CONTRIBUTIONS

TO THE

STUDY

OF

HELODERMA SUSPECTUM.

BY

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(Plates XVI.–XVIII.)

Contents.

I. Introductory Remarks.

During the summer of 1887 the present writer came into possession of two very fine living specimens of *Heloderma suspectum* that had been obtained for him in Southern Arizona, in that section of the United States zoogeographically known as the Sonoran Region, and where the natural habitat of this, by far the largest of all of our North-American lizards, is located.

Never having been so fortunate as to have enjoyed the opportunity of studying the habits and life of the Heloderm in its native haunts, I can add nothing here to the accounts of others already published; nor am I familiar with the mode of reproduction in this interesting species of lizard, though I have heard it stated, by good observers, that it is an oviparous reptile. The two living specimens above referred to were separately packed each in a small box, and in coming to me arrived in excellent condition, after making a journey of several hundred miles, lasting six or eight days, and each lizard consuming only on the day of starting part of a boiled egg. Upon being removed from their boxes they drank freely of water, and afterwards each ate the best part of a hard-boiled hen's egg. Both of these acts, however, were performed with marked deliberation, so much so that one would little have suspected that the creatures were in any way particularly hungry. In eating they employ their broad, black, forked tongue to a considerable extent, protruding the organ slowly from the mouth, spreading it out, and licking the morsel well before it is taken into the mouth and swallowed. They may also, in drinking, occasionally be seen to lap the fluid with this organ, and still in a more or less deliberate manner. These two specimens have already been several months in my keeping and under my daily observation, during which time they have not eaten half a dozen hens' eggs between them, sometimes taking them hard-boiled, but as a rule seeming to prefer them raw; they have refused all other nutriment which has been placed before them.

I have shown elsewhere that another American lizard, *Phrynosoma*, is capable of enduring an absolute fast for a period of three months or more ('Science,' vol. vi. no. 135, Sept. 4, 1885, pp. 185, 186); and it is a well-known fact that other reptiles can do likewise. Moreover I am quite sure, from what I have seen, that a good healthy adult *Heloderma* would prove to be another representative in this category, capable of sustaining a prolonged period without taking any nutriment whatever into its system.

When one of these reptiles is placed on the open ground and left to itself, it soon takes itself off, and notwithstanding its rather awkward mode of progression makes withal very good time. Head, body, and tail are all kept in contact with the ground, while the alternate fore and hind limbs are thrown forwards as the animal takes its rather ample steps and keeps its way along, with no other apparent motive in its mind beyond making good its escape. In walking thus, it constantly protrudes, and again whips back into its mouth, its great black tongue, evidently to some degree using the organ as a detector of anything that may possibly stand in the road to impede its progress.

If you now suddenly check it, the animal quickly rears its body from the ground by straightening out its limbs, wheels about, opens its mouth widely, snaps its tongue in and out, and gives vent to a threatening blowing sound. The whole aspect of the reptile, taking its great size into consideration, is now quite sufficient to keep the best of us at bay at first, and the moment it is let alone it takes the opportunity to make off again, usually in another direction.

The bite of the *Heloderma* is now known to be venomous, and to small mammals soon fatal; but as the writer has elsewhere published accounts of this, the subject will not be renewed in the present connexion (see Am. Nat., Nov. 1882, pp. 907, 908; 'Nature,' Dec. 14, 1882, p. 154; and 'Forest and Stream,' Aug. 4, 1887, p. 24).

My two specimens seem to be quite attached to each other, and are never so well satisfied as when curled up together in a sunny corner of their cage; I am unable from their external characters to determine their sex, and this will only be possible later on, when we come to examine into their structure.

These lizards are, too, very fond of basking in the hottest of noonday suns, and I have satisfied myself that upon these and other occasions, when I have closely watched them, they possess to a certain extent chameleonic powers, for I have observed the orange part of their scaly armour pass from that colour to a decided salmon tint and *vice versâ*, remaining normally, however, at some shade of orange or yellow. When thus sunning themselves they have a habit of stretching their limbs backwards, even to the extent of having the feet with their dorsal aspects in contact with the ground, the palms and soles being directed upwards. They will then close their eyes and lay in this position for hours at a time. So far as their physical strength is concerned, it seems to be about equal to that of young Alligators of a corresponding size; they do not, however, possess the power of striking a blow with the tail, enjoyed by the latter reptile. And in getting over rough ground, where branches, large stones, or other obstacles stand in the way, Heloderms evince no little patience, ingenuity, and downright obstinacy in overcoming such barriers to their progress. By a series of simple experiments I have been enabled to satisfy myself that the senses of sight, smell, and hearing are all quite acute in these reptiles, and they are also sensitive to the sense of touch. As to their general intelligence, however, or such mental attributes as they may be possessed of, I have made no special investigations, but from my casual observations I am inclined to believe that they stand rather above the average reptile in both of these respects.

II. On the Form and External Characters of *Heloderma suspectum.*

One of these reptiles in my possession is considerably larger than the other, and by an approximate estimate only of their respective lengths, for I intend to present exact measurements further on, I would say that the smaller of the two was, from tip to tip, about 28 centimetres long, while the other has a total length of about 41 centimetres. The smaller one is by far, both in its markings and general coloration, the handsomer of the two.

My large *Heloderma* has a total length of 41·3 centimetres and a mid-girth of 18 centimetres, but this latter, of course, is very variable, as the animal may alter it considerably by inspiration and expiration at its will.

Other measurements, which I have carefully taken, are presented in the accompanying table, and they will give a fair idea of the proportions of one of these reptiles. It will be seen also that the relative proportions vary with age. Moreover, as with all Vertebrates, these proportions may actually vary for each individual, just as we find robust and stout men to compare with slender and tall men.

Table of Measurements.

(Measurements in centimetres and fractions.)

	Larger one.	Smaller one.
Total length	41·3	29·2
Mid-girth (variable)	18·0	12·1

Table (continued).

	Larger one.	Smaller one.
Greatest width on top of head	4·2	3·0
Between the eyes	2·7	2·1
Between the nostrils	1·2	0·7
From chin to commissure of gape ..	3·8	2·8
Middle toe, fore foot	2·0	1·5
Middle toe, hind foot	1·7	1·3
Vent to tip of tail	12·5	9·0
Mid-girth of tail	8·1	5·0
Chin to vent	28·8	20·2
From armpit to groin of same side ..	17·1	12·5
Width of vent	1·1	0·7

Coloration.—As I have elsewhere said, the two colours of *Heloderma suspectum* are black and some shade of yellow, orange, or salmon. No two specimens of this Lizard ever agree either in point of coloration or in the peculiar markings. Sometimes the black is intense and shiny; sometimes dull and almost of a brownish tint. It always brings out the two tints brilliantly to wet the animal in water. As a rule the muzzle, chin and throat, cheeks, and fore part of the head on top are jet-black; occasionally a few yellow scales will be distributed over the throat, and in my larger specimen there are over each eye two pale yellow tubercles. On the top of the head an imperfect cross can generally be made out, the arms of which are composed of a single row of tubercles, broken at the intersection, and with its anterior extremities reaching as far forward on either side as the regions over the roofs of the orbits, while the posterior ends extend back as far as the angles of the jaw. A few scattered black tubercles usually are to be found in the area between the entering angles of this cross. Passing next to the neck and body we find the markings of a very different character. Assuming the yellow or orange to be the ground-colour, we discover that these parts are generally surrounded at irregular intervals by some four or five broad, fantastic, transverse bands, composed of the black tubercles on the dorsal aspect and the flatter scales on the nether parts. These bands are not of an unbroken black colour, but have both irregular borders and bizarre figures of the orange or yellow ground-colour over their internal areas, composed for the most part of blotches, bars, and hieroglyphical patterns, and sometimes the figures of these black bands may become confluent with each other. The colours are duller and paler on the ventral parts than they are above, although the general configuration still prevails, with rather more marked confluence of the banding. In my larger specimen there are also found in the transverse orange interspaces a few scattered and small isolated spots of black, composed of, as usual, a few black tubercles which have merged at these localities. Generally the tail is marked by alternate bands of the same colours found upon the body; these are commonly four or five in number, of about equal widths, and arranged so as to have the tail terminate in a black tip.

These bands are unbroken in my smaller specimen, but in the larger one a single imperfect row of orange tubercles passes round the middles of the mid black bands, which are double on the black band next the body, while two or three scattered black tubercles are seen upon the intermediate orange bands.

From rather above the knees and elbows down to the tips of the several digits all four of the limbs in my smaller specimen are of a uniform shiny jetty black, which is not the case in the larger individual, where these parts are irregularly marked all over by both black and orange. At present I am unable to state whether or not these markings change at all with the growth of the animal, but I am rather disposed to think that they do not. Moreover, I have had Heloderms under my observation for two years at a time, and during that period never knew the animal to shed its skin, as do some other lizards and snakes. When I say this, I do not mean to imply that a shedding never takes place, because that would not be true, for at the present time (March 7th, 1888) the skin is shedding from the toes and soles of the feet of my larger Heloderm, leaving the scales bright and new as it comes away. What I do mean is that I have never observed it peel off in great pieces, as it is known to do in some of our Lacertilians, where I have frequently seen it slip off nearly entire, forming a tissue paper-like cast of the entire form of the lizard.

Of the Form.—For the first few years of its life, the Heloderm has a broad oval outline to its head, but as the animal matures this is superseded by the marked triangular form, where the angles at the muzzle and opposite the mandibular articulations are rounded off, and we may add that at all ages the head of this lizard is always much depressed, being quite flat on top, while considerable fulness pertains to the throat posterior to the mandibular symphysis. When the animal is asleep we may by close observation see his sides swell and collapse very slightly as he breathes, and at such times, too, the most lax and posterior part of this throat-region perceptibly pulsates in synchronism with the animal's respiration. Sometimes he has a way of taking several quick breaths in rapid succession, when all these movements become much more obvious. The body of this lizard is of an elongated ellipsoidal form, being depressed, so that on section at about its middle it would show an ellipse with its major axis horizontally disposed. The tail is large and heavy, being subconical in form, gradually tapering to a pointed tip; the posterior limbs spring from points at its junction with the body, and as the latter is considerably broader just beyond this point, it always gives the casual observer the impression that these hind limbs arise from the sides of the tail. No such deception ever strikes one upon viewing the anterior pair of limbs, as in that region the neck is proportionally of considerably larger calibre than is the root of the caudal appendage.

There is but very little difference either in the bigness or the length of any of the limbs, though it may be slightly in favour of the hinder pair, while for their entire lengths they are much of the same calibre, showing only slight constrictions therein at the knees and elbows, and no very decided swells mark the sites of the muscular masses of the thigh or brachium. Manus and pes are both flattened from above downwards and of a subcircular outline, while from each, around its anterior periphery, spring the toes of this pentadactyle lizard. The digits are all of nearly the same length, but in the case of manus the mid-toe appears to be the longest and the pollex the shortest, while in the pes the mid-toe and the next one to its outer side are of about the same length, and again the hallux is the shortest. Each toe is terminated by a small, sharp-pointed, decurved claw, which is of a horn-colour before the moult, but which thereafter is seen to be a pure glistening white. These claws are generally much worn by the constant walking of these heavy reptiles over the rocks of their native haunts, and, indeed, in very old individuals the toes seem to be almost clawless, both ungual phalanx and its horny sheath having been worn down to the very base.

As will be seen by the above table of measurements, the external narial apertures are, comparatively speaking, situated rather far apart; they are, too, of good size, being of a subcircular outline, with a pale-coloured mucous membrane lining them within. *Heloderma* has fairly large eyes, in which the irides are of a dark snuff-brown, and the external lids, which can be closed completely, when open create an aperture broadly elliptical in outline. The opening of the mouth in this reptile is very capacious, and the commissures of the gape are situated at some distance posterior to vertical lines let fall, on either side, from the pupils of the eyes. The lower lip is rounded and is overlapped by the upper lip, the margins of which are sharp; but in the case of both the tissues are quite pliable and consist of nothing more than the flat scutes overlying the soft parts they cover.

Either external ear consists in an oblique slit, situated at some little distance from, but in line with, the commissure of the gape; its borders are rounded, and its lower angle is the anterior one of the two. Unlike some other Lizards, the tympanum is rather deeply situated, and is only brought into view by carefully opening the ear, by which I mean parting its margins. In front of the entrance to this aural meatus, the row of tubercles bounding it are of some considerable size, while those on the posterior margin of the aperture are comparatively minute, the latter being in continuation with those found beneath the throat.

This method of the arrangement of the scales or tubercles is repeated again in the vent of this animal, where we find a broad slit-like aperture transversely disposed and with a soft rounded posterior border, bounded by a row of very minute tubercles; while in front the opening is more rigid in character, which is largely due to the far greater size of the bounding scutes and their consequent greater immobility.

Of the Teguments.—Viewed as a whole, the external epidermic armour of this reptile consists in, for the entire dorsal aspect, a stuccoing of knob-like tubercles of various sizes, which, as they pass to the ventral surface of the body, gradually assume the flat type of scale, having different forms in different localities. These tubercles are found to be largest on top of the head, more especially on the lateral parietal regions, and over the entire facio-frontal aspect; here, as in the case of the smaller mesial ones, they are crowded close together, are of varying outline, but in no specimen are they arranged upon any definite plan as they are in some other Lizards, in *Lacerta* for example. Moreover, they do not quite agree in any two specimens, a fact that, upon comparison, at once becomes evident. Tubercles of a similar character extend down upon either side of the head as far as the commissure of the gape, filling in the region between the eye and the aural entrance: these gradually become smaller as they near the throat, which latter space is entirely covered over by an even layer of closely-set tubercles of a very much smaller size and of a uniformly subcircular form. Here these peculiar scales are the smallest of the kind as compared with those anywhere else on the body of this reptile: they are all in contact with each other, unless the animal from some cause swells out its throat, when the skin may be seen in the evenly distributed interspaces. Upon studying the arrangement, number, and distribution of the circumocular, narial, and labial scales in these two specimens of mine, I find that in none of these particulars are they exactly alike. A large oblong rostral scute is present, with a smaller scute upon either side of it, while external to either of these is a quadrilateral subnarial scute. Next follow the superior labials proper, the marginal ones being usually nine in number on either side, which become gradually smaller as we proceed from before backwards. Above the anterior moiety of these labials, extending between eye and nostril, there is another row of smaller size, some five or six in number, which I am of the opinion will be pretty constantly found in that locality. Of this latter row the largest scute is just posterior to the nostril, while the smallest and most posterior one, triangular in form, is wedged in just beneath the suborbital row. Three large tubercles is the rule for the supraciliary scutes, with four suborbitals, and either one or two small post- and preorbitals. Normally, again, there seem to be two anterior nasal scutes, with a large postnasal one, and commonly one wedged in above and between these two. Passing next to the arrangement of these upon the mandible, we find always present a fair-sized chin-scute, followed posteriorly by four mental scutes, on either side of the median line, while the lower labials seem to average fourteen in number. Between these latter and the mental scutes, the interval is filled in by three oblique rows of flat scutes, those of the larger size being in the most external row, while the smallest occupy the inner one, and these latter gradually merge into the area of small tubercles which overlay the throat and which have been already described above.

We may now turn our attention to the scutation of this reptile's body, and we find upon the dorsal aspect that the tubercles gradually diminish in size as we pass backwards from the occipital region, although they maintain very much the same character and arrangement. Soon, however, they commence to dispose themselves in regular transverse rows and are of a pretty uniform size. This state of things continues all the way to the root of the tail, with scarcely any perceptible difference in the size of the individual tubercles, although perhaps the larger ones may range along the middle of the back. They are so arranged that any single tubercle in one row stands opposite the interspace between two other tubercles either in the row in front of or behind it. When the Heloderm is fat and in good condition, the individual tubercles stand apart from each other, separated by a distance equal in any case to about the diameter of the base of the tubercle next to the space. And when the reptile is laying out perfectly straight and at rest, these several rows of tubercles seem to be separated from each other by crease-like lines marking the intervening skin; but the moment the animal twists to one side or the other, these transverse lines are immediately obliterated, while oblique ones, running straight down the concaved side, take their place. As I have already described above, these knob-like tubercles of the dorsal aspect of the Heloderm's body in passing down the sides gradually assume the flat scale-like type. From between the armpits and the groins these are of an even oblong form, arranged in regular transverse rows, being in contact with each other, while the individual scales of one row break joints with the scales in front of and behind them, much in the same manner as bricks in a building do. Between the legs in front these oblong scales gradually assume a rounded form, and in passing still more anteriorly they become still smaller, to eventually merge into the minute tubercles, already described, that cover the throat. These ventral scales also become more rounded as they pass between the hinder pair of limbs, as well as slightly smaller. The two middle preanal scales are markedly larger than the few remaining ones that make up this row upon either side of them; and, as I have already said, the tubercles on the posterior margin of the vent are quite minute in comparison. The tubercles covering the dorsal aspect of the great rounded tail of this reptile pass regularly from those on its back, having the same arrangement and character, only they are placed closer together, being nearly or quite in contact with each other. Further, as these caudal tubercles pass round to the underside of this appendage, they, too, become gradually flatter, but in their case only two middle rows running the length of the underside of the tail may said to be flat. The rows of small tubercles covering any one of the limbs are arranged much after the same fashion as are those upon the back, while upon the soles of the feet they are seen to be very much worn. Any single toe shows a transverse arrangement of its single row of oblong scutes, both upon its ventral and dorsal aspect, and between these, on either lateral surface of the digit, is another longitudinal row of rounded scales, all three being carried down so that the terminal ones surround the claw.

As has already been hinted at in a foregoing paragraph, in shedding but small patches of skin come away at a time, and these show a perfect casting of the scales or tubercles they originally covered.

Of other Parts which may be examined externally.—By the aid of a lens and carefully going over the region immediately over the parietal foramen, I failed to discover any external traces whatever of a "parietal eye," described by Spencer as existing in *Sphenodon punctatum*, and which has been found in so many Saurians since by other observers. Indeed, the tubercles are placed so close together on the top of the head in *Heloderma*, that a depression of any kind would be recognized at once. It is possible we may find something of the kind when we come to examine the brain in these specimens of mine.

Passing to the ventral border of the thigh, on either side, careful scrutiny failed to reveal to me any evidences of the pori femorales, that series of apertures which are the external openings of certain cutaneous glands in some Reptiles. Nor from an external examination do I find any evidences of the large anal glands, such as were found by Günther to exist in *Sphenodon*. From an outer survey alone I would say that both of these specimens were females, but of course more extensive dissection will prove that point. Ossifications exist in the cutis of *Heloderma*, but the squamo-tuberculated skin of this reptile nowhere develops any special spines or similar appendages[1].

So far as I have been able to discover from the literature of the subject, little or nothing is as yet known of the reproduction of this lizard, beyond the fact that Captain Bendire, of the U. S. Army, found a number of eggs in a specimen of *Heloderma suspectum* that he opened (60). Indeed, there still remains much that it is very desirable to know in so far as the habits of this reptile are concerned ; we may refer especially to the means it employs to secure its food, as well as the various kinds that go to make up its diet-list.

We find here and there authors referring to the nauseous odour emitted on the part of the *Heloderma*, and, although I have had them in captivity for a year or more together, I have never noticed any such characteristic as pertaining to them, and I have studied them under a great variety of circumstances. Professor Garman has remarked that, "As if better protected from below, the *Heloderma* is said to turn himself on his back when attacked." It never has been my fortune to have observed this habit in the case of *Heloderma suspectum*, and I am of the opinion that such is not the case with it.

[1] Just here I would say that a year has passed by since this monograph was completed up to the above point, or where the index reference to this footnote occurs; during that time my large specimen of the *Heloderma* has died and duly been placed in alcohol, while the writer's residence is no longer at Fort Wingate, N. Mexico, but at his home a few moment's ride from Washington, D.C., where all the libraries and collections are open to him and easy of access. Through the kindness of Professor G. B. Goode, the director of the U. S. National Museum, I have also had placed at my disposal another fine, large alcoholic specimen of the *Heloderma suspectum* from Arizona, as well as the loan of a handsomely mounted skeleton of the same reptile, from the collections of of that Institution. In view of these facts, I will not, in future pages of this memoir, refer to any particular specimen used in my work; for it is sufficiently extensive now to obviate the necessity of that course ; with increased material comes a broadening of the field, permitting our passage from the description of a couple of specimens to more general observations in the premises.

Experiments made by a number of competent investigators during the past few years have satisfactorily demonstrated the fact to my mind that the venomous or non-venomous character of the bite of the *Heloderma* is placed beyond the peradventure of cavil, for there can be no doubt now but that its bite is soon fatal, at least to the smaller kinds of animals. Whether it has ever proved fatal in the case of man I believe still remains an open question, although I am inclined to believe that that, too, will sooner or later be substantiated.

With respect to the affinities of the *Helodermatidæ*, authors have entertained a variety of opinions; and, so far as I can ascertain, herpetologists are still considerably in doubt as to the position of these reptiles in the system, and which group constitute their nearest kin. The opinion has been very generally held that the Heloderms are more or less nearly related to the *Varanidæ* or perhaps to *Iguanidæ*. Cope, in his recent work (61), places them as a family between the *Xenosauridæ* and the *Anguidæ*; while Gill (56) has created a superfamily for them, ranging it as the *Helodermatoidea* next above his superfamily the *Varanoidea*, and the *Aniellidæ*, of his superfamily *Anielloidea*, immediately preceding them. Bocourt (34) recognizes the family *Helodermidæ*, and "associates with it under the family *Trachydermi*, Wiegm., several lizards to which it offers considerable zoological affinities; they differ from it in having smooth ungrooved teeth. Such a difference might at first seem to militate against their union with *Heloderma*, but this dental character, of great importance in the higher Vertebrata, has only a secondary importance among the Reptiles, as is exemplified by the serrated teeth of *Macroscincus coctæi*, D. & B." (Zool. Rec. 1878). A few years ago, Steindachner (35) described a new reptile from Borneo to which he gave the name of *Lanthanotus borneensis*, and which he claimed was related to the Heloderms. We are, however, of the opinion that that fact is by no means a settled one. Nevertheless, Boulenger has placed the genus *Lanthanotus* after the family *Helodermatidæ* in the Catalogue of Reptiles in the British Museum (55), but remarks that "Whether the following genus is to be placed here, or constitutes a distinct allied family (*Lanthanotidæ*, Steindachner), must remain doubtful until its anatomical characters are known. Its dentition was originally stated to be the same as in *Heloderma*, but this has been subsequently corrected by Steindachner." In the Catalogue we have cited, Boulenger has characterized the *Helodermatidæ* for us in a masterly manner, and in the same place he presents us with the characters of *Lanthanotus*, so far as they are at present known from Steindachner's description. It is evident, then, that a complete account of the anatomy of this Bornean reptile, one of the supposed affines of *Heloderma*, is very much to be desired; I am inclined to think, however, at present, that when its morphology comes to be fully known, its affinity with the *Helodermatidæ* will not be found to be a near one by any manner of means, judging, as I do, from some of its external characters.

III. Of the Myology.

To assist me in the demonstration of the muscles of this lizard I have at my hand an excellent paper entitled "Notes on the Myology of *Liolepis belli*," by Alfred Sanders (P. Z. S. 1872, p. 154); also one entitled "Notes on the Myology of the *Phrynosoma coronatum*," by the same author (P. Z. S. 1874, p. 71); also the admirable memoir, "On the Myology of *Chamæleon parsonii*," by Professor St. George Mivart (P. Z. S. 1870, p. 850); and finally the more generalized contribution to the study of the muscles in Lizards presented us by Prof. C. K. Hoffmann in Bronn's 'Thier-Reichs' (45). With these I must likewise mention the studies of Professor Mivart upon the *Iguana* (P. Z. S. 1867); and other works on the muscles of reptiles by the same distinguished author. As to the names I here bestow upon the muscles of the Heloderm, I can say with Sanders, who remarked in his paper on the myology of *Liolepis*, that "With regard to the nomenclature, it must be regarded as merely a tentative expression of opinion, liable to be changed at any time on the demonstration of error." It is a long day yet before we can say in truth that our knowledge of the myology of reptiles is in any way complete, and a great many forms still remain to be worked out.

Muscles of the Head.

1. *Mylo-hyoideus anterior.*—We find in the present subject this muscle to be but feebly developed; it arises, on either side, from the inner aspect of the lower border of the ramus of the jaw, for about its anterior moiety, and as far forward as the symphysis. Mesially, it indistinguishably blends with its fellow of the opposite side, making no median raphe. Postero-laterally it faintly overlaps the *mylo-hyoideus posterior*, while at the middle of the throat it almost seems to blend with that muscle: and this delicate, superficial plain of transversely disposed muscular fibres overlays a number of the group of the more deeply situated and true hyoidean muscles.

2. *Mylo-hyoideus posterior* is a far better developed muscle than the one I have just described, and apart from its greater size it differs from it in that it exhibits a fairly well-developed medio-tendinous raphe for nearly its entire length. Into this the muscle of either side merges. Springing from the occiput and the dense fascia at the antero-superior part of the neck, from the mandibular suspensorium, as well as from the inner aspect of the posterior moiety of the mandible itself, the posterior mylo-hyoid sends its fibres, for the most part, transversely to the middle line of the throat, where they blend with the delicate, longitudinal, raphenous line in a manner which I have already indicated. The posterior border of this muscle is well-defined and thickened: it crosses the throat just anterior to the region of the chest; while laterally the hinder margin of an aural aperture is formed by its free muscular edge. Anteriorly it is very thin where it meets the anterior mylo-hyoid in

a manner already alluded to. These two muscles seem to constitute the *platysma myoides* of Sanders, and from this it will be seen that *Heloderma suspectum* is one of those lizards wherein the mylohyoidean muscles are conspicuously developed. By removing them we at once expose the deeper set of the true muscles of the hyoid arches.

3. *Temporalis.*—Notably dense and bulky, this is one of the, if not the, most powerful muscles of the system to be found in this lizard's economy. It takes origin from the parietal, from the nether surface of the squamosal and postfrontal, and from the anterior aspect of the quadrate ; from this extensive surface its fibres rapidly converge as they pass downwards and forwards, and becoming strongly tendinous they make insertion upon the postero-external border of the coronary process of the mandible ; this constitutes its chief insertion, but beyond this its tendon also fastens itself to the outer surface of the coronary, extending to the corresponding aspect of the adjacent side of the mandible as far forward as the dentary element, and posteriorly to a slight extent towards the hinder end of the bone. It will be seen from this that the muscle quite fills the temporal fossa, its insertional margin being limited sharply above by the cranial bones that go to form the outer edge of the orbit; and it is between the posterior border of this muscle and the anterior margin of the *digastric* and *neuro-mandibularis* that we discover the subelliptical periphery of the ear, with its tympanic membrane tightly stretched over it.

In making my dissections of these parts, I find an interesting tendon which arises from near the posterior end of the mandible, and passing directly forwards, on a line with the upper edge of the lower jaw, commences to expand about opposite the coronoid process of that bone, and spreading out like a fan, thence on becomes intimately attached to the antero-lateral skin of the throat. It is superficial to all these structures, except of course the skin, where anteriorly it is attached, being in contact above with the poison-gland of the corresponding side. Now there are a few muscular fibres to be seen in the anterior portion of this tendon, so that upon contraction it will tend to press with some force the poison-gland against the mandible, and thus be auxiliary to forcing its secretion through the gland's ducts at the time this reptile makes its bite.

4. *Pterygoideus externus.*—Chiefly carneous, this is another large muscle of this region, which arises from the inferior aspect of the corresponding pterygoid to pass backwards and outwards in the form of a subelliptical bundle of fleshy fibres that take it upon themselves to completely envelop the articular extremity of the mandible, being inserted into the three elements that go to form that end of the bone. This muscle is somewhat tendinous at its origin, but almost entirely carneous at its insertion.

5. *Pterygoideus internus.*—More modest in its proportions than the last described, this muscle finds its origin upon the outer margin of the parietal bone, and the adjacent surface of the prootic, at the antero-external region of the orbit. From this point of origin its fibres

take on the same direction as the fibres of the *temporalis*, of which it seems almost to be the anterior part, and passing downwards and forwards, they are inserted, being somewhat tendinous, into the inner aspect of the ramus of the mandible, below and at the same time behind the coronary process[1].

6. *Neuro-mandibularis.*—Both this and the next muscle are but feebly developed in our present subject, and so much alike are they, both in their origins and insertions, as well as in the direction of their fibres, that one might easily mistake them for one and the same structure. The *neuro-mandibularis* is the more posterior of the two, and upon either side it arises from the hinder free margin of the parietal bone, from its mid-posterior point for a distance outwards of about four millimetres. It is thin and tendinous here, but soon gathers itself into a small, somewhat laterally flattened, bundle of fibres which pass directly downwards to the posterior tip of the mandible, where they make a firm tendinous insertion.

7. *Digastric.*—Is rather a smaller muscle than the *neuro-mandibularis*, being related to it as we have already described in the foregoing paragraph. It is the muscle of the deep layer which goes to form the posterior fleshy border of the aural opening, the *mylo-hyoideus posterior* being the superficial one. It arises from the point of meeting of the quadrate, squamosal, and parietal bones, at the postero-lateral aspect of the cranium, and passes directly downwards to make a common insertion with the *neuro-mandibularis* on the hinder end of the lower jaw.

Mivart does not allude to the *neuro-mandibularis* as occurring in either Parson's Chamæleon or in the Iguana, while Sanders describes it as being present in *Phrynosoma*, as well as in *Liolepis*. Hoffmann recognizes it in his general account of the myology of Lizards, while again Mivart (Elem. Anat. p. 311) figures *two digastrics* for *Menopoma*, the posterior one of which I take to be the *neuro-mandibularis*.

Muscles of the Hyoidean Apparatus.

8. *Genio-hyoideus.*—This is a flat muscular sheet composed of fasciculi of coarse fibres, which, with the fellow of the opposite side, forms a substantial fleshy underflooring to the buccal cavity. Either genio-hyoid arises, carneous, from the entire anterior surface of the corresponding thyro-hyal of the hyoid, and its fibres, converging but very slightly, pass directly forwards to become inserted along the inner aspect of the ramus of the mandible for the middle third of its length. The deeper fibres of this muscle pass upwards to become inserted into the base of the tongue. This muscle is inclined to be more tendinous at its insertion than it is at its origin, where in front it is separated from its fellow by quite an interval.

9. *Cerato-hyoideus.*—By dividing the *genio-hyoideus* transversely through its middle and reflecting back the cut extremities, we expose the deeper set of the hyoidean muscles. The *cerato-hyoideus*

[1] I fail to find a "*superficial temporal*" in this lizard, as is described by Mivart in *Chamæleon parsonii* (P. Z. S. 1870).

consists of a loosely connected plain of coarse fibres, which arise from the outer half of the posterior cornua of the hyoid, from the under surface of the anterior horn of the same bone, and from the membrane of the floor of the mouth. Passing directly forwards it inserts itself, tendinous, into the inner aspect of the dentary element of the mandible posterior to the symphysis. From this it will be seen that this muscle is posteriorly broad and anteriorly narrow.

10. *Mandibularis.*—This is a muscle that, thus far, I have failed to find any published description of, although it was evidently seen by Fischer, who has presented us with an imperfect drawing of it, and apparently left the muscle unnamed (see fig. 1, Taf. xcvii. Bronn's 'Thier-Reichs,' Bd. vi., iii. Abth., 33 & 34 Lief. 1882). When I say an imperfect figure, I mean that the muscle does not interdigitate with the *m. genio-hyoideus superficialis* as Fischer has represented it, at least it does not in the several specimens of *Heloderma suspectum* wherein I have examined it. The *mandibularis* is a small muscle which has an origin for about half a centimetre on the inner aspect of the dentary element of the mandibular ramus just posterior to the point of attachment of the *cerato-mandibularis.* It is quadrilateral in form, and its fibres pass directly across the inter-ramal space to meet the muscle of the opposite side, which it does in a delicate fascia in the median line. It is deep to the *genio-hyoideus*, and I have provisionally bestowed the above name upon it, until its homologies are better known.

11. *Cerato-mandibularis.*—In this we have a muscle that appears to represent but a little more than the differentiated external margin of the *genio-hyoideus.* It arises, on either side, from the apex of the posterior cornua of the hyoid bone, and its fibres taking on the same direction as those of the *genio-hyoideus*, the muscle inserts itself by a delicate tendon into the antero-internal aspect of the mandible just posterior to the insertion of the *genio-hyoideus*, and upon the same plane with it. This muscle is the *cerato-mandibular* of Mivart, and, in part, the *mylo-hyoideus* of Sanders; it being the *cerato-mandibularis* of Hoffmann.

12. The *Omo-hyoideus* is a handsomely developed muscle in this lizard, arising for the most part from the anterior border of the clavicle of the same side, and from the summit of the interclavicle, and apparently by a single head. Its fibres form a flat band, which, passing forwards and inwards, insert themselves into the posterior surface of the basihyal, and the hinder margin of the corresponding thyro-hyal for the inner two thirds of its length. Mesially it meets the muscle of the opposite side for a limited distance in front, and for the most part is superficial to the next two muscles to be described. Externally it is overlapped by the *sterno-mastoideus,* and we note that passing obliquely across its middle a tendinous line is to be seen, from the external, and at the same time the most anterior, half of which its fibres are inclined to be more outwardly directed, before making their insertion into the thyro-hyal.

13. The *Sterno-hyoideus* is a much slenderer muscle than the last

described one, and in its characters it almost agrees with the same muscle in *Liolepis*, as described for us by Sanders. Arising from the summit of the interclavicle and the adjacent fascia, it takes a course directly up the middle of the neck, to become inserted into the basihyal and for a limited distance on the adjacent thyro-hyal, on their posterior margins. This muscle is almost in contact with the fellow of the opposite side for its entire length.

14. The *Sterno-hyoideus profundus* is situated deep to the two last-mentioned muscles, it taking origin from the interclavicle, the corresponding clavicle for nearly its entire length, and from the deep fascia of the neck adjacent to these parts. From this origin its fibres are directed upwards, forwards, and outwards, to finally insert themselves along the hinder border of the thyro-hyal of the same side, from its tip inwardly to the point of insertion of the *sterno-hyoideus*. At the postero-mesial point of origin this muscle and the fellow of the opposite side are in contact.

Muscles of the Shoulder-Girdle and the Upper Extremity.

15. The *Sterno-mastoideus* in this lizard is a strong, broad, and flat muscle, which arises from the summit of the interclavicle at its external aspect, also from the adjacent fascia as far back as the shoulder-joint. Passing obliquely upwards, forwards, and outwards, it is inserted into the outer end of the squamosal of the corresponding side. At its insertion it is covered by the *neuro-mandibularis*. Posterior to this the *sterno-mastoideus* is attached to the superficial fascia overlying the deeper muscles of the back of the neck, as far back as the third cervical vertebra. In this locality the muscle becomes very thin. The anterior and posterior portions of this muscle are somewhat individualized, more especially the dorsal moiety of the muscle, where the cranial and cervical insertional parts are quite distinct.

16. *Trapezius.*—This muscle is comparatively feebly developed in *Heloderma*, being subtriangular in form, and overlapping behind the anterior portion of the *latissimus dorsi*. It arises as a thin sheet of tendon from the fascia that springs from the cervico-dorsal vertebræ at the summits of their neural spines, from about the last few cervical vertebræ, to include the first two dorsals. The fibres, forming a thin muscular plane, converge as they pass down towards the shoulder-joint, where they again become tendinous, and are finally inserted at the anterior portion of the outer aspect of the suprascapular of the same side, to the fascia below and posterior to this, and more anteriorly to the outer extremity of the corresponding clavicle.

17. *Latissimus dorsi* is a much better developed muscle than the last described, being a strong, flat, triangular fasciculus of rather coarse muscular fibres, which arise for the most part from the aponeurosis of the dorsum that is attached to the neural spines of the tenth to the twenty-first vertebræ inclusive, being adherent to the fascia covering the deeper muscles for some little distance outwards

from these points. Passing downwards and forwards it becomes inserted by a strong tendon into the proximal third of the corresponding humerus upon its ulnar aspect. The outer margin of this muscle develops a strong tendon, which, as the muscle itself passes between the heads of the triceps to its insertion, branches off to insert itself into the triceps, upon its inner head. Mivart found a similar tendon to this in *Iguana*, and Sanders in *Phrynosoma*; but the latter anatomist found it absent in *Liolepis*.

18. *Levator scapulæ*.—This is a flat, triangular muscle that arises fleshy from the external aspect of the anterior part of the scapular and suprascapular, and from the anterior margins of both of these bones. Its fibres converging as they pass directly forwards and passing between the deep muscles at the side of the neck, it is finally inserted by a strong tendon into the side of the atlas.

19. *Pectoralis*.—*Heloderma* has this important breast-muscle well developed; it arises from the external longitudinal half of the entire length of the interclavicle, from the posterior border of the inner end of the clavicle, from the ventral aspect of the sternum, from the corresponding surfaces of the last four costal ribs and the intercostal fascia, and finally posterior to these parts from the fascia of those muscles of the abdomen which are situated deep to the pectoralis.

From these several points of origin, a *pectoralis* of either side has its fibres converging to a point represented by the tuberosity of the humerus of the same side, and here they are inserted, tendinous, upon a line defining its mesial aspect, and for its entire margin.

20. *Deltoideus* in the species before us arises by two heads—the anterior head from the underside of the mesial extremity of the clavicle; the posterior head from the interclavicle close to the anterior head, and from the surface of the sternum immediately adjacent: these two heads are in contact for their entire lengths, and their fibres are sent directly to the corresponding humerus; passing backwards and outwards, they become inserted by a strong tendon upon the head of that bone, just anterior to the next-to-be-described muscle. It appears that Sanders found in *Liolepis* and in *Phrynosoma* only that part of the *deltoideus* which represents its clavicular portion present. I believe it has a double head in the *Iguana*.

21. The *Supraspinatus* is a flat, triangular muscle of the chest, which, in this lizard, arises from the anterior half of the mesial margin of the coracoid, by means of a strong aponeurosis; the fibres converge as they take their way to the humerus of the same side, and are inserted, tendinous, into the tuberosity of that bone, close to the insertion of the *pectoralis*.

Here in *Heloderma* the *supraspinatus* appears a most to be divisible into two parts, the anterior half of the muscle being connected with the posterior half by an easily separable fascia; but as their origins are continuous, as well as their insertions, the muscle could in no way be properly described as having two heads.

Hoffmann, who calls this muscle the *m. supracoracoideus*, informs us in his synonymy that it is the *subclavius* of Rolleston, the *pectoralis* II. of Stannius, and the *epicoraco-humeral* of Mivart. Fürbringer also called it the *supracoracoideus*. As in *Liolepis*, the *supraspinatus* is covered by the *deltoideus* at least for its inner anterior part and anterior border. Mr. Sanders, who says that he has "seen Prof. Rolleston's paper (Trans. Linn. Soc. vol. xxvi. pt. 3), 'On the Homologies of certain Muscles connected with the Shoulder-joint,' in which he goes far to prove that the 'epicoraco-humeralis' (which was Dr. Mivart's name for the supraspinatus) corresponds to the subclavius; but these differences of interpretation are reconciled by Mr. Galton's paper 'On the Myology of the *Orycteropus capensis*,' in the same volume, in which the author shows that the subclavius in that animal has, among other insertions, one into the fascia covering the supraspinatus. Another piece of evidence bears upon this point; I believe that the nerve which in anthropotomy supplies the supraspinatus, arises from the same cord of the brachial plexus and close to the same one which supplies the subclavius, so that the muscle in question really corresponds to the subclavius at its origin, and to the supraspinatus at its insertion" (P. Z. S. 1872).

22. The *Infraspinatus* in *Heloderma* is a broad, thin, and fan-shaped muscle which arises from a curved line occupying a middle position upon the external surface of the suprascapula. From this point of origin its fibres tend immediately to converge to a point, but terminate in a strong, flat tendon which inserts itself upon the tuberosity of the humerus just beyond the insertions of the *deltoideus* and *supraspinatus*.

23. The *Teres minor* is one of the deeper muscles of this shoulder-girdle group, and it arises from the antero-external border of the coracoid and the adjacent margin of the scapula. Its fibres pass upwards, backwards, and outwards, when, becoming tendinous, the muscle inserts itself upon the proximal end of the humerus of the same side, just beyond its head. Not far from its insertion, the *teres minor* is bound down by a strong tendinous aponeurosis, which latter comes off from the tendon of the long head of the *triceps*, connecting this last with the head of the humerus. Fürbringer called this muscle the *scapulo-humeralis profundus*, in which he was followed by Hoffmann; and according to this latter author it represents the *supraspinatus* of Pfeiffer and Rüdinger, the *infraspinatus* of Mivart, the *suprascapularis* of Rolleston, and the *teres minor* of Sanders: may we not in truth believe that there is still work to be done in the myology of reptiles?

24. *Serratus superficialis.*—Two of the *serrati* muscles form an oblong fleshy mass upon the external aspect of the thoracic parietes, connecting the vertebro-costal ribs with the posterior border of the suprascapula. *Serratus superficialis* arises by two digitations, the most posterior of which springs from the outer surface of the posterior extremity of the second sternal rib, while the larger or anterior one comes off from a similar point upon the first sternal rib. Its fibres run forwards and upwards, and insert themselves upon the hinder border of the suprascapula, at its postero-inferior angle.

This muscle is superficial and closely applied to the *serratus profundus*, its fibres having the same direction almost throughout its length; it is so inserted, however, that the wider *s. profundus* extends beyond it, both beyond its superior and inferior borders posteriorly; while anteriorly, the lower margins of these two muscles are nearly in the same line, and the *s. profundus* expends its greater width above it, having a higher insertion upon the suprascapula.

25. *Serratus profundus.*—As I have already pointed out in the description of the *s. superficialis*, the present muscle lies immediately beneath the same. It arises from the superior extremities of the first two sternal ribs; from the lower end of the last cervical rib; and from the lower end of the first dorsal rib, as well as from the fascia stretching between these parts of the skeleton. Its fibres taking a course forwards and upwards, they become inserted upon the entire posterior border of the suprascapula, making slight encroachment upon the adjacent internal surface of the same bone.

26. *Serratus tertius.*—This is the third muscle of the *Serrati* group, and it arises by fleshy digitations from the fascia between the last two cervical ribs (this part of the origin is very weak), from the free extremities of the penultimate and next two anterior cervical ribs. From this origin the muscle is thrown upwards as a thin, fleshy sheet, covering the thoracic aspect of the corresponding scapula and suprascapula, to finally insert itself along the free, inner margin of the last-named bone, for the anterior four fifths of its superior edge.

27. *Sterno-coracoideus internus superficialis.*—To examine this muscle from the ventral aspect one must disarticulate the coracoid and the sternum, as the muscle lies within the thoracic cavity. It will be found to arise from the externo-dorsal surface of the sternum; from the anterior border of the same surface and from one or two of the sternal ribs and the fascia between them, upon the same side. From this origin its fibres pass directly forwards, converging somewhat as they do so, to become inserted into the coracoid, on its inner aspect and near its lower anterior border, immediately in front of the *subscapularis.*

28. *Sterno-coracoideus internus profundus.*—As its name indicates, this muscle is deep to the one just described. It arises from the inner chest-wall, and from the thoracic aspect of the posterior moiety of the sternum beyond it; when, converging, its fibres becoming tendinous, it finally inserts itself upon the inner surface of the coracoid, above and somewhat anterior to the *sterno-coracoideus internus superficialis.* Both these muscles were found to be present in *Liolepis belli* by Sanders, while Mivart describes but one of them as the "sterno-coracoid" as occurring in Parson's Chamælon. Following Fürbringer, they have also been termed the *m. sterno-coracoideus internus superficialis* and *m. sternocoracoideus internus profundus* by Hoffmann, who has said of them that "Die *Mm. sterno-coracoidei interni superficialis* und *profundus* werden in der Regel durch zwei an der Innenfläche des Brustbeins und ventralen

Brustgürtels gelegene Muskeln repräsentirt, die Sternum mit Coracoideum verbinden. Am einfachsten ist die Bildung bei *Platydactylus* .... Hier entspringt ein ansehnlicher Muskel von der Innenfläche und dem vorderen äusseren Rande des Sternum, sowie von den angrenzenden Enden der Sternocostalleisten und geht nach vorn zur Innenfläche des Coracoideum. Dieser *M. sterno-coracoideus internus* lässt an seinem insertiven Theile eine geweb-liche Differenzirung erkennen, derart, dass die mediale Portion sehnig und weiter vorn sich inserirt als die laterale, welche fleischig sich an das Coracoideum ansetzt."

"Diese Differenzirung entspricht der ersten Anlage einer Trennung in zwei ganz selbständige Muskeln, *M. sterno-coracoideus internus superficialis* und *M. sterno-coracoideus internus profundus*, wie sich dieselbe in ausgebildeten Zustande bei den meisten typischen Sauriern findet."

"Der *M. sterno-coracoideus internus superficialis* entspringt von der Innenfläche der inneren Lippe der Coracoidfurche des Sternum und inserirt sich medial neben dem hinteren Theil des Ursprungs des *M. subcoracoideus*."

"Der *M. sterno-coracoideus internus profundus* entspringt von der Innenfläche des Sternum, namentlich im Bereiche des hinteren Abschnittes, sowie von den angrenzenden Enden der Sternocostalleisten. Er geht in eine lange und ziemlich schmale Sehne über, welche sich an der Innenfläche des Coracoideum inserirt."

"Bei den fusslosen Sauriern ist dieser Muskel in der Regel bis auf spärliche, seitlich gelegene Rudimente (*Pygopus*, *Pseudopus*, *Lialis*), die speciell dem *M. sterno-coracoideus internus superficialis* zu entsprechen scheinen, verkümmert oder total reducirt (*Ophiodes*, *Acontias*)." (Bronn's 'Thier-Reichs,' Bd. vi. 22–24 Lief. pp. 625, 626, 1881).

29. *Sternocosto-scapularis.*—This muscle, described by Fürbringer, is found to be well developed in *Heloderma*, and is seen to arise, fleshy, from the anterior surface of the outer extremity of the first sternal rib, and as a flattened and narrow fasciculus of fibres to pass directly forwards to the internal surface of the scapula. Here it is inserted, its insertion being found between the two divisions of the *suprascapularis* muscle. Mivart, who calls this muscle the "costo-coracoid," found it absent in *Chamæleon parsonii*, but present in *Iguana*; in the former, however, it is represented by a "sheet of membrane" (P. Z. S. 1870, p. 865). According to Hoffmann, it is entirely absent in *Platydactylus*. And this last-named author describes still another shoulder-girdle muscle for lizards, the "teres major," which I find to be lacking in *Heloderma*; of it he says, "Entspringt entweder von dem hinteren Abschnitt der Aussenfläche des Suprascapulare (*Uromastix*, *Stellio*, *Trachysaurus*), oder von dem hinteren Rande der Scapula und des Suprascapulare (*Euprepes*) und inserirt sich am Humerus in der Nähe des Processus medialis, entweder für sich (*Scincoiden*) oder mit dem Latissimus dorsi (*Uromastix*)" (*loc. cit.* p. 624).

30. *Subscapularis.*—As in the majority of true lizards, this muscle

is here divided into two parts: the most posterior part envelops the hinder border of the scapula and suprascapula in a fleshy mass, encroaching slightly upon the adjacent surface of the coracoid. After this it converges to form rather a strong tendon, which is subsequently joined by the weaker tendon from the second part. This latter arises from the inner surface of the corresponding coracoid, covering a longitudinally-placed, elliptical area, occupying the greater share of its lower third. As already intimated, its tendon joins the tendon of the first part, just beyond the border of the coracoid, when almost immediately they become inserted into the distal margin of the head of the humerus at its posterior aspect. Between these two divisions of the *subscapularis*, the *sternocostoscapularis* muscle is inserted, upon the mesial aspect of the shoulder-blade. Externally, the *subscapularis* covers by its origin about half of the scapula, extending but very slightly upon the suprascapula, and in this locality is covered for its anterior portion by the *infraspinatus*. Just before inserting its tendon upon the humerus, a portion of the former is deflected and so expanded as to become inserted into the juxtaposed capsular ligament of the shoulder-joint, and this part of the insertion of the *subscapularis* seems to be enjoyed by the muscle among most Lizards.

Fürbringer and Hoffmann term this muscle the *subcoracoscapularis*, but the name I here adopt for it is the one that has been used by Mivart, Sanders, Stannius, Pfeiffer, Rüdinger, and other anatomists.

31. The *Biceps* here arises but by a single tendon, of some considerable width, which has its origin upon the external surface of the coracoid of the same side, it being limited to a curved line on the posterior moiety of the bone immediately within the line of the sterno-coracoidal articulation. The muscle passes directly down to a point just in front of the elbow-joint. It is not until it gets opposite the head of the humerus, however, that the thin flat tendon of the *biceps* becomes carneous, and even here it does not show any disposition, as it does nowhere else throughout its extent, to divide so as to exhibit anything that might be compared to two heads. At the middle of the brachium the muscle is considerably bellied and fleshy. Opposite the elbow-joint it again becomes tendinous, and its tendon here is transversely disposed, binds down the anterior aspect of the *brachialis anticus* muscle, as it spans the interosseous space, and finally is inserted into both the ulna and the radius, the ulnar insertion being much the stronger of the two.

Sanders found that the *biceps* is only represented by its coracoidal head in *Liolepis*, while Mivart found that in Parson's Chamæleon its insertional slips arched over the *brachialis anticus* muscle, exposing the latter to view in front, and he says of it, that "Descending in front of the insertion of the pectoralis, it there becomes fleshy, and becomes more or less divisible into two bellies, which embrace the brachialis anticus in front, but leave part of the latter visible within and without the arm." As I have just said, here in *Heloderma* it covers the *brachialis anticus*, and simply spans the interosseous space in front of it as it makes its double insertion, and it agrees with all these forms in possessing only its coracoidal head.

32. *Coraco-brachialis brevis.*—This is one of the deep muscles of the shoulder-girdle found upon the anterior aspect of the chest, and is here very well developed. It arises from the outer surface of the coracoid, between the rounded, posterior angle of that bone to a point anteriorly next to the origin of the *teres minor.* Its area of origin is luniform, the concavity being towards the humerus; and agreeing in form, posteriorly, with the coracoid, which in this locality it nearly covers. Its fibres converge as they pass towards the humerus, upon which bone the muscle is inserted, the insertion being upon a line extending from the head of the bone to a point at the junction of upper and middle thirds, on its anterior surface: the *coraco-brachialis brevis* also makes a partial insertion into the capsule of the shoulder-joint.

Posteriorly, this muscle is firmly overlapped by the thin, flat tendon of the *biceps,* while more anteriorly some of the superficial muscles cross it to the humerus.

33. *Coraco-brachialis longus.*—This is a very differently characterized muscle from the one I have just described, it being long and slender, passing parallel to the humerus for its entire length. It arises, upon either side, from the posterior rounded angle of the coracoid, making slight encroachment upon the adjacent posterior surface of the bone. From this origin this long and fleshy muscle goes directly to the internal condyle of the humerus, into which it inserts itself: its insertion also extends slightly up the shaft of the bone, while its fascia merges with the fascia of the shoulder-joint.

Sanders, Fürbringer, and Hoffmann all adopt the same names for these muscles as I have given them here, the first-named authority using them in the case of *Liolepis belli* as early as 1872. Both the *coraco-brachialis brevis* and *longus* are invariably present, so far as I am aware, in all true Lizards.

34. *Brachialis anticus.*—Comparatively larger than we find it in many Vertebrates, this muscle becomes one of the important ones of the arm, being even larger than the *biceps.* It arises, somewhat tendinous, from the entire antero-external aspect of the shaft of the humerus, from tuberosity to condylar extremity, being intimately associated with the *triceps* upon its inner side, and in contact with the *biceps* externally. Passing between the muscles of the forearm in company with the tendon of the *biceps*, it inserts itself, tendinous, into the proximal extremities of the radius and ulna, upon their anterior surfaces, being largely covered by the insertional tendon of the *biceps* in front.

Fürbringer terms this muscle the "humero-antebrachialis inferior," a name also adopted by Hoffmann; it being the *brachialis anticus* of Mivart and the *brachialis internus* of Rüdinger. It generally inserts itself into both bones of the forearm, but Mivart found that in *Chamæleon parsonii* this muscle inserted itself only into the ulna.

35. *Triceps.*—This thick and powerful muscle at the back of the arm, here in our present subject exhibits four points of origin, viz.:—

(1) Its first head, and distinctly the largest, arises from the entire posterior aspect of the shaft of the humerus, from the head of the bone to the condyles. This part of the origin of the *triceps* is comparatively carneous.

(2) Another, and a very much smaller, carneous head springs from a longitudinal line upon the posterior aspect of the shaft of the humerus, extending from the tuberosity to a point a little above the internal condyle. At the upper part of the shaft of the humerus the insertional tendon of the *latissimus dorsi* passes between these two heads.

(3) A strong, cord-like tendon of the *triceps* springs from the superior glenoid margin of the scapula, which merges into the fleshy part of the muscle after it passes the head of the humerus. We find given off from the proximal end of this tendon, a thin, though strong tendinous sheet, which passes across to the humeral head, binding down as it does so the insertional extremity of the *teres minor*.

(4) Finally, we find a long flat tendon of the *triceps* arising from the inner surface of the coracoid near its postero-inferior angle. This crosses over to the upper part of the belly of the muscle, and merges into it at a point immediately in front of the insertion of the *latissimus dorsi*. A tendinous connection is made between this last-named muscle and this coracoid-head of the *triceps* at the point we have indicated.

The *triceps* is inserted by a powerful tendon into the olecranon process of the ulna, but no sesamoid develops therein as was found to be the case in Parson's Chamæleon by Mivart, and in *Liolepis belli* by Sanders. This sesamoid is also alluded to by Hoffmann as the "patella ulnaris," in Bronn's 'Thier-Reichs' (*loc. cit.* p. 632).

Of the Musculature of the Antibrachium and Manus.

36. *Supinator longus.*—This, one of the most important and conspicuous muscles of the forearm, arises semitendinous from the external condyle of the humerus, and immediately makes insertion along the entire length of the shaft of the radius, upon its supero-external aspect. Hoffmann has very truly remarked in reference to this muscle that "Man kann an diesem Muskel gewöhnlich zwei zuweilen drei oder selbst vier Portionen unterscheiden (letzteres bei *Iguana*, nach Mivart). Alle diese Portionen entspringen von dem Epicondylus s. Condylus externus humeri (bei *Platydactylus* auch noch von dem unteren Drittel des Humerus, bei *Liolepis* oberhalb des Condylus). Seine Insertion findet, wie gesagt, an der ganzen Länge des Radius statt." These remarks apply equally well to the *supinator* in *Heloderma*.

37. *Extensor digitorum longus.*—In this we have another muscle which is prominently developed in the forearm of our present subject. Arising by a strong tendon from the external condyle it passes down the limb to merge into a thin, flat tendon over the wrist-joint, beyond which it trifurcates, a slip going to be inserted

in each case into the base of the second, third, and fourth metacarpal bones. Just beyond its origin this muscle is very thick and fleshy, and in this locality fuses to some little extent with the *supinator longus*, while at its insertion a thin tendinous expansion more or less unites its slips of division, and spreads out over the back of the carpus.

38. *Extensor carpi radialis.*—Running parallel with the *extensor digitorum longus*, this muscle likewise arises, tendinous, from the external condyle of the humerus, and, as it approaches the carpus, it forms a slender tendon which inserts itself into the *os carpi radiale*.

This muscle has not more than a quarter the bulk of the *extensor digitorum longus*, with which it is quite intimately connected along its radial border.

39. *Extensor digitorum brevis.*—Superficially, on the back of the manus, we observe a divided set of muscles, which constitute the short extensors of the phalanges. Five-parted, but each slip more or less distinct, the *extensor digitorum brevis* arises from the dorsal aspect of the five metacarpal bones at their proximal extremities, and from the ossicles of the first row of the carpus. These slips are fleshy over the back of the hand, but become tendinous, each one at the bases of the digits, and a tendon runs along the back of each phalanx to the base of the ungual joint, where it is, in each case, inserted.

Proximally, these muscular slips are imbricated, while distally their tendons, as they pass over each phalangeal joint in the fingers, send down lateral tendinous slips on either side, which attach to the sides of the heads of the finger-bones.

40. *Extensor carpi ulnaris.*—Springing from the postero-external aspect of the external condyle of the humerus, in common with the *flexor carpi ulnaris*, by a strong tendon, this muscle passes down the side of the forearm; when opposite the radial side of the wrist it develops a strong tendon which, passing between the muscles of the hand on that side, finally inserts itself into the proximal end of the fifth metacarpal, upon its external surface.

41. *Ulno-metacarpalis pollicis.*—I propose this name for the present muscle in lieu of the "*Ulno-pollicialis dorsalis s. Abductor pollicis longus*" of Fürbringer, or even the "*M. ulno-metacarpialis I*" of Hoffmann. It is the *Abductor pollicis longus* of Stannius, the *Extensor ossis metacarpi pollicis* of Mivart and Sanders. It arises from the dorsal aspect of the lower third of the forearm; springing from the upper surface of the shaft of the ulna, it passes obliquely across the carpus, to finally develop a strong little tendon which is inserted into the proximal end of the pollex metacarpal, upon its dorsal side.

42. The *flexor carpi ulnaris* arises by two heads—one from the posterior surface of the radial condyle of the humerus, and the other from the side of the proximal extremity of the ulna and from the olecranon process of that bone. These are at first strong tendons, but soon become carneous and forming a flat, powerful muscle running down the outer side of the forearm, which again becomes tendinous at the wrist, to finally insert itself into the pisiform bone, upon the

ulnar side. To speak more strictly, this superficial muscle of the forearm does not altogether run down its outer side, but rather crosses the limb somewhat obliquely, from the proximo-radial side to the ulno-distal aspect.

43. *Flexor carpi radialis.*—This rather slender muscle, though it develops a strong tendon both at its origin and insertion, arises from the internal humeral condyle, and, passing down superficially, on that side of the forearm, it becomes inserted into the os carpi radiale, and furthermore sends a tendinous slip to be inserted into the proximal extremity of the pollex metacarpal.

44. The *Pronator radii teres* is a conspicuous muscle of some considerable bulk, which arises from the internal condyle of the humerus, by means of a strong tendon, and is inserted into the anterior surface of the shaft of the radius for fully half its length. It is fleshy at its insertion, and intimately related to the *flexor carpi radialis* for its entire length.

45. *Pronator accessorius.*—Mivart found this interesting muscle present both in the Iguana and in Parson's Chamæleon, but according to Sanders it is absent both in *Liolepis* and *Platydactylus*, and present in *Phrynosoma.* Hoffmann states that it is absent in *Goniocephalus*, and he terms the muscle the *M. ulno-carpalis.* Rüdinger termed it the *Pronator quadratus proprius*; Mivart gave it the name here adopted; it is the *Pronator radii brevis* of Sanders, and the *Ulno-navicularis* of Fürbringer. *Heloderma suspectum* has it arising from the anterior aspect of the internal condyle of the humerus by rather a slender tendon, whence it passes directly across to the radius to make a carneous insertion upon rather more than the middle third of the shaft of that bone, along a line upon its inferior aspect. The tendons of the *biceps* and the *brachialis anticus* pass between this muscle and the proximal third of the shaft of the radius, to their insertions.

46. *Pronator quadratus.*—Having removed the superficial layer of muscles from the anterior aspect of the forearm, we readily expose the present one. It is seen to be a fleshy plane of muscular fibres which obliquely span the inter-radio-ulnar space; arising from a line extending down the shaft of the ulna on its radial side, these fibres pass forwards to the radius and insert themselves on the entire length of its shaft, on the side opposite the ulna.

Heloderma suspectum, then, possesses all three of these *pronator muscles* in its forearm, but we see from what has gone before that some lizards may have but one of them, others only two, and still others all three: so, then, we may judge that when the morphology of these Vertebrates is better known, these differences may come into play, as one good set of characters, in their classification.

At the postero-external aspect of the distal end of the ulna, at the back of the carpus, there is found in *Heloderma* a concavo-convex bonelet which I take to be the "pisiform." Attention is drawn to this ossicle here as we shall have to refer to it in the description of our next muscle.

47. *Flexor perforans digitorum.*—Before rendering my account

of this muscle, and the next one to be described, in *Heloderma*, I would say that I have found fundamental differences in both of them as compared with the corresponding muscles in other Lizards, as they are described for us by the various authors before me, for a number of forms. So different, indeed, did I find the present one, that I dissected it out in three forearms of three separate individuals; not only that, but I was not satisfied until I had again gone over all the other muscles of the forearm, removing them one at a time until only the *flexor perforans digitorum* and the *flexor perforatus digitorum* remained. The present muscle was found to be the same in all of these specimens. It arises by a broad and common tendon, in two well-defined parts, from the internal condyle of the humerus. Of these the larger and more massive part arises on a line below the origin of the *flexor carpi radialis*, while the origin of the second part is to be sought beneath the tendon of origin of this last-named muscle. Nice discrimination is required to properly separate these muscles at their common origin; and Sanders found that in *Liolepis* the *flexor carpi radialis* and the *flexor perforans digitorum* were inseparable in this part of their course.

Returning to the first part of the muscle we have now under consideration, we find that it stretches between the internal humeral condyle and the pisiform bone of the carpus, its carneous portion forming a muscular mass, of no inconsiderable bulk, at the middle of the flexor aspect of the forearm. Its insertion covers the entire palmar surface of the pisiform bone, the insertion of the tendon of the *f. carpi ulnaris* being found to its outer side. At the middle of the forearm, over the interosseous space, this part throws off a flat, muscular slip, which, becoming tendinous just before arriving at the wrist, joins the tendons of distribution of the second part of the *flexor perforans digitorum*, and with them passes beneath the annular ligament of the carpus.

Now both of these parts of our present muscle not only have an origin from the internal condyle of the humerus, as I have already described above, but they both likewise arise from the entire length of the contiguous surface of the shaft of the ulna: this division of the origin is quite free from the belly of the smaller, or second part of the *f. perforans digitorum*, but it becomes far more intimate with it at the carpus, at the point where the tendon commences that passes beneath the annular ligament to go to the fingers. This last-mentioned tendon still remains to be described. A large, flat sesamoid occurs in the broad and compressed trunk of this as it passes over the wrist-joint. In the palm the tendon splits into five strong slips, and these are distributed in regular order to the five digits, each one passing to the end of its proper finger to be inserted into the base of the ungual phalanx, upon its flexor side. A triangular muscular slip of some considerable size is given off from this tendon as it passes over the wrist, and its fibres converging they become inserted into one or two of the mid-carpal bones. Sanders found a muscular development similar to this in *Liolepis*. The muscular slip that goes to the pollex digit apparently does not give off either auxiliary muscular slips or tendons, but simply passes through the semitendinous tube developed for it by the *flexor perforatus digitorum*. At the point of bifurcation, from the dorsal aspect of the tendon-slip that goes to the second digit, we find two muscular slips given off: the one on the ulnar side distally forms a slender tendon which joins the corresponding tendon of the *flexor perforatus digitorum*; the one on the radial side inserts itself into the base of the proximal joint of the corresponding phalanx. This arrangement also obtains in the case of the third and fourth digits, and to a considerable extent with the fifth digit also.

48. The *Flexor perforatus digitorum*, as in so many lizards, is a muscle confined to the palm of the hand. In the reptile before us it arises by a common tendon from the pisiform bone and to some extent from the annular ligament of the wrist. From its point of origin it immediately radiates in the direction of the fingers, primarily dividing into five slips, each one going to its proper digit, and together forming a comparatively thick muscular pad for the palm of the hand. Each and all of these slips are quite distinct, and the one devoted to the pollex is especially thick: this latter at its insertion develops two small tendon-slips which attach, upon either side, to the proximal end of the first phalangeal joint at its latero-palmar aspect, and between these passes the tendon of the deep flexor which goes to this digit. A firm connective tissue both extensively and intimately surrounds the joint at this point, and has to be dissected away before the true relations of the parts can be clearly seen; and, further, we find that a tubular canal arises in this locality, stretching longitudinally along the nether aspect of the phalanx, being attached to its sides, and through it passes the digit-tendon of this finger furnished by the deep flexor. In the case of the second finger the arrangement is essentially quite different from what I have just described it for the thumb; and here, too, as already pointed out above, the power of the muscle is augmented by the reception, at its ulnar side, of an auxiliary slip offered on the part of the deep flexor. We also find the fibrous, tubular canal present, as already described, and in this finger, as is indeed the case with all of the remaining phalanges, this tube abruptly terminates at the middle of the joint next behind the ungual one, at its palmar aspect, while an inner secondary tube also presents a terminal aperture opposite the middle of the proximal phalanx. Returning, now, to the difference in the arrangement of the tendons in this finger, I would point out the following interesting structures: instead of the insertional tendon-slip of the *flexor perforatus digitorum* of the second digit becoming inserted on either side of the proximal joint at its base, as is the case in the pollex, and thus allowing the deep tendon of the *perforans* to pass between them, it splits, and allows the same to pass through the perforation, but after that this slip-tendon of the *perforatus* is inserted as a single cord into the base of the second phalanx of the digit.

Here I will also invite attention to some other structures, which perhaps more properly should have fallen under my description of the *flexor perforans digitorum*, but they are more forcibly brought to our notice at this point in our dissections. In the case of the second digit, which we still have under consideration, it is seen that when the tendon of the *flexor perforans digitorum* has passed through the perforation of the *flexor perforatus digitorum*, it in turn sends off a very delicate tendon which is perforated in its turn by the tendon of the *f. perforatus digitorum*, and which thereafter becomes inserted into the base of the second phalanx immediately posterior to the insertion of the tendon of the same. Again, when the tendon of the *f. perforans digitorum* passes the second joint of this second finger it sends off still another delicate tendon, which this time becomes inserted into the phalanx just referred to, at a point just posterior to its head. Finally, I find upon closer observation that in the case of the muscular slips which are thrown off on the part of the slip-tendons of the *f. perforans digitorum* in the palm of the hand, and which go to be inserted into the bases of the proximal phalanges of the third and fourth digits, that they so divide that the muscular slip between the second and third, as well as between the third and fourth metacarpals goes partly to the base of one finger and partly to the other, on either hand, for insertion. We will now consider the method of insertion of that slip of the *f. perforatus digitorum* which serves the third digit. This is very peculiar. Its main tendon is inserted into the palmar aspect of the distal extremity of the second phalanx, and is duly perforated near its middle by the proper tendon of the deep flexor. In addition to this it throws forwards still another and a delicate tendon, which in turn is inserted into the *base* of the phalanx just mentioned. This last tendon is perforated at its middle by the tendon both of the first-described tendon of the *f. perforatus*, as well as by the tendon of the *f. perforans digitorum*. We find here, also, that the tendon of the deep flexor sends off a delicate slip opposite each phalanx of the digit under consideration, which, in every case, becomes inserted into the several phalanges immediately posterior to their heads. The arrangement in the case of the fourth digit is essentially the same as that we have just described as obtaining in the third. In the fifth digit it is also the same, but the *f. perforatus digitorum* does not possess the auxiliary perforated tendon.

Comparing this with what Sanders found in the corresponding parts in *Liolepis belli*, we find them to be quite different in many particulars, as the reader may see by referring to that anatomist's work upon the reptile to which I allude. On the other hand, I am unable to compare these parts with the corresponding ones in *Iguana tuberculata* as they are offered us by Professor Mivart, for the reason that that investigator omitted to give a full account of the details as to the manner of insertion of the deep and superficial flexors in the form he selected for their demonstration, and in his drawing of the same the integuments have not been removed from the phalanges (P. Z. S. 1867, p. 785, fig. 6).

One would hardly look for such a high degree of specialization in the matter of these flexors of the hand of *Heloderma* as the reptile is not called upon to use that member, so far as the writer knows, for any particular operation requiring either marked flexibility or suppleness; it simply plods about, and neither runs up trees, grasping the smaller twigs, nor does it especially use its fore feet in feeding.

Before closing what I have to say about this muscle I would direct attention to the fact that Professor Mivart, in his 'Elementary Anatomy' (p. 331), has said, that in *Iguana* "this muscle can hardly be said to be inserted by definite tendons"; while, again, their mode of insertion in *Phrynosoma* seems, according to Sanders, to be very simple (P. Z. S. 1874, p. 80).

49. The *Abductor quinti digiti* arises, fleshy, from the anterior aspect of the pisiform bone, and, its fibres contracting to become tendinous distally, it inserts itself into the shaft of the fifth metacarpal bone, immediately proximad to its head and upon the palmar aspect.

50. The *Adductor quinti digiti* is here well represented, being a delicate, thin, little band of muscular fibres which arise from the inner side of the proximal end of the pollex metacarpal, and, passing obliquely across the palm of the hand, are inserted into the proximal extremity, on the inner aspect, of the proximal phalanx of the fifth digit. This very distinct and interesting muscle I examined with the greatest care, but it does not seem to be recognized by Hoffmann, nor does it agree with what Sanders found in *Liolepis*. In *Heloderma* it is at once brought into view the moment we cut across and turn back the *f. perforans digitorum*, and it is found to be wider across its middle part than it is either at its origin or its insertion.

51. The *Adductor quinti digiti proprius* is a thick muscle which arises from the two outer bones of the second row of the carpus, upon the ulnar side, and passing directly forwards and a little outwards, inserts itself, carneous, along the entire length of the fifth metacarpal, upon the inner aspect of its shaft. This may be the *Adductor quinti digiti* of Sanders as found by him in *Liolepis* (P. Z. S. 1872, p. 168), while the muscle I here describe as the *Adductor quinti digiti* may be his *Abductor quarti digiti* (*loc. cit.* p. 169); but even in that event they are essentially very different, since the *Abductor quarti digiti* of Sanders, as found by him in *Liolepis*, is inserted into the ulnar side of the last phalanx of the fourth digit.

52. *Abductor metacarpi pollicis* is the name I here propose for another very well-developed muscle in the palm of the lizard before us. It arises from the two outer bones of the second row of the carpus upon the radial side, and from the dense aponeurotic fascia of the same region. Passing forwards and a little outwards the muscle is inserted, carneous, along the entire length of the shaft of the pollex metacarpal, upon its inner aspect.

53. *Lumbricales.*—The auxiliary muscular slips which I described above when speaking of the *flexor perforatus* and *perforans digitorum* muscles undoubtedly represent the lumbrical muscles in this

reptile. There were found to be five of them, and they passed from the tendon-slips of the *f. perforans digitorum* in the palm of the hand to the corresponding tendons of the *f. perforatus digitorum* and the bases of the proximal joints of the digits, as already pointed out above. Professor Mivart has carefully described these as they occur in *Iguana tuberculata* (P. Z. S. 1867, p. 785).

54. *Interossei palmares.*—There are *three* of these in the palm of the hand of *Heloderma*; they are unusually handsomely developed, somewhat peculiar, and I have studied them with great care, aided by a powerful lens. They arise by three thin, though strong, tendons, from two bones of the second row of the carpus. The first one springs from the outer one upon the ulnar side; the second one from the same bone as well as from the second in the row; the third comes off entirely from the second bone of the row. The first-mentioned muscle enlarges and becomes carneous as it passes forwards and is inserted, fleshy, into the distal extremity of the shaft of the fourth metacarpal bone upon its palmar aspect and just behind its head. Number two, or the middle one of the three of these *interossei palmares*, possesses a similar form to the one just described, and makes a similar insertion upon the shaft of the third metacarpal. Finally, the one on the side of pollex is inserted in a like manner into the second metacarpal.

I am thus careful in presenting these insertions of the palmar interosseous muscles, for the reason that Professor Mivart found that in *Iguana tuberculata* they were inserted "one on each side of the proximal phalanx of each of the three middle digits" (P. Z. S. 1867, p. 786). From their position here, it will at once be seen that these muscles are not truly "interossei," but rather rest upon the palmar aspects of the metacarpal bones, and it is from their position in the hands of most mammals that the term has been derived.

55. *Interossei dorsales.*—The first of these arises from the radio-palmar aspect of the base of the second metacarpal, and passing obliquely forwards and outwards becomes inserted along the inner side of the shaft of the pollex metacarpal, and distally by a tendon into the base of the proximal phalanx of the same digit, at its internal latero-dorsal aspect. We also note a thin, but rather broad, tendon, stretching obliquely between the two metacarpals here referred to, at their further extremities, the insertion upon the second metacarpal being the higher on the shaft. The second dorsal interosseous arises from the base of the third metacarpal at a point corresponding to that, just described, on the second metacarpal as the origin of the first dorsal interosseous, and, passing obliquely across, is similarly inserted into the proximal phalanx of the second digit, and along the inner side of the shaft of its metacarpal bone. Similar interosseous muscles to these are found between the digits and their metacarpal bones of the third and fourth, and the fourth and fifth, phalanges, as are also the auxiliary oblique tendons referred to above; and thus it will be seen that *Heloderma* possesses four *interossei dorsales.*

Of the Musculature of the Trunk and Tail.

56. *Spinalis dorsi.*—*Heloderma suspectum* has this muscle quite powerfully developed, it being a firm, longitudinal welt wedged in between the neural spines of the vertebræ on the one hand and the *longissimus dorsi* muscle on the other, and extending the entire length of the back. Its thickest parts are in the cervical and dorsal regions, while down the latter half of the tail it gradually tapers away to a tendinous thread at the tip. Its structure is well seen in the mid-dorsal region, where superficially it is characterized by a series of oblique, closely juxtaposed, tendons, which, passing forward from the muscular mass, and stretching by nearly four of the vertebræ, are each in turn inserted into a neural spine of one of the same. Still more deeply situate we find other tendons somewhat similar to these last, which are inserted into the interspinous ligaments, the fascia, and more or less upon the sides of the neurapophyses themselves. All these I take to be tendons of insertion of the *spinalis dorsi*, and cutting down more deeply on the muscle we find its origin to be a system of tendons which arise from the anterior margins of the prezygapophyses of the vertebræ and by fleshy origins from the superior aspects of the same. Where the muscle passes over the pelvis, corresponding attachments are made to the sacral vertebræ. Following it into the cervical region, we find the *spinalis dorsi* still thick though more laterally compressed, and it is finally inserted, first by a tendon, having something of the character of a *ligamentum nuchæ*, into the middle of the posterior border of the parietal bone, mesiad to the *complexus*, into the supraoccipital which the latter overhangs, and also by stout carneous fasciculi into the posterior margins of the neurapophysis, the postzygapophysis, and to some slight extent into the ventral surface of the atlas vertebra. These insertions are not entirely fleshy, but semitendinous, and the neural spine of the atlas is much aborted. As we pass from sacrum to tip of tail the *spinalis dorsi*, as I have already said, gradually diminishes in size, while at the same time it comes to be more and more intimately blended with the *supracaudal* upon either side of it, as it is between these muscles that it is found in this part of its course. The muscles of the nuchal region of *Heloderma* are very much blended together, and consequently difficult of dissection and individualization. Hoffmann has also called this muscle the *spinalis dorsi*, but incorrectly quotes Sanders as having termed it the "*sphincter dorsi*" (Bronn's 'Thier-Reichs,' Bd. vi. Abth. iii. p. 618, quoting P. Z. S. 1872, p. 161).

57. The *Longissimus dorsi* may almost be considered as the direct extension forwards of the supracaudal muscles, for it is only at the leading sacral vertebra, superficially, that we can detect a semi-distinct, transverse, line of demarcation that seems to indicate the point where a blending takes place among the caudal muscles on the one hand, and the *longissimus dorsi* and the *sacro-lumbalis* on the other. Along the dorsum the present muscle is quite intimately united, by an intervening bond of semidense fasciæ, with

the mesially situated *spinalis dorsi*, and the *sacro-lumbalis* upon its outer side. And its origin seems to be in the sacro-lumbar region, where it arises, for the most part, from the diapophyses of the vertebræ; but as it passes to the middle of the back, and the cervical region beyond, its attachment becomes insertional, and by tendinous points of development it makes fast to the apices of the postzygapophyses, and to the dorsal surfaces of the ribs on their outer sides. Origin and insertion apparently are more or less blended in mid-dorsal region, but this muscle is distinctly insertional in the cervico-dorsal and cervical regions, while still more anteriorly the *longissimus dorsi* becomes specialized and goes to form muscles that will next be described.

58. *Complexus.*—This is a most powerful muscle here, constituting as it does the antero-median insertion of the *longissimus dorsi* upon the skull. We may consider it as coming off from more or fewer of the post-axial vertebræ, and it is inserted into the posterior border of the parietal bone, as well as into the hinder surface of the cranium below it. All these muscles of the neck are quite intimately blended, more especially the two or three at present under consideration.

59. The *Trachelo-mastoid* is another muscle which continues the *longissimus dorsi* forwards to the skull behind, being situated external to the last, and inserted principally into the *os occipitale externus.*

60. *Transversalis colli* is the last of the three muscular fasciculi which insert themselves into the posterior aspect of the cranium, as the forward prolongations of the *longissimus dorsi.* It attaches itself at a point lower than any of them, being inserted into the basioccipital near the *rectus anticus major*, and intimately associated on its outer side with the *cervicalis ascendens.* This muscle is the *complexus minor* of Mivart, as found by him in Parson's Chameleon.

61. *Sacro-lumbalis.*—In our present subject this muscle arises from the superficial aspect of the hinder end of the ilium of the corresponding side, and, passing as a narrow band over the pelvic region, it commences to broaden as it covers the ribs. From thence on to the neck it has a width greater than the *spinalis dorsi* and the *longissimus dorsi* together, but mesiad it is not so thick vertically, while it gradually becomes thinner as it passes outwards. As in the case of the two muscles just mentioned, the general direction of its fibres is directly forwards, and its insertion is found to be upon the dorsal surface of each rib, for more or less their inner thirds. These insertions are tendinous and very firm, while the ventral surface of the muscle itself is quite intimately blended with the intercostals, and more posteriorly with the *quadratus lumborum.* On its inner side, for its entire length, it is easily dissected from the *longissimus dorsi*, the two muscles being quite distinct, while anteriorly it merges into the *cervicalis ascendens*, a muscle which constitutes its proper continuation forwards.

62. *Cervicalis ascendens.*—This muscle is handsomely developed

here. It arises from the anterior border of the leading cervical rib, and passing forwards and slightly inwards it is inserted into the side of the centrum of the atlas vertebra. The tendon of the *levator scapulæ* of the same side is also attached there, just anterior to it.

63. *Rectus posticus major.*—Underlying the *complexus,* this muscle arises from the neurapophyses or neural spines of the first three or four cervical vertebræ, and passing directly forwards becomes inserted upon the posterior aspect of the cranium, into the supraoccipital bone. As the atlas is without neural spine, in its case the muscle only arises from the neurapophyses.

64. *Rectus anticus major.*—This is a very distinct and handsomely developed muscle; arising from the ventral aspects of the first eight cervical vertebræ, or, more strictly speaking, from the ventral aspects of the centra of these vertebræ, and also from the anterior borders of the third to the fifth cervical ribs inclusive, it passes forward to insert itself into the basioccipital bone of the base of the cranium. Its points of origin from the ribs are to be found close to the vertebræ.

65. A small *Scalenus anticus* is to be seen arising from the lateral aspect of the second cervical vertebra, and the next one or two that follow it, and its fibres passing backwards and outwards are found to be inserted into the leading two free ribs of the neck, while internally it also attaches to the centra of the fifth and sixth vertebræ. Sanders has said of this muscle in *Liolepis,* that "at its insertion it is continuous dorsad with the sacro-lumbalis, and posteriorly with the intercostales." The same may be said of it in *Heloderma.*

66. *The Caudal Muscles*: *the Supracaudal.*—Structurally the tail of this reptile is quite a remarkable part of its organization, as the following description will go to show. It will be seen that it is naturally divided by four muscular sulci. Of these, one is a supero-median longitudinal sulcus, that, as in the case of all the others, runs the entire length of the tail: there are two mid-lateral sulci, one upon either side; and, finally, an infero-median longitudinal sulcus. These grooves are carried clear down to the caudal vertebræ, each being lightly held together by connective tissue in life, except the superior one, in which feeble tendinous bands stretch across obliquely from side to side, that go to bind the supracaudals more closely together than any of the remaining tail-muscles.

From this arrangement it will be seen that each lateral half of the tail has two divisions, a supero-lateral and an infero-lateral one. Each of these is made up of certain caudal muscles, which, beginning muscular at the body, become more and more fibro-tendinous as they proceed towards the tip of the tail. Upon making a transverse section of one of these parts, the fact is revealed to us that internally it is composed of two longitudinally disposed compartments, divided by the muscle dipping down between them. Either of these compartments is large and conically tipped at its proximal extremity, from whence it gradually tapers to a point at its distal end. The eight compartments of the tail, thus formed, are completely filled with fat, which, in this alcoholic specimen now under my investigation, is of nearly a pure white colour. Feeble fibrous divisions divide it apparently into irregular cells; these merge into a line along the vertebræ, any pair of compartments forming a single longitudinal, fibro-tendinous line, which blends with the tendinous insertional part of the enclosing muscle, that attaches along from vertebra to vertebra in the same locality. I fail to call to my mind at the present moment any other lizard that is thus supplied with a large store of adipose tissue in its tail, and it would almost seem that it was to serve the purpose of a storehouse commissariat, upon which the entire economy of this reptile could draw in times of need, during its brief period of hibernation in some regions of its range, or, as in torrid Arizona, when the food-supply becomes scarce or difficult for this clumsy lizard to capture.

The *supracaudal* muscle is the direct continuation backwards of the *spinalis dorsi*, and being but attached to the neurapophyses and neural spines of the tail-vertebræ, it is the smallest muscle of the group.

The tendons do not show superficially as do the tendons of the *spinalis dorsi* along the back, a feature that disappears as the two muscles merge into each other just posterior to the pelvic region. Indeed, when we come to first remove the integuments entirely from the tail of a large alcoholic specimen of *Heloderma*, the structure is quite devoid of any striking characters, and it is only when we come to use our scalpel that the sulci and other parts are revealed. No tendons or divisions are discernible upon first sight at all.

67. The *ilio-caudal* continues backwards to the end of the tail the *longissimus dorsi* and *sacro-lumbalis* muscles, and it practically in the tail fills the space between the neural spines and the diapophyses of the caudal vertebræ. For the last three fourths of its length this muscle fuses completely with the supracaudal, and the two together combine to form one of the double compartments described above, that are filled with fat.

68. *Infra-caudal.*—This is the largest muscle of the caudal group, and it ensheaths, on either side, two of the fat compartments alluded to in a previous paragraph. It arises from the posterior aspect of the transverse process of the last sacral vertebra of the same side, from the fascia of the muscles in the immediate post-anal region, from the tuberosity of the ischium by a long, cord-like tendon, and from the margin of the vent itself; it is inserted, *seriatim*, into the diapophyses and the chevron-bones of all the caudal vertebræ, to the end of the tail.

69. *Femoro-caudal.*—To expose the next set of caudal muscles we must make a submedian, longitudinal incision through the *infero-caudal* muscle of one side, following it upon a curve extending down through the other tissues to the tibio-femoral interarticular cartilage, then carefully dissect these muscles out. The one here to be considered arises from the dorsal aspects of the transverse processes of the four proximal caudal vertebræ; it soon becomes thick

and fleshy, although laterally compressed, and at first passing directly forwards, soon turns outwards, and becoming tendinous is inserted into the trochanter major of the femur of the same side. Before arriving at this insertion, the *femoro-caudal* throws off another tendon, which, passing down through certain other muscles of the thigh, is inserted into the hinder surface of the interarticular cartilage between the tibia and the femur. Professor Mivart found this second tendon of insertion likewise present in *Iguana*.

70. The *Ischio-caudal* muscle arises from the outer aspect of the chevron-bone of the eleventh caudal vertebra, counting from the sacrum, and, ensheathed in the fat that is surrounded by the *infero-caudal* of the same side, it passes directly forwards, as a subcylindrical, muscular cord of some size; running close to the vertebræ, it becomes bulbous just before arriving at the vent, and dipping down, and passing forward between the two layers of the *cloacal* muscle, is finally inserted into the tuberosity of the ischium.

71. *Cloacal muscle.*—This arises, almost carneous, from the ventral surfaces of the diapophyses of the fourth and fifth caudal vertebræ, and passing downwards and forwards as a moderately thin sheet of muscle it becomes inserted along upon the upper surface of the cloaca from its posterior lip forwards. As already stated above, the *ischio-caudal* passes between its layers on its way to its insertion. This cloacal muscle is situated to the outer side of the *femoro-caudal*, and internal to the *infra-caudal*.

72. *Transversus perinei.*—Superficial to all the muscles here described, and stretching transversely across the region just posterior to the cloaca, we find a thin muscular layer faintly divided into two by a median, longitudinal line. Either lateral half of this represents one of the present muscles, a *transversus perinei*. For the most part it is attached to the post-cloacal fascia of the region in question.

(From this point onwards we resume our descriptions of the muscles of the trunk.)

73. *Rectus abdominis.*—Arising from the xiphoidal extremity of the sternum, and from the costal rib that there articulates, either *rectus abdominis* passes down the entire length of the body to the anterior pelvic region, being throughout its course intimately united with its fellow of the opposite side. Posteriorly it becomes inserted into the ischio-pubic ligament and the neighbouring fascia.

74. *Pyramidalis.*—This muscle is formed by a strong triangular slip thrown off by the *rectus abdominis* just above the insertion of the latter. Its fibres converge, and passing outwards and slightly backwards they are inserted, upon either side, into the "hamular process" of the pubis. Sanders found this muscle present in *Liolepis*, but he does not award it a separate description (P. Z. S. 1872, p. 161).

75. *Obliquus abdominis externus.*—This broad and powerful sheet of muscle here arises by an anterior expansion from the inner surface of the skin overlying the chest; by means of strong digitations from all of the dorsal ribs, and from six or seven of the abdominal ribs that follow them; and, finally, by far less distinctly

defined digitations from the outer surfaces of the majority of the remaining abdominal ribs in a line along the external border of the *sacro-lumbalis* of the same side. For its entire length, mesiad, the muscle now under consideration apparently blends with the *rectus abdominis*, and I fail to find any other insertion for it. It is quite possible that the part I describe above as being attached to the integuments overlying the thorax, may more properly be considered as belonging to the *rectus*, as the fibres therefrom seem to extend down the body ; the two muscles are quite closely blended here.

76. *Obliquus abdominis internus.*—In *Heloderma suspectum* the thirty-first to the thirty-third vertebræ, inclusive, bear very short ribs, and consequently upon the ventral aspect of its body there is a region which is devoid of special bony protection. It is here that the present muscle spreads out and by its muscular wall largely protects what would otherwise be a weak point. It arises by a strong tendon from the anterior border of the ilium of the same side, and, passing forwards and inwards, it gradually merges anteriorly with the lower part of the intercostals and the abdominal fascia of the region in question.

77. *Transversalis.*—The transverse fibres of this muscle are at once made apparent upon dissecting away the last-described muscle, and it is found also to be principally confined to the lower prepelvic region of the abdomen. It comes away as fascia from the external border of the *quadratus lumborum*, while, mesially, its strong fascia blends with the fascia of the *transversalis* of the opposite side, and is carried up beneath the *rectus* to a point nearly as high as the costo-sternal ribs.

78. *Quadratus lumborum.*—This muscle is beautifully developed in the reptile before us. It arises by means of a dense, sheet-like fascia from the anterior rim of the ilium of the same side, and from the adjacent border of the diapophysis of the first sacral vertebra as far in as its centrum. Soon becoming muscular, its fibres passing directly forwards insert themselves into the entire length of the posterior surface of the rib to the thirtieth vertebra. Ventrally, it also attaches itself to the dorsal surfaces of the so nominated "lumbar ribs," *en passant*, by tendinous anchorages.

79. *External intercostals.*—The internal and external intercostals are both separately and very strongly developed in our present subject. Together they fill in all the spaces among the vertebral ribs, as well as between the sterno-costal hæmapophyses.

Taken in mid-region, an *external intercostal* arises from the entire anterior surface of the rib, save from about half a centimetre of its vertebral extremity, and its fibres passing forwards and upwards they are inserted into the entire posterior surface of the next anterior rib, save for a short distance above its free extremity. Between the sternal ribs the fibres of the external intercostals pass directly forwards, and, in each case, very nearly fill in the entire space. We observe that from the sternum backwards through the pleurapophysial series there are muscular fibres coming away from the free ends of the ribs, for about half a centimetre of their lengths in each case, that pass downwards and forwards. These appear to be so many separate origins of the *obliquus abdominis externus*, but they do not properly belong to the series of the intercostals. They pass across to become inserted into the transverse tendinous intersections of the abdominal muscle to which we have referred. Where the *external intercostals* are covered by the *sacro-lumbalis*, the two muscles are very intimately fused together, but careful dissection is all that is required to demonstrate their individual independence.

80. *Internal intercostals.*—These are quite as well developed as the external ones, and taken in mid-region they arise and are inserted in the same manner as the more superficial set; but in the present case the fibres pass forwards and downwards, thus leaving contrary-disposed vacuities at the vertebral and free ends of the ribs. With respect to the intersterno-costal spaces, the fibres of the present set of muscles are directed almost entirely inwards and but very slightly forwards.

81. *Retrahentes costarum.*—A large part of the thoracic parietes and, continuous with it, nearly all of the abdominal parietes are amply lined with strong, oblique muscular fasciculi. The first series of digitations are supplied by the *transversalis*, and these interdigitate, *seriatim*, with the fasciculi of the present muscle, and thus together they constitute a thick muscular lining to the internal body-wall.

The *retrahentes costarum* arise, upon either side, from the lateral aspect of the bodies of the vertebræ for nearly the entire length of the spine, from the post-cervical region down nearly to the sacrum, in which latter locality the *quadratus lumborum* fulfils their part. They pass obliquely forwards and outwards, to become inserted into the middle of the shafts of the ribs upon their internal aspects, interdigitating, as I have already said, with the fasciculi of the *transversalis.*

Muscles of the Hip-Girdle and of the Pelvic Limb.

82. *Iliacus.*—A very interesting and broad sheet of muscle that arises from within the pelvis, being attached, for the most part, to the ventral and dorso-ventral surface of the pubis, as well as to the median fibrous band that stands as a raphe between it and the fellow of the opposite side. It may extend also slightly upon the ischium. The fibres converging and passing over the pelvic brim, are inserted into the anterior surface of the proximal extremity of the shaft of the femur of the corresponding side, as well as into its trochanter minor, and into that tendinous band seen to be crossing obliquely the caput femoris, and into the fascia overlying the femoro-pelvic articulation.

Mivart, in his work upon the myology of the *Iguana*, considered the present muscle to represent the *psoas* and the *iliacus* combined, and in describing it divides the same into some four or five parts. In *Heloderma* I find these several parts more or less distinctly indicated, but believe with Hoffmann that the muscle can be very well described in its entirety, such as has been done in the present instance.

83. *Gracilis.*—This is a strong and rather thick ribbon of muscle that passes obliquely down the antero-inferior aspect of the thigh, its lower margin being in contact with the *sartorius* for its entire length. The *gracilis* arises from that process, immediately anterior to the acetabulum, which is crossed by the pubo-ischiadic suture, its origin being tendinous. For the most part it is inserted into the fascia covering the tibial side of the knee-joint, while a few of its fibres join those of the *sartorius*, the two muscles being very intimately united, here, at their insertion. Sanders found a *gracilis* as well as a *sartorius* muscle in both *Liolepis* and *Platydactylus*; but Hoffmann seems disinclined to recognize the existence of the latter in Lizards (Bronn's 'Thier-Reichs,' Rept. 22–24 Lief. 1881, p. 645). They are both undoubtedly handsomely developed here in *Heloderma suspectum.*

84. *Sartorius.*—In this we have a great muscular sheath that envelops nearly the entire ventral aspect of the thigh, and which arises from the hamular process of the pubis, as well as from the ilio-ischiadic ligament. Below, it is inserted into the proximal end of the tibia, upon its anterior aspect, just below the head of the bone.

85. *Pelvo-tibialis.*—There is a small muscle in this region that lies immediately beneath the *gracilis* for nearly its entire length, and which I will here describe under the name given it by Sanders. Prior to that writer, Mivart had designated it in the Iguana as the "*tibial adductor*," and subsequently Hoffmann termed it the "*M. pubo-ischio-tibialis lateralis.*" Of these several names I consider the one bestowed upon it by Sanders to be decidedly the best one. In *Heloderma* it arises by a single tendinous head from the ischium just in front of the acetabulum. Passing down the antero-ventral aspect of the thigh as a narrowish ribbon of muscle, it again becomes tendinous as it nears the tibia, enters the popliteal space, and is inserted, just below its head, upon the mesial aspect of the bone just mentioned.

86. *Semimembranosus.*—What I describe here as the ilio-ischiadic ligament is a tendinous ligamentous arch which arises from the tuberosity of the ischium, and passing round the inside of the thigh to the front is there inserted into the ilium. From this arch our rather slender *semimembranosus* arises and passes down to be inserted into the outer side of the proximal end of the tibia. I can find no origin for it upon the ischium in *Heloderma.*

87. *Semitendinosus.*—This muscle is handsomely developed in our present subject. It arises, tendinous, from the ilio-ischiadic ligament, posterior to the line of the shaft of the femur. Becoming carneous it forms a fusiform muscle which is concaved towards the thigh and convexed upon its opposite aspect. Opposite the femoral condyles its tendon appears, and this is bifurcated, one branch going to the inner side of the proximal end of the tibia for insertion, the

other, more cord-like, extends down the leg, where it is in relation with the *soleus muscle*.

88. The *Rectus femoris* arises by two thoroughly distinct heads; one of these, and by far the slenderer, has its origin upon the pelvis, just in front of the acetabulum, the tendon in this case being flat and of some length. At about the middle of the thigh this head, which has now become muscular, merges with the larger division of the *rectus*, although both it and its tendon can be easily traced as far as the patella. The larger head of the *rectus* arises from the pelvis immediately over the acetabulum by a broad tendinous origin. Soon becoming fleshy, the muscle passes directly down the dorsal aspect of the thigh, and, by a tendino-aponeurotic expansion, is inserted into the top of the patella, from which it is in turn reinserted into the outer surface of the head of the tibia, through the intervention of the *ligamentum patellæ*.

89. *Gluteus maximus*.—Although here a distinct muscle, it has pratically the same origin and insertion as the larger of the two heads of the *rectus femoris*, with which it is almost indistinguishably fused. It assists in covering the dorso-superficial aspect of the thigh posterior to the latter, and in its action aids the *rectus* in extending the leg upon the thigh, as in all Vertebrata where it is present. Upon its underside, this muscle, in the lower part of its course, exhibits a strong tendency to blend with the *vastus externus*, which lies beneath it.

90. *Pectineus*.—By transversely dividing at their middles the *rectus femoris* and the *gluteus maximus* and reflecting the mesial stump, we bring to view the more deeply situate muscles of the thigh, and the present one can be easily examined. It is here found to be of a triangular form, and arises from the ilium posterior to and above the acetabulum; it is also attached to the nether side of the tendon of the *gluteus maximus*, and more internally to the pubo-ischiadic ligament. Largely carneous in its organization, its fibres pass downwards and forwards to the shaft of the femur, where they are inserted upon a longitudinal line extending down the middle third of the same at its postero-ventral aspect.

91. The *Biceps femoris* is a perfectly straight, subcylindrical muscle of nearly uniform calibre throughout its length. Its single and only head arises from the outer surface of the ilium, at its anterior third, just behind and above the acetabulum, but posterior to the origin of the *pectineus*. It is inserted on to the outer aspect of the shaft of the fibula immediately below the head of the bone. At its origin it is fleshy, but it is inserted by a comparatively strong tendon, as is quite commonly the case in Lizards. Sanders found this muscle arising from the posterior end of the ilium in *Liolepis*; while Hoffmann, from his description of this muscle, seems to think that this is the only origin it can have (Bronn's 'Klassen,' *loc. cit.* pp. 644, 645).

92. *Adductor brevis*.—This is one of the smallest and at the same time one of the most deeply situated muscles of the thigh. In some respects it seems to correspond with either one or the other of the

gluteal muscles ascribed by Mivart to Parson's Chameleon ; but as the comparative anatomy of the gluteals is still in a very unsatisfactory condition in so far as their exact determination is concerned, and as this is a short adductor, pure and simple, I prefer to provisionally bestow the above name upon it. It both arises and is inserted by tendon, while otherwise it is a short flat muscle of nearly uniform width, which has its origin upon the pubis, anterior to and above the acetabulum, from whence it passes directly to the anterior margin of the great trochanter of the femur, where it is inserted.

93. *Adductor longus.*—Here we have another one of the deep muscles of the thigh, being situated on its antero-inferior aspect. Apparently it arises entirely from the ilio-ischiadic ligament, which, however, is at this point strongly connected to the ischium. At first flat and thin, its fibres soon converge as they descend to their insertion, which is found upon a longitudinal line occupying the lower two thirds of the shaft of the femur, on its ventral aspect. This muscle seems to correspond very well with the "*adductor magnus*" of Mivart, as that distinguished anatomist describes it in the Iguana (P. Z. S. 1867, p. 791).

94. *Vastus externus.*—A number of Lizards have the *vasti* muscles very small, while here in *Heloderma* they are of considerable size. The *vastus externus* in the reptile before us is barely one fourth as large as the *v. internus.* It arises from the anterior aspect of the shaft of the femur, covering its middle third and a portion of its lower third ; below, it becomes tendinous and merges with the tendon of the common extensor of the leg upon the thigh.

95. *Vastus internus.*—Comparatively, a great bulky muscle, that covers the shaft of the femur, from which it arises, from head to condyles, upon its antero-posterior aspect. As in the case of the *vastus externus*, its strong tendon below blends with the tendon of the *rectus femoris*, while the two *vasti* muscles themselves are practically almost fused into one.

96. *Pyriformis.*—The muscle I take to be the present one in *Heloderma* makes quite a remarkable departure from the *pyriformis* as it occurs in other Lizards. Indeed, it might here almost be called an *accessory femoro-caudal* in some particulars, as our description will go to show. The main part of the muscle arises fleshy from the ventral surface of the diapophysis of the first caudal vertebra, encroaching slightly upon the centrum of the bone. The fibres converge and are directed down the back of the thigh. As they come to an apex, this apex is joined by a small axillary muscle that arises from the tendinous arch of the ilio-ischiadic ligament. Together the muscles at once unite to form a delicate tendon, which, in its course towards the head of the tibia, is closely juxtaposed to the tendon of the *femoro-caudal* or rather to its branch tendon. At the lower third of the thigh this tendon of the *pyriformis* and the branch tendon of the *femoro-caudal* fuse into one cord, which is inserted into the tendon of the external head of the *gastrocnemius* muscle a few millimetres below the insertion of the latter into the external condyle of the femur.

In sequence with it, the above-mentioned larger part of the *pyriformis* seems to be the continuation forwards of the *cloacal muscle*, of the infracaudal group of muscles.

In different forms of Lizards we find the *pyriformis* muscle very differently constituted, and consequently very different descriptions of it extant ; so when we come to consider the diverse nomenclature that has been awarded to it, the question of its study becomes quite puzzling. For instance the *pyriformis* of Sanders is said by Hoffmann to be the *femoro-caudal* of Mivart, while Hoffmann himself has called it the *M. coccygeo-femoralis longus s. Pyriformis* ; while on the other hand the *pyriformis* of Mivart is the *coccygeus inferior* of Sanders, the *M. coccygeo-femoralis brevis* of Hoffmann, and which is the *subcaudalis* of Stannius. I still believe that the myology of reptiles demands fuller research at the hands of anatomists.

97. *Coccygeus inferior.*—A muscle which arises by a thin sheet of tendon from the hæmapophyses of the second, third, and fourth caudal vertebræ. Forming anteriorly a delicate slip of muscle, it is inserted into the ischium just posterior to the acetabulum. The *coccygeus inferior* lies to the inner side of the *femoro-caudal*, that is, it is mesiad to it, while the point of its insertion is internal to that of the *obturator externus.* Sanders found this muscle present in *Liolepis,* where it arises from the extremities of the hæmal spines of the caudal vertebræ from the tenth to the third.

98. *Coccygeus externus.*—Arising from the ventral aspects of the diapophyses of the second and third caudal vertebræ, this laterally compressed muscle passes directly downwards and slightly forwards to insert itself powerfully into the ilio-ischiadic ligament. It will be noticed that this muscle lies almost in the same plane with the *pyriformis* in front and the *cloacal muscle* posterior to it, the three being in sequence, their apposed margins in contact, and the whole situated to the outer side of the *femoro-caudal. Phrynosoma* possesses the *coccygeus externus* as is stated by Sanders.

99. *Obturator internus* is a large and powerful muscle in *Heloderma suspectum,* arising from the pubis and ischium at the ventral aspect of the pelvis. These fibres of origin start mesiad from the symphysial line, and, converging to some extent and becoming slightly tendinous, they are attached, by an extensive insertion, upon the summit of the shaft of the femur, on top of the trochanter major. The muscle as thus constituted is thick and covers over nearly all of the ventral aspect of the pelvis in front of and immediately beneath the acetabulum ; the *iliacus* covering a strip along and beneath the pubis anteriorly.

100. *Obturator externus.*—With a bulk that is barely one third of that of the *obturator internus,* the present muscle arises, tendinous, from the tuberosity of the ischium, posterior to and below the acetabulum. Forming a strong, thick band it passes round the summit of the femur to make insertion by a powerful tendon at a point upon the proximal end of the shaft just below the *caput femoris,* upon the posterior aspect. This point is separated from the insertion of the *obturator internus* by a space of some three millimetres, the two in

this locality being nearly opposite each other. When the femur is articulated *in situ* these insertions of the *obturators* look to the outer side.

Muscles of the Leg and Foot.

101. *Gastrocnemius.*—Both heads of this muscle are here represented and strongly defined. The *external head* arises by a long, cord-like tendon from the outer aspect of the external condyle of the femur, and passing directly down the back of the leg, parallel to the shaft of the fibula, it becomes fleshy at the upper third of the leg and, forming a flat, thin, and rather broad muscle, goes to the tarsus for its insertion. It is inserted into that prominently projecting ossicle of the distal row of tarsal bones, nearly in line with the fibula.

The *internal head* of the *gastrocnemius* arises from the proximal third of the outer side of the shaft of the tibia, and passes obliquely across the back of the leg, where it is seen to be a broad, thin, and conspicuous muscle. It is inserted into the mesial edge of the belly of the external head of the muscle we have under consideration, a short distance above its insertion. At neither its origin nor its insertion is the internal head of the *gastrocnemius* inclined to be at all tendinous. We find the round cord formed by the fusion of the tendons of the *pyriformis* and the auxiliary tendon of the *femoro-caudal* inserted into the tendon of origin of the external head of the *gastrocnemius* a few millimetres below the point from whence it arises. A very long and strong internal lateral ligament of the knee-joint is found in *Heloderma*, and it can be examined just above the origin of the internal head of the *gastrocnemius*, but it in no way overlaps the latter as Mivart states to be the case in Parson's Chameleon.

102. A *Soleus* is here but very feebly developed, consisting of only a few fibres and withal intimately attached to the inner surface of the external head of the *gastrocnemius*. It arises from the back of the tibia at its proximal end, and is inserted in common with the tendon of the *gastrocnemius* into one of the ossicles of the distal row of the tarsus. The internal margin of the *soleus* muscle is re-enforced by a tendon which is sent down by the *semitendinosus* muscle of the thigh.

103. *Peroneus secundus.*—This muscle arises from the antero-external aspect of the fibula, from a point corresponding to the insertion of the *biceps* to within a short distance of the external malleolus. Beyond this it forms a tendon, which, passing to the tarsus, becomes inserted into that bone that has been designated by Sanders as the "cuboid." Comparatively large and thick at its lower portion, it here gives off a fascia which, spreading over the back of the tarsus, is so attached that it forms a binder to hold in place the flexor tendons passing beneath it; above, it is closely associated with the *biceps*, the tendinous portion of its origin being just anterior to the tendinous portion of the insertion of the latter.

I have failed to find a *peroneus primus* present in *Heloderma*. Sanders found one present in *Phrynosoma*, and Mivart one in *Iguana*, and I believe it is usually present in Lizards.

104. *Extensor longus digitorum*.—Occupying a conspicuous and median position upon the anterior aspect of the leg, this muscle arises by a strong, flat tendon which comes off from the external condyle of the femur, passes down in front of the same, and below the femoro-tibial articulation becomes a comparatively flat and narrow muscle, continuing thus to the tarsus. In this latter locality its tendon begins to form, and, when over the metatarsus, this latter splits into two other delicate tendons. Mivart found the same bifurcation in *Iguana tuberculata*, and he has said that, "Of these two tendons, the peroneal one curves round tibiad, and is inserted into nearly the middle of the plantar surface of the third metatarsal;" the other one is similarly implanted into the second metatarsal. This agrees precisely with what we find in *Heloderma*.

105. The *tibialis anticus* is a muscle of the interno-lateral aspect of the leg in this reptile. Arising from the antero-lateral surface of the shaft of the tibia, from the side of the head of the bone, and to some extent from the fascia at the tibial side of the knee-joint, the *tibialis anticus* forms a fleshy muscle at the inner rather than at the anterior aspect of the leg. At about the middle of its course it is quite intimately connected with the internal head of the *gastrocnemius*, at the origin of the latter from the tibial shaft. Opposite the ankle the present muscle again becomes tendinous, and this, its tendon of insertion, passes to the distal extremity of the first metatarsal bone, where, upon the tibial side of its dorsal aspect, it is inserted.

It appears to be quite generally the case among Lizards that the *tibialis anticus* occupies an antero-lateral position upon the leg, rather than a mid-anterior one as it does in so many of the Mammalia.

106. *Extensor brevis digitorum*.—We find this muscle to some extent quite complicated, and it arises by several independent slips, which have diverse origins and insertions. Their disposition seems to be as follows:—

(1) An oblique fasciculus that arises from the anterior surface of the distal end of the fibula, and which, passing forwards and inwards across the top of the foot, is inserted into the superior surface of the proximal phalanx of the hallux.

(2) A smaller fasciculus than the last, also arises from the fibula below it but more particularly from the fibulare (of the co-ossified bones of the proximal row), and, passing directly forwards, becomes inserted upon the dorsal aspect of the proximal joint of the fifth digit.

(3) Fasciculus number three arises from the antero-superior surface of the mid-ossicle of the distal tarsalia, it passes between the bifurcated tendon of the *extensor longus digitorum*, and arriving at the third digit it makes an insertion upon the upper surface of its proximal phalanx.

(4) Arising from the next inner ossicle of the distal tarsalia, but *not* passing through the tendinous slips of the *extensor longus digitorum*, this has an insertion similar to the last, but here upon the second digit.

(5) The fourth digit is similarly supplied, only in its case the fasciculus arises from the extreme end of the fibula, and it has likewise two lateral slips, one upon either side, inserted upon the dorsal aspect of its proximal phalanx, and these arise on either side from the bases of the proximal joints of the third and fifth digits. So it will be seen that not only in this, but in other particulars, the present muscle differs from the corresponding one in *Iguana*, as described for us by Mivart (P. Z. S. 1867, p. 794).

107. *Popliteus.*—*Heloderma* has this muscle comparatively very large. It arises from the tibial side of the fibula, for about its proximal fourth, and passing obliquely downwards and inwards is inserted into the shaft of the tibia for nearly the entire length of its fibular aspect. At the back of the leg, at its origin and for some way beyond, it is somewhat intimately attached to the *flexor longus digitorum* that covers it; while in passing to its insertion it fills in much of the interosseous space with its flat, triangular muscular expanse.

108. *Peroneo-tibial.*—Anteriorly, and belonging to the deep set, we have this interesting muscle. It spans the inter-tibio-fibular space below. Arising from the lower third of the shaft of the tibia, its fibres pass across to become inserted into the corresponding extremity of the shaft of the fibula. Behind, it is largely covered by the *tibialis posticus*, as the latter passes to its insertion.

109. *Tibialis posticus.*—As is commonly the case among Lizards, this muscle possesses a triangular form with its apex above. It arises from the inner aspect of the fibular shaft, tibiad, for the distal half of its extent. Its fibres converge as they pass downwards and inwards, and when near the tarsus they become strongly tendinous, which tendon is powerfully inserted into the *tibial ossicle* of the co-ossified elements of the proximal row of the ankle. Over the lower part of the tibia, a firm fascia fuses with the tendon of this muscle, which there spreads out to cover to some extent the tarsal joint, to which it gives a certain strength and support.

110. *Flexor longus digitorum (perforans).*—Large and carneous in its upper part, this muscle arises from the posterior aspect of the external condyle of the femur; from the posterior aspect of the proximal half of the shaft of the fibula; and from the tendon of the external head of the *gastrocnemius* muscle. It is also quite intimately attached to the underlying *popliteus* at its origin. From these several points the *flexor longus digitorum*, as a muscle of some considerable bulk, passes down the back of the leg to become, near the ankle, quite suddenly flat and then completely tendinous. It passes dorsad of the tendinous arch at the ankle, and in the sole of the foot splits into five small tendons, which are distributed, one to each, to the five pedal digits. Each perforates the tendons of the *flexor brevis digitorum*, after which they send to the joints of the toes as they go to their distal inser-

tions slender accessory slips, all of which are much the same as we found to be the case in the hand, and which has been quite fully discussed above. We shall dwell more in detail upon these points when we come to describe further on the smaller and special muscles found in the sole of the foot.

111. *Flexor accessorius.*—Mivart describes a muscle, which is divisible into two parts, under this name in *Iguana* (P. Z. S. 1867, p. 797), but it is only its first part that in any way agrees with a muscle which I propose to call by this name in *Heloderma.* I find that it arises as a thin, small, fleshy muscle from the posterior aspect of the *fibular ossicle* of the co-ossified bones of the proximal row of the tarsus and to a limited extent from the adjacent surface of the distal end of the fibula. Soon forming a flat tendon it at once passes to the tarsal aspect of the tendon of the *flexor longus digitorum,* where, at a point about opposite the proximal row of tarsal bones, it fuses with it, and thus, as will be seen, constitutes a true accessory muscle to this deep flexor.

112. *Fexor brevis digitorum* (*perforatus*).—This arises, semi-tendinous, from the dense transverse fascia of the ventral aspect of the ankle, and also from the corresponding surface of the fibular side of the fused ossicles of the proximal row of the tarsal elements. Radiating, it divides into five muscular bundles, which pass in proper order to the five toes; the one belonging to the hallux being the smallest, while the one going to the little toe is the largest.

The short fasciculus that goes to the hallux is chiefly inserted into the proximal end of the first phalanx of that digit, and simply forms a tendinous tubular sheath through which passes the tendon of the deep flexor, and not a distinct insertional, perforated tendon as is the rule with this muscle in the case of the other toes. We note here that the tendon of the deep flexor sends off an accessory slip to every joint as it passes to the distal phalanx for insertion. In the case of the little toe the arrangement is quite similar to what we have just described for the hallux, while the tendon of the deep flexor does not send off any accessory slips to the joints of this digit. With respect to the three middle toes, the arrangement of the insertional tendons of the deep and superficial flexors corresponds with the structure of the same parts as we described them for the manus.

113. *Lumbricales.*—So far as I can discover it is only the tendons of the deep and superficial flexors going to the three middle toes that are supplied with lumbrical muscles, and these are arranged very much as we found them in the hand of the reptile we have under consideration, having quite similar origins and insertions.

In this connection we must observe another muscular slip: it arises from the distal surface of the fused ossicles of the proximal row of the tarsus, beneath the origin of the short flexor, and, passing forwards and inwards, it becomes inserted on to the plantar side of the broad tendon of the long flexor in the sole of the foot, before the former splits up to be distributed to the toes.

114. *Flexor fibulo-tarsalis.*—I find no muscle elsewhere described

that exactly corresponds to this. It occurs upon the flexor aspect of the leg, and arises from the end of the fibula, close to the origin of the *flexor accessorius*, and as a strong little bunch of fibres it passes directly across to the bone representing the proximal tarsal row, and is inserted thereupon, on its proximal surface.

115. *Abductor hallucis.*—A small muscle that arises, tendinous, from the distal surface of the consolidated bone of the first row, and passing forwards is inserted into the proximal phalanx of the hallux at its base. Mivart found this same muscle present in *Iguana* (P. Z. S. 1867, p. 797).

116. *Flexor minimi digiti.*—Decidedly more inconspicuous than the last, this muscle arises from the same bone upon the fibular side of the foot, and passing forwards it makes a similar insertion into the base of the proximal phalanx of the little or outer toe.

117. *Adductores digitorum.*—Deep to all the plantar muscles thus far described, this set consists of three flat, carneous, little strips which are superficial to the *interossei*. They have a common origin from the bone representing the first tarsal row, and, radiating forwards over the sole of the foot as three distinct fasciculi, they become inserted in their proper order into the bases of the proximal phalanges of the second, third, and fourth toes, on the fibular side in each case.

118. *Interossei plantares pedis.*—Differing from these muscles in the manus, the *interossei* of the plantar region are more numerous than those of the palm, while those of the dorsum are less so. Their origin and insertion, however, are essentially the same. There seem to be five of these fasciculi present in the sole of the foot of *Heloderma*—three central ones, and one each to the inner side of the outer toe and hallux.

119. *Interossei dorsales pedis* do not seem to exceed three in number, and they are devoted to the three middle digits. They are disposed much as we find them in the hand.

Mivart found *interossei* muscles also present in the pes of *Iguana tuberculata*, but the additional layer of fasciculi that he there describes, I take to be my *Adductores digitorum* (see P. Z. S. 1867, p. 797).

I find no muscles present in the pelvic limb of *Heloderma suspectum* other than those I have described above.

IV. On an Examination of the Contained Organs of the Cœlom.

Cutting open the body-cavity by a median, abdominal incision, we at once bring into view the various organs that it harbours. It will be seen that these are covered by the reflected layer of th peritoneum, which in *Heloderma* is almost perfectly colourless, and being very thin can hardly be said to obscure the viscera from our view at all. This peritoneal layer differs from that membrane as we find it in *Iguana* and *Lacerta*, in that it is not deeply pigmented posteriorly and colourless anteriorly, as may be inferred from what we have just said. In the submedian, longitudinal plane it constitutes the umbilical ligament, and this double fold of membrane partially divides the cœlom into right and left halves. Of unusual size, the *corpora adiposa* here lie between the internal muscular parietes and the peritoneal layers, while the kidneys are external to the latter, the reproductive glands internal to it, the two being separated by the horizontal portion of this membrane. Following the peritoneum to its attachments we find it to be fast all along the spinal column, while ventrally it is firmly attached mesio-longitudinally to the muscular wall of the cœlom. The parietal layer also makes fast to the tendino-fascial divisions, here and there, that indicate the lines of insertions of the digitations of the principal body-wall muscles. Other than this, both the visceral and parietal layers of the peritoneum in this Lizard are but loosely attached to the parts they cover, and may by gentle traction be easily detached. Thoracic and abdominal cavities are partitioned from each other by the usual reflection of this membrane, while below the liver the large anterior abdominal vein is seen to be borne in the ventro-parietal layer. Continued as the umbilical ligament, it passes between the lobes of the liver as a single layer, which in our present subject bears the ramifications of a large vein.

Beddard has called the visceral layer of the peritoneum, as it occurs in certain Lizards, the "horizontal membrane;" and this author, in a masterly paper upon this subject (P. Z. S. 1888, p. 99), has said that "In *Monitor* there is some little difference (from *Iguana* and *Lacerta*) ; when the body-walls are cut open and reflected, the alimentary viscera are not exposed as they are in *Iguana*. A loose membrane covers these viscera ; the membrane looks as if it were simply the lining peritoneum of the abdominal cavity which had got separated and detached from the abdominal parietes; this is, however, not the case ; an examination by the aid of the microscope showed clearly that a layer of peritoneum covers the abdominal musculature, and is quite distinct from the horizontal membrane ; in *Varanus griseus* the peritoneal layer was particularly distinct, for the reason that it contained numerous pigmented corpuscles. For the greater part this membrane is free from the ventral parietes; anteriorly it is attached to the median ventral line ; dorsally it is attached along the spinal column; here and there it is also attached to the lateral parietes by membranous bands. It passes over the lobes of the liver and the stomach, and shuts off the lungs from the abdominal cavity. The umbilical ligament dividing the two liver-lobes is present as in *Iguana*, and is attached to the dorsal side of the horizontal membrane. This horizontal membrane also separates the kidneys from the reproductive glands ; the latter lie internally to it ; the kidneys are placed outside it. The ventral surface of this membrane bears a vein of some size, the anterior abdominal vein. The fat-body, when present, lies below the membrane, and is therefore shut off from the abdominal cavity." In many forms, and Beddard gives us a list of some of them (*Lacerta, Uromastix, Cyclodus, Iguana*, and others), this horizontal membrane is for the greater part absent ; and thus it will be seen that the Lacertilia are arrayed in two sections, in so far as this particular structure and its differences are concerned. Further it will be seen, from what has been set forth above, that *Heloderma* agrees with *Varanus* in the anatomical arrangemennt of its peritoneal layers.

Corpora adiposa.—These, as I have already said, are very large in *Heloderma* ; the right one, having a length of ten centimetres, and a width of three and a half centimetres, is somewhat longer, but scarcely wider than the left one. In outline, either is shaped something like a hemi-ellipsoid, the plane surface facing dorsad, while the convex one looks downwards and outwards. Anteriorly, either one of these paired fat-masses has fully one-third of its bulk turned in upon itself from without, inwards, and in such a manner that the plane surface of the turned-in portion is opposed to, and in contact with, the plane surface of the remainder of the mass. These fat-bodies have rounded margins, and are throughout irregularly lobulated, the lobules being of various sizes. As has been stated, they are separated from the abdominal cavity by the horizontal membrane of the peritoneum ; in position the right one extends from the pelvis anteriorly to a point up opposite the middle of the stomach ; while the left one extends from the pelvis anteriorly to a point up opposite the middle of the liver, and dorsad to that organ. The right *corpus adiposum* sends down into the pelvic cavity a small, lobulated prolongation of its mass, and in consequence this one extends further posteriorly than does the left one ; anteriorly, their ends are about opposite each other. Two small lobulated commissures of fat yoke these *corpora adiposa* together just anterior to the pelvis ; if constant, they might be known as the *anterior and the posterior commissures of the fat-bodies.* All of the fat constituting these masses is of a pale straw-colour throughout, and the lobules are very distinct, being simply held together by a very delicate connective tissue, and by the vessels that ramify among them. I found a branch of the anterior abdominal vein that passed right and left coming from between their interlobular spaces, and it joined the main vein in the median line. The *corpora adiposa* do not seem to have any very firm connections with any of the structures in the abdomen, and it but requires the very gentlest of pulling to detach them and to lift them *in toto* from that cavity. In a young *Heloderma* I find these masses proportionately considerably smaller and situate very much farther beyond the pelvis ; they are, too, well overlapped by the lobes of the liver, and in the case of the left one it seems to be underlaid, posteriorly, by the loop of the duodenum.

The Liver.—In a former paragraph we gave with sufficient fulness the manner in which the hepatic peritoneal folds assisted to hold this important organ in its place in the body-cavity. Anteriorly, the heart lies, for its apical portion, between its two principal lobes, while below these latter there is brought into view the stomach, the pancreas, and part of the intestines. In position the liver lies somewhat to the right side of the cœlom, and the right *corpus* *adiposum* strongly impinges upon its right lobe. Composed of the usual hepatic tissue, the liver of *Heloderma* is, during life, of a deep brownish-red colour, but this turns paler after the organ has been placed in spirit, and it becomes tinged with a greenish hue. Ventrally, as a whole, this gland is convex over its surface, it being behind more or less concaved. Primarily, it is divided into two principal lobes; the right lobe has a length of about 7·5 centimetres and a width of 2·5 centimetres, while the left lobe is something like a centimetre less in both of these dimensions. Its borders are rounded, and it measures through its thick part, which is near its centre, about a centimetre.

Regarding it upon its ventral aspect (Plate XVI. fig. 1), we are to observe that the right lobe exhibits near its posterior apex one or two small fissures, while a small teat-like process of the glandular substance issues from the same lobe to cross towards the left behind the gall-bladder. This right lobe is likewise indented in such a manner that the gall-bladder is exposed to some considerable extent through an oblong aperture. Between the lobes, behind, issue the bile-ducts, and the portal vein makes its entrance.

Viewed upon its dorsal aspect (Plate XVI. fig. 2), the liver of this Lizard presents us with a number of interesting points for our examination. Chief among these is a small supplementary lobe which comes off from the anterior part of the right lobe near its mesial border. It projects freely, being subcylindrical in form with rounded apex, and in direction it is oblique, passing up close to the outer side of the heart. From this latter fact I propose to call it, in those specimens wherein it is present, the *lobulus cardiacus*. Other very much smaller lobuli are to be seen upon this aspect of the liver in the specimen before us, whether these are constant or not, I cannot at this writing say. Several of these occur at the apical extremity of the right lobe; two overlapping ones are seen at the hinder part of the *fossa cystidis felleæ*. In this latter fissure obliquely lies the gall-bladder, an organ which we will describe further along.

The *pons hepatis*, or the ligature that binds the right and left lobes of the liver, in *Heloderma* is very extensive and very thick, extending as it does from the fissure of the gall-bladder to a point anteriorly where the two lobes meet the apex of the heart.

The *portal vein* enters the left lobe of the liver at its lower part, as a single trunk. Its branchings take place after the vessel passes into the hepatic substance. At about 4 centimetres behind the liver the anterior abdominal vein joins the portal as its main tributary. Beddard figures the portal vein of *Varanus salvator* as entering the right lobe of the liver (P. Z. S. 1888, p. 104); but this does not agree with a specimen of *Varanus niloticus* before me, wherein the portal vein distinctly enters the left lobe of the liver, branching just as it does so[1].

[1] I am indebted to Professor Alexander Agassiz for the specimen of *V. niloticus* to which I refer, and to Professor Samuel Garman for his kindness in selecting it from the collections of the Museum of Comparative Zoology of Harvard College, and forwarding it to me.

The Gall-bladder is of a pear-shaped form and of comparatively large size. Its position has already been given above. Its own duct (*cystic*) passes down to the duodenum, being joined in mid-course by a biliary duct coming from the right lobe of the liver. Smaller ducts pass from it to enter the right hepatic lobe just mentioned, while upon its surface several minor branches seem to anastomose with each other. In addition to all these we make out an hepatic duct proper; this issues also from the right lobe of the liver, and passing down joins at mid-course the pancreatic duct. A branch joins also this hepatic duct with the gall-bladder. It was a long time before I could bring myself to believe that these several branching ducts were not anastomosing vessels borne in the peritoneum overlying the parts under consideration. I am now, however, fairly well satisfied, after the most careful examination that I could make, that the arrangement is as I have given it.

According to Beddard a somewhat similar condition of affairs is to be found in *Varanus salvator* (P. Z. S. 1888, p. 105, fig. 4). The structure is one that requires and will repay more extended and careful research, and to this end I should very much like to examine large living specimens of *Heloderma*, and if possible compare them with more specimens of *Varanus salvator*.

The Pancreas.—This organ is of proportionately good size in the reptile before us, and it is to be sought, as usual, in the loop of the duodenum. From its ventral aspect there arises an elongated papilla, and it is at the extremity of this that there enters the single hepatic duct formed by the two smaller ones which emerge from the sulcus in the right lobe of the liver; while lower down one of these latter appears to send a branch to the duodenum. For its middle third, one of these ducts exhibits a peculiar reddish enlargement, of no great size; I am at a loss to know whether this be normal or not. This enlargement is strung along on the duct for a distance of a centimetre or more, and has the appearance of a very narrow elongated gland through which the duct must pass before arriving at the pancreatic gland. From the apex of the pancreas the common duct, here very short, enters the gut.

Peculiar as this arrangement of the cystic, hepatic, pancreatic, and common ducts in *Heloderma* is, it is not without parallel among Vertebrates, for the arrangement is simulated in the Frog, where, too, a system of branching hepatic ducts coming from the liver unite to form a single duct that passes into the substance of the pancreas, where it eventually unites with the common bile-duct on its way to the duodenum[1].

In *Heloderma* the hepatic veins emerge from the liver at its anterior part and soon enter the postcaval vein, as the latter passes forwards to the right side of the heart.

[1] For a good drawing of these structures in the Frog, see Wiedersheim's 'Comparative Anatomy of Vertebrates,' translated by W. Newton Parker, 1886, p. 241, fig. 197. Compare also what Sir Richard Owen has to say upon this point in his 'Comparative Anatomy and Physiology of Vertebrates,' vol. i. pp. 448–454.

While in New Mexico, several years ago, I collected a large series of *Phrynosoma douglassii*, and I have an alcoholic specimen of one of these before me at the present time. Upon opening it I find that the greater part of its peritoneum, posteriorly, is deeply pigmented (almost or quite black), while it lacks the horizontal membrane dividing the cœlom, and so agrees with the *Iguana-Lacerta* group as pointed out by Beddard[1].

The liver of this *Phrynosoma* is very thin and broad, spreading out nearly across the abdominal cavity. Its left lobe is considerably the larger and the thinner; it extends well behind and laterally covering, for the most part, the neighbouring viscera. I find its gall-bladder subspherical in form, with very thin coats, while in the arrangement of its duct (for there is but one of them) and the hepatic duct it agrees with what T. J. Parker found in *Lacerta viridis*—that is, a "common bile-duct, running parallel to the portal vein and opening posteriorly into the duodenum: at its anterior end it is formed by the union of the cystic duct and the hepatic duct from the liver itself" [2].

Judging, then, from Professor W. N. Parker's figure of the Frog, we may have (1) several ducts leading from the lobes of the liver, and combining in a single duct that goes to the gall-bladder; (2) a duct from the gall-bladder to the pancreas; (3) a duct from the liver to the pancreas; (4) the proper hepatic ducts combining to form one that enters the pancreas and in it join a duct traversing that gland; (5) a common biliary-pancreatic duct passing from the end of the pancreas to the duodenum.

Judging from Beddard's description of *Varanus salvator*, we may have in that lizard:—(1) at least three ducts leading from the liver to the gall-bladder; (2) at least two proper hepatic ducts that unite before joining the common duct; (3) a cysto-hepatic duct that joins the cystic duct—a final union, posteriorly, with a single cystic duct and an hepatic duct to form the common duct; (4) an interlacement of cystic ducts upon the surface of the gall-bladder. The relations with the pancreas are not given by the writer quoted.

Judging from T. J. Parker's description of *Lacerta viridis*, we may have simply the cystic duct uniting with the hepatic duct to form the ductus communis choledochus which opens into the duodenum.

Judging from what we find in *Heloderma*, we may have:—(1) a cystic duct uniting with an hepatic duct to form a single duct that opens into the duodenum; (2) proper hepatic ducts that pass to the pancreas, usually two that unite in a single one before coming to that gland; (3) a common duct from the pancreas to the duodenum:

[1] Proc. Zool. Soc. 1888, p. 100. I am inclined to think that this character is going to prove to be of no little value in the study of the structure of Lizards in future researches.

[2] Parker, T. J., 'A Course of Instruction in Zootomy (Vertebrates),' 1884, p. 165. According to Owen, "In the *Iguana* there is a distinct hepatic duct which enters the duodenum about an inch from the pylorus, a cyst-hepatic duct which enters the side of the gall-bladder, and cystic ducts which leave the globose bladder abruptly" (*loc. cit.* p. 451).

(4) a few interlacing ducts, joined by one or two (?) hepatic ducts occurring on the surface of the gall-bladder or just near it.

In figure 2, of Plate XVI., I present a drawing of the liver (and other parts associated) of *Heloderma*, and although in that drawing the parts are of their normal sizes and lengths they are pulled rather downwards and forwards in order to show them off better.

The Spleen.—This peculiar organ is of a bright red colour in the living *Heloderma*, and, as in so many Lizards, is freely swung in the fold of the peritoneum known as the mesogaster. In form it is subovoid, being rounded at one end and rather pointed at the other, and lies about a centimetre from the concave curvature of the stomach. It measures in length, in a large specimen of the *Heloderma*, 1·4 centimetre, and has a width of about 8 millimetres. A large vein leads from it which joins the *portal vein*, while it is supplied with arterial blood by the *splenic artery*, which is a branch of the *dorsal aortic artery*. In its position it lies upon a crossing of a number of the vessels borne by the mesogaster, but in so far as I can see they seem to have no other special connection with this organ.

Very little seems to have been written about the spleen in Lizards. Dr. Günther has said that the "spleen and pancreas are very elongate and narrow" in *Hatteria* [1]. As referring to Reptiles, the word "spleen" does not even occur in the General Index (vol. iii.) of Sir Richard Owen's 'Anatomy of Vertebrata,' and I fail to find anything definite about that organ in the Reptilia in the same work. In *Rana* the spleen is placed near the anterior commencement of the rectum. Turner, who is pleased to notice the great value of work done in "comparative anatomy," has not a word to say upon the comparative morphology of the *spleen* in his article upon the general subject of Anatomy, and in that article confines what he has to say upon the organ under consideration to a few words having reference to the anatomy of the spleen in a single type representing but a single family of the Vertebrata (*Homo*) [2]. It is hardly to be expected that we shall ever possess a very complete knowledge of the physiology of this organ so long as we remain so ignorant of its comparative morphology. In this Lizard it has simply the appearance of a large, isolated lymphatic gland, and the remark of Huxley that "The spleen is substantially a lymphatic gland," may still bespeak the summation of our knowledge upon that point [3].

The Alimentary Canal.—In describing this we shall for the present pass by the tongue and certain other structures that pertain to the mouth-parts, and present what we have to say about them further along.

The *Œsophagus* consists of a straight tube extending from the buccal cavity to a point opposite the apex of the heart. In its pha-

[1] Günther, "Contributions to the Anatomy of *Hatteria* (*Rhynchocephalus*, Owen)," Phil. Trans. pt. ii. 1867, p. 28.

[2] Turner, William, Article "Anatomy": Encyclopædia Britannica, 9th edition, vol. i. (see pp. 819 and 907).

[3] Huxley, T. H., 'The Anatomy of Vertebrated Animals,' p. 91.

ryngeal portion it is capacious, but it gradually narrows as it proceeds backwards, so that it becomes of very much diminished calibre before arriving at the cardiac extremity of the stomach, where its coats are markedly strong and thick. All the internal membranal lining of the mouth, the pharynx, and the œsophageal tube, down as far as a point opposite the base of the heart, is normally, in the living *Heloderma*, of a deep black colour, due to an abundant deposit of pigment in the mucous coat lining the parts in question. Below this, however, such colouring entirely disappears, and the internal coat again assumes its more natural tints. Strong, longitudinal rugæ already make their appearance here in the posterior fourth of the œsophagus, and these are continued on into the stomach; we also observe that both the circular and longitudinal muscular fibres of this division of the alimentary tract are well-developed as we come to examine its posterior portion.

The *Stomach*, in a full-grown lizard of this species, measures for its greatest length about 9·2 centimetres and at its greatest width about 2·5 centimetres; this last measurement is taken at the junction of the middle and the pyloric thirds. The anterior or the somewhat shorter border of the organ exhibits one general concave curvature that may be divided into two lesser and similar ones; the posterior and at the same time the longer border exhibits one general convex curvature for its length. Muscular fibres can plainly be made out upon its external surface running in the longitudinal direction adown its cardiac moiety, they being continuous with those of the œsophagus.

At the cardiac end of this gastric pouch the œsophageal tube gradually widens as it merges into it, and in reality no proper line can be drawn to define any exact cardiac orifice; but this does not strictly apply to the pyloric extremity, for there we can very well define the line of union between gut and stomach. Upon opening the latter, we have presented us for our examination the abundant longitudinal rugæ of the cardiac half of the sac, while these are generally reduced to two for the mucous lining of the pyloric moiety, and from these two well-defined ridges strong transverse rugæ branch off. These are continued to the "pyloric valve," an annular muco-muscular ridge which constricts the orifice of this end of the stomach where it joins the small intestine. A lens of moderate power will discover to us the gastric alveoli, but they are not conspicuous, and it would require a good microscope to make out such structures as gastric follicles and peptic glands if they exist in the internal mucous coat of this lizard, as they no doubt do.

The entire intestine, in this same specimen, measured from the stomach to the border of the anus, has a length of 40 centimetres, and it presents the usual Lacertilian characters[1]. The duodenal por-

[1] In the specimen under examination a complete invagination of the small intestine existed, which, however, did not in any way involve the duodenum, although it was very extensive below that point. The gut was but slightly thickened from the inflammatory process, and by gentle traction the inslipped or upper portion was easily pulled out, and this I did, wondering all the time whether such an accident often took place in lizards.

tion curves round the pancreas, and in it the coats of the tube appear to be thinner than in any other part of the tract. Both the stomach and the duodenum are connected to the spinal column by a broad fold of the peritoneum; in the case of the first it is known as the "mesogaster," and in the second as the "mesentery." These folds are absent in Man.

In all of the specimens I have examined, the "ileo-cæcal valve" is notably rudimentary in character, and indeed in this form the termination of the small intestine hardly seems to enter into that part of the tract, here spoken of as the rectal pouch, but which in part must also, for its anterior division at least, represent the *colon*. In *Heloderma*, too, the blind pouch that represents the *cæcum* is so shallow that it would hardly attract our especial attention were it not for the fact that it forms quite a conspicuous feature in a number of other species.

So far as the general calibre of the intestine is concerned, we are to note that this is the greatest along the duodenal division, and from this onwards to the point where it joins the rectal enlargement the alimentary tube gradually diminishes in its calibre, being very noticeably smaller for the last fourth of its length. It enlarges again slightly just before it terminates. Without giving it a special microscopical examination, the intestine seems to be composed of the usual coats, and upon cutting into it it struck me that the *intestinal villi* were comparatively very large, especially along its middle portion.

My big specimen of this lizard had a rectal sac some 9 cms. in length, and of a form that quite well agrees with that of a *Lacerta viridis*, as figured for us by Professor T. J. Parker in his 'Zootomy,' on page 160 of that work (*r*). The mesenteric fold of the peritoneum is continued backwards upon the rectum, and in this region it is spoken of as the *mesorectum*. From this it will be seen that the entire gastro-intestinal tract is supported, from one end to the other, by a continuous fold of the peritoneum, which latter attaches itself to the spinal column, along in the median line.

The blind pouch or *cæcum* of the rectum is here very small and scarcely definable. For instance, it is nothing like as prominent as Owen figures it for *Draco volans* (*loc. cit.* vol. i. p. 445, fig. 303, *h*).

The Urogenital System.—Unfortunately all the specimens of *Heloderma* at present to hand are females; consequently it does not lie within my power in this memoir to record anything relative to either the urinary system or the generative aparatus in the male.

In the urogenital system of the large specimen of this lizard mentioned above the following facts are presented for our consideration.

An elongated, large, pear-shaped *urinary bladder* with thin walls is to be observed. This has a length of 6 centimetres, measuring 2·5 at its widest part, and is supported by the usual tissues, and opens in the usual manner into the ventral wall of the cloaca. Parker (T. J.) found this viscus "bilobed" in *Lacerta viridis*, but I find no such condition in our present subject, its anterior fundus being uniformly rounded.

In my larger specimen the ovaries are very much atrophied, while the oviducts have very much more the form of those in *Lacerta viridis*, as drawn for us by Parker in his 'Zootomy,' than they have in *L. muralis* as seen by Parker (W. N.), and figured in his translation of Wiedersheim's 'Comparative Anatomy of Vertebrates' (p. 318). In other words, their anterior ends are rather split-leaf like than elongo-folded tubule-like. A comparison of the two figures in question will make my meaning clear.

The *kidney* is large and several-lobed rather than two-lobed as it is in *Lacerta viridis*, and its posterior slender part equals in length the anterior or enlarged part. The *ureters* open in the usual way in the cloaca. In *Heloderma* the kidneys are of about an equal size, and each one extends about as far forwards as the other. Standing between the anterior aperture of the oviduct and the atrophied ovary in my larger specimen, I make out a *parovarium*, which is thin and subcircular and about as large as my index-finger-nail. Leading backwards from it, I can with ease trace the rudimentary *duct of Gärtner*. Upon either side, at the sites of the penes in the male, I find present a papilla which possibly represents a *clitoris* in this lizard.

V. Notes upon the Thoracic Organs.

Upon opening the cavity of the chest we find a very firm pleuritic membrane, continuous with the serous membrane covering the liver, spreading across the heart from lung to lung and enveloping those organs, as well as enclosing the structures about the heart's base. Dividing this down the median line we observe that the last-named organ is likewise contained in its own serous sac, the *pericardium*, while our dissections further show that the outer membrane closely ensheaths the *lobulus cardiacus* of the liver and the *thyroid gland* at the ventro-posterior end of the trachea (see figure 3 of Plate XVI., *l.c.*, *t.g.*).

Opening next the pericardium the heart is brought fully into view, with its ventricle and two large auricles.

The Thyroid Gland.—This structure is quite large in our present subject (fig. 3, *t.g.*), and occupies a very different position from the thyroid in such a reptile as *Lacerta viridis*. In *Heloderma* I find it at the root of the trachea overlying the great vessels at the base of the heart. This is more in accord with what we find in Birds, where in some forms of them it lies upon the origin of the carotid artery; there is, however, a gland upon either side at the base of the thyroid in a young Stork [1].

As in the Crocodiles, the thyroid of *Heloderma* is bilobed; the transverse, basic portion lies across the trachea next the base of the heart, and connects the two lobes. These are subcylindrical in form, with pointed apices, each passing forwards by the windpipe, on either side.

[1] See Wiedersheim's 'Comparative Anatomy of Vertebrates,' Engl. ed. by W. N. Parker, p. 227, fig. 185 (*tr.*).

The Heart and Great Vessels.—Such examination as I gave this organ, and the vessels leading to and from it, revealed to me nothing that might be considered especially remarkable. Upon comparing the entrance and emergence of the principal veins and arteries as they take place from the cardiac cavities in the lizard before us, I find that the arrangement agrees rather with *Lacerta* than it does with *Varanus*. In making this assertion I am obliged to rely largely upon the two figures given in the 'Comparative Anatomy of Vertebrates' (p. 285, fig. 229, A & B), where the arrangement of the vessels is seen to be very different in these two types of Lizards.

With respect to the heart, the walls of the *atria* are markedly thin in *Heloderma*, while, on the other hand, the ventricular parietes are composed of thick muscle of a spongy nature, which renders the single cavity of that division of the heart especially small. The right auricle has nearly double the capacity of the left, and the left has nearly three times that of the ventricle. Nothing especial seems to characterize the *sinus venosus*, *sinu-auricular aperture*, the *septum auricularum*, or the *auriculo-ventricular aperture* or its valve, or the *musculi pectinati*, all of which structures I examined with great care.

Such notes as may seem to be required hereafter upon the general venous and arterial systems will be given, but it is my present impression they are not distinguished from the same, as we find them in ordinary Lizards, by any marked peculiarity.

Of the Lungs and Air-passages.—The *larynx* is seen to be placed dorsad to the base of the tongue, riding above it, as it were, while the deep-black integumental mucous membrane which lines the buccal cavity ensheaths them both. A sharp, thin, medio-vertical slit occurring on the front of the larynx represents the *glottideal aperture*; it is unguarded by any epiglottideal valve, but its lips are closely apposed to each other, and are thick, being so constructed that food is prevented from getting into the windpipe. There is a median membranous frænum connecting the anterior end of the tracheal tube to the base of the tongue, but beyond lying immediately over the hyoidean apparatus, the larynx seems to bear no special relation to the last-named structure. I mention this fact, for the reason that Professor W. N. Parker has said (in his translation of Wiedersheim's work), in speaking of the larynx of reptiles, "One point, however, must be specially noticed, viz., the close connection which obtains between the larynx and the hyoidean apparatus—more particularly the dorsal surface of the basi-hyal" (*loc. cit.* p. 255).

The structure of the *larynx* in *Heloderma* is quite simple: we have at its summit, upon either side, a movably articulated arytenoid bone, and postero-laterally, upon either side, outside the larynx, a cricoidal process. Extending from a cricoidal process to the anterior tip of the arytenoid bone of the same side, we have a *dilator muscle*, which by its contraction will open the glottis. Then, anteriorly, in the median line, dorsad, we find the larynx is roundly notched: a *constrictor muscle* arises from the base of this notch, one for either side, and passing round outside the larynx, becomes inserted into the posterior end of the corresponding arytenoid. The dilator muscle, upon either side, is superficial to the constrictor of the same side. The constrictors by their common contraction close the aperture of the glottis during the acts of respiration and deglutition. Dorso-laterally, the cartilaginous wall of the laryngeal box is ample and broad, while ventrally it is narrow; and its capacity is but slightly increased over that of the end of the trachea, which it surmounts.

In my female *Heloderma* the *trachea*, including the larynx, had a length of seven and a half centimetres, to the bifurcation of the bronchi, being composed of about 57 cartilaginous rings, each and every one of which are incomplete down the median dorsal line. Some few of these tracheal rings bifurcate, as we occasionally find them in Man. Either *bronchus* is unusually long, its rings being incomplete as they are in the trachea, which it lacks but little of having the same calibre. For instance, in this same specimen a bronchus measures three and a half centimetres in length, while its size changes but little from the bifurcation to its terminus, thus being nearly half as long as the trachea. According to Mivart, the bronchi in Lizards are usually "very short" (Encycl. Brit. vol. xx. p. 458), and to this rule *Heloderma* certainly forms an exception. A pulmonary vessel follows up either bronchus along its anterior aspect, as one does along the opposite side of the tube, each coming from the posterior portion of the lung.

Either lung is larger anteriorly than it is posteriorly, ending behind in a rounded tip (see fig. 3, Plate XVI.), while it is in the fore part only that we find a pulmonic tissue of the finer more spongy sort, as these sacs behind are covered by a serous coat of a denser texture, and are filled in by air-cells of the larger more open kind, as is the case very generally in this class of Vertebrates. These lungs are of about the same shape, size, and length in our present subject, and their extremities within the abdominal cavity take up but little room.

Now either bronchus curves slightly as it comes through the anterior moiety of the lung, and its rings are lost posteriorly in that part where the pulmonic tissue begins to become coarse. Bronchial branches are not definite, as communication is made with the lung-tissue by means of short-necked apertures found at a few points along their sides, principally anteriorly.

VI. Notes upon the Oral Cavity and Associated Parts.

At the roof of the mouth we have presented us for examination, posteriorly, the *Eustachian pits*. These are large and deep, especially behind; they shallow out as we proceed mesiad and towards the front. At the back part of either one of them there is situated the subelliptical aperture that leads into the organ of hearing, and these apertures, in a large specimen of *Heloderma*, are nearly 3 centimetres apart. Anterior to the point where the Eustachian pits cease, the lining membrane of the roof of the mouth is not so deeply pigmented; while it fits very closely to the superimposed bones of the skull, thus giving rise to several paired pits of greater or less depth, and an azygos one that stands between the *apertures of the posterior nares.*

These latter are of fair size, somewhat rounded in outline, and separated from each other by a transverse distance of nearly a centimetre in the adult. From either one there leads forwards a doubly curved slit-like groove, the lips of which are flexible and in contact by their edges for their anterior two-thirds. This groove terminates in front in a small, rounded opening, which is the mouth-entrance to the cavity containing the *Organ of Jacobson.* A line drawn perpendicular to the plane of one of the posterior narial openings would be found to be considerably in front of the eye of the same side, and still further in front of the brain. In the dried skull the direction of the narial chamber lies longitudinally; but in the living animal the external nostril is laterally situated, so that an angle is formed in the passage in front.

The Tongue.—Bocourt and Boulenger have given a superior view of the tongue in *H. horridum,* and it has been figured by other anatomists.

It is thick and broad at its base, rather thin and acutely but not deeply bifid anteriorly. It is more than twice as wide behind than it is in front, having rounded margins for its thicker parts. Peculiar papilla forming epithelium is seen covering the hinder two-thirds of its free surface, which is gradually developed from the smoother coat of the fore part of the organ. A faint medio-longitudinal groove marks its superior aspect, and it is bound down by a thick median frænum ventrally. Dissection shows it to be composed of two symmetrical halves, which are separated from each other by a thin fibrous septum, found in the medio-vertical plane. Posteriorly, extending deep into its base, we find the rod-like body of the hyoid, and about it considerable adipose tissue is deposited.

Either lateral half of the tongue possesses two special muscles that here require description:—

120. The *Lingualis.*—This is purely an intrinsic muscle of the tongue, which arises in the substance of its base, and, extending longitudinally through the entire dorsum, its fibres are gradually lost as it comes to the apex. It overlies the *genioglossus* and the *genio-hyoideus.*

121. The *Genioglossus.*—A muscle which must be considered but partly intrinsic to the tongue I propose to describe under this name. It is seen to arise, upon either side, from the inner aspect of the mandible near the symphysis, and its fibres passing backwards and upwards, spreading out as they do so, the muscle at once becomes entirely incorporated in, and devoted to, the tongue. Its insertion for the most part is limited to the hinder half of the organ, extending from the frænum to the base, and outwards as far as the lateral margin.

The broad, thick, fleshy, unensheathed and independent tongue of *Heloderma,* then, is a very different affair as compared with the tongue in many other reptiles, or with such a lizard, as *Varanus* for instance, where the morphology of the structure is essentially very different[1].

The Teeth.—These appear to be embedded in the thick buccal membrane that overlies both jaws within the oral cavity in the lizard before us, and it is only in the dried skull that we are enabled to satisfactorily study them. In either jaw the curved line of teeth stand in a slit-like groove of the mucous membrane to which we refer, which is continuous all the way round, and, in addition to this, we find the teeth piercing the basic part of this groove and raising a kind of a papilla at the point of each individual puncture.

Bocourt has given us excellent figures of the sharp, curved, conical pleurodont teeth of *Heloderma* (34), and these have been copied by other naturalists; so it will be quite unnecessary for me to reproduce these now well-known structures here.

In a very fine mounted skeleton of a specimen of *Heloderma suspectum* in the collections of the Smithsonian Institution at Washington, which I have been permitted to study, I find the following to be some of the characters of the teeth of this reptile. From twelve to fourteen of these seem to be about the normal complement that are destined to ornament the mandible, while perhaps a pair more are to be found in the upper jaw. In front these teeth are tiny and small; they very considerably increase in size laterally, while posteriorly they are again smaller, especially in the upper jaw. The largest of all are to be found in the middle of the series in the mandible, the smallest in the premaxilla. Contrary to what I have always understood from published descriptions, I find all of the larger teeth, in both jaws, characterized by the peculiar grooving, although it is best marked in the large ones opposite the site of the poison-gland upon either side. Pleurodont to a less distinctive degree than we find in some other Lizards, these poison-fangs are firmly anchored through anchylosis by a broad base to the rather transversely-spreading ramus, in the case of the mandible, while in the case of the maxilla of the skull they are more laterally attached. When, through accident or otherwise, any of these teeth happen to be lost they are quite rapidly reproduced again, as I have seen from my own observation.

All curve more or less backwards, and Günther has said of them that "In the genus *Heloderma* the teeth are vertically grooved so as to remind us of their structure in Serpents. The teeth indeed are more grooved than in them, for one vertical groove passes down on the antero-inner side and another on the postero-outer side of each tooth" ('Encycl. Brit.' 9th ed. p. 457).

[1] For a good figure of the tongue, hyoidean arches, and associated parts of a *Varanus*, see Gegenbaur's 'Elements of Comparative Anatomy' (English translation), p. 553, fig. 310 (Lond. 1878). It is very evident that a bifid tongue, as in the case of a *short* humerus in a Swift and a Humming-bird, is by no means an index that all of the remainder of the structure in the compared forms will be more or less alike, and consequently point to affinities that in reality do not exist.

Just at this point I will pass from the consideration of those organs that are entirely contained either within the body- or mouth-cavities and record next a few brief notes upon some external structures, such, for instance, as the poison-glands and their ducts[1].

VII. The Poison-glands. (Plate XVI. fig. 4.)

J. G. Fischer (44) has presented us with a fair drawing of the venom-organs of *Heloderma horridum* as they occur upon either side of the lower jaw. Of the ducts, of which there are four in the specimen I dissected, they passed, at a short distance apart, from the mesial aspect of the middle of the gland upwards each to its opening on

[1] Before parting company, however, with our researches upon the organs contained in the cœlom and the cavity of the thorax, I would like to say a word or two more in reference to the observations I have made concerning the system of hepatic, cystic, and pancreatic ducts; and, secondly, as to the description recorded of the thyroid gland of *Heloderma*. In the case of the first-mentioned structures I desire to repeat the statement that my opinion about them is not final, as I should very much like to see additional material and fully re-investigate structures that seem to be so notably different from the more usual arrangement of these ducts in other vertebrate forms. To be sure I devoted several hours to the careful examination of the ducts in question, and, as far as the circumstances would admit, I was satisfied in my own mind as to the peculiarities they presented; but that part of tho vascular system of the specimen undergoing dissection was not injected, and this may have given opportunity for error. Notwithstanding the cautionary words I here give, both my description of these parts and my drawings of them may be absolutely correct; and if they be, why so much the better for the writer and his reputation. Speaking of these hepatie ducts I see that Professor Hoffmann found some interesting arrangement of them in Alligators and Crocodiles (see Bronn's 'Thier-Reichs,' Rept. Bd. vi. 33 & 34 Lief., 1882), and, according to him, the distribution of the ducts varies for *different species* of Alligators, as shown by the drawings in the work quoted (Taf. C). It must be evident, however, from what I have said upon a former page of this memoir, and from what Beddard found in a species of *Varanus* with regard to its biliary ducts, that further investigation into these structures in Lizards will well repay the labours of the morphologist.

As to the thyroid gland in *Heloderma*, and the description I have recorded in reference to it, I would say that I am aware of the position occupied by this structure in other Lizards, as in *Lacerta* it occurs as two separate lobes opposite each other on the sides of the trachea some little distance above the base of the heart. I examined with no little care the organ I have described as the thyroid in our present subject; it was firm and flexible, and under a lens of moderate power had all of the appearances that characterize glandular tissue. Be it noted, too, that the pericardial sac does not normally extend anteriorly beyond the base of the heart, nor connect with any other sac overlying the origin of the great vessels that I am at present aware of. Still, a small rupture had taken place in one of the thin auricles of my specimen and some blood had escaped into the pericardial sac, and this, stained with its own colouring-matter and hardened with the alcohol, had, I must confess, some little resemblance to the structure I have described as the thyroid; but it may have been a resemblance and nothing more. The parts were all particularly sound and perfect otherwise; furthermore, after carefully dissecting up both sides of the trachea, I utterly failed to find in my specimen any such thing as a thyroid in the locality wherein it occurs in *Lacerta*. Again, it may have been some pathological growth, but an examination of a few recently killed Helodermś would soon clear up all such doubtful points, and I sincerely trust that some day this will be done.

the outer surface of the mandible, where they entered. Fischer found in his specimen that these ducts branched as they quit the gland; this was not the case in the reptile examined by me. Each duct passes obliquely upwards and inwards through the lower jaw, and its internal opening within the mouth is found at the base of the tooth it supplies, near the termination of the groove of the tooth.

These glands resemble each other in size, shape, and position, and they in all probability have the same function. Either one of them lacks something of being rather less than two centimetres for its antero-posterior diameter, and is about a centimetre wide. Sub-elliptical in outline it will measure at its thickest part, which is at its centre, four or less millimetres, while the organ is held in its position by the firm connective tissue that surrounds it. Over its surface, superficially, it is easy to discern the ramifications of the vein that comes away from it and thereafter joins the internal jugular. A tendinous expansion, which arises from the outer surface of the superficial muscles near the hinder end of the mandible, is seen to spread out over this organ in large subjects. It is narrow and rather strong at its commencement, to become very thin and closely adherent to the skin as its fibres diverge anteriorly. There seems to be scarcely any muscular tissue in this tendon, but I am inclined to believe that by its contraction in the living reptile the venom of the gland can be forcibly jetted through the ducts and so along the grooves of the teeth at the time of its bite. In my specimen the four ducts serve the anterior moiety of the organ, its hinder half being without these glandular conduits.

Now, although the upper teeth of *Heloderma suspectum* are grooved, I fail upon dissection of the parts to find any gland present wherewith they might be supplied with poison. Indeed the skin overlying the latero-labial region is quite adherent to the skull along its margin, while just above it, between the eye and the external nostril, the bases of the dermal tubercles and the underlying bone often coossify.

There seems to be no reasonable doubt at the present time but that the secretion of these glands in *Heloderma* is of a poisonous nature, and that the injury caused by its injection into the circulation of living animals varies. Still further research is required before we can possess anything like a complete knowledge of its action upon different animals and under varying conditions. It is hoped that experiments tending to make clear such points will be undertaken by the scientific investigator from time to time.

VIII. The Olfactory Cavities and the Organ of Jacobson.

With the very finest of wire saws I made both a transverse and a longitudinal section through the narial chamber of one side in a specimen of *Heloderma suspectum*. The operation brought the structures of the region plainly into view; but, so far as I was enabled to discover, it revealed nothing that seemed to depart in any noteworthy way from the arrangement of the olfactory organ in the Lacertilia generally.

Jacobson's Organ appeared to be not as large, comparatively, as it has been found to be in some forms, as in *Lacerta viridis* for instance; it is, however, well-developed, and, as stated in a former paragraph, connects by means of a special tubular canal with the oral cavity, opening upon the roof of the mouth, anterior to the posterior narial aperture.

As for the olfactory organ itself it exhibits, as usual, an antero-external and postero-internal chamber, which are connected with each other by means of a mid-passage.

The postero-internal or true olfactory chamber presents for our examination a large, semi-rolled turbinal bone springing from its outer wall. This is covered with the usual mucous membrane, which supports the terminal ramifications of the nasal nerve.

Relying, as I do, upon the drawings made by Parker, Hoffmann, and others, which are before me, of the nasal chambers of *Lacerta viridis*, I am of the opinion that *Heloderma* differs from that form in these parts in that we find in the true postero-internal nasal cavity of the latter reptile a large turbinated, cartilaginous scroll hanging from, and at the same time attached to, the roof of the chamber in question. Externo-laterally this is connected with the lateral turbinal, the lining membrane passing from the one on to the other.

IX. Notes on the Anatomy of the Eye.

My examination into the structure of this organ was by no means exhaustive, and only sufficient to bring the following points to my notice. Both eyelids seem to enjoy the usual movement of opening and closing, rather more especially the lower one. The aperture between them is horizontal. Small dermal tubercles fringe the margins of these eyelids, and somewhat larger ones cover their external surfaces. A very delicate tarsal cartilage is developed in the lower lid, but any such structure appears to be entirely absent from the upper one. By the aid of a lens of some power I succeeded in finding the Meibomian glands in the lower lid, where they seem to be best marked. A nictitating membrane is strongly developed, as is its governing tendon. In *Heloderma* this membrane is placed quite vertically, and in a state of rest is found covering the antero-internal part of the eyeball. In front of it there is to be seen a semi-elongated, though not large, *lacrymal gland*, the duct of which passes to open into the buccal cavity. Very much larger than this is the *Harderian gland*, the body of which in our present subject forms a thick, squarish cushion for the eye, resting upon the floor of the orbit. Anteriorly it becomes smaller, forming a kind of neck, which, crooked outwards upon itself and in contact with the eyeball, opens by a single duct upon the outer surface of the nictitating membrane. This anterior portion of the gland is crossed by the anterior rectus muscle, which holds it against the eye. Little or no fat was found in the orbital cavity. Having their usual origins and insertions as seen in the Lizards generally, the following muscles were examined, viz:—

122. *Rectus anterior.*
123. *Rectus posterior.*
124. *Rectus superior.*
125. *Rectus inferior.*
126. *Obliquus superior.*
127. *Obliquus inferior.*
128. *Musculus choanoides.*
129. *Pyramidalis.*
130. *Levator palpebræ superioris.*
131. *Depressor palpebræ inferioris* (feebly developed).
132. *Orbicularis palpebrarum* (feebly developed).

The pupil is round, and the sclerotal plates are thin, these latter having each a form somewhat similar to what we find in Birds. Careful examination failed to demonstrate the presence of the *pecten* within the eyeball, though future specimens may go to show its presence. It is known to be absent in *Hatteria* and *Chelonia*[1]. Around the entrance of the optic nerve the sclerotic coat seems to occasionally slightly ossify. I have also found this to be the case in a variety of genera of Birds. We find the cornea to be not very markedly convex, while the lens is comparatively of good size, it being quite flat externally, and convex upon its internal aspect.

X. Notes on the Anatomy of the Ear.

Heloderma has the tympanum of the ear large and fully developed, making the usual attachments to the parts and bones in the vicinity, thus creating a capacious meatus. Upon dividing this, the external ear-drum, all around at its periphery, and reflecting it, we bring into view the cartilagino-osseous chain of elements that connect the tympanum with the inner ear. Both the passage of the Eustachian tube and the cavity of the middle ear are capacious. Lying along the dorsal roof of this chamber, and close to it, we observe the well-developed columella auris; it passes forwards and inwards and very slightly upwards; the osseous rod-like portion being included in a fold of the common lining epithelium, as is likewise the infra-stapedial process in its own fold.

The middle ear is partially divided into two cavities by the inner edge of the quadrate bone, and we see that it is within the inner part of this cavity that the ossified medio-stapedial portion of the columella auris lies, while the outer cartilaginous extremity of the rod

[1] Since writing the above I have carefully examined an eye in very fair condition from an alcoholic specimen of *Heloderma suspectum*, and in it I discovered an extremely delicate fold of tissue extending from the capsule of the lens to a point near the entrance of the optic nerve. It was non-pigmented. This structure quite possibly represents the *pecten* or "falciform process," but it is here by no means so well marked as I have found it in many species of Birds.

Of course the demonstration of the presence of a *tapetum* in old alcoholic specimens of *Heloderma* is difficult, and I was not successful in any instance.

is found in the other. The latter develops the usual extra-, infra-, and suprastapedial processes, while the last-named sends off a small special apophysis of its own that lies in the epithelium lining the internal surface of the ear-drum. Mesially, the columella auris is slightly enlarged, tipped with cartilage and closely fitted into the fenestra ovalis. Upon properly opening the dense, flinty, osseous otic capsule, I find a sacculus of fair size and with the three semicircular canals disposed somewhat as they are in *Lacerta*. The lagena is moderately well developed, but shows barely any inclination to become spiriform. Beyond these casual observations I made no special note, in so far as the auditory organ was concerned. This apparatus widely varies in the Lacertilia, and to make correct and exhaustive dissections of these parts requires much time and abundance of material, neither of which are quite as I would have them at present.

XI. A few brief Notes upon the Arterial System.

Upon examining the dorsal aorta below the heart, it is seen that in its branching it is inclined to throw off rather a generous supply of offshoots. At the point where the cœliaco-mesenteric is usually given off, two arteries arise—the hepatic, which thereafter gives off smaller mesenteric branches; and, secondly, a cœliac, which chiefly supplies the stomach, the spleen, and the pancreas. About a centimetre below the point where the cœliaco-mesenteric comes away there is given off a large mesenteric branch, which with its branches furnishes the principal arterial supply to the intestine and its supporting mesenteric membrane. A few smaller mesenteric offshoots are sent forth at irregular distances below this point. Branches from these, as well as from the dorsal aorta, still more posteriorly, supply the *retrahentes costarum* muscles and less important structures along the region of the spine. The ovarian branches exhibit no special peculiarities. There may be as many as seven renal branches upon either side; a generous supply of hæmorrhoidal arteries are also thrown off; while a vesical branch to the bladder is supplied by the right common iliac. Posteriorly, the dorsal aorta is continued to the end of the tail as the caudal aorta, and for the entire length of this appendage it passes between the arches of the chevron bones.

I made no especial research for the existence of the *retia mirabilia* along the caudal portion of the vertebral column in this lizard, but have reason to believe that if such vascular anastomoses there occur, in our subject, they will be found to be not very markedly developed in the region to which we have referred. It is generally understood that a rete mirabile is more likely to be discovered along the vertebral column in the tail of those forms of Lizards and Blindworms wherein that structure is often lost through some mishap and nature reproduces the appendage again. This is especially true of the Blindworms. It is not likely that our thick-tailed *Heloderma* often parts with that extremity of its body; it is nevertheless true, however, that when it does, nature supplies a new tail in precisely the same manner as we see it reproduced in other Lizards similarly gifted.

There is before me at the present moment a mounted skeleton of a *Heloderma suspectum* belonging to the U. S. National Museum, wherein the hinder third of the skeleton of the tail has been replaced by feebly developed cartilaginous nodules, and it is very evident that that specimen, in life, sometime or other lost that part of its economy.

The *Lymphatic system* of *Heloderma* has not been examined by me; that is beyond what I have given above in reference to the *spleen.*

XII. Some Observations upon the Nervous System.

Although it possesses a peculiar *facies* of its own, the brain of *Heloderma suspectum* is quite typically Lacertilian in the majority of its parts. Either *olfactory lobe* is rather short, comparatively, and is of nearly uniform calibre throughout. The outer envelope of the brain ensheaths these lobes together, up to their anterior tips. Measuring from the posterior surface of the cerebellum to the tip of an olfactory lobe, the greatest length of the brain of this reptile is 2·3 centimetres, while is greatest width, taken through the cerebral mass transversely, is one centimetre. Each *cerebral hemisphere* is reniform in outline, full, and beautifully rounded. The posterior limbs of the somewhat slender *optic chiasma* are closely applied to the rather large *pituitary body*, which latter presents the usual *infundibulum*, and withal has a form much as we find it in *Lacerta viridis.* Upon opening one of the cerebral hemispheres we observe that the *corpus striatum* is large and rounded and occupies considerable space in the central cavity. A *choroid plexus* is easily made out. Turning to the *pineal body* we find it small and rather inconspicuous, and when the brain is in its case *in situ* within the skull this structure comes closely in contact on the ventral surface, in the middle line, with a large longitudinal venous sinus that is seen in this cavity in *Heloderma.* I have made no especial histological examination of the pineal body in our present subject, and consequently cannot with authority say at what stage the "parietal eye" may be: I am of opinion, however, that it is undoubtedly in a very rudimentary condition. It is a fact that a very considerable venous sinus stands between it and the cranial roof, and that not a vestige of a parietal foramen is to be found piercing the latter. This latter feature is well seen in a skull of *Iguana tuberculata* before me that belongs to the collections of the Smithsonian Institution (No. 12600). After reading Baldwin Spencer's announcement of his important discovery, it is quite natural that this point should specially interest me upon dissecting the brain of *Heloderma*[1].

Young Heloderms show no better development of this eye than do the adult specimens, in so far as I have examined them.

Passing to the *olfactory lobes*, we find them to be rather small in comparison with the size attained by the hemispheres in the Lizard before us, the two lobes together barely having a width equalling the width of one of the hemispheres.

[1] Spencer, W. Baldwin, "The Parietal Eye of *Hatteria.*" 'Nature,' May 13th. 1886, p. 33.

The *cerebellum* is cup-shaped, smooth, and comparatively of large size; its anterior concavity entirely covers the hinder portion of the optic lobes. Behind it, the dorsal aspect of the *medulla oblongata* is much scooped out, while its ventral flexure is but fairly well-marked.

Upon carefully examining the roots of the cranial nerves, the foramen of Monro, the posterior commissure, the encephalic ventricles, and other minor structures of the brain-mass, I find nothing that might in any way be considered worthy of special record.

I will say here, however, that I felt a strong desire to work out the cranial nerves; they looked very tempting, but my material would hardly admit of it, as my dissections of the eye, ear, tongue, and muscles of the head had already made extensive inroads upon this part of the bodies of my several specimens, and in consequence the cranial nerves had to be frequently cut or broken up.

Of the Sacral and Brachial Plexuses.—Coming to the spinal nerves, the only ones to which we have paid any special attention in our subject are the branches that go to make up the brachial and sacral plexuses. These I observed quite closely. But upon studying the descriptions and examining the figures of these parts in a goodly number of species and genera of reptiles as given us by a great many anatomists, I have been forced to believe that these structures will never be anything more than uncertain ones in so far as they afford any reliable characters for classificatory purposes. Mivart speaks to the point in reference to this matter when he says, "As to the particular spinal nerves which go to form these plexuses respectively, and as to the mode of their interlacement and mode of giving origin to the limb-nerves, there is not only diversity between different genera of the same order and species of the same genus, but also between different individuals of the same genus, and even between the two sides of the same individual reptile"[1].

Regarding the brachial plexus in an adult specimen of *Heloderma* before me of the right side, I find that the fifth nerve that emerges from the spinal column, in addition to its sending off its smaller branches for muscular supply in its vicinity, also sends a long delicate branch which merges with the sixth spinal nerve, and so it constitutes the anterior part of the brachial plexus. The sixth, seventh, and eighth spinal nerves are very considerably larger than any of those that precede them or that immediately follow them, and they may be considered as constituting the main portion of the plexus. As they come out of the intervertebral foramina of the spine, the first two mentioned nerves pass over the posterior end of the *rectus anticus major* muscle, while the eighth spinal is still more extensively covered by the most anterior fasciculus of the *retrahentes costarum* series. Now the sixth spinal nerve as it approaches the shoulder-joint gives off four principal branches which supply various muscles of this region, and a little further on at its termination this is the fate of the main trunk itself. It, however, also sends off a short and rather thick branch that joins and merges with the trunk of the seventh nerve, before the latter anastomoses with the eighth. Following out-

[1] Encyclopædia Britannica, 9th edition, article "Reptiles," vol. xx. p. 460.

wards the trunk of the seventh spinal nerve, we observe that the first branch that it gives off is a short thick one, which it sends to join the main stem of the sixth, and this branch crosses the branch sent to the nerve now under consideration by the sixth, which is the branch described in the last paragraph. In other words, the sixth and seventh trunks are mutually joined to each other, near their middles, by rather short thick branches which cross each other. Below this point, and still following the trunk of the seventh spinal nerve, we note that it soon thereafter joins with and merges into the trunk of the eighth spinal nerve, and gives off no branches before so doing. No branches are given off from the trunk of the eighth spinal nerve before its mergence with the trunk of the seventh, and the two below that point constitute a still larger trunk, which upon arriving at the axilla passes on down the arm, breaking up as it does so into the more usual branches that go to supply the muscles of the brachium, antebrachium, and the hand.

It is hardly necessary to add that the vessels, the subclavian vein, and the brachial artery are situated ventrad to this nervous plexus of the brachium.

Upon comparing this arrangement of the nerves in the brachial plexus of *Heloderma* with the descriptions and figures as given us by Hoffmann (45) of such species as *Platydactylus ægyptiacus, Uromastix spinipes, Pseudopus pallasii, Chamæleon vulgaris,* or even *Crocodilus acutus,* I fail to find scarcely any agreement whatever, and it is only in such a form as *Uromastix* that we note any approach to what we find in *Heloderma.* This agreement refers to the number of nerves and their connections that go to form the plexus; but even in these particulars the two species are at variance, though in both four spinal nerves constitute the plexus, they being VI–IX in *Uromastix* and V–VIII in *Heloderma.*

Next we come to consider the *lumbo-sacral plexus,* and there is no doubt but that quite as much inconstancy of arrangement exists here as we noted above with reference to the brachial interlacement. Indeed, Mivart included the sacral plexus in his remarks as we quoted him above, and my own observations go to sustain the opinion he has expressed in the premises.

Using the same specimen of *Heloderma* as we did in our examinations of the brachial plexus, and still confining ourselves to the right side of the animal, the following arrangement of the nerves is to be made out. There are two vertebræ in the sacrum of this lizard, and there are three nerve-trunks that enter into the formation of the lumbo-sacral plexus. The spinal nerve that emerges from the intervertebral foramen between the last two lumbar vertebræ is a small one, and it immediately divides into two delicate branches. Of these the anterior one goes to supply the muscles in the vicinity, while the posterior branch trending backwards joins, at about its middle, a much larger spinal nerve that comes out from the spinal cord between the last lumbar and first sacral vertebræ. This latter, beyond this point, in turn merges with that spinal nerve that emerges from between the two sacral vertebræ; and the common trunk thus formed passes out of the pelvis and down the pelvic limb, dividing up into branches to supply the muscles of the extremity. Either of the two posterior trunks of the sacral plexus distribute one or more nerve-branches to the pelvo-crural group of muscles, these branches being thrown off both prior and subsequent to their mergence with each other.

Now I am not familiar with any Lizard wherewith to compare *Heloderma* in the matter of its very simple mode of sacral nerve-interlacement. Gegenbaur, in his 'Elements of Comparative Anatomy' (English edition, p. 434), presents us with a diagram (fig. 227) intending to indicate the most usual arrangement of the sacral plexus in a reptile, and, although it is quite simple, it is not so simple as it is in the subject we have before us. On the other hand, according to Hoffmann (45), the sacral interlacement in such forms as *Alligator mississipiensis, Cyclodus boddaerti, Hydrosaurus marmoratus,* and *Monitor indicus* is conspicuously intricate, the more especially in such a form as the Alligator (see Taf. lxxxvii. in the work quoted). To a certain extent this must have its significance, as in the Crocodilia we recognize a group of Reptiles that structurally stand the highest of the class to which they belong, and in them the mode of interlacement of the spinal nerve-plexuses is complicated; and this would seem to point to the fact that in the case of *Heloderma*, wherein the interlacement of those plexuses is most simple, it is most probably affined with a far more lowly order of Reptiles, perhaps with some of the very lowest of existing North-American types.

XIII. Of the Skeleton.

The Vertebral Column.—Upon counting the vertebræ composing the spinal column of an adult specimen of *Heloderma suspectum* I found that there were in all sixty-four of them. Of these eight belonged to the cervical division of the column, twenty-two to the dorsal, five to the lumbar, two sacral, and twenty-seven in the tail or caudal division. In character these vertebræ are procœlous, the more spherical cups and balls being seen in mid-cervical region, while those of the transversely elliptical pattern are best developed in the dorsal portion of the column; and, finally, the more rudimentary ones are devoted to the ultimate joints as we gradually pass to the end of the tail. Commencing with the *atlas* it is found to be composed of five separate pieces; three of these are devoted to the formation of its anterior cup for the cranial condyle. Of these three pieces, one is a mid-ventral one, while either of the others are ventro-laterally situated. Each side of the neural arch is formed by one of the two of the remaining pieces of the five of the component elements of this vertebra; and in a large specimen of this lizard none of these five parts had co-ossified. A *proatlas* does not seem to exist in *Heloderma*.

Turning to the *axis vertebra* we find it characterized by a very long and prominent neural spine; indeed, its length distinguishes it from any other vertebra in the column. Its odontoid process is conical with rounded apex: a thin plate of cartilage, supported by the atlas, prevents it from being in contact with the condyle of the occiput during the life of the reptile. The postzygapophyses of this vertebra face almost directly downwards, articulating with the counterfaced prezygapophyses of the third cervical vertebra. From this point, backwards, this is essentially the direction assumed by these articular facets throughout the vertebral series. Passing next to the third vertebra, it is seen to possess a form that, in its main features, agrees with all the other vertebræ to the anterior sacral one. It is to be observed, however, that they grow almost imperceptibly wider as they are followed in that direction; the last lumbar being the widest, and the vertebra now under consideration the narrowest in its transverse diameter. This third cervical vertebra has a peg-like and conspicuous neural spine directed upwards and backwards. This is also characteristic of all the vertebræ as far back as to include the second caudal, from whence they gradually become thinner, more lofty and pointed—to again become reduced and gradually disappear as the few terminal joints of the tail are approached, wherein they are quite suppressed. Rudimentary pleurapophysial prominences exist, one upon either side of the fore part of the centrum of the third cervical vertebra, but it does not develop the autogenous hypapophysis, a character common to some lizards. Indeed there are no hypapophyses present upon the ventral aspects of the centra of the vertebræ in *Heloderma* until we arrive at the first caudal one that bears a chevron-bone. A subcircular intervertebral foramen is found between the vertebræ for nearly the entire length of the column, it being intended for the exit of the spinal series of nerves. It is of good size where the brachial plexus comes out, but the largest apertures are those between the last two lumbar vertebræ, or where the larger branches of the lumbo-sacral plexus emerge, one upon either side. The centra of the vertebræ, including the first caudal, are of average length, rather broad, and flat upon their ventral aspects; the tail series beyond become gradually narrower, and comparatively longer, as they diminish in size to the ultimate one. Facets for articulation with the heads of the free vertebral pleurapophyses (of those vertebræ that possess them) exist, one upon either side of all the centra at their anterior parts.

Choosing at random a dorsal vertebra from the middle of the series, we are to note upon its superior aspect the thin anterior edge of its neural spine and the almost equilateral outline that bounds its nearly horizontal superficies.

Apart from their largely developed lateral processes, the two free sacral vertebræ agree in the main in their forms with the first caudal vertebra. Their transverse processes are large, rounded, and thick, with dilated outer ends, the bigger pair belonging to the anterior vertebra. These outer extremities, upon either side, seize the ilium between them, the anterior one having the superior hold, the posterior one the under. Slender and rather conspicuous lateral processes also characterize the caudal vertebræ; they are probably pleurapophysial developments. Gradually diminishing in size from first to last, to finally disappear altogether, they are seen to be sharp-pointed and stand directly outwards, the first pair being pierced by a foramen upon either side and near the middle of the process. Freely articulated and prominent, Y-shaped, chevron-bones exist throughout nearly the entire series of caudal vertebræ. They gradually diminish from first to last, disappearing altogether near the end of the tail, each being directed downwards and backwards and articulating as usual with the postero-inferior rim of the vertebra at its ventral aspect.

As I have already stated above, *Heloderma* reproduces that part of its tail that at any time may, through accident, be fractured off.

A pair of free *ribs* first occur upon the fourth cervical vertebra; they are about a centimetre long, slightly curved, flattened, and tipped with cartilage. The facet for their articulation upon either side is rather extensive, but the head of the rib dces not bifurcate. Similar ribs characterize each and all of the remaining cervical vertebræ from the fourth to the last. They, however, grow gradually longer and more cylindrical; indeed, they simply intergrade in form imperceptibly into the thoracic series of the beautiful, strong, and curved ribs that are possessed by this lizard. Passing to the dorsal series we find that it is only the four leading anterior pairs that are connected with the sternum through the intervention of hæmapophyses. These latter are long and sweeping, and are preformed entirely in cartilage. The shortest pair are the anterior ones, the longest the posterior; the two mid pairs being regularly intermediate in their lengths, and for comparison we find the hinder pair about one third longer than the first pair. They articulate in little pit-like facets that are situated at nearly equal distances apart on the posterior borders of the sternum. The articular facets for the heads of the long hinder pair are found side by side occupying the apex of the postero-mesial extremity of the sternum. Pointed cartilaginous tips, ranging in length from eight to two millimetres, embellish the free extremities of all of the remaining dorsal ribs, from the fifth to the twenty-second inclusive. These ribs are beautifully and regularly curved; their vertebral heads are rather large and are non-bifurcated, while their bodies are subcylindrical in form. The longest pairs are found upon the 13th and 14th dorsal vertebræ. The first three pairs of lumbar ribs are short in comparison, each rib rarely measuring more in length than a centimetre, while the pair upon the fourth lumbar vertebra are rudimentary, and the last lumbar is entirely without them. Cartilaginous tips seem to be absent from the ends of these ultimate riblets of the series, a fact worthy of notice.

Heloderma possesses a comparatively small *sternum*, it being represented by a lozenge-shaped plate of cartilage, as is the case in the vast majority of ordinary lizards. Quite firmly attached to it and overlapping its anterior angle is seen the hinder end of the interclavicle, the latter being situated ventrad. Its mesio-posterior angle is occupied by two facets for a pair of the costal ribs, as already pointed out, while the contiguous borders to this angle are monopolized by the remaining hæmapophysial facets. Either anterior border is grooved for its entire length to accommodate in articulation the sharpened edge of the corresponding coracoid. Such a form as *Lacerta viridis*, according to Mr. T. J. Parker, has in its sternum characters additional to the ones here described, for it will be observed that *Heloderma* lacks the "small central fontanelle" and the "two slender flattened cornua" which are produced posteriorly. Indeed, this simple type of sternum in our present subject does not seem to agree exactly with any other form in particular. And to satisfy one's self of this fact it is only necessary to compare the description offered above with the figures of reptilian sterna that have been collected together for us by Hoffmann in Bronn's Thier-Reichs (Rept. 18–21 Lief., 1881).

The Skull.—To complete the account of the axial skeleton a consideration of this important part of it still remains. The first thing that strikes one upon a general examination of the skull of *Heloderma suspectum* is what may be characterized as its peculiar solidity, a certain massive compactness. All the bones composing it are stout and strong. This appearance is still further enhanced by the fact that it is thickly studded for the anterior superficies of its roofing bones by the co-ossified dermal tubercles, and some of these may be found over the parietal region. Old oaken chests or various kinds of heavy furniture leave the same impression upon our minds, when they, too, have certain parts of them studded with round-headed, brass hob-nails.

Sutural traces can, but with difficulty, be made out in some instances, although in the mandible and in most other localities no such obliterations are met with. Except in front, the encephalic casket is well protected by bony walls, and this kind of protection is also nearly as well afforded to the orbits and the rhinal spaces; the bounding peripheral margins of these latter are quite circular in outline, while the antero-external narial apertures are very much of the same form. The form of the snout is broadly rounded, and the maxillary alveolar margins are strong and horizontally broad, thus creating a substantial base for the besetment of the teeth. Normally, the massive mandibular rami do not fuse by ossification at the mandibular symphysis.

What is one of the most remarkable facts, however, about the skull of this reptile is the now well-known circumstance that its zygomatic arch is almost completely atrophied, and further that by the union of the post- and prefrontal bones, the frontal is most completely prevented from participating in the formation of the orbital periphery.

In outline the comparatively large foramen magnum is a transverse ellipse, while the condyle of the occiput below it is reniform in shape and distinctly exhibits throughout life the sutural traces of the bones that enter into its formation. Spacious from side to side, but not lofty, the posterior temporal fossæ are much over-arched by the free posterior edge of the parietal bone. Either parotic process is stout, being directed upwards, backwards, and principally outwards, while the various infero-lateral foramina at or near its base are of comparatively large size: relatively larger, for instance, than we find them in the skull of a big *Iguana tuberculata* that I have at hand.

The posterior nasal fossæ are elongo-pear-shaped apertures with the bulbous ends directed backwards, while either palatine foramen is of an oval outline and of no great size. The inferior temporal fossa is capacious, and a firm thin plate of cartilage standing vertically in the median plane divides the orbital cavities internally. This is the *interorbital septum.*

Of fair extent, the *basis cranii* is nearly a horizontal surface, showing but a very slight general concavity over it. This is at variance with such a form as *Iguana tuberculata,* where the area to which we refer is considerably concaved. In a previous paragraph we have already sufficiently referred to the tympano-eustachian fossa and the characters of the columella auris.

Whatever may be the condition of the *parietal* ossifications in the very young *Heloderma,* they are in the adult reptile represented solely by a solidly ossified and dense plate of bone. This bifurcates behind, and either limb is directed backwards and outwards and slightly downwards to articulate with the squamosal of the same side as well as with the corresponding parotic process. Viewed from above the anterior margin of the parietal plate is represented by a finely serrated transverse line; the superior surface of the bone is nearly horizontal and usually supports a group of the ossified dermal tubercles, which have fused with it. Near the middle of its ventral surface is seen a small pit, which it would seem is situated too far back to represent the vestige of the parietal foramen. It by no means pierces the bone. At some distance within its external free margin, on either side, this bone develops a longitudinal ridge. This is most conspicuous near its middle, and resting here against its outer aspect are the upper ends of the columella and the prootic.

In old specimens of this Reptile, the *frontal bones* are indistinguishably fused together, and upon a superior aspect of the skull not a trace of the median suture that originally stood between them can be made out. And even within the cranium it is hardly to be discerned at all. By a straight transverse coronal suture, this frontal bone articulates posteriorly with the parietal; while we have already mentioned the fact as to how it is prevented from participating in the formation of the orbital periphery by the meeting of the pre- and postfrontal elements. Posteriorly, these united frontals are almost entirely masked from our view by the layer of fused and ossified dermal tubercles that overlie the entire fore part of the skull. One never meets with skulls of old individuals of *H. suspectum* as free from this feature, nor with the naso-frontal and fronto-parietal sutures anything like as clearly defined as is seen in the skull of *H. horridum* which is figured for us by Mivart (Encycl. Brit. 9th ed. vol. xx. p. 451, fig. 12 *f.*). Ventrally, the frontals of the skull of our present subject offer us a peculiar character. Opposite the orbits each one sends downwards and inwards a broad and curved plate of bone which mesially meets and fuses with a corresponding plate coming from the bone of the other side. This arrangement gives rise to a transverse osseous bridge, and the large mesial foramen it assists to form has passing through it certain important structures which are on their way to the rhinal spaces. That is, during life such is the case. Passing next to a consideration of the *nasals*, they are seen to be fused together in a manner quite similar to that which has just been described for the frontals, and it is only upon the roof of the rhinal spaces that the sutural traces can be made out at all. Laterally, a *nasal* articulates with the corresponding maxillary and prefrontal; anteriorly the two unite to send forward a process that articulates with the premaxillary in the middle line; posteriorly the naso-frontal suture is seen to be represented by a deeply zigzagged line; and, finally, these fused nasals at their antero-inferior surface, mesially, meet the hinder ends of the septomaxillaries. They assist in the formation of the peripheries and upper parts of the external narial apertures.

Articulating with the nasals, the vomers, the maxillaries, and the septomaxillaries, the *premaxilla* presents a strong mid-process in front which is carried backwards as the nasal process. Its alveolar portion is rather broad and commonly bears upon either side four teeth. Behind these, and in the middle line upon the ventral aspect, are seen two small processes placed side by side. The united anterior apex of the vomers just reaches to them. A similar character to this is seen in a skull of *Iguana tuberculata* at hand, only in it the apices of these two little apophyses have fused together, thus forming a foramen between them.

Again viewing the fore part of the skull upon its externo-lateral aspect, we observe that the thickly set, fused osseous dermal tubercles are carried down over the maxillary and jugal bones upon either side. They do not, however, entirely cover the *maxillary*, for a narrow strip of its externo-alveolar portion is free from them, and this extends from the jugal all the way round to the narial aperture of the same side. As in so many other forms of Lizards, this smooth and narrow surface of the maxillary seen upon its external aspect, bounded below by its free alveolar margin, is characterized by a longitudinal row of some six or seven minute foramina; they pierce the bone opposite the teeth, or in some instances even between them.

Either one of the maxillaries articulates with a good many bones; it articulates with an os transversum, with a palatine, with a jugal, lacrymal, and prefrontal, with a septomaxillary and a premaxillary, with a nasal, and finally it may even come in contact with one of the vomers of the corresponding side. A maxillary forms the outer lateral wall of the nasal fossa, and also a part of the roof of the same cavity. It also, in *Heloderma*, contributes largely to the formation of the bony part of the roof of the mouth; and here upon its ventral aspect it is somewhat concaved, while along its alveolar edge the row of teeth are found. These latter are grooved in a manner similar to the teeth found in the mandible, notwithstanding the fact that they do not now seem to be intended to conduct a poisonous fluid at the time the reptile inflicts its bite.

Septomaxillaries are large and thoroughly ossified. They are in contact with the maxillaries, the premaxillary, the nasals, and the vomers, and contribute largely to the osseous floor and inner wall of either narial aperture in front.

Parial *vomers* are found in the skull of *Heloderma.* They are represented by rather long stout ossifications; subcylindrical in form, and either one showing a partial groove down its dorsal aspect longitudinally. A septomaxillary notches a vomer on the same side, externally, near its anterior end. These vomers are in contact in front, but they gradually diverge from each other as they pass backwards to articulate with the palatine of either side. How different these bones are from the broad, flat vomers as we find them in *Iguana tuberculata*, where they are in contact with each other, mesially, for their entire lengths!

Either *jugal* is represented by a strong curved bone which forms the postero-ventral boundary of the external periphery of the orbit. Behind it articulates with the postfrontal, while anteriorly it is suturally connected with the lacrymal, the os transversum, the maxillary, and the prefrontal. True fusion has almost taken place among some of these sutures, notably the anterior ones. At its postero-inferior angle behind, the jugal develops a stumpy apophysis. Essentially this bone is a very different affair from what we find in a *Varanus*, wherein it is reduced to almost spiculiform proportions and curving upwards fails to reach the postfrontal [1].

Making extensive articulations by very firm sutures with the parietal, the prefrontal and frontal, and the jugal, a *postfrontal* bone is here a fair-sized ossification that forms the supero-posterior angle of the orbit, and completes the corresponding part of its periphery. Instead of being a small and comparatively unimportant bone, as indeed it is in some of the Lacertilians, the *prefrontal* in *Heloderma* constitutes one of the most essential elements at the fore part of the cranium. It is in sutural contact with the postfrontal and frontal, with the nasal and the lacrymal, with the jugal, the palatine, and finally with the maxillary. With the lacrymal it forms the anterior wall of the orbit, as well as its antero-superior margin. Internally, it bounds the lacrymal foramen, while its dorsal surface is largely covered by a lateral extension of the co-ossified dermal tubercles.

Forming the outer boundary of the osseous lacrymal duct or canal, and wedged in between or rather among the prefrontal, maxillary, and jugal bones, we find the small *lacrymal* ossification. Externally it is generally covered by one of the dermal ossifications that overlie the surface of the skull in front, and it fuses with it.

A *palatine* is seen to be a large tripronged bone that develops a transverse ridge upon its dorsal aspect. This ridge articulates with the prefrontal bone. The inner fork of the palatine articulates with the hinder end of the vomer of the same side; its posterior fork engages the antero-internal limb of the corresponding pterygoid;

[1] My thanks are due to Mr. F. A. Lucas for the loan of a skull of a specimen of *Varanus bengalensis*, as well as an imperfect skeleton of *Crotaphytus collaris*, both from the collections of the U. S. National Museum (Nos. 29226, 29151 respectively).

lastly, the external fork of a palatine articulates with the maxillary and the transpalatine or os transversum. With the pterygoid it completes the inner periphery of the palatine foramen; it forms its entire anterior boundary, as it does the posterior boundary of the internal narial aperture.

An *os transversum* is an important element in the lateral chain of bones at the base of the skull. It is deeply cleft behind in the horizontal direction, and into this closely fits the external limb of the corresponding pterygoid, which is wedged for the purpose. And it is thus that the pterygoid is extended to the maxillary, as through the palatine it is by its internal fork extended to the vomer of the same side. Articulating, then, with a palatine, with the maxillary and the pterygoid, and touching the jugal to its outer side, the os transversum completes the outer periphery of the palatine foramen; and also affords an important contribution to the osseous floor of the orbital cavity.

The *pterygoids* are a somewhat long and slender pair of bones. Either one presents an enlarged anterior moiety and a straight and slighter hinder shaft. These two portions form a curve which presents its concavity to the outer side, and pressing against its inner side at the middle is the extremity of the corresponding basi-pterygoidal process. This latter is stout and prominent, and has the appearance of pushing the pterygoid firmly against the quadrate of the same side, as the columella appears to prevent it from rising upwards. The pterygoid develops a small lip of bone at its ventral side, which, extending backwards, overlaps the basipterygoid process and thus prevents the slipping. As to its articulations, we are to note that a pterygoid meets the columella, the basipterygoid process the quadrate, while anteriorly it is powerfully wedged into the os transversum, suturally linked to the palatine, and barely touches the jugal. To some extent a pterygoid assists to complete the osseous flooring of the orbit, and it also completes the boundary of the palatine foramen behind.

Dr. Mivart has said in his article "Reptiles,' in the 9th edition of the 'Encyclopædia Britannica (p. 451), that "The skull of *Heloderma* is very remarkable in that it has no zygomatic arch whatever."

And this is commonly the way in which this fact is stated. It is not, however, strictly true, for upon examining skulls of both old and young individuals of *Heloderma suspectum* I find at least a very substantial rudiment of the arch in question. It also has been noticed by Bocourt and by Troschel. It consists of a freely articulated conical ossicle standing on top of the quadrate, being moulded to the outer side of the posterior end of the squamosal, with which it also freely articulates. It is seen to be present upon both sides. That it is the osseous rudiment of the hinder end of the zygomatic arch in this reptile there cannot be the shadow of a doubt.

The *squamosals* are well developed and occupy their most usual position as seen in Lizards, being, upon either side, accurately moulded on the posterior bifurcation of the parietal bone. Either squamosal articulates with the parotic process, the parietal, the rudiment of the zygomatic arch, and finally contributes in a very limited degree to the articulatory facette for the *quadrate bone*.

This last-named element of the lateral aspect of the cranium is large in *Heloderma*, and transversely unusually broad. Its outer moiety behind is concaved in the vertical direction, while its anterior face, though slightly convex, is nearly flat. Tubercular eminences and depressions finish off its summit, and two obliquely-placed articular facets, intended for the mandible, occupy its mandibular end.

Most Lizards have the *epipterygoid* (columella) extending between the pterygoid and the anterior edge of the prootic; in *Heloderma*, however, it quite reaches to the ventral surface of the parietal. In *Iguana tuberculata* it lacks a couple of millimetres of accomplishing this; in both of these reptiles it rests against the prootic above.

Already I have said that the *foramen magnum* is of good size, being a transverse ellipse in outline, and that the *occipital condyle* faintly shows the sutures upon its convexity throughout life.

And now we pass to a consideration of some of the bones that more directly enter into the formation of the brain-case. Presenting nothing worthy of special remark, the *basioccipital* is nevertheless interesting from the fact that the process it develops upon either side, below the optic aperture, is of rather unusual prominence and size. We have already alluded to the large parotic processes; each one is formed by the *exoccipital* and *opisthotic* of the corresponding side.

A character of some value is seen in the fact that the *supra-occipital* fails to reach the ventral surface of the parietal by not an inconsiderable interspace; this, of course, likewise applies to its lateral portions, the *epiotics*. More anteriorly, the *prootic* of either side articulates both with the under surface of the parietal, as well as with the superior end of the epipterygoid. The several otic bones mentioned appear to go to form the auditory capsule in the same manner as they do in all ordinary Lizards.

Every trace of the suture between the *basioccipital* and the *basi-sphenoid* has been absorbed in skulls of adult individuals; I find it persisting, however, in the skull of an old *Varanus bengalensis*, and according to Parker (T. J.) this is also the case with *Lacerta viridis*. This suture, when it persists, is generally a straight transverse line.

Strong *basipterygoid processes* with dilated ends are developed on the part of the basisphenoid, and they spring from their usual points, and articulate, in a manner already described above, with the pterygoids.

Ossifications representing the *parasphenoid*, as well as the *ali-sphenoids*, may be present in the skulls of fully-matured individuals. They are to be found in their usual positions.

No especial study was made of the openings that give exit to the cranial nerves from brain-case, other than to note the facts that the vagus and condylar foramina are to be found at their most common sites as seen in ordinary Lizards. The anterior margin of the prootic is also notched for the passage of the 5th and 7th nerves, this notch being converted into a foramen by the membrane that helps to enclose the fore part of the cranial casket when the skull is normally complete. The 8th nerve emerges from the internal auditory meatus.

Next turning to the *mandible* I would add a few words to what I have already said in reference to the teeth. The ducts which lead from the poison-gland upon either side do not pass directly through the ramus of the jaw to the base of the groove of the tooth to be supplied, as one might naturally suppose. Rather this is the arrangement. Let us choose a large tooth from the middle of the series for an example. In the first place it must be noted that when the grooves upon the tooth are followed down to the base of the tooth it is not at that point that we find the internal foramen that is intended to transmit the poisonous fluid to the groove in question. The external duct enters by means of a foramen directly through the outer bony wall of the ramus. This leads into quite a cavity which exists in the body of the jaw and at the base of the tooth. Now the foramen that leads into the mouth and finally supplies the tooth with the venom makes its entrance, as I have already said, at the base of the structure, but by this I by no means intend to imply that the dental groove leads into this opening. On the other hand it is found exactly opposite the tooth and well towards the mesial plane. It will be seen that the base of the tooth slopes inwards and slightly backwards, and the reverse of this course indicates the direction of the internal division of the foraminal passage when followed from within outwards. From the structure of these parts, then, I am compelled to infer that the fate of the venom upon being jetted from the gland is this :—it passes directly, though somewhat obliquely, through the body of the mandible, and enters the mouth through the foramen at the extreme base of the tooth towards the median plane. The edges of the thickened mucous membrane on either side of the row of teeth form there a longitudinal gutter as it were ; this is flooded full upon the venom being thrown into the buccal cavity, it surrounding the teeth in consequence. Then, simultaneous with this, when the reptile makes its bite, the grooves upon the teeth simply serve as conduits to conduct the venom into the wound. And when one comes to think of it, this is a very simple arrangement, the more especially so when compared with the more highly perfected poison-fangs of such a reptile as *Crotalus*.

Heloderma has a mandible to its skull that seems to be composed of the usual number of bones found in the make-up of lower jaws of all ordinary Lizards. There is a strong well-developed *articular*, with its large angular process directed posteriorly, and with its articulation for the quadrate, the latter showing two concavities facing upwards, backwards, and inwards. Upon the inner side of the ramus, between the articular and the coronary, there is to be found a short longitudinal gutter with a foraminal pit at either end of it. *Meckel's cartilage*, as usual, is ensheathed by the anterior portion of the articular element of the mandible, from whence it proceeds forwards to the symphysis, being exposed along the inner side of the dentary for its anterior moiety. The *angular*, pointed behind and truncated in front, occupies nearly the middle third of the ventral border of the ramus. The two bones thus far alluded to are designated by Hoffmann as the *articulare* and the *angulare*, respectively. And it is my intention in the present connection to use the nomenclature for the ramal elements given us by that distinguished anatomist (see Bronn's 'Thier-Reichs,' Rept. 22–24 Lief. 1881, Taf. lxvii. figs. 4–5), as his account of these ossifications is far more satisfactory than any other that I happen to have at my hand at the present moment. The *coronoideum* occupies its usual position, developing upon its mid-dorsal border a strong quadrate coronoid process, which takes on an upward and backward direction. This element articulates with the *dentale*, the *complementare*, the *operculare*, and the *articulare*. Forming the base of a fossa between the bifurcations of the coronoideum, upon the mesial aspect of the ramus, occurs a thin splint-bone, the *complementare*, and this is probably the "splenial" element of some authors. Beyond the ossifications thus far described we find an *operculare*; it is a flat, irregular shaped bone that stands between the dentale on the one hand and the coronoideum, complementare, and the angulare on the other, forming a fair share of the mid-portion of the surface of the inner aspect of the ramus.

Still more important is the *dentale*, which, as we know, bears the teeth. This is here quite a powerful bone forming the distal moiety of the mandible, being markedly concaved upon its mesial aspect, and correspondingly convexed both vertically and antero-posteriorly on its external surface. As I have already said, the symphysis of the two dentary elements is notably weak; indeed, the bones of the two sides are little more than in contact at the point in question.

Two small foramina pierce the operculare upon its inner aspect, as does one the angulare posterior to these. Externally there is also an opening of this character which is found in the suture between the coronoideum and the articulare, being vertically below the coronoid process.

The *hyoid apparatus*.—At its hinder extremity the slender *basihyal* is just sufficiently enlarged to admit of its articulation with the anterior and posterior cornua. Posterior to this point it does not send back any median process, while in front its delic e cartilaginous rod is continued forwards into the tongue. Upon either side of its hinder and slightly enlarged end it has articulating with it the mesial heads of the *anterior cornua*. These latter have their slender shafts at first directed, upon either side, forwards and outwards, when at a certain distance they are bent upon themselves, and then are directed outwards and backwards. At the point of flexion there appears to be some sort of a simple joint present.

The *posterior cornua* are represented by paired bony rods of a subcylindrical form; they articulate with the basihyal posterior to the mesial heads of the anterior cornua. Curving backwards and outwards, their hinder ends are tipped with cartilage, which latter character reminds one of the thyro-hyals as seen in most birds—all ordinary existing birds. It is only the anterior joints of the posterior cornua of the hyoidean arches in this Lizard that ossify; all the remaining parts of the apparatus are cartilaginous, even in very old specimens.

From this brief description it will be seen that the hyoidean arches in *Heloderma* simply add another pattern of these structures to the various forms they assume among Lizards generally. According to Cuvier, Hoffmann, the Parker, and many other anatomists, these parts differ in a number of species of the Geckos, in *Gonyocephalus*, in *Iguana*, in *Scincus*, in *Chamæleon*, and in many other species and genera.

In such a species as *Lacerta viridis*, according to Professor T. J. Parker ('Zootomy'), all three cornua of the hyoid apparatus are present, the anterior, middle, and posterior, and such elements are represented as the hypo-hyal, the stylo-hyal, the cerato-hyal, and the epibranchial of the second branchial arch.

On the Shoulder-Girdle and the Pectoral Limb.

A description of the simple form assumed by the sternum in *Heloderma* has already been presented above. This structural simplicity appears to be extended to the *shoulder-girdle*. A broad part of the mesial border of either *coracoid* remains cartilaginous, and this is wider in front than it is behind. Fusing with the corresponding scapula, the osseous part of the coracoid at a point upon the posterior margin of the girdle yields to the articular surface of the glenoid cavity its ventral moiety. Just anterior to this point is to be seen a small fenestra, that appears to indicate the original divisional space between the *precoracoid* and the coracoid proper. In rough outline the form of the coracoid simulates the sector of a circle, the apex being at the glenoid cavity. Anteriorly these bones overlap each other, while posteriorly the mesial margin of either one articulates with the groove occupying the antero-external border of the sternum. In a specimen before me it is the left coracoid that underlaps the right, while the clavicles and interclavicle tend to hold them in this position. It may not, however, be that the left bone is always positioned ventrad. From all this it will be observed that the coracoid in *Heloderma* having the form described, its several elements are so fused together that it remains only to make out the cartilaginous *epicoracoid* (mesial rim), the precoracoid and coracoid proper being indicated by the position of a small foramen only, while the *mesocoracoid*, if it ever exists as a separate ossification in this reptile, is here now completely co-ossified with the other elements.

Being rather less than one third the size of the coracoidal portion of the girdle, the *scapula* has its upper and lower extremities dilated, the bone, as in the case of the coracoid, being transversely flattened. Its antero-ventral end fuses with the coracoid, while its postero-ventral end goes to help form the dorso-superior part of the glenoid cavity. Its antero-superior angle articulates with the outer end of the corresponding clavicle, and its dorsal border articulates, for its entire length, with the superimposed suprascapula.

The expanded dorsal part of the scapula is harmoniously extended by the still more dilated semi-osseous *suprascapula.* The dorsal border of this element of the girdle is markedly convex, the mid-point of its arc almost reaching to the transverse processes of the vertebræ of the spine above it. *In situ*, it is seen to be a thin plate resting upon the last four cervical ribs by its mesial flat surface, being connected with the rest of the girdle in the manner we have described.

The *Interclavicle* (episternum) is represented by an azygos bony bar, which is somewhat dilated and vertically compressed behind, while it is small and tapering in front, at which latter point it stands between the mesial ends of the clavicles, being slightly dorsad to them. Posteriorly its dilated extremity is attached to the ventral surface of the antero-mesial angle of the sternum, the union being through the medium of firm ligament.

Either *clavicle* is represented by a slender, subcompressed bone articulating in a manner already indicated above. When seen *in situ* it at first passes from its articulation with the interclavicle outwards. Near the middle point of its shaft it bends at a gentle angle upwards, and from thence goes to its facet, found at the antero-dorsal angle of the corresponding scapula. The mesial end of the clavicle is but slightly larger than its outer extremity, and the form of the bone thus affords a good classificatory character. Upon close examination, in some specimens, it may be discovered that its extreme outer tip may come into contact with the suprascapula at its antero-ventral angle.

The Pectoral Limb.—Averaging some 3·4 centimetres in length, the *humerus* presents a rather short subcylindrical shaft, with scarcely any curvature. Its extremities are markedly expanded, the imaginary planes in which they lie intersecting each other at an angle of about 35 degrees. The head of the humerus is an elongated facet, and throughout life the sutural trace showing where this is united with the rest of the bone is distinctly visible. To the radial side of this is a bony crest for muscular insertion, having a form much as we see it in ordinary existing birds. This crest is turned ulnad so as to make an angle with the rest of the head of the bone, which is also similar to what we find in this last-mentioned class. Distally, there is an ulnar and radial tubercle, condylar surfaces for articulation with the bones of the antebrachium. In their form these also remind us of the corresponding structures in birds, though here in this Lizard the epiphysial sutural trace is visible during the life of the individual. The epiphysis in question includes the entire articular portion. Above the radial tubercle, the side of the expanded end of the shaft develops a moderately prominent ridge several millimetres long. At the middle of this, upon its dorsal aspect, is found a small pit that has the appearance of an incompleted foramen. This character is constant.

Both the *radius* and *ulna* long retain, at their distal and proximal extremities, the evidences of the epiphysial sutural traces. Subcylindrical in form, the shaft of the *radius* is but very slightly bent, and its enlarged distal end is moulded to articulate with the radial ossicle of the carpus. Its proximal extremity is also enlarged, cup-shaped at its summit, and flattened at the ulnar aspect of its head so as to be brought close against the corresponding extremity of that bone when the skeleton of the arm is properly articulated.

The *ulna*, nearly as large as the radius in point of size, has a compressed shaft, with a very conspicuous, semiglobular, articular condyle at its distal extremity. At the other end of the bone the olecranon is well-developed, and a "greater sigmoid cavity" handsomely excavated. What is interesting here is the fact that no "lesser sigmoid cavity" is formed to admit in articulation the head of the radius, which latter is placed at the expense of a flattening in order to articulate with an apposed flat surface on the ulna, which occurs at the site of the "lesser sigmoid cavity" as it is presented to us in anthropotomy. Thus it will be seen that a sliding movement is admitted of here, but not a rotary motion on the part of the head of the radius, as is the case in many of the higher Vertebrata.

Five *carpalia* represent the distal row of ossicles in the wrist of *Heloderma*, while proximally we find the *ulnare*, the *radiale*, and a *centrale*. Careful search, aided by a good lens, failed to discover any evidences whatever of the presence of an *intermedium*, much less the vestiges of any *rudimentary digit*. In a previous section, the large sesamoid that occurs in the great flexor tendon as it passes over the carpus has already been described; and ligamentously attached to the outer side of the ulna is a large pisiform. As to articulations, two of the carpalia extensively articulate with the ulnare and with each other, while the inner one of the two is in contact extensively with the middle ossicle of this distal row. This last-named one in turn engages the entire inner surface of the ossicle of the carpalia upon its radial side, while its proximal apex comes slightly in contact with the centrale. Number four of the carpalia engages the entire distal surface of the centrale, but barely touches the last ossicle of the distal row upon the radial side. This one is devoted to the radiale and also articulates with the centrale. Proximally, the centrale articulates with the ulnare and radiale. Finally, it is hardly necessary to mention that the carpalia, as a rule, each engage a metacarpal distally, while radiale and ulnare articulate with the radius and ulna, respectively.

The joints of the several *digits of the manus* remind us considerably of the corresponding parts as we find them in the toes of small ordinary existing birds, more especially the distal ones. Counting the claw in each case, we note that the first finger upon the ulnar side possesses three joints; the next one to it has five; the middle one has four; the next one, radiad, has three; while, finally the radial digit has but two. Passing from this last one, then, towards the ulnar side we observe that they stand 2, 3, 4, 5, 3.

Taken as a whole, this pectoral limb of *Heloderma* is a very well-developed one, and in the absence of the *intermedium* it agrees with the Crocodiles; it will be remembered, however, that aside from this point these latter have a very differently constituted carpus from the one we have just described in the Lizard before us.

On the Pelvis and the Pelvic Limb.

In its general characters and in its outlines, the *pelvis* of *Heloderma* agrees with that part of the skeleton as it is found in all ordinary Lizard-forms known to us. The *acetabulum* is extensive but not very deeply excavated, it being formed in the usual way by the union of the three bones composing the os innominatum. The *ilium* contributes its share to the dorsal third of the acetabulum, and from this expanded portion it at first passes upwards, then curves upon itself to pass almost directly backwards, and only slightly upwards. All this last part of the ilium is stout in character and rod-like in form, being compressed from side to side. The manner in which it is seized by the two sacral vertebræ has already been described above when speaking of the vertebral column. Posteriorly the ilium is carried nearly a centimetre beyond its sacral articulation, terminating behind in a free blunt point. The *pubis* (or the pubic bone) represents the smallest element of either half of the pelvis, it being the antero-ventral one and forming the antero-ventral part of the acetabulum. Dorsally it is nearly straight from the last-named point to the *symphysis pubis*, while from side to side it is convex. In the same direction, ventrally, it is somewhat excavated. At its usual site it is pierced by the foramen for the passage of the *obturator nerve*, while just anterior to this point a fairly well-developed *pectineal process* is to be seen.

More irregular in form than either the ilium or the pubis, the *ischium* completes the postero-ventral part of the acetabulum. To describe it, one might say that it is composed of a broad flattened arm that passes downwards and inwards from the acetabulum, to merge, ventrally, into a quadrilateral plate, its second part; and that the mesial border of this plate forms the line of the *symphysis ischii*. This latter is slightly separated by a slip of calcified cartilage, and this is continued posteriorly, beyond the symphysis, into the ventral wall of the cloaca, as a small *os cloacæ*.

The anterior apex of the united ischia is but 5 millimetres distant from the posterior apex of the united pubic bones, and this is spanned by an azygos ligament, that, as usual, divides the not large *foramen cordiforme* into the two *obturator foramina*. Either one of these latter is of a subelliptical form. Immediately anterior to the pubic symphysis, we find a small nodule of cartilage that has been designated as the *prepubis*. And this is connected with the mesial pubo-ischiadic ligament, and even the hinder portion of this latter may in some instances chondrify.

The Pelvic Limb.—As in the case of the anterior limb, we find the long bones of this pelvic extremity culminating at their proximal and distal ends in epiphyses composed of calcified cartilage, and the sutural traces between them and the true bone of the shafts are visible throughout the life of the individual. One of these superadded pieces caps the trochanter of the *femur*, a bone which here has a length of about 3·5 centimetres. Its shaft is cylindrical in form and nearly straight; the head which surmounts it (mostly epiphysial) is a transverse ellipsoid, rearing somewhat above the process seen at the preaxial side of it, which represents the *trochanter*. A pit is seen for the *ligamentum teres*, and this is partly excavated at the expense of the epiphysis, and partly at the expense of the shaft adjacent. Distally, the condyles are rounded in front, with a shallow rotular channel between them; while upon the posterior aspect they are especially sculpt in order to articulate with the corresponding surfaces presented on the part of the proximal ends of the two bones of the leg.

A very small osseous *patella* is visible in the *ligamentum patellæ*, at a point opposite the knee-joint.

Transverse sections made at the proximal, middle, and distal parts of the shaft of the *tibia* are seen to be triangular, subcircular, and subtriangular, respectively. The head of this bone is much enlarged, less so its distal extremity, while its shaft is but slightly curved along its lower third. The *cnemial ridge* is pretty well marked, as are the tuberosities at its summit, intended for articulation with the femur.

Quite straight and slender, the *fibula* has a very small proximal extremity as compared with that of the tibia, while its distal end is transversely widened out, being markedly compressed in the antero-posterior direction. These two bones of the leg are of about equal length, each averaging 2·5 centimetres, or about one centimetre longer than the femur.

Returning for a moment to the knee-joint, we are to note the presence of the internal and external semi-lunar fibro-cartilages, but the osseous sesamoids found in these parts in some Lizards (*Lacerta*) are here only performed in cartilage. In this last statement, of course, I do not include the patella.

Co-ossification is extended to all the elements of the proximal row of the tarsus, but this fusion is not so complete as to entirely obliterate the original sutural landmarks. For even in fully adult specimens an examination of this now single bone reveals the limitations of three segments that compose it; these we take to be a *tibiale* (astragalus), a *fibulare* (calcaneum), and the *centrale*. The last-named one is very large, comparatively, and may include an *intermedium*, but there is no evidence of it. Proximally, this *tibio-fibulare* has a large facet upon either side to accommodate in articulation the fibula and the tibia, while distally it is in contact with the tarsalia and two of the metatarsals.

Passing to the consideration of the *tarsalia* themselves, we are to note that in the case of *tarsale* 1 and 2 they appear only to be represented by an inconspicuous intercalated bit of thin cartilage, barely preventing the contact of the tibio-fibulare with the first two metatarsals. Proximal epiphyses of these latter, however, are moulded to meet the ends of perfect articulation. Subcuboidal in form, *tarsale* 3 is a well-ossified bonelet articulating with second and third metatarsals, with tarsale 2, and with the tibio-fibulare, or the co-ossified mass representing the elements of the proximal row. The basal ends of the 2nd and 3rd metatarsals are markedly smaller than they are in the 1st and 4th, indeed in the latter it has its proximal extremity very conspicuously expanded. *Tarsale* 4 is a larger nodule of bone that articulates with the tarsal elements upon either side of it, with the 4th metatarsal, and with the tibio-fibulare. Finally, more remarkable than any of the rest is *tarsale* 5 ; it is a wonderfully irregular bone in form, and peculiar in other respects. It articulates by merely a vertical line with the tibio-fibulare. Externally it sends forward a prominent process that, by a trochlear facet at its extremity, articulates with the basal phalanx of the 5th metatarsal. It also articulates with tarsale and metatarsale 4, while in the sole it sends downwards a strong process that serves for muscular and other attachments. This latter is augmented by the form assumed by tarsale 4 at its inner side, and it is this common apophysis that gives attachment to some of the short plantar muscles that, in my chapter on the myology (given above), may have been a little differently described, from the confusing propinquity of the ossicles in question. So that a knowledge of this fact will make clear in those premises what might otherwise be considered not an exact description. Professor T. J. Parker, in his studies of *Lacerta viridis*, considered tarsale 4 to be the "cuboid" (Zootomy, p. 152). Vestiges of a very rudimentary character appear to be preseut in one of my specimens of *Heloderma* of a sixth pedal ray, it being in connection with tarsale 5 upon the fibular side of the ankle.

The *metatarsals* differ in form but slightly from the metacarpals, and these differences pertain more especially to the proximal extremities, and these have already been pointed out above. Still more insignificant are the differences to be found between the corresponding joints of the digits of manus and pes, and their numerical arrangement is also similar. We saw in the hand that, passing from the radial to the ulnar side, the fingers possessed 2, 3, 4, 5, 3 phalangeal joints, respectively; now in the foot, in passing from the tibial to the fibular side these numbers exactly correspond, or we find 2, 3, 4, 5, 3 phalangeal joints to the toe respectively.

An excellent diagnostic character twixt pes and manus in this Lizard is to be found in the comparative size and form of the fifth metatarsal and the fifth metacarpal; in the case of the former it is notably short and small, while in the latter quite the reverse of these characters exists, for no especial curtailment of its length is to be noticed, and in bulk it rather exceeds any one of the middle three joints of the palm.

XIV. A brief Synoptical Recapitulation of the more Salient Morphological Characters of *Heloderma suspectum*, selected from the researches set forth in the present Memoir.

Herpetologists have long been familiar with those topographical characters that are presented on the part of either *H. horridum* or *H. suspectum*. Bocourt, in characterizing the group he created to contain these reptiles[1], gave them tersely as follows:—"Parties supérieures du corps hérissées de tubercules semi-osseux, disposés sur le tronc et sur la queue en séries transversales très-rapprochées les unes des autres. Plaques ventrales plates et quadrilatérales. Pas de plicature de la peau formant un sillon le long des flancs. Dents maxillaires appliquées sur le bord interne des mâchoires et creusées d'une rainure longitudinale assez profonde. Langue non rétractile."

And for the genus (*Heloderma*):—"Tête forte et épaisse. Corps trapu. Membres et doigts courts, à peu près de même longueur. Queue arrondie. Ventre protégé par des plaques lisses, quadrilatérales, ne formant que des séries transversales. Des paupières. Une ouverture auriculaire. Pas de pores fémoraux." Essentially, these are the most available characters presented in the form of *H. suspectum*, and by dissection the following, more deeply situate, are brought to light:—

Heloderma suspectum will probably be found to be an oviparous reptile.

(1) And it has between the rami of its mandible a mandibularis muscle.

(2) With all three pronator muscles present in its forearm.

(3) With peculiar longitudinal cones of adipose tissue intercalated with the muscles and the other structures of the tail.

(4) With large corpora adiposa.

(5) With the horizontal membrane or the visceral layer of the peritoneum present and well developed.

(6) With an anastomotic arrangement of the bile and hepatic ducts, and with the same having a peculiar connection with the pancreas (?).

(7) With a rather large, pear-shaped, thoroughly isolated spleen present.

(8) With a bilobed thyroid gland present and situated just above the heart (?).

(9) With the walls of the atria of the heart thin, and with those of the ventricle thick, while the cavity of the latter is small and not divided.

(10) With the anterior end of the trachea placed dorsad to the base of the tongue.

[1] Sous-Famille—Trachydermi glyphodonta.

(11) With a simple laryngeal apparatus and trachea, but with long bronchi.
(12) With a thick, fleshy, unsheathed, and slightly forked tongue.
(13) With curved, conical, grooved, sharp-pointed teeth: when this reptile bites, these teeth transmit the poison from the poison-glands to the wounds they inflict.
(14) With the secretion of either submandibular gland of a poisonous nature, and with the four ducts of the gland opening into the mouth by foramina situated beneath its lining membrane, near the bases of the teeth.
(15) With lacrymal and Harderian glands present in either orbit, and with the pecten present in either eye.
(16) With a fully developed tympanum for the ear.
(17) With sixty-four vertebræ in its spinal column, of which eight are cervical, twenty-two are dorsal, five lumbar, two sacral, and twenty-seven in the tail. They are of the procœlous type.
(18) With a sternum that is entire.
(19) With the dermal tubercles covering the fore part of the skull, co-ossifying therewith in the adult.
(20) With almost complete atrophy of the zygomatic arch, only a bit of its posterior extremity remaining.
(21) With the frontal bone excluded from participating in the formation of the superior margin of either orbital periphery, and this by the union of the post- and prefrontal bones.
(22) With a single parietal bone unperforated by a parietal foramen.
(23) With a stout epipterygoid that reaches the parietal roof above.
(24) With a free dorsal margin to the supraoccipital (*i. e.* that edge is not in contact with the ventral surface of the parietal).
(25) With clavicles that are of nearly uniform calibre throughout their lengths.
(26) With a straight interclavicle that is small and nodular in front, dilated behind. Anteriorly, it stands between the mesial ends of the clavicles.
(27) With only the ulnare, radiale, and centrale composing the proximal row of carpus, and with five carpalia in the distal row.
(28) With digits of manus and pes, in which, counting from first to fifth, inclusive, the number of phalangeal joints run 3, 2, 3, 4, 5, 3, respectively.
(29) With a well-developed pectineal process, upon either side, on the anterior margin of the pelvis.
(30) With a small os cloacæ.
(31) With a very small, but ossified patella in the pelvic limb.
(32) With a single bone forming the proximal row of the tarsus, but the sutural traces in it, standing among tibiale, fibulare,

and centrale, plainly visible throughout life. With three well-ossified bones in the distal row of the tarsus. These represent the tarsalia.

XV. Concluding Remarks.

There were two prime objects the writer had in view when he undertook the present memoir; the one was to give an account of the anatomy of the reptile of which it treats, and the second, to point out, if possible, some of the forms to which it was related. *Heloderma* seemed to be deserving of a more complete chapter devoted to its structure than had, prior to the production of the present work, been awarded it. How well this has been accomplished it remains for the reader of the foregoing pages to decide for himself.

With respect to my having succeeded in throwing any light upon the probable affinities of *Heloderma*, it must be owned that such success as has been attained is by no means as complete as the writer had originally hoped for, and this has brought with it its due measure of disappointment. Failure in this direction has been due principally to the lack of proper material for comparison, material which it was found impossible to obtain, notwithstanding the fact that a great many earnest efforts were made to do so. Bocourt (34) has presented us with a sufficiently complete *résumé* of the opinion of authors as to the affinities of the *Helodermatidæ* down to the year 1878, so it will not be necessary to recapitulate that excellent piece of work here. My own studies of the *Varanidæ* convince me of the fact that *Heloderma* is far removed from that group, having very little structural affinity with it. This applies with equal truth to any true kinship that may have been entertained as existing between the *Helodermatidæ* and the *Iguanidæ*.

In so far as my opinions go in reference to such affinities as may exist between two such forms as *Lanthanotus boreensis* and *Heloderma suspectum*, they quite agree with those of Mr. Garman, and the affinity in that direction "seems to me rather fanciful." Perhaps a remote affinity may exist between *Lanthanotus* and the Crocodiles, but such interesting points can only be decided when Curators come to learn one point and practice another. In the first instance the ultimate fate of an important form of reptile should not be to place it in a jar of alcohol, stand it upon a shelf, and then ascertain how many years it will take to have nearly all its characters rot within a spirit-preserved skin; and in the second instance, the simple method of ascertaining many of the most important internal characters from such specimens, to the benefit of the specimen and the progress of science, should be more universally indulged in.

Personally, the writer has compared the skeleton of *Heloderma suspectum* with the skeleton of *Crotaphytus collaris*, but there is no affinity in that direction; and the fact of the matter is, there is far more to remind one of the skeleton of *Iguana tuberculata* in the osteology of such a species than there is to suggest anything to do with such a radically different type of structure as is presented in the skeleton of a *Heloderma*. Indeed, if we take the skulls of *Iguana tuberculata* and *Crotaphytus collaris* it is not a difficult matter to pick out quite a number of points of near resemblance.

From all that I have seen in the works of other authors, I am strongly inclined to believe that when the morphology of such species that are now grouped in the genera *Xantusia, Xenosaurus,* and *Lepidophyma* is thoroughly worked out, no inconsiderable amount of light will be thrown upon the subject of the affinities of the *Helodermatidæ.* So far as our present knowledge of existing reptiles extends, I am convinced that it is in the direction that I have just indicated that we must look for the affines of our *Heloderma suspectum.*

When we come to consider the group of characters that are presented us on the part of the form to the anatomy of which the pages of this memoir have been devoted, there can be but one opinion in our minds as to the classificatory rank that should be awarded to the Heloderm in the system. For a great many years zoologists have met all the way through the animal series forms the taxonomic arrangement of which demanded a somewhat higher rank than the genus seemed to suggest. This need seems to have been quite thoroughly satisfied in the creation of the subfamily, as it is now generally employed and has been so long in use. On the other hand, at a considerably later date, the necessity for a group ranking higher than the family became apparent, and this was first met by Gill, who in 1872 introduced the use of Superfamilies [1]; and they have been steadily growing in favour with naturalists ever since. The same zoologist has already created a superfamily to contain the Heloderms. This he has termed the *Helodermatoidea*, and has selected the following characters to designate it, viz.:—" Eriglossate Saurians with concavo-convex vertebræ; clavicles undilated proximally, and post-orbital bony arches, but without post-frontosquamosal arches" (Smithsonian Report, 1885, pt. i. p. 800).

The *Helodermatidæ* is the only known family of this superfamily, and it, as we now know, contains but the two species which have been referred to in this memoir. They are the only ones at present known to science. To return to the taxonomy of them, the present writer is of opinion that the morphological characters presented on the part of these reptiles, which characters have been set forth in detail in this work, go to support the classification suggested by Gill, and it is proposed, in so far as it applies to the definition of the Heloderms in the system, that the arrangement be adopted. It is adopted here.

Many things have, during my studies of the *Helodermatidæ*, inclined me to believe that these reptiles are probably derived from a rather old stock, and that during comparatively recent times they have not changed much in their organization. And further, I doubt very much that we will ever meet among the more recent forms of existing types of reptiles any that will show in their morphology

[1] These were first used, by the author quoted, in a paper entitled "On the Characteristics of the Primary Groups of the Class Mammals," Proc. Am. Assoc. Adv. Sci. vol. xx. p. 291.

very close affinity with them. Günther has said[1] that "Central America possesses, besides, five other families, small in species and restricted in range (some belonging to the fauna of great elevations), but highly interesting types. These are the *Eublepharidæ*, *Xenosauridæ*, *Aniellidæ*, *Helodermatidæ*, and *Lepidophymatidæ*. Their localization and differentiation can be accounted for on the hypothesis that they are the remains of the fauna of the various islands into which Central America was broken up at a former period." This is likewise quite in the line of my thinking.

XVI. Bibliography.

The following works are the principal ones that refer to the HELODERMATIDÆ, and the most important of them have been consulted by the writer in connection with the present monograph.

(1) 1651. Hernandez (Franciscus).—'Historiæ animalium et mineralium Novæ Hispaniæ liber vnicus'; Cap. p. 315.—(This is the first authority that alludes to *H. horridum*, and in the volume quoted we find a very fair description of the Reptile, the author stating that it was known to the Mexicans as the Acastelepon, but to the Spanish Créoles as the "Escorpion.")

(2) 1829. Wiegmann (Arend Fridericus Augustus).—Isis, pp. 627–629.—(Under the name of *Trachyderma horridum*, Wiegmann, in this place, presents us with rather a superficial description of a Mexican specimen of the reptile; see also the same work, p. 624, *H. horridum.*)

(3) 1830. Wagler (Joannes).—Natürliches System der Amphibien. P. 164.—(This naturalist places *Heloderma* among the *Thecoglossæ pleurodontes.*)

(4) 1833. *Idem.*—Descriptiones et Icones Amphibiorum. Fasc. 2.—(An unpaged description, in Latin, illustrated by an indifferently executed figure of *Heloderma horridum*, from an alcoholic specimen which had been brought to Berlin.)

(5) 1833. Schinz (Heinrich Rudolph).—Naturgeschichte und Abbildungen der Reptilien. Text and Atlas, 4to. Leipzig. P. 95; tab. 33.—(Wagler's drawing accompanied by a no better description in German.)

(6) 1834. Wiegmann (Arend F. A.).—Herpetologia Mexicana seu Descriptio Amphibiorum Novæ Hispaniæ. Berolini. Pp. 6, 7, and tab. i.—(Here this author's well-known suborder of the *Squamata* is divided into three series,—the *Leptoglossi*, the *Rhyptoglossi*, and the *Pachyglossi*. Of these the *Leptoglossi* is again subdivided into the *Brevilingues* and the *Fissilingues*, and in the last-mentioned group the *Heloderma* has been placed, in a family created for it, the *Trachydermi*. His coloured figure of *Heloderma horridum* is too brown in its colouring, and in form only presents us

[1] Encyclopædia Britannica, 9th ed. vol. xx. p. 470 (1886).

with a fair idea of the reptile. A drawing is also given of the superior aspect of the head.)

(7) 1836. Duméril (A. M. C.) and Bibron (G).—Erpétologie Générale ou Histoire Naturelle complète des Reptiles. T. iii. pp. 499–501.—(In this justly celebrated work a brief description of the *Heloderma* is given, which adds nothing to previous descriptions of other authors.)

(8) 1837. Gray (J. E.).—Proceedings of the Zoological Society of London. P. 132.—(Places the *Helodermatidæ* with the *Leptoglossæ*, a subdivision of the Saurians as proposed by Wiegmann.)

(9) 1838. Bonaparte (Charles Lucien).—"Synopsis Vertebratorum Systematis." Nuovi Annali delle Scienze Naturali. Anno i. Tomo ii. Bologna, pp. 105–133.—(On page 124, family 13 is represented by the *Helodermatidæ*, and subfamily 20 by the *Helodermatina*, the latter being the only subfamily ranged under the former. The cacography in either case is retained. The year, although given as above both on back of volume and the titlepage, shonld probably be 1839, unless Tomo iii. was published in 1839. Compare same work below.)

(10) 1840. *Idem.*—"Prodromus Systematis Herpetologiæ." Nuovi Annali delle Scienze Naturali. Anno ii. Tomo iv. Bologna, pp. 90–101.—(Here the Heloderms are placed with the *Leptoglossi* of this author, between the *Varanidæ* and the *Ameividæ* (Tribus 2); and upon p. 95 the following characterization of them is given : "Familia 13. *Helodermatidæ*. Lingua. . . . laminæ supraorbitales cutaneæ : oculi palpebrati ; aures conspicuæ : membrana tympani superficialis ; caput tuberculato-squamosum, depressum : corpus elongatum.

"Subfamilia 21. *Helodermatina*. Dentes adnati : cutis sulculis exarata : squamæ tuberculiformes osseæ : pori femorales nulli."

(11) 1840. *Idem.*—"Systema Vertebratorum." Trans. Linn. Soc. London ; vol. 18. pp. 247–305. Separate, l. p. l. 58 pp. Helodermatidæ and Helodermatina, p. 294 ; Sep. 37.—(In the last place there occurs the same characterization of the *Helodermatidæ* and the *Helodermatina* as is quoted above from the Prodromus, with the exception that the words "Familia" and "Subfamilia" were not introduced, and owing to a certain re-arrangement the subfamily is 20 instead of 21 as above given.)

(12) 1845. Gray (J. E.).—Catalogue of the Specimens of Lizards in the Collection of the British Museum. P. 14.—(*Heloderma horridum* is here alluded to under the name of "The Caltetepon," and isolated as the representative of the family "Caltetepons" (*Helodermidæ*).)

(13) 1853. Troschel (F. H.).—Archiv für Naturgeschichte ; t. i. p. 294.—(Taf. xiii. and xiv. present us with very good figures,

giving side and basal view of skull, the former showing the manner in which the dermal tubercles of the head eventually ossify and fuse with the skull; there are also given figures of the upper view of the tongue, the hyoid, the limbs, ribs, sternum, and pelvis.)

(14) 1856. DUMÉRIL (AUGUSTE).—"Description des Reptiles nouveaux ou imparfaitement connus de la collection du Muséum d'Histoire Naturelle et Remarques sur la Classification et les Caractères des Reptiles." Archives de Muséum d'Histoire Naturelle. (Deuxième Mémoire.) T. viii. p. 491.—(Under his "Quatrième Famille: *Varaniens* ou *Platynotes*" occur the following remarks:—"Cette tribu des Thécoglosses est formée par la réunion de quatre familles. La première (*Palæosauri*) ne comprend que des genres fossiles; . . . . La deuxième enfin (*Helodermata*) ne se compose que d'un seul genre, celui que Wiegmann a établi sous le nom de *Heloderma*." This is followed by an allusion to the work of Troschel upon the structure of this form.)

(15) 1857. GRAY (JOHN EDWARD).—"On the Genus *Necturus* or *Menobranchus*, with an account of its Skull and Teeth." Proc. Zool. Soc. London, p. 62. (In the place quoted the following notes occur:—"The chief difference between the teeth of the Proteus of the Lakes and the fangs of Serpents is, that in the former the aperture of the cavity is nearer to the centre of the tooth, some distance from the apex, while in the fang of the Serpent it is generally near to the tip. I know of no other instance of a Batrachian having this structure of its teeth, nor do I know any instance, except in the Mexican Lizard, called *Heloderma horrida*, in which *all the teeth* are uniformly furnished with a basal cavity and foramen, and this Lizard is said to be noxious; but the fact has not been distinctly proved.")

(16) 1858. GIRARD (CHARLES).—United States Exploring Expedition during the years 1838–42, under Captain Charles Wilkes, U.S. Navy. Herpetology, p. 195.—(Refers to the Helodermis as belonging to the family *Varanidæ*.)

(17) 1859. BAIRD (SPENCER F.).—Report of the United States and Mexican Boundary Survey. P. 11, pl. xxvi.—(The plate gives a left lateral view of what appears to be a specimen of *Heloderma suspectum*, indifferently figured. There is also on the same plate an under view of the head, the vent (enlarged), and the details ot the toes.)

(18) 1859. *Idem.*—Pacific Railroad Reports; No. 4. Report upon the Reptiles of the Route, vol. x. pt. vi. p. 38.—(*Heloderma horridum* mentioned in a list of reptiles collected by the expedition.)

(19) 1862. PETERS (WILHELM).—"Über Cercosaura und die mit dieser Gattung verwandten Eidechsen aus Südamerica." Abhandlungen der königl. Akademie der Wissenschaften zu Berlin, p. 172. (On the page referred to, the following

remarks occur:—"Die *Gerrhonotus*, welche enige äussere Aehnlichkeit mit deu *Cercosauri* haben, entfernen sich von ihnen durch die dachziegelförmige Beschuppung des Unterkinns, vorzüglich aber durch die eigenthümliche schwammige Zunge, welche mit zwei besonders geformten glatten Spitzen endigt, ganz ähnlich, wie es die treffliche Abbildung von *Heloderma horridum* zeigt, welche Hr. Troschel (Archiv für Natur. 1853, xix, 1 Taf. xiii. fig. 1) geliefert hat.")

(20) 1864. Cope (Edward Drinker).—Proceedings of the Academy of Natural Sciences of Philadelphia: p. 227.—(Makes a group *Pleurodonta* containing the *Iguania*, *Diploglossa*, *Thecaglossa*, and *Leptoglossa*, giving the characters of each, placing the *Helodermatidæ* with the *Anguidæ* and *Gerrhonotidæ* in the *Diploglossa*.)

(21) 1864. Sumichrast (F.).—'Annals and Magazine of Natural History.' Lond. xiii. pp. 497–500. (Considers the *H. horridum* as belonging to the *Varanidæ*; gives a very interesting account of its habits and other matters referring to the species. Speaks of the difficulty of studying this species from the fact that it is nocturnal in its habits: of how tenacious they are of life, and even after life is apparently extinct the muscles long respond to stimulation.)

(22) 1864. *Idem.*—"Note sur les Mœurs de quelques Reptiles du Mexique." Bibl. univers. et Revue Suisse, Arch. des Scien. Phys. et Nat. t. xix. pp. 45–61. (Places *H. horridum* in the family *Varanidæ*, and gives a brief account of its external appearance and of its habits. This paper seems to be substantially what had already appeared in the Ann. and Mag. of Nat. Hist., for which see No. 21 *antea*.)

(23) 1865. Kaup (J. J.).—"Einige Nachträge zur Gattung *Heloderma horridum*." Wiegm. Archiv für Naturgeschichte, pp. 33–40; pl. iii. figs. 1 and 2.—(The figures present us with very fair drawings of superior and inferior views of the skull of a *Heloderma horridum*.)

(24) 1866. Cope (E. D.).—Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 303, 311.—(*H. suspectum* referred to in a collection of Reptilia and Batrachia of the Sonoran Province of the Nearctic Region. The collection was made by Dr. E. Coues.)

(25) 1869. *Idem. loc. cit.* p. 5.—(This same author briefly refers to the characters of the *Helodermatidæ* in this place, and defines *H. suspectum* as a distinct species.)

(26) 1873. Gervais (Paul).—Journal de Zoologie, p. 453.—(There are three plates with this excellent paper, giving figures of many of the structural parts of *H. horridum*, this talented anatomist having secured a large specimen of the Reptile.)

(27) 1873. *Idem.*—"Structure des dents de l'Heloderme et des Ophidiens." Comptes Rendus, tom. lxxvii. p. 1069.—(A brief account of the teeth in *Heloderma*.)

(28) 1873. SUMICHRAST (F).—"Coup d'œil sur la distribution géographique des reptiles au Mexique." Bibl. univers. et Revue Suisse, Archives Scien. Phys. et Nat. t. xlvi. pp. 233–250.—(In speaking of certain reptiles and their distribution, he adds:— . . . . . "d'autres sont particulières à celle du Pacifique et parmi elles il faut citer d'abord l'Heloderme, *Hel. horridum*: ce curieux reptile que quelques naturalistes considèrent comme un membre de la famille paléotropicale des Varanides, mais qui formera sans doute plus tard le type d'un groupe particulier, le *Cyclura quinque-carinata* (*Enyaliosaurus*, Gray), etc.")

(29) 1875. YARROW (H. C.).—Report upon the Collections of Batrachians and Reptiles made in portions of Nevada, Utah, California, New Mexico, and Arizona, during the years 1871, 1872, 1873, and 1874. U.S. Geographical Survey West of the 100th Meridian. (Lieutenant Geo. M. Wheeler, U.S.A., in charge). Pp. 562, 563.—(Refers to a specimen of *H. suspectum* taken on the Route of the Expedition, and disclaims any belief in the fact that its bite is poisonous or dangerous.)

(30) 1875. BLANCHARD (Em.).—"Observations sur les mœurs de l'*Heloderma horridum*, Wiegm., par M. F. Sumichrast; Note de M. Bocourt présentée par M. Em. Blanchard." Comptes rendus des séances d'Académie des Sciences, tom. lxxx. p. 676.—(Brief observations upon experiments with the bite of the Heloderm.)

(31) 1875. COPE (E. D.).—'Bulletin,' United States National Museum, No. 1, pp. 19 and 47.—(Places the *Helodermatidæ* (group *b. Diploglossa*) with his *Pleurodonta*; and on p. 47 gives the habitat of *H. suspectum* as the Sonoran region.)

(32) 1875. BOCOURT (F.).—Comptes rendus des séances de l'Académie des Sciences, tom. lxxx. p. 676.—(Details of habits and experiments tending to show the venomous nature of the bite of this Lizard, from the observations of Sumichrast. This author also refers to the nauseous odour of *H. horridum*.)

(33) 1876. WALLACE (ALFRED RUSSEL).—The Geographical Distribution of Animals. Vol. ii. p. 390.—(Notes upon the distribution of the *Helodermatidæ*.)

(34) 1878. DUMÉRIL (AUG. M. C.) and BOCOURT (F.).—Mission scientifique au Mexique et dans l'Amérique Centrale. Pt. iii. pp. 287–302, pl 20 E. figs. 1–13, and pl. 20 G. figs. 1, 3, 3 *a*, 3 *b*, 6, 6 *a*, 7, 7 *a*, 8–11 *a*.—(A very excellent account of *H. horridum*, with a brief *résumé* of all that appeared to be known of the reptile up to the date of issue of this work, and illustrated by valuable figures in the plates.)

(35) 1878. STEINDACHNER (FRANZ).—Denkschriften der kaiserlichen Akademie der Wissenschaften (Wien), 38 Band, p. 95.—(In this place are described some reptiles new to science, and for one of them (*Lanthanotus borneensis*) a new family is created (*Lanthanotidæ*), of which the author of the

work says "Die in den nachfolgenden Zeilen beschriebene Art bildet den einzigen bisher bekannten Vertreter einer eigenen Familie (*Lanthanotidæ*), welcher sich zunächst an die *Helodermidæ* an den Mangel eines äusseren Ohres sowie durch die eigenthümliche Beschilderung des Rückens, welche jener gewisser Krokodile (z. B. *Cr. acutus*) ähnlich ist, sich wesentlich unterscheidet. Die Kieferzähne sind übrigens wie bei *Heloderma* hinten gefurcht, dagegen fehlen grosse plattenförmige Schilder am Mundrande."

This contribution presents us with a very good plate of *Lanthanotus borneensis* (Taf. ii. nat. Gr.), and a glance at it is sufficient for us to perceive how one could, through an opinion arrived at by the impression of the superficial resemblance that this lizard bears to a *Heloderma*, come to believe that such an affinity actually existed. Such a diagnosis, however, is sometimes arrived at in sober earnest, the more especially when the investigator is ignorant of the internal structure of at least one of the forms undergoing comparison.)

(36) 1878. *Idem.*—"Note" [über *Tejovaranus* und *Lanthanotus*] in "Ichthyologische Beträge (vii.)," Sitzungsb. k. Akad. Wissensch. (Wien) v. 78, 1 Abth. pp. 377–400 (p. 399). —(This observation reads as follows:—"Note. Bei dieser Gelegenheit erlaube ich mir zu bemerken dass *Tejovaranus branickii* m. mit *Callopistes maculatus*, Gravenh. = *Aporomera flavipunctata*, Dum. & Bibr., identisch und die Gattung *Tejovaranus* somit einzuziehen sei. Die Kieferzähne von *Lanthanotus borneensis*, m. (s. Denksch. Wien. Acad. Bd. 38, p. 95), endlich sind hinten nicht gefurcht, sondern im Durchschnitte ganzrandig; es zeigt sich somit in dieser Beziehung keine Ähnlichkeit mit der Gattung *Heloderma*, bei welcher die Zähne vorne gefurcht sind."—Appearing as this "Note" did at the end of a paper describing some Fishes of the Galapagos Islands (VIII. Ueber zwei neue Fischarten von den Galapagos-Inseln), it may have escaped the observation of many herpetologists, who, I feel confident, will be glad of the more general circulation that I have given it by publishing it in the present connection.)

(37) 1880. Sumichrast (F.)—Bulletin Société Zoologique de France, p. 178.—(Under "Helodermiens" presents a few notes in reference to small mammals dying from the bite of *H. suspectum.*)

(38) 1880. Packard (A. S.).—Zoology. N. York. P. 504.—(Popular reference to the *Helodermatidæ.*)

(39) 1882. 'The American Naturalist.' Philadelphia. P. 842. —(Editorial note: testimony as to the poisonous nature of the bite of *H. suspectum.*)

(40) 1882. Günther (A. C.).—Encyclopædia Britannica, 9th Edition: Art. "Lizard," vol. xiv. p. 735.—(Refers to the bite of *H. horridum* as being poisonous, and cites cases.)

(41) 1882. Yarrow (H. C.).—Bulletin of the U.S. National Museum, No. 24, pp. 9 & 48.—(Name of *H. suspectum* occurs in list of N.-American Reptiles.)

(42) 1882. Sclater (Philip Lutley).—Proc. Zool. Soc. London, p. 630.—(Remarks:—"3. A Heloderm Lizard (*Heloderma suspectum*) from Arizona, presented by Sir John Lubbock, Bart., M.P., F.R.S., F.Z.S., July 16."

"This Lizard, which is new to the collection, is remarkable as belonging to the only positively known venomous form of the Lacertilian Order. It has been ascertained by actual experiment that its bite is fatal to small mammals.")

(43) 1882. Boulenger (George Albert).—*Loc. cit.* p. 631.—(Remarks:—"I may add that *Heloderma* is probably not the only poisonous lizard. *Lanthanotus borneensis*, a pretty close ally of this lizard, described four years ago by Dr. Steindachner, exhibits, according to that author, a similar dentition.")

(44) 1882. Fischer (J. G.).—Anatomische Notizen über *Heloderma horridum*, Wiegm. Verhandl. des Vereins für naturw. Unterhaltung zu Hamburg, Bd. v. p. 2, plate iii. —(Comments upon and gives drawings of the poison-glands in the *Heloderma*.)

(45) 1882. Hoffmann (C. K.).—Reptilien: in Bronn's Klassen und Ordnungen des Thier-Reichs. Bd. vi., iii. Abth. 30–32 Lieferung, pp. 890–892; and *loc. cit.* 33 and 34 Lieferung, Taf. lxxxxvii. fig. 2.—(The author reproduces Fischer's figure of the dissection of the poison-glands in a *Heloderma*, and comments upon them and the affinities of the Reptile.)

(46) 1882. Shufeldt (R. W.).—"The Bite of the Gila Monster (*Heloderma suspectum*)." The American Naturalist, Philadelphia. November; pp. 907, 908.—(The author of the paper was severely bitten by an adult specimen of the *Heloderma suspectum*, and although much pain and grave symptoms immediately supervened, the results passed entirely away in a few days with barely any treatment.)

(47) 1882. 'Nature.' London. Vol. xxvii. No. 685; Dec. 14, pp. 153, 154, fig. 28.—(Some very excellent remarks upon the two species of *Heloderma*, and also a good woodcut of the reptile.)

(48) 1882. Fayrer (Sir Joseph).—Proceedings of the Zoological Society of London, p. 632.—(Has reference to the poisonous effects of the bite of the *Heloderma*.)

(49) Garman (Samuel).—The Reptiles and Batrachians of North America. Published by the permission of the Kentucky Geological Survey. P. xi.—(In some respects a good account of *Heloderma*, but a few of the statements made in reference to its habits do not apply, at least to *H. suspectum*.)

(50) 1883. Mitchell (S. Weir) and Reichert (Edward T.). —Medical News, Feb. 10, and Science, vol. i. no. 13, p. 372. —(Celebrated papers upon the examination of the poisonous effects of the bite of *Heloderma*.)

(51) 1883. 'THE AMERICAN NATURALIST.' Philadelphia. P. 800. —(Editorial, referring to the experiments of Mitchell and Reichert.)

(52) 1884. SCLATER (P. L.).—Proc. Zool. Soc. London, p. 475.—(Under noticeable additions to the Zoological Society's Gardens for the month of July, remarks:—"1. A second specimen of the Heloderm Lizard (*Heloderma suspectum*), received in exchange from the Central Park Menagerie, New York, U.S.A., July 3rd.")

(53) 1884. BOULENGER (G. A.).—Annals and Magazine of Natural History, (5) xiv. p. 120.—(Characterizes the *Helodermatidæ*, and places them between the *Aniellidæ* and *Varanidæ*.)

(54) 1884. GARMAN (SAMUEL).—The North-American Reptiles and Batrachians. A List of the Species occurring North of the Isthmus of Tehuantepec, with references: p. 12.—(Characterizes the family *Helodermidæ*, and alludes briefly to *H. horridum* and *suspectum*.)

(55) 1885. BOULENGER (G. A.).—Catalogue of the Lizards in the British Museum. Vol. ii. pp. 300–302.—(Presents the characters of the Family, and of the two species known to science.)

(56) 1885. GILL (THEODORE). — Smithsonian Report, Part I. p. 800.—(Proposes the superfamily *Helodermatoidea*, containing the only known family *Helodermatidæ*; both are briefly characterized.)

(57) 1885. GÜNTHER (A. C.).—Biologia Centrali-Americana. Reptiles, pl. xxvi.—(Figures a young specimen of *Heloderma horridum*.)

(58) 1886. GÜNTHER (A. C.) and MIVART (St. GEORGE).—Encyclopædia Britannica, 9th Edition, Art. "Reptiles." Vol. xx. pp. 439, 451, 458, figs. 12 & 27.—(The *Helodermidæ* are placed in the Suborder (1) Lacertilia vera (group B), between the Aniellidæ and the Varanidæ. Bocourt's figures of skull and teeth reproduced. Characters of the skull are alluded to, and the nature of the teeth and other points.)

(59) 1887. SHUFELDT (R. W.).—The Gila Monster. Forest and Stream: New York. Aug. 4; p. 24, figure (life-size) of the reptile.—(A popular account of *H. suspectum*.)

(60) 1887. BENDIRE (C. E.).—'Forest and Stream' (newspaper). Aug. 18; pp. 64, 65. Under title of "Whip Scorpion and the Gila Monster," describes the eggs removed from a specimen of *H. suspectum*:—"If I remember rightly, this specimen contained about eight fully formed eggs, all about three quarters of an inch in length by one third of an inch in width, bluntly pointed at each end, resembling the egg of an Alligator in shape, but with a smooth, soft, white skin instead of a hard, glossy shell like the latter.")

(61) 1887. COPE (E. D.).—Bulletin of the U.S. National Museum, No. 32, p. 40.—In a Catalogue of Batrachia and

Reptilia of Central America and Mexico, places the Helodermidæ between the Xenosauridæ and the Anguidæ.
(62) 1888. YARROW (H. C.).—Bite of the Gila Monster. Forest and Stream, New York, June 14th. Vol. xxx. no. 21, pp. 412, 413.—(This is part vi. of this writer's series of papers on "Snake Bite and its Antidote," in the same newspaper.)
(63) 1888. *Idem.*—A Reference Handbook of the Medical Sciences, embracing the entire range of Scientific and Practical Medicine and Allied Science. By various writers. Illustrated by chromolithographs and fine wood-engravings. Edited by ALBERT H. BUCK. New York (William Wood & Co.). Vol. vi. p. 171, pl. 28.—(Plate 28 is a chromolithograph of *Heloderma suspectum*, and illustrates the article contributed by Dr. Yarrow, entitled "Reptiles, poisonous," pp. 165–174 —a few brief remarks on p. 171, within the title, being devoted to the *Heloderma.*)
(64) 1889. MITCHELL (S. WEIR).—The Poison of Serpents. The Century Illustrated Monthly Magazine, vol. xxxviii. no. 4. New York, August 1889, p. 505.—(A popular account of venomous reptiles, wherein an allusion is made to the poisonous saliva of *Heloderma suspectum*; an indifferent figure of the reptile illustrates the article.)

EXPLANATION OF THE PLATES.

PLATE XVI.

All figures reduced $\frac{3}{4}$.

Fig. 1. Direct ventral view of the liver, gall-bladder, and ducts, &c. of an adult specimen of *Heloderma suspectum*. *g.b.*, gall-bladder; *r.l.*, right lobe of liver; *l.l.*, left lobe of liver.

2. Direct dorsal aspect of the same specimen as is shown in figure 1 with additional parts added. *l.c.*, lobulus cardiacus; *P.v.*, portal vein; *d.c.*, common duct; *a.a.v.*, anterior abdominal vein; *g.e.*, a structure that appeared like a ganglionic enlargement upon the pancreatic duct in the case of the specimen examined; *p.*, pancreas; *d.*, duodenum.

3. Direct ventral view of the heart, lungs, thyroid gland, and other parts of *Heloderma suspectum*. The various organs are *in situ*, but the pericardium and other serous membranes have been removed with the exception of *l.c.*, lobus cardiacus. *t.r.*, trachea; *c.a.*, carotid artery; *t.g.*, thyroid gland; *r.l.*, right lung; *l.c.*, anterior cap of the peritoneum (cut short) in which the *lobulus cardiacus* of the liver is lodged were that organ represented in the drawing *in situ*; *œ.*, œsophagus; *i.j.*, internal jugular; *l.l.*, left lung; *H.*, heart (showing the ventricle and the two auricles).

4. Ventral view of the head of an adult specimen of *Heloderma suspectum* with the integuments removed, and showing the poison-glands. The tip of the tongue (*T*) is protruding from the mouth, and the mandible (*M*) is partially seen through the superficial layer of muscles. The left poison-gland (*p.gl'*) is represented as being drawn outwards by means of a small dissecting hook and chain, to expose its four ducts which lead through the mandible to the bases of the teeth. On the right side the gland is shown *in situ* (*p.gl.*), as well as the vein that returns the blood from it and afterwards joins the external jugular.

Plate XVII.

Fig. 1. Left lateral view of skull and mandible of a specimen of *Heloderma suspectum*, the latter disarticulated; life-size from the specimen (adult). *mx.*, maxillary; *pmx.*, premaxillary; *smx.*, septomaxillary; *ol.*, co-ossified dermal tubercles; *prf.*, prefrontal; *fr.*, frontal; *psf.*, post-frontal; *j.*, jugal; *pa.*, parietal; *co.*, columella; *pr.o.*, prootic; *sq.*, squamosal; *pl.*, pterygoid; *rz.*, vestige or rudiment of zygomatic arch; *q.*, quadrate; *d.*, dentary; *com.*, complementare; *cor.*, coronoideum; *ar.*, articulare; *an.*, angulare.

2. Superior view of the right ramus of the mandible of *H. suspectum*. *op.*, operculare. Other letters as in Fig. 1.

3. Mesial aspect of the right ramus of the mandible of *H. suspectum*. Letters as in Fig. 1.

4. Superior aspect of the skull of *H. suspectum*, the mandible removed. *l.*, lacrymal; *l.c.*, lacrymal canal; *so.*, supraoccipital. Other letters as in Fig. 1.

5. Superior aspect of the skull of *H. horridum*, mandible removed. (After Bocourt.) Lettering as in Fig. 1.

6. Ventral aspect of the skull of *H. suspectum*, mandible removed; life size. *tt.*, teeth; *v.*, vomer; *pl.*, palatine; *tr.*, transpalatine (os tranversum); *bs.*, basisphenoid; *btp.*, basipterygoid process; *eo.*, exoccipital; *bo.*, basioccipital. Other letters as in Fig. 1.

Plate XVIII.

Fig. 1. Dorsal aspect of the right pelvic limb of a specimen of *H. suspectum*, natural size. *f.*, femur; *p.*, patella; *t.*, tibia; *fb.*, fibula; *tfe.*, tibio-fibulare; *tr.*, distal tarsalia; *e.*, epiphysis on proximal extremity of metatarsal of the second toe.

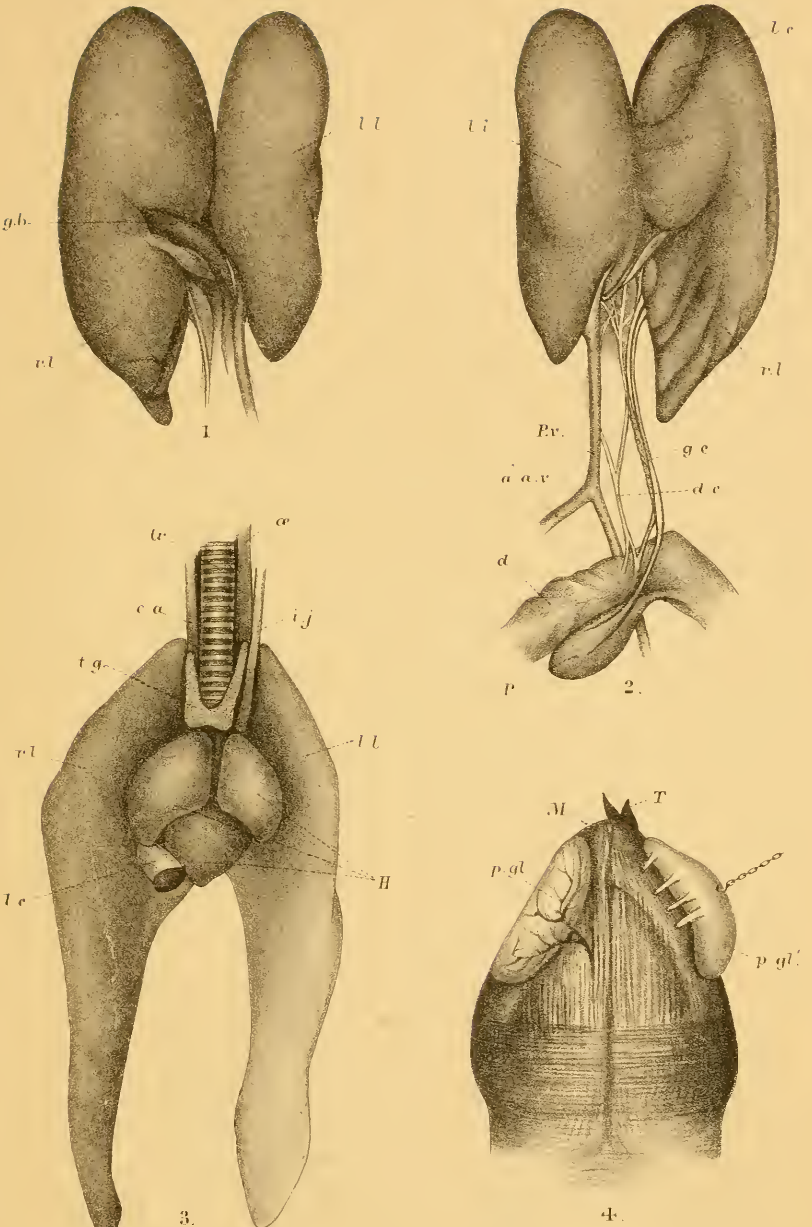
2. Ventral aspect of right humerus of a specimen of *H. suspectum*, natural size. *h.*, humerus.

3. Dorsal aspect of the antibrachium, carpus, and manus of the right pectoral limb of *H. suspectum*, natural size. *ul.*, ulna; *rd.*, radius; *uc.*, ulnare; *re.*, radiale; *p.*, pisiforme; *c.*, centrale; *cp.*, distal carpalia.

4. Direct dorsal view of the pelvis and sacrum of *H. suspectum*, natural size. *pb.*, pubis; *of.*, foramen for the passage of the obturator nerve; *il.*, ilium; *f.cr.*, foramen cordiforme; *p.p.*, pectineal process; *is.*, ischium; sv^1 and sv^2, the two vertebræ that go to form the sacrum, the first and second respectively.

5. Ventral aspect of the sternum and shoulder-girdle and associated parts of *H. suspectum*, natural size. *s.*, scapula; *cl.*, clavicle; *co.*, coracoid; *ic.*, interclavicle; *st.*, sternum; *c.rb.*, costal ribs.

6. Ventral aspect of the hyoid arches of *H. suspectum*, somewhat enlarged. *b.hy.*, basihyal; *a.co.*, anterior cornua; *p.co.*, posterior cornua.



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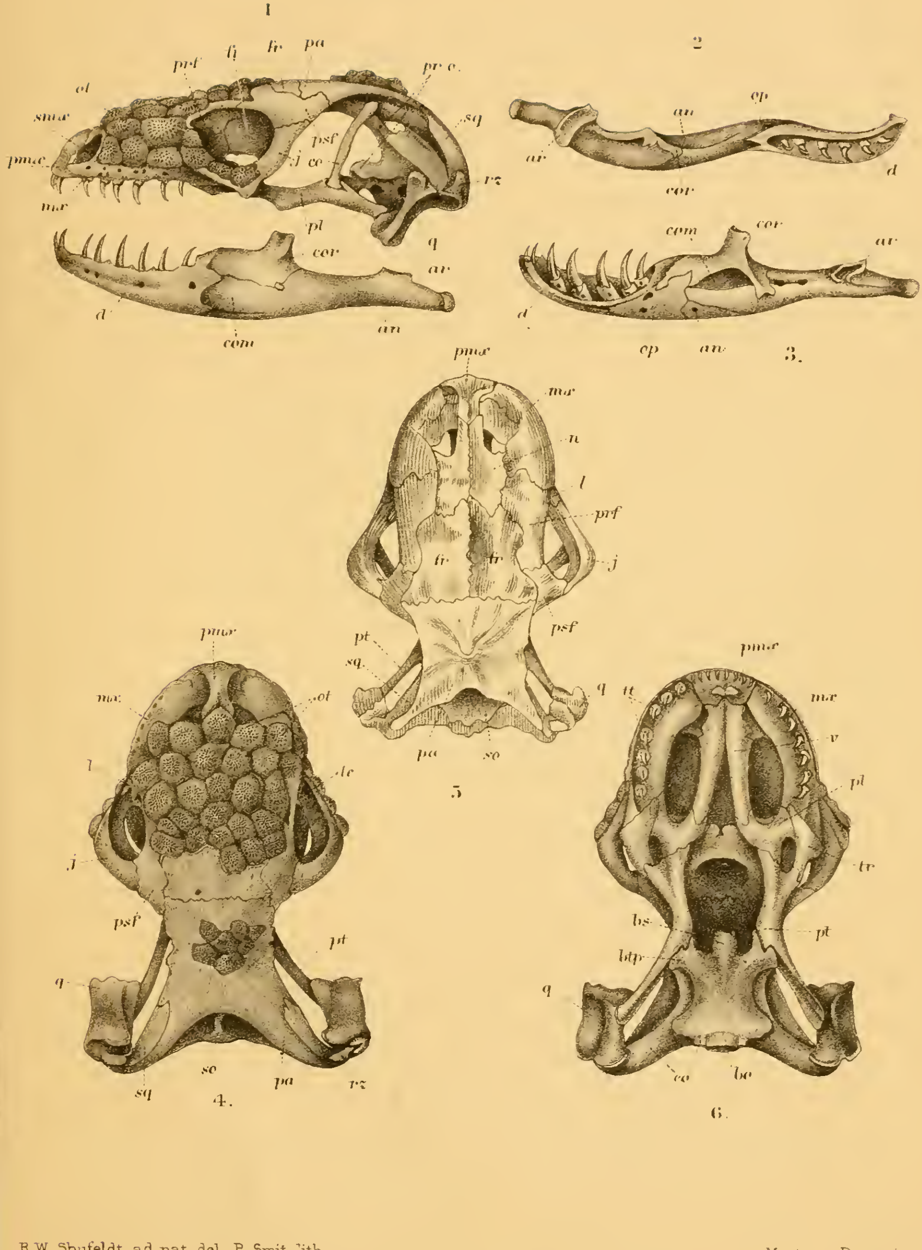
ANATOMY OF HELODERMA SUSPECTUM.



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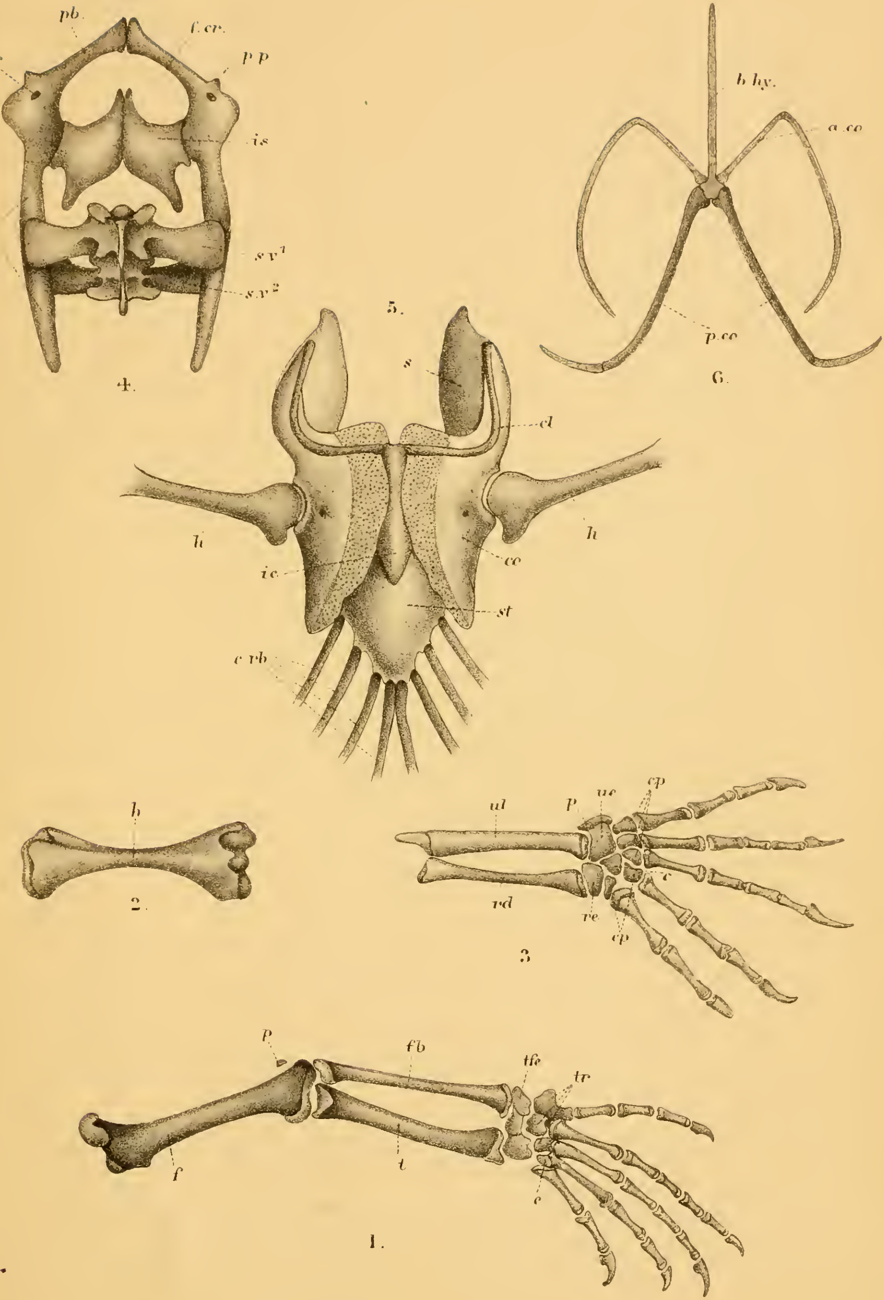

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