side of the body, the carotid continuing its forward course. There is not the least trace, that I could discover, of the *ductus Botalli* joining the systemic and carotid arches, which is so prevalent among the *Lacertilia*. The contact between the two trunks concerned is so close and exists for so long a space, that there is, so to speak, every opportunity for the connection to have been preserved. Yet it is absent. In this feature *Heloderma* obviously agrees with *Varanus* and *Amphisbæna*, in which genera there is no such *ductus Botalli* to be found.

The left aortic arch gives off no branches. The right aorta gives off several pairs of intercostals as well as the subclavians, which, as in many Lizards, arise the one behind the other. As is the rule elsewhere, the left subclavian arises behind the right. Very shortly after the junction of the two aortæ arises a slender

\* "Contributions to the Anatomy of the Lacertilia," P. Z. S. 1904, vol. ii. p. 9.

† P. Z. S. 1890.

œsophageal artery; there is then a considerable gap until, on a level with the anterior extremity of the liver, an artery arises which closely accompanies the branches of the vertebral vein already described, and supplies the liver and the stomach. There is then a considerable gap until the origin of the three usual arteries which supply the greater part of the alimentary tract. The first of these is that supplying the stomach, spleen, and commencement of the intestine; the two which follow are so close together that they may almost be said to arise in common. Of these the cæcal artery is the anterior.

§ *Summary of more important facts in the Vascular System of Heloderma.*

As compared with other Lacertilia, the following facts in the anatomy of the vascular system of *Heloderma* are particularly noteworthy:—

- (1) The absence of any *ductus Botalli* between the carotid and systemic arches. *Varanus* (as well as some other Lizards) agrees with *Heloderma*.
- (2) The origin of the anterior abdominal vein as a direct continuation of the ischiadic veins as in *Varanus* and the Crocodilia.
- (3) The persistence of the foetal umbilical vein as an affluent of the postcaval vein, not in front of the liver as in Snakes, but in the region of the liver as in Birds. It is possible that *Varanus* agrees in this\*.
- (4) The existence of anterior parieto-hepatic veins as in Snakes and certain snake-like Lizards, in addition to the usual posteriorly developed veins opening, as in other lizards, into the extremity of the right lobe of the liver. Here also *Varanus* agrees with *Heloderma*.
- (5) The independence of the gastric portal system from the intestinal portal system. The veins of the stomach either open directly into the liver, or by way of the anterior abdominal vein†; they do not join the portal vein.

(2) *On the Venous System in the Genus Varanus.*

The only notes hitherto published upon the venous system of the genus *Varanus* relate exclusively to the species *V. griseus*‡. Having made a careful dissection of this § as well as of two other species, and having accumulated some notes upon a few facts in

\* Below, p. 611.

† The connection of the gastric veins with the anterior abdominal vein is of course also to be seen in the Crocodilia.

‡ Corti: *De Systemate Vasorum Psammosauri grisei*, 1847.—Hochstetter: "Beiträge z. Entwicklungsgeschichte des Venensystems, &c.," *Morph. Jahrb.* xiv. p. 464. The species is called *V. arenarius*, a synonym.—Beddard: "On the Venous System in Certain Lizards," *P. Z. S.* 1905, vol. i. p. 447.

§ Not the same individual described in the paper above quoted.

other species again, I am able to add something to the recorded knowledge of the venous trunks of this—as I consider it—aberrant genus of Lacertilia.

*Hepatic Portal System.*—The Lacertilia generally differ from the Chelonians and the Crocodilia in possessing but one anterior abdominal vein, while the latter, with the exception of *Dermochelys*, possess two\*.

The Ophidia and *Hatteria* agree with the Lacertilia with some slight exception.

Thus in certain Boidæ† the anterior abdominal divides after the union of the two pelvic roots to reunite again before entering the liver. It is therefore noteworthy that *Varanus niloticus* (only this species among those which I have examined *ad hoc*) has, like these Ophidians, an anterior abdominal which is double for a part of its length. In one specimen the arrangement was as follows:—the right root of the anterior abdominal vein before joining the left root gives off two branches; the first of these is the right anterior abdominal, the second is a vein which brings blood from the ventral surface of the pelvis. The right anterior abdominal is of less calibre than the left or main anterior abdominal trunk; the two unite not far behind the junction of the portal vein with the conjoined anterior abdominal vessels. In a second specimen of the same species the anterior abdominal was also double; but I am unable to give exact details. So also with a third individual which was dissected by me a good many years ago, but of whose anatomy I possess notes.

It will be noted from the above description, that the double character of the anterior abdominal vein in *Varanus niloticus* may be rather different from that of the Python and nearer to that of the Crocodilia. For in the serpent the double vein occurs after the fusion of the two pelvic roots, while in *Varanus* the second, smaller, anterior abdominal vein is a direct offshoot of the corresponding pelvic root. It is, that is to say, separate from the very first. *Varanus* does not show, so far as I have observed, any signs of a doubling of the anterior abdominal vein at the liver end. If the comparison between *Varanus* and the Crocodilia be justified so far as concerns these features, it is clear that the posterior junction between the right and left anterior abdominals in *Varanus niloticus* is to be compared with the junction in *Crocodilus cataphractus*‡ between the two anterior abdominals, though the situation of this connecting vessel is not precisely the same in both reptiles.

*Umbilical Vein.*—Besides the two epigastric veins already described, there is a median vein which is connected posteriorly with the anterior abdominal and anteriorly opens into the post-caval vein between the two liver-lobes. Its course was ascertained

\* Burne: "Notes on the Muscular and Visceral Anatomy of the Leather Turtle," P. Z. S. 1905, vol. i. p. 320.

† Beddard: "Notes upon the Anatomy of Certain Snakes of the Family Boidæ," P. Z. S. 1904, vol. ii. p. 116.

‡ *Idem*, p. 620.



accurately. It does not form part of the liver circulation, but is definitely connected with the general circulation by means of the postcaval. It seems to me to be possible, although I am unable to offer any embryological evidence, that this vein is a persistent umbilical. It has very much the same relations as has the vein in *Heloderma*\*, which is, as I think, to be referred to a persistent umbilical, except for the fact that it communicates in *Varanus* with other veins; this is not the case with the umbilical of *Heloderma*, or of snakes, in which it occurs with one exception. That exception is *Bitis nasicornis*†, where I found that the undoubted umbilical vein was connected with the epigastric system. There is thus a precedent for a persistent umbilical connected in the adult with other veins among the Squamata.

The same is the case with the persistent umbilical of Birds and of *Echidna*‡. Thus the connection with the parietal and other veins is not at the least evidence against regarding this vein in *Varanus* as the persistent umbilical. Moreover, the connection does not occur in both of the species, in which I have detected what I believe to be a persistent umbilical. In *Varanus niloticus* the umbilical is connected just at its entrance into the postcaval with a forwardly running branch. On the other hand, in *Varanus exanthematicus* the vein had no such branch and appeared to end posteriorly without making any connection with the epigastric system or being elsewhere connected with the parietes. I have not any notes or sketches showing this vein in *Varanus griseus*, and its occurrence is not mentioned by either Corti§ or Hochstetter||. It is particularly difficult to prove a negative in the case of veins; and accordingly I prefer rather to dwell upon the presence of the vein that has just been described in two species of *Varanus*.

*Azygos and Lateral Parietal Veins.*—On the right side of the body is a vein which seems to correspond to the azygos of other reptiles, but to be of more limited extent than is often the case. The vein, in fact, plunges into the thickness of the parietes directly it reaches the side of the vertebral column. In another specimen the azygos consisted of two branches, which also disappear into the parietes at once. The vein of course arises from the right vena cava superior. I am inclined to think that Hochstetter is in error when he speaks of a vessel obviously corresponding in the following words:—"Eine dritte sehr mächtige [Intervertebralvene] findet sich rechts als die vorderste im Brustraum und geht in weitem Bogen in die V. cava superior sinistra¶ ein." From this azygos, before it reaches the side of the vertebral column, arises the posteriorly running lateral abdominal or, better, lateral parietal vein, as I propose to call it. The vessels have already been to some

\* *Supra*, p. 602.

† "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 41.

‡ Cf. Beddard: "Anterior Abdominal Vein in *Echidna*," P. Z. S. 1884, p. 553; and Hochstetter in Semon, "Zoologische Forschungen," &c., Jen. Denkschr. 1895.

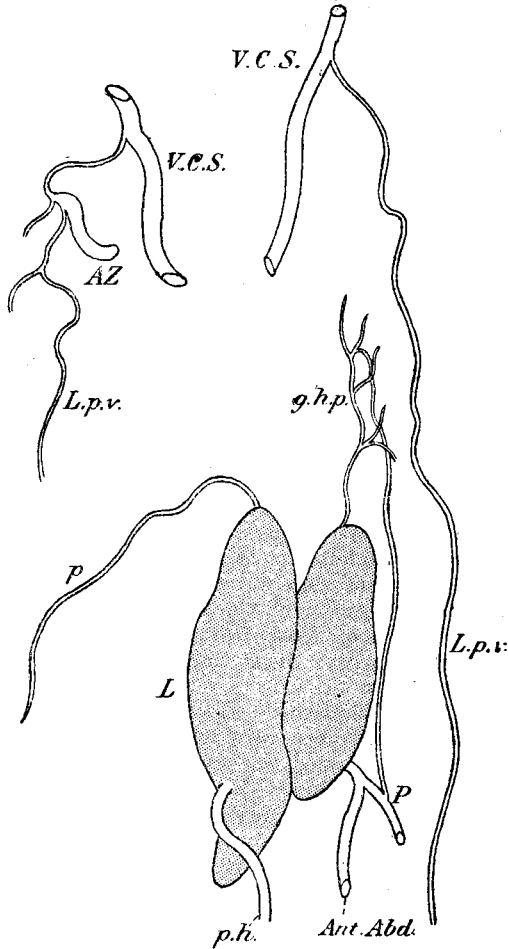
§ *Loc. cit.* (on p. 610).

|| *Loc. cit.* (on p. 610).

¶ *Italics mine.*

extent described by myself in the present species \*. They are hardly referred to by Hochstetter.

Text-fig. 103.



Liver and certain adjacent veins in *Varanus griseus*.

AZ. Azygos; Ant.Abd. Anterior abdominal; g.h.p. Gastro-hepatic; L. Liver; L.p.v. Lateral parietal vein; P. Portal; p. Anterior parieto-hepatic vein; p.h. Posterior parieto-hepatic vein; V.C.S. Precaval veins (venæ cavæ superiores).

On the right side of the body in the example of *Varanus griseus*

\* P. Z. S. 1904, vol. i. p. 448.

upon which I report here, the lateral parietal vein was defective here and there between its origin with the azygos stem from the right superior vena cava and the origin from it of the anterior hepatic branch. After this point it was present as a continuous vessel to some way beyond the origin from it of the suprarenal portal stem. On the left side of the body, the vein originates from the left anterior vena cava at a point nearer to the head than does the right. Thence it is traceable as a continuous vessel to a point just short of the origin from the parietes of the left suprarenal portal. Neither in this individual nor in those previously described by me\* is there any connection with the pelvic veins. In other respects there is a fairly close agreement between all three specimens.

In *Varanus exanthematicus* I found rather different features in the azygos and lateral parietal veins. Both anterior venæ cavæ gave off a backwardly running vein. This vein on the right side arose in front of the subclavian and had a very short course upon the parietes. The vein of the left side arose behind the orifice of the subclavian vein and divided into two short branches. Neither of these veins was connected with the posteriorly situated lateral parietal veins. Posteriorly these veins were obvious on both sides of the body. On the right side they could be traced from opposite the testis into direct communication with the root of the anterior abdominal vein. In this connection therefore with the pelvic veins, the lateral parietal vein of *Varanus exanthematicus* appears to differ from that of *Varanus griseus*. On the left side, the connection with the left root of the anterior abdominal vein was also quite obvious, but there was a slight gap along the course of the vein. The connection of the lateral parietal veins with those of the hind limbs obviously brings *Varanus* more into line with other Lacertilia, where these veins are general and where such a connection occurs.

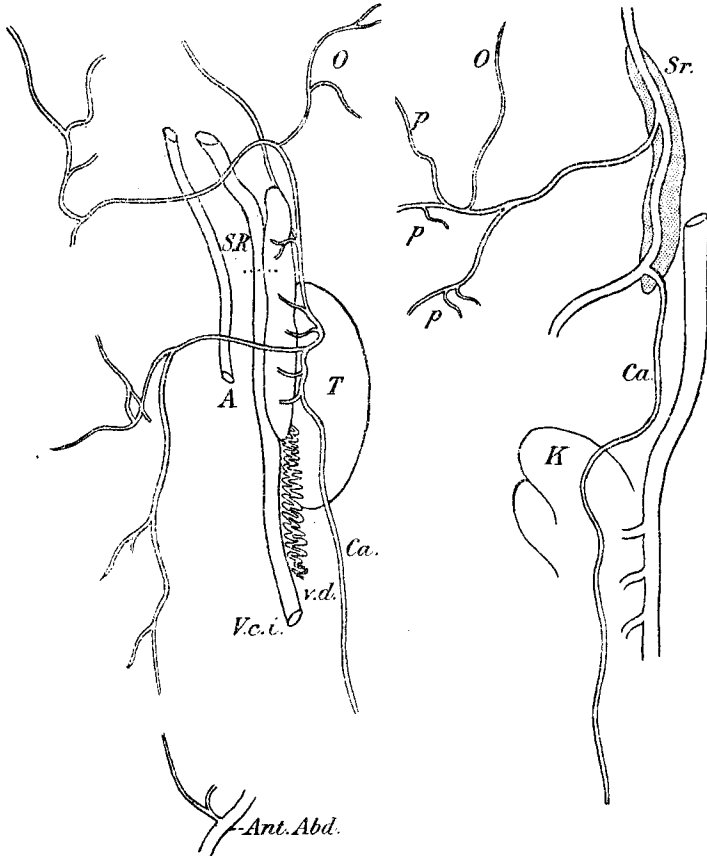
*Remains of Posterior Cardinals.*—Hochstetter has mentioned in the case of *Varanus griseus* a vein which runs along the vas deferens and which he termed the vena deferentialis, describing at the same time its connection with the suprarenal portal veins. The commencement of this vein from the afferent is also figured by him. I have elsewhere† compared this vein to a similar vein in the Boidæ and suggested its equivalence to the posterior cardinal. This view was obviously uncertain as long as the conditions obtaining in the female *Varanus* were unknown. For a vein supplying the vas deferens might be merely regarded as the necessary physiological equivalent of a vein supplying the oviduct and developed *ad hoc*, without any morphological meaning at all. The same vein, however, exists in the female. I found in a female *V. niloticus* that the afferent renal vein was prolonged headward of the kidney and ran alongside of the efferent renal vein over the suprarenal body, receiving the suprarenal portal vein, which will be described

\* *Loc. cit.* (on p. 610).

† P. Z. S. 1906, vol. i. p. 21.

immediately. This vein also was found in a male *V. exanthematicus*. Its existence is probably therefore a characteristic of the Varanidæ.

Text-fig. 104.



Veins of suprarrenal body and adjoining regions in *Varanus exanthematicus* (left-hand figure) and *V. niloticus* (right-hand figure).

A. Aorta; Ant. Abd. One root of anterior abdominal; Ca. Posterior cardinal; K. Kidney; O. Vein from omentum; S.R. Suprarrenal body; p. Parietal veins; T. Testis; v.d. Vas deferens; V.c.i. Postcaval.

*Suprarrenal Portal Veins.*—These have been already recognised by Corti, Hochstetter, and myself in *V. griseus*. They vary somewhat in numbers and in arrangement in the several individuals which I have dissected.

These suprarrenal veins, as is the case in other Lizards—it is not mentioned by Hochstetter for *Varanus*,—arise in two ways.

Some originate from the more lateral parietes, either actually from the lateral parietal vein when that is present in this region of the body, or from the area usually occupied by it. Others arise from the parietes near to the dorsal line, and are therefore connected with the posterior vertebral vein. In *Varanus niloticus* (text-fig. 104, p. 615) I found on the right side two suprarenal portal veins. The anterior of the two was formed by the union of three vessels springing from the lateral parietes. A small vein from the "omentum" joined this vessel. The posterior of the two suprarenals arose from the parietes close to the dorsal line. Both opened into the posterior cardinal vein where it traversed the suprarenal body. On the left side of the body, the anterior of three suprarenal portals arose from the body-wall close to the dorsal line, and thus corresponds exactly to the dorsal parieto-hepatic vein opposite to it.

In a specimen of *Varanus exanthematicus* the arrangement of these portal veins was a little different and is represented in text-fig. 104.

The lateral parietal vessel, after leaving the root of the anterior abdominal on the right side of the body, ends in the suprarenal portal in the way illustrated in the figure referred to. The vein thus emerging from the lateral parietal arches over the suprarenal body and divides into two branches, one anterior and one posterior. Each of these again divides into two to supply the suprarenal body, and is also connected with the posterior cardinal vein. A second suprarenal portal arises in front of that just described by a number of branches from the body-wall and joins the continuously running cardinal vein. It also receives a branch arising by many twigs from the "omentum" in the liver region. A third suprarenal portal is anterior to this again and enters the front of the suprarenal gland. On the left side of the body the arrangement was, save for minute details, the same as that which has been described upon the right side of the body. The fewness of the suprarenal portals is thus a characteristic of *Varanus* as contrasted, for example, with *Iguana*\*.

*Dorsal Parieto-hepatic Vein.*—In the chapter entitled "Systematis venosi fragmenta"† Corti speaks of "*Vena intervertebralis* quae a posteriori pulmonis dextri extremitate obiecta, atque a foramine quodam intervertebrali scaturiens, se in accessorio hepatis lobulo prope *venam renalem communem* abdit." The vein is figured by Corti, and is also described by Hochstetter‡ in the same species of *Varanus*. I have already confirmed the statement of the two anatomists for *Varanus griseus*§, and I find now precisely the same arrangement in another example of the same species, of which this single vein is doubtless characteristic. It may be observed that in this species, as well as in *V. exanthematicus* and *V. niloticus*, *V. bengalensis*, and *V. ocellatus*, the vein in question is

\* P. Z. S. 1904, vol. i. p. 443.

† Loc. cit. p. 466.

‡ Loc. cit. p. 48.

§ P. Z. S. 1904, vol. i. p. 448.

supported by a fold of membrane which attaches the "Hohlvenenfortsatz" of the liver to the parietes and forms a pocket as in *Iguana* and some other Lizards, including *Heloderma*. The single vein is not, however, a generic character of *Varanus*. It is single in *V. exanthematicus* and in *V. ocellatus*; but in two out of four examples of *Varanus niloticus* which I have dissected the conditions were different. In two small specimens there was only a single vein as in other species; in one large individual there were distinctly two veins, which reached and penetrated the liver separately; in the fourth specimen, also large, and a female like the last, there were also two veins, which, however, joined soon after their emergence from the parietes to form a single trunk entering the liver as such. In the two small individuals which were males (and not very well preserved in spirit) it seemed to me that there was a junction between two veins quite close to the body-wall. The more prevalent arrangement among the Lacertilia is that there are several of these veins\* running a parallel course to the liver.

In addition to this vein (or, rarely, veins) the liver also receives blood from the dorsal or dorso-lateral parietes in its anterior region. In *Varanus griseus* Hochstetter has mentioned a vein—"eine Zweite Leibeswandvene dringt direkt in die kopfwärts gerichtete Spitze des rechten Leberlappens, diese wurzelt in der entsprechenden Partie der dorsalen Leibeswand"†. There is no further description of the vein. The vein in question is accurately described by Hochstetter as entering the very tip of the right lobe of the liver. It corresponds exactly in position to a vein from the stomach which enters the tip of the left lobe‡. The origin of the vein from the parietes is of some interest. It originates in fact from a longitudinal vein, the lateral abdominal, whose relations to other veins has been already described. The same vein occurs in *Varanus niloticus*, where I found it fuller than in the example of *V. griseus*. The same vein plainly exists in *V. exanthematicus*, with the same connections with the vein of the dorso-lateral parietes.

The existence of these venous affluents of the portal system is of interest in comparing *Varanus* with other Reptiles. In the presence of vessels from the dorsal parietes joining the liver-circulation anteriorly as well as posteriorly, *Varanus* differs from *Lacerta*, *Iguana*, and some other Lacertilia. It agrees, however, in this with *Heloderma*, as has been already set forth in the present communication§. The connection, however, in this latter instance is with the vertebral vein, while in *Varanus* the hepatic affluent in question is only indirectly connected with the vertebral vein system, and arises directly from the lateral abdominal vein, which

\* I may take this opportunity of referring to another character which I have found only in one species, and not in a considerable number of others. In *V. gouldi* the apex of the heart has a gubernaculum tying it to the pericardium. This is generally stated to be absent, and I have not found it in *V. bengalensis*, *V. griseus*, *V. niloticus*, and *V. exanthematicus*.

† Loc. cit. p. 466.

‡ *V. infrà*, p. 618.

§ *V. suprà*, p. 606.

is a particularly prominent vein in the Varanidæ as contrasted with other families of Lacertilia. In the connection of the lateral vein system with the hepatic circulation, *Varanus* shows a point of resemblance to the Crocodilia, where such a connection also occurs, and with which I deal in a subsequent page of the present communication\*. I do not, however, lay so much stress upon this comparison as upon the difference which *Varanus* shows in this part of its circulatory system from other Lacertilia.

*Gastro-hepatic Vein.*—It is important to note that *Varanus* differs from many other Lacertilia† in the limitation of the gastro-hepatic veins to a single vein. Hochstetter has already correctly noted that there is but one vein of this series which enters the extreme anterior tip of the left liver-lobe. I have found exactly the same state of affairs in an example of *Varanus griseus* recently dissected. I find also exactly the same vein occupying the same position in *V. exanthematicus*. In *Varanus niloticus* the same gastro-hepatic vein was present and appeared to be particularly large. It is a point worthy of note that the position of this vein, that is of its place of entrance, is exactly the same in the left lobe as the anterior parieto-hepatic vein in the right lobe. It is possible that the great width of the liver in *Varanus* is responsible for the separation of two veins which in *Heloderma*‡ enter conjointly, the liver being in that Lizard narrow anteriorly.

### (3) On some Veins in the Crocodilia.

Although the main features of the vascular system generally, including the veins, in the Crocodilia are fairly well known§, there are a few details which have not received attention; and, moreover, there yet remains, as it seems, a good deal to be ascertained before the variations of the venous system from genus to genus is at all understood. I shall show in the following pages that the veins with which I deal are by no means uniformly disposed in all Crocodiles. The observations which I place before the Society were almost entirely conducted upon well-injected specimens, and are therefore, as I hope, trustworthy as records of positive fact. It is obviously less possible to insist upon the absolute reliability of negative facts.

### § Azygos Veins or Venæ Vertebrales.

Rathke's description of the azygos veins would not give rise to the impression that they show differences among different

\* *V. infra*, p. 622.

† Not, however, from *Phelsuma madagascariensis* and *Tarentola annularis*, where there is also but one gastro-hepatic vein.

‡ Above, p. 607.

§ See especially: Rathke, "Untersuchungen über die Entwicklung und den Körperbau der Krokodile," Braunschweig, 1866; Jacquart in Ann. Sci. Nat. (4) ix. 1858, p. 129; Hochstetter in Morph. Jahrb. xix. 1893, p. 476; Jourdain in Ann. Sci. Nat. (4) xii., 1859; Beddard in P. Z. S. 1905, vol. ii. p. 466.

kinds of Crocodiles. This vein (the vena vertebralis communis)\*, is stated to arise from the anterior cava as a single trunk and to have a very short course superficially along the vertebral column, disappearing from sight—"nach dem er die vierte V. intercostalis absendet hat in den Kanal des Rückgrats um sich mit den Venæ spinales zu verbinden." It has thus, as he remarks, only a short course, which terminates immediately behind the fourth rib. There is no indication given as to what species or which species this description refers to. The general account of the venous system is stated merely to refer to "ältere Krokodilen," though definite species are now and again referred to in footnotes appended to the description; not so, however, in the case of the veins which concern us here. There is no evidence that I can extract which points to any particular species. I find, however, that there are variations, and that the three species which I have examined do not agree.

In *Crocodilus cataphractus* the azygos veins answer pretty well to the descriptions given by Rathke; though there are certain differences, and also some other matters not touched upon by Rathke, to which I desire to direct attention. The number of ribs in this species is not mentioned by him†. I find that there are only 12 pairs, *i. e.* 2 false anterior ribs, 7 true ribs, 3 posterior false ribs. The azygos veins are of exactly the same size on both sides of the body. They arise from the anterior cava on each side behind the origin of the subclavian. On the right side of the body the origin was by two distinct affluents, forming with each other and the vena cava a triangle‡. I did not find any such double origin on the left side. The vein runs in a directly transverse direction (*i. e.* transverse to the longitudinal axis of the body), and close to the vertebral column on each side plunges at once into the parietes. Thence it never reappears upon the surface of the musculature as a longitudinally running vessel, but remains completely buried and hidden below it.

The azygos vein is closely accompanied by the corresponding artery (arteria vertebralis communis), which also rises below the surface of the musculature, but is visible at intervals below the peritoneal membrane. At a point about halfway between the origin from the vena cava and the disappearance into the parietes, both artery and vein give off a longitudinally and posteriorly running branch along the lateral body-wall which has its counterpart (in the case of the vein) in *Varanus* §.

In *Osteolemus tetraspis* the azygos veins show features of difference which obviously aid in establishing the justice of the generic separation of this Crocodile. As the following statement of fact is based upon the examination of two individuals, I imagine that it can be taken as a description of the normal conditions obtaining in this species. The azygos arises from the vena cava, at least

\* *Loc. cit.* p. 255.

† *Loc. cit.* p. 55.

‡ *Cf.* p. 620, where the same state of affairs is described in *Osteolemus tetraspis*.

§ See p. 616.



on the right side, in common with the internal mammary\*, from which it soon diverges and runs the usual course to near the dorsal middle line.

It is remarkable that on the left side (only, not on the right) the azygos arises by two origins—a thicker anterior trunk, and a much more slender posterior vessel. This is quite analogous to what has already been described in *Crocodylus cataphractus*, including the asymmetry, which is still more remarkable. The azygos also gives off, precisely as in *Crocodylus cataphractus*, a vein running along the lateral thoracic parietes. Arrived at the side of the vertebral column some little way in front of the origin of the *longus colli* muscle (also as in *Crocodylus cataphractus*), the azygos does not plunge into the thickness of the parietes as in the last-mentioned Crocodile, but runs back quite superficially as in a Mammal. It is thus displayed for the whole of its course to as far back as where the dorsal parieto-hepatic trunks communicate with it. This course corresponded (at any rate in one of the two specimens dissected) to 6 ribs. The chief difference, therefore, which this species shows from *Crocodylus cataphractus* is in the possession of superficially running azygos veins.

In *Caiman sclerops* the two azygos veins arise symmetrically with regard to each other from their respective jugulars, right and left. In both cases they arise behind and not very near to the subclavians and separately from the jugular, *i. e.* not in common with any other vein. Each is closely accompanied by the corresponding artery which is a branch of the carotid. I could detect no lateral parietal branch of each vein; but as the specimen was quite a small one, they may have remained undetected. Each azygos reaches the dorsal line far forwards at the level of the fourth rib in front of that whose vertebra bears the origin of the *longus colli* muscle. Then the vein disappears and does not run superficially on each side of the body; but some way in front of the liver it reappears and passes in a slightly sinuous course to the end of the liver, where it gives rise in the usual way to the hepatic branches, which will be described later. Thus the present genus agrees to some extent with *Osteolemus* in the superficial course of the two azygos or posterior vertebral veins, there being the difference that in *Caiman* the vein runs superficially only posteriorly. The artery is superficial throughout.

*Anterior Abdominal Veins.*—These veins, which, as is well known, are completely double in the Crocodilia, show certain differences in different species. Rathke has called attention† to the fact that the two veins often differ in calibre. He does not mention certain points to which I shall now refer.

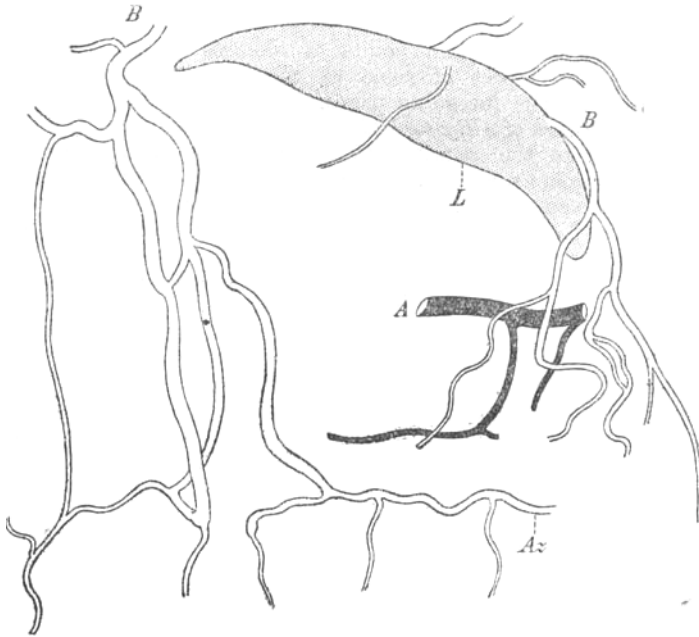
In *Crocodylus cataphractus*, as in *Crocodylus acutus*, a slender vessel leaves the left anterior abdominal vein some way behind the liver, and running obliquely forwards joins the right anterior

\* Whether this is also the case with *C. cataphractus* I am not able to say. According to Rathke they are separate in origin.

† *Loc. cit.* p. 257 footnote.

abdominal vein not very far from the edge of the liver. In the smaller example of *Osteolaemus tetraspis* which I have dissected I could detect no such connection at all; the two veins were quite independent throughout their course. In a larger specimen of this species, a vein ran from the left anterior abdominal and was observed to pass obliquely forwards; I lost it in the neighbourhood of the gall-bladder, and so am inclined to suspect that it did not join the right anterior abdominal but entered the liver separately. Its point of origin, moreover, was further forward than the connection in *Crocodylus cataphractus*.

Text-fig. 105.



Portal veins of liver in *Osteolaemus tetraspis* (left-hand figure) and *Crocodylus cataphractus* (right-hand figure).

A. Aorta; Az. Azygos of left side; L. Liver; B. Entrance into liver of veins connected with azygos.

Though I am uncertain as to the destination of the branch of the left anterior abdominal vein in *Osteolaemus*, I have noted and been able to follow the course of an apparently identical vein in *Caiman sclerops*. The left vein in this Crocodilian is smaller than the right, and a little way behind the liver it divides into two branches, of which the right is rather the thicker. The latter enters the liver in the furrow between the two lobes and receives a branch from the stomach before so entering. The left branch enters the portal system of the left lobe. The division of the left

anterior abdominal takes place almost exactly on the middle of the stomach, as also in an example of *Alligator mississippiensis* with which I have been able to compare this Caiman. Moreover, in both Alligators the right branch received a twig from the stomach which underlay (when the reptiles were examined in the usual position of dissection) the left division of the left anterior abdominal. The same branching is described by Jacquart in the "Caiman à museau de brochet," but the details seem a little different.

The material does not at present exist for a comparison of the different genera of the Crocodilia, and for a classification based upon the entire structure of these reptiles. It is in the meantime interesting to note—though it is obviously premature to found any generalisation upon the facts—that the West African *Osteolemus* does show certain points of likeness to the American Crocodilia in respect of some of the veins that have been dealt with in the foregoing pages. In *Alligator*, as shown by Jacquart's figure of *Alligator lucius*\*, and by my own observations, which I take the opportunity of recording in the present communication, upon *A. mississippiensis*, the two anterior abdominal veins are *not* connected by an obliquely running commissure†. The same vein is also absent or at least modified in *Caiman sclerops*. On the other hand, as I have shown, certain species of the genus *Crocodylus* possess it. Now this connecting vein is absent or at least modified in *Osteolemus*. Again, the latter genus has the two azygos veins exposed superficially along their course, while in *Crocodylus* the same veins are for the most part entirely buried under the musculature. In this particular also *Osteolemus* agrees with the species of *Alligator* which I have referred to in the foregoing pages, viz. *Alligator mississippiensis*.

*Dorsal and Lateral Parieto-hepatic Veins.*—These veins, termed by Rathke *venæ vertebralis postremæ*, really consist, as was not noted by him, of veins arising from two sources. There are veins connected with the *vena vertebralis posterior* or azygos, on each side, or, if the latter be not visible superficially, emerging from the parietes close to the vertebral column, and there are trunks of more lateral origin from the parietes. Save for the Varanidæ‡, this double origin of the dorsal parietal affluents of the hepatic portal system is not found among the Lacertilia, or at least has not been as yet recorded, and certainly does not exist in many forms. The presence of the lateral parieto-hepatic affluent is accompanied in both the Crocodilia and the Varanidæ by the development of a longitudinally running lateral parietal vein, which, though represented in the Lacertilia, is not so important in them. I have already given some account of these veins in *Crocodylus acutus*§. I am now able to give further details of this system in the Crocodilia from the examination of other species.

\* Ann. Sci. Nat. *loc. cit.* pl. 3. fig. 1.

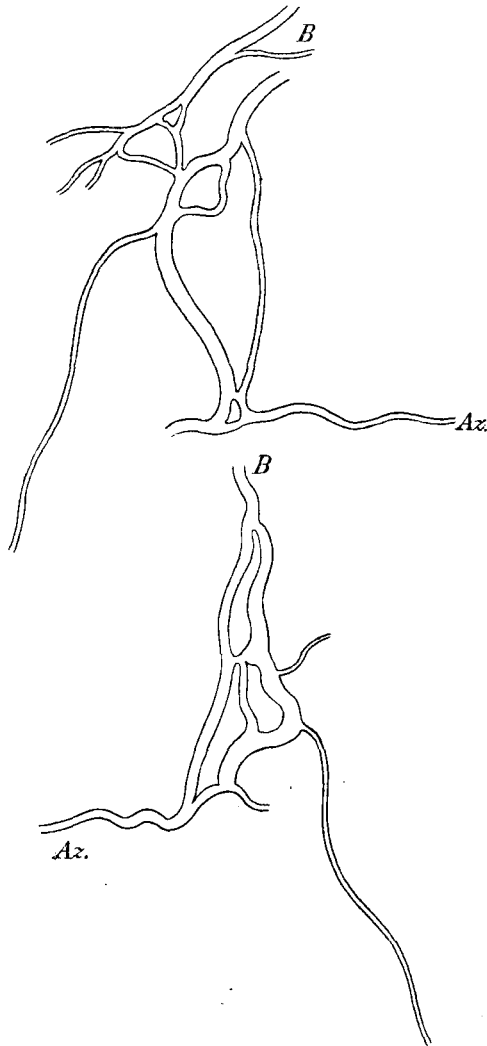
† It is noteworthy that in both *All. mississippiensis* and *Caiman sclerops* the left vein is nearer to the middle line than the right vein.

‡ *Supra*, p. 616.

§ P. Z. S. 1905, vol. ii. p. 466.

In *Crocodilus cataphractus* the arrangement of these vessels on the right side of the body was as is shown in the accompanying figure (text-fig. 105, p. 621). Two branches arise from the parietes close to the vertebræ, of which the anterior is the more slender ;

Text-fig. 106.



Veins connecting azygos with liver in *Caiman sclerops*.

Upper figure the left side, lower figure the right side. Lettering as in text-fig. 105.

these unite some little way before they reach the liver. Shortly after reaching the liver, but before burying itself in the substance of the same, the vein receives another which is made up of three tributaries, of which two are from intercostal spaces immediately following those which give rise to the first two of these dorsal parieto-hepatic branches. The third vessel arises from the parietes laterally. The vein formed by the union of the five venous twigs which have been just enumerated enters the substance of the liver considerably to the right of the entrance of the right anterior abdominal vein. Between the two enters a vein which conducts only blood from the lateral parietes. As is also shown in the figure referred to, the posterior vertebral artery arises from the aorta and reaches the parietes between the two anterior intercostal veins. This is the same on both sides of the body.

These branches from the azygos to the liver are also arranged with perfect symmetry in relation to each series on the two sides of the body. They commence in each case opposite to the same vertebra. The actual sizes, however, of the several branches differ, though the total volume appears to me to be much the same. On the left side there are two thick trunks which are not far short of the azygos itself in calibre. These join before reaching the edge of the left lobe of the liver. After joining, the common trunk bifurcates into a wider and a narrower branch. The wider branch enters the liver at the apex of the left lobe immediately. The narrower branch receives almost at once a thinnish parietal branch, and passes downwards along the free posterior edge of the left liver-lobe to some way along that margin, though considerably short of the middle line. Here it enters the liver-substance independently of not only the anterior abdominal vein, but also of the lateral parietal and considerably to the left of both these veins. The wide calibre of these various veins contrasts with the very narrow corresponding intercostal arteries and their branches. This contrast is much more marked than in other regions of the vascular system, where the arteries and veins are more equized.

I have examined only one individual of *Crocodylus cataphractus*, and it might therefore be supposed that the conditions observed being subject to variation were hardly distinctive of the species. Whether this be so or not I do not know; but in any case there is so considerable an agreement between two individuals of *Osteolemus tetraspis* of which I have dissected the veins under consideration, that I describe the following conditions with some confidence as distinctive of that species. On the left side of the body there are four vessels belonging to the system of veins which is at present dealt with. The three anterior of these belong entirely and only to the vena vertebralis posterior, and they arise from it. The actual way in which these vessels join and rejoin with each other before reaching the liver is illustrated in the sub-joined figure (text-fig. 105, p. 621), and is rather more complicated than the arrangement found in *Crocodylus cataphractus* and *C. acutus*; that is to say, there are anastomoses between the trunks

in question before they finally join to enter the liver. An inspection of the figure will do away with the necessity of a detailed description. In addition to these three stouter vessels a more slender trunk arises (behind them) and is connected above with the veins running directly from the stomach to the liver. This vessel (in both specimens, I believe, but certainly in one) is also derived from the lateral parietes, and thus exactly corresponds to a similar vessel in *Crocodilus cataphractus*, which is also in the same way the last of the series.

In *Caiman sclerops* there are again differences of detail. The right and left sides are shown in the accompanying figures (text-fig. 106, p. 623). In both cases there is a branch from the lateral parietes, which, as in other Crocodilia, is the last of the series of the parieto-hepatic veins. On the right side only two trunks arise from the azygos, but the posterior immediately divides to shortly reunite with both of the primary branches. On the left side there are only two vessels arising from the corresponding azygos. These are fused immediately after their origin, but divide again at once. Further details will be obvious from an inspection of the illustrations. In comparing the course of these vessels in the several Crocodilia which I have had the opportunity of examining, it is possible to arrive at certain differences and agreements between the four species dealt with.

In the Crocodiles (*C. acutus*\* and *C. cataphractus*) the number of trunks forming the dorsal parieto-hepatic affluent of the portal system is greater by one or two than in either *Osteolemus* or *Caiman*. On the other hand, in the two last-named genera the interconnections between the several trunks before they unite to open into the liver are to be remarked, and are not seen in the two species of *Crocodilus*. Furthermore—but as this depends upon negative evidence, less stress is laid upon it—the vein in question in *Osteolemus* and *Caiman* is connected before its entrance into the liver with the stomach plexus of veins. It is interesting to observe that in this system of veins as well as in others *Osteolemus* and *Caiman* show likenesses to each other and corresponding differences from *Crocodilus*.

In addition to the constantly present laterally arising trunk which in all the Crocodilia examined joins the dorsal parieto-hepatic vein, there are other vessels also lateral in origin which have a separate entry into the liver. In *Osteolemus tetraspis* three slender veins arise from the parietes laterally more ventrally than the lateral affluent of the dorsal parieto-hepatic already described; each enters the liver separately. On the left side I could find only one corresponding vein. In *Crocodilus cataphractus* each lobe of the liver has also a corresponding vein originating from the lateral parietes. It enters the liver between the anterior abdominal and the dorsal parieto-hepatic veins. I have not observed this vein in other Crocodiles.

\* P. Z. S. 1905, vol. ii. p. 466.

4. Description of the External Characters of an unborn Fœtus of a Giraffe (*Giraffa camelopardalis wardi*). By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received May 29, 1906.]

(Text-figures 107-109.)

On May 5th (Saturday) of the present year the female Transvaal Giraffe purchased by the Society in 1895\* died, and was examined on the Monday following at the Prosectorium. The animal was found to be pregnant, and the fœtus was female.

Inasmuch as the fœtus was not of full-time, it became a matter of importance to determine its age and to compare its appearance with that of the newly born Giraffe. The newly born Giraffe has been described by the late Sir Richard Owen †, and the time of gestation varies from 431 to 444 days, according to his statements.

The age of the fœtus upon which I report here is a matter of inference. Mr. Pocock has been so good as to furnish me with the following facts bearing upon this question. It appears that the mother was "on heat" from May 1905 to the end of August or beginning of September. This condition then ceased. The reason for this cessation must have been either conception or the end of the period of heat. The latter view was the one taken until the death of the animal revealed the fœtus. Thus the fœtus was about 8 calendar months old. A nearer estimate than this cannot be formed. The fœtus may be said therefore to have passed about two-thirds of the normal period of gestation.

The most striking feature exhibited by the fœtus is undoubtedly the total absence of the least trace of the characteristic markings of the Giraffe. The colour was nearly uniform, and I give later a fuller description of the hues of the coat in various regions of the body. The horns are very prominent with long hairs, and a cartilaginous (?) horn-core could be felt within each. The early development of these as compared with some ruminants is noteworthy.

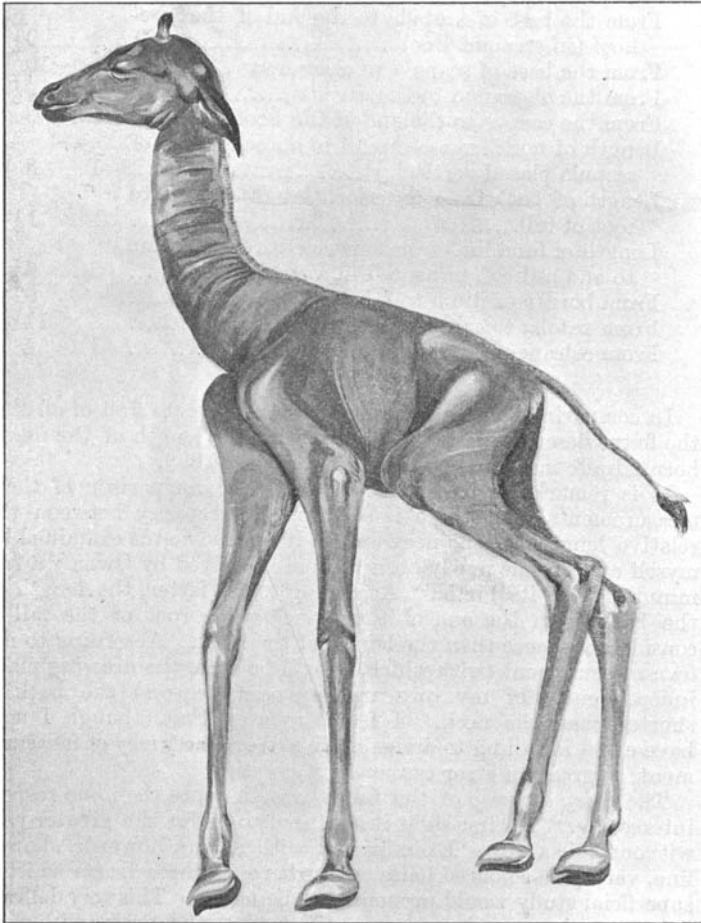
The proportions of the body are shown in the accompanying figure (text-fig. 107) and the lengths of different regions of the body and limbs are indicated by the table of measurements which follows. The most striking difference from the adult Giraffe is, as it appears to me, the comparative shortness of the neck, which is quite visible in the figure (text-fig. 107). The general appearance of the head and neck is, apart, of course, from the horns, not unlike that of a Lama; there is no particular suggestion of the

\* See P. Z. S. 1895, p. 161.

† Trans. Zool. Soc. vol. iii. p. 21, and Comp. Anat. & Phys. Vertebrates, London, 1868, vol. iii. p. 739.

Okapi about this or any other region of the body. It will be noticed in the figure that the neck is much creased, more so than the skin of the body, which is perhaps indicative of a rapid growth in this region. The very soft hoofs terminate in quite pointed extremities.

Text-fig. 107.



Fœtus of Giraffe, illustrating the general proportions of the body.

The following are some of the principal measurements, many of which correspond with those tabulated by Owen for the newly born Giraffe.



	Feet. inches.	
From the muzzle to the root of the tail following the line of the back .....	3	5
From the muzzle to the interspace of the horns...		9
From the horns to the termination of the mane at the shoulder .....	1	9½
Length of the back, from the mane to the root of the tail .....		10½
From the base of scapula to the end of the fore-hoof (in straight line) .....	2	9½
From the base of scapula to olecranon .....		10
From the olecranon to the carpus .....		9½
From the carpus to the end of the hoof.....	1	3
Length of neck from occipital to anterior edge of scapula placed vertically .....	1	3
Length of back from anterior edge of scapula to root of tail.....	1	1½
Length of hind limb from superior border of ilium to end of hoof, measured in a straight line ...	2	6½
From border of ilium to fabella .....		9
From patella to calcaneum .....		11
From calcaneum to end of hoof .....	1	4

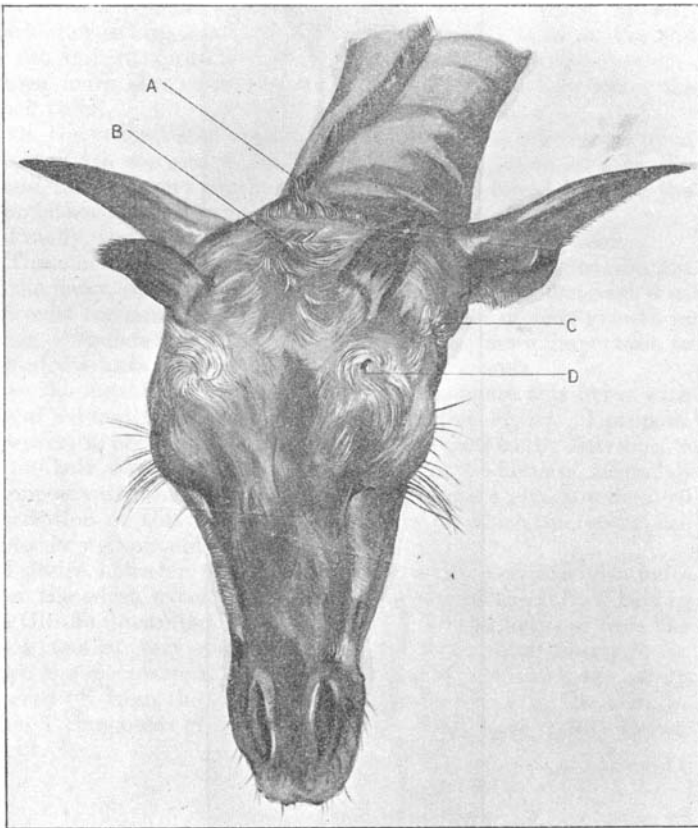
In comparing these measurements, we may note first of all that the fœtus described here is exactly half the length of the newly born Giraffe measured by Owen in the year 1839.

It is remarkable to find, from a further comparison of these measurements, that there is a serious discrepancy between the relative lengths of the neck and body in the fœtus examined by myself and in the newly born animal measured by Owen "a few minutes after its birth." According to the latter, the length of the back from the end of the mane to the root of the tail is considerably more than the length of the neck. According to my own measurement (with which, as will be seen, the drawing made independently of my own measurements agrees) the back is shorter than the neck. I feel convinced that, though I may have erred in failing to arrive at an extreme accuracy of measurement, so great an error cannot have crept in.

The *hairy covering* of the fœtus was in more than one respect interesting. At first sight it appeared to be for the greater part without hair at all. Examination with a lens, however, showed fine, very pale-coloured hairs everywhere in those tracts which a superficial study would pronounce to be naked. This very delicate hairy covering was, however, manifest upon the neck and legs as a whitish bloom when the skin was comparatively dry, not, however, upon the trunk and flanks. In those regions where the hair was thus evident without the use of a lens the hairs were naturally longer; still they had the same whitish colour, and the suggestion given is as if the neck and feet, and especially the feet, had been powdered.

The head was completely furry with longish close-set hairs, definitely brown in colour though palish, and showing distinct whorls. There was one whorl above each eye, another between the eye and the ear, and a median unpaired whorl in the occipital region. I saw nothing of the kind in the nasal region. The eyelashes were quite conspicuous (see text-fig. 108).

Text-fig. 108.



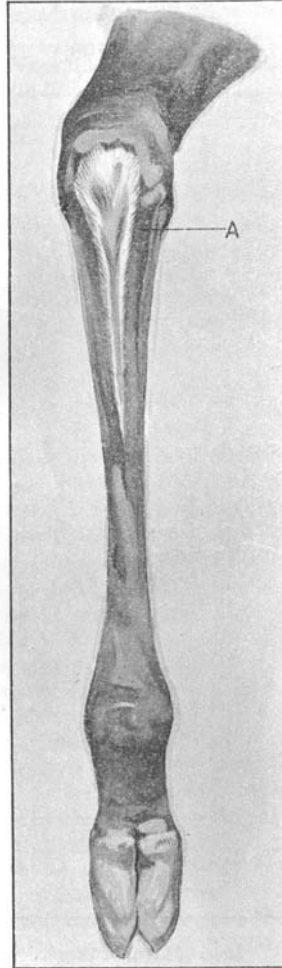
Head of fœtus of Giraffe.

A, commencement of mane; B, C, D, whorls of hair.

Besides this general hairy covering, most pronounced upon the head, there were other tracts covered with much stouter hairs. Each fore limb had (see text-fig. 109) a strongly marked tract, extending over a part of the carpus and a portion of the meta-

carpus for  $5\frac{1}{4}$  inches, which was densely covered with strong hairs of a whity-brown colour. This tract was wider above and ended below, in a fine point. It would touch the ground if the animal

Text-fig. 109.



Front view of fore foot of fœtus of Giraffe.

A, patch of strong hair on the carpus and metacarpus.

were placed in a kneeling posture, as it was quite anterior in position. The posterior surface of each "hock" (calcaneum) had

a much less extensive, more feebly developed, and less sharply marked patch of hairs.

On the head each horn consisted of a fold of skin in which the separate and movable horn-core could be felt as of gristly consistency. This fold of skin was capped by long hairs, which were black at the extremity as in the newly born and adult Giraffe. The mane was quite visible as a distinctly marked tract of close-set longish hairs definitely fawn-coloured; it ended just below the shoulder. At the root of the tail and for a little way down it there was a continuation of this crest, but not nearly so well-marked or so circumscribed. The tuft of black hairs at the end of the tail was quite obvious. A smaller tuft of shorter whity-brown hairs also existed at the extremity of the tail below the black patch.

On the ventral median line in the abdominal region and upon the sternum was also a band of hair, not so pronounced as the mane, but still very conspicuous; this was not found between the legs, either hind or front.

Finally, the vulva was encircled with longish white hairs.

These are, I believe, the chief facts concerning the distribution of the hairy covering of the young Giraffe. The material does not exist for much comparison with the mode of hair-growth in other Ungulates, and it is therefore all the more important to record the facts with a view to future comparisons.

In the meantime I have been able to compare this fœtus with one of evidently not very different age of *Ovis vignei*. I propose, however, to accumulate more facts with regard to the distribution of the hair and other external characters in the fœtus of Mammals as opportunity serves me, and do not therefore give any detailed description of this fœtus, the characters of which, moreover, are probably well enough known.

I desire, however, to call attention to a patch of strongish hairs upon the wrist, exactly in the same position as the tuft of hair in the Giraffe illustrated in text-fig. 109. In the fœtus of *Ovis* the patch was of very much less extent, not reaching nearly so far down the metacarpus. It was, furthermore, not nearly so sharply marked off from the surrounding integument as in the Giraffe, though composed of hairs of exactly the same whity-brown colour.

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