Description of a New Genus and Species of Marsupialia, "*Notoryctes typhlops*."*

By E. C. Stirling, M.A., M.D

Lecturer on Physiology in the University of Adelaide, Hon. Director of the South Australian Museum.

[Read February 3, 1891].

The first specimen of this animal, received by the South Australian Museum, was forwarded by the courtesy of Mr. A. Molineux, Secretary of the Agricultural Bureau. Wrapped merely in a rag saturated with kerosine and enclosed in a revolver-cartridge box, it had travelled over a thousand miles largely by packhorse and coach. Consequently it was in a very bad condition on arrival in Adelaide. On this specimen, which appeared to be a female, were based some preliminary notes communicated to the Royal Society of South Australia on the 4th September, 1888, and an almost similar communication was made to the correspondence columns of '*Nature*' shortly afterwards. Some few months subsequently I received three more specimens, all males, of which one only was in anything like good preservation. The reasons for the delay in the publication of the present description, which is based upon an examination of the four specimens then to hand, and for the new name under which it now appears, are explained in a concluding paragraph. By the kindness of His Excellency the Governor, Lord Kintore, I have recently had the opportunity of making, with him, the complete transit from North to South of the Australian Continent. Though the opportunity of traversing the zoologically unexplored regions of Central Australia would, under any circumstances, have proved an attractive programme, a special inducement for the journey was afforded by the fact that our route must pass through the tract of country in which the animal had been found, and hence arose the possibility of my being able to secure additional specimens. In this expectation I have happily been successful, for, I was fortunate enough to secure six complete examples, and one skeleton. Amongst these are four females, which sex had been represented only by the first specimen. This, however, was so much decomposed as to leave some doubt of its character. On my return from the transcontinental journey, I found the present

* The name "Psammoryctes," originally selected for this new genus, having been already appropriated, that here employed is substituted.

paper in the printer's hands, and it will be submitted practically as I left it. Nevertheless, I am now in a position to offer some interesting particulars of its habits, which were obtained on my journey, and also to verify the important fact of the existence of a well-marked pouch in the female, on which point I could not at first be absolutely certain from the bad condition of the soft parts in the first specimen received. Unfortunately, an accidental circumstance together with certain political exigencies made it necessary that His Excellency's journey should be made with greater rapidity than could be wished from my point of view, and it thus became impossible for me to reach the exact locality where the specimens had been found; but I passed within fifty miles of the spot, and through country which is of a precisely similar character. Further, I had the advantage of meeting on our journey the man who himself captured the first specimen sent down, and by the kind consideration of the manager of the Idracowra Station, their book-keeper, Mr. J. F. Bishop, was instructed to wait for me at a stated locality through which our track must pass. To Mr. Bishop's zealous efforts I owe the whole of the last lot of specimens, as well as much valuable information concerning their habits and habitat. As may be imagined, it was with feelings of much satisfaction that, on reaching our camp one evening at the Horse-shoe Bend of the Finke River, I met Mr. Bishop with his welcome complement of specimens safe in his saddle-bags. From Mr. C. Benham also, who had previously been employed on the same run, and by whom the first specimen was forwarded to the Museum, I have also received much valuable information concerning the animal. Both Mr. Bishop and Mr. Benham have seen the animals alive, in a state of nature as well as in captivity, and the following notes comprise all the information that I could acquire from these two principal sources, as well as from some natives of the locality whom I questioned on the matter.

HABITS AND HABITAT.

It appears that the first specimen was captured by Mr. Wm. Coulthard, manager of the Frew River Station and other Northern runs belonging to the Willowie Pastoral Company. Attracted by some peculiar tracks, on reaching his camp one evening on the Finke River, while traversing the Idracowra Station with cattle, he followed them up and found the animal lying under a tussock of spinifex or porcupine grass *(Triodia irritans)*. Though he is an old bush hand, with all the watchful alertness and powers of observation usually acquired by those who live lives of difficulty and danger, this was the first and only specimen of the animal he ever saw. As previously stated, this found its way to the Museum through the agency of Messrs. Benham and

Molineux. The three subsequently received shortly afterwards, as well as the last lot recently secured by Mr. Bishop during our journey through the country, were also found on the Idracowra Station. This is a large cattle-run comprising several hundred square miles of country in the southern part of the Northern Territory of South Australia, which lies immediately to the West of the telegraph line between the Charlotte Waters and Alice Springs Stations. The great dry watercourse of the Finke River, which runs from N.W. to S.E., bounds the run for some eighty miles on the North and North East. Its distance from Adelaide is roughly speaking a thousand miles. Flats and sandhills of red sand, more or less well covered with spinifex and acacias, constitute a large portion of the country, and the rainfall is inconsiderable. Curiously enough, all the specimens hitherto received by me have been found within a circumscribed area, four miles from the Idracowra Head Station, which is situated on the Finke watercourse itself, and almost invariably amongst the sandhills. I have it, however, on very fair authority, that the animal has been seen on the Undoolya Station, which lies immediately South of the McDonnell Ranges, and that one also was found drowned after heavy rain at Tempe Downs, a station situated about 120 miles W.S.W. of Alice Springs. These points will sufficiently define its range, so far as is known at present. They do not appear to be very numerous. Very few of the white men in the district had ever seen it, even though constantly travelling, and not many of the natives whom I came across recognised the well-executed coloured drawing I carried with me. It must be remembered, however, that I did not pass through the exact spot which so far appears to be its focus of distribution. Nor did a very considerable reward, which I offered, cause any specimens to be forthcoming between the first lot received, over two years ago, and that recently secured during my transcontinental trip. With few exceptions the animals have been captured by the aboriginals, who, with their phenomenal powers of tracking, follow up their traces until they are caught. For this reason they can only be found with certainty after rain, which sets the surface of the sand and enables it to retain tracks that would immediately be obliterated when it is dry and loose. Nor are they found except during warm weather. So that the short period of semi-tropical summer rains appears to be the favourable period for their capture. For this suitable combination of wet and warmth, Mr. Bishop had to wait three months before he was able to get them, and in all cases they were found during the day time. Perpetual burrowing seems to be the characteristic feature of its life. Both Mr. Bishop and Mr. Benham, who have seen the animal in its native state, report that emerging from the sand it travels on the surface for a few feet, at a slowish pace, with a peculiar sinuous motion, the belly much flattened against the ground while it rests on the outsides of its fore-paws, which are thus doubled in under it. It leaves behind it a peculiar sinuous triple track, the outer impressions, more or less interrupted, being caused by the feet, and the central continuous line by the tail, which seems to be pressed down in the rear. Constantly on the look-out for its tracks, I was often deceived by those of numerous lizards, which are somewhat similar in these respects. It enters the sand obliquely and travels underground either for a few feet or for many yards, not apparently reaching a depth of more than two or three inches, for whilst underground its progress can often be detected by a slight cracking or moving of the surface over its position. In penetrating the soil free use, as a borer, is made of the conical snout with its horny protecting shield, and the powerful scoop-like fore-claws are also early brought into play. As it disappears from sight, the hind limbs, as well, are used to throw the sand backwards, which falls in again behind it as it goes, so that no permanent tunnel is left to mark its course. Again emerging, at some distance, it travels for a few feet upon the surface and then descends as before. I could hear nothing of its making, or occupying at any time, permanent burrows. Both my informants lay great stress on the phenomenal rapidity with which it can burrow, as observed both in a state of nature and in captivity. In some notes sent me by Mr. Benham the following statement appears :—"Almost any of the men here (Idracowra) can tell you how one got away from me in the loose sand. I brought it home alive, and began talking about how fast it could burrow, so Mr. Stokes wanted to see it. We took a spade and loosened the top soil near the house, and put it down ; I kept my hand close to it until it was nearly out of sight, and then started scratching after it, but it was too quick ; so I took a shovel and began to dig after it, but could not get him. One of the men then came with another shovel, and also a lubra (aboriginal female) who scratched, but the three of us failed to get him." Making all allowances for possible misdirected energies in this experiment, there is no doubt but that their burrowing powers are remarkable. Mr. Bishop, who knew of my approach, made great efforts to keep alive for me some of those he had captured, and placed them for safe keeping in buckets of sand, but in spite of all care and attention one only lived as long as four days. Night and day the sound of their ceaseless burrowing was to be heard. Acting on my advice, previously given, in consequence of an examination of the contents of the intestines of one of the earlier specimens, he supplied them with ants as food, but they ate none. They did, however, eat one "witchety," the native name of large white grubs, much relished by the blacks as an article of food, which are the larval forms of certain Longicorn beetles and Lepidoptera, and Mr. Benham informed me that one of his ate a piece of bread on one occasion, but it only lived a day. They thus appear to stand captivity extremely badly. On being handled they make no attempt to bite. No blackfellow that I questioned had ever seen the young, nor did they know anything whatever of any nests or breeding places used by them. Their native name is "oor-quámata," the terminal "*r*" of the first syllable being much rolled so as almost to convey the sound of an interpolated short "*i*" between the "*r*" and the "*q*"; the accentuated syllable is strongly marked, the vowels having the same value as in "quarrel." Mr. Benham stated that the natives have a superstitious dread of them, and applied to one the term "kudoicka," which they translate as "devil-devil"; but I could not get this confirmed by any of the blacks I saw. In fact the natives seem to know very little about them and could give me no information whatever as to what their food was or whether they got it under or above ground. With the material at my disposal I should be able definitely to settle this point, and indeed, in one of my first specimens, I did most certainly find the remains of ants and some other insect debris in what remained of the intestines; but as the Editor of these Transactions urgently calls for the completion of this paper, I am reluctantly obliged to postpone to a future issue the result of further investigation on this and other points.

GENERAL DESCRIPTION.*

(Pl. II., III., and IV.)

The fur, in the three specimens (all males) in which it was sufficiently well preserved for accurate description, may be described as being generally of a light fawn colour, long, soft and of a bright lustrous and silken appearance. In parts it deepens to a glistening golden hue, and in others it inclines more to a silvery aspect. In the last specimen received, which was in a much better state of preservation than any of its predecessors, the fur was considerably lighter than in the others, and the silvery tint more pronounced. The colours of all these have faded considerably

* It will be remembered that the following description is based upon an examination of the first four specimens received in 1888 and 1889. One only of these had been satisfactorily preserved in spirit; all the others were merely wrapped in rag saturated with kerosine and enclosed in small tin boxes. I have, however, incorporated some additional information, having reference to the pouch in the female.

since they have been kept in spirit, but plates II. and III. which were made soon after their receipt, give a fair idea of the original colour.* In two, the fawn changed to a darker and somewhat rusty tint round the root of the tail, both on the upper and under surface; but this was scarcely marked in the lighter coloured specimens. Two also showed a distinctly darker coloured patch on the back over the region of the pelvis.

The shoulder, being brought forwards close up to the skull, leaves no appearance externally of a neck, and the head together with the front portion of the trunk, gradually widening from the snout backwards to the shoulders, form a sort of blunt-ended cone, which is flattened somewhat on its under surface and directed downwards. This, with a curiously similar ventral flexion of the posterior part of the trunk and tail, gives the whole body a characteristically arched appearance, so that when placed on a flat surface the snout, hands, feet, and tail are almost in the same plane.

The dorsal surface of the nose is covered with a hard horny shield, marked by a transverse ridge which divides it into an upper (posterior) and a lower (anterior) segment. The front margin of this shield bounds the external nares and is prolonged downwards on on each side of these apertures; it forms also the anterior border of the septum narium which is continuous with a horny plate of a similar texture, though less hard and horny, corresponding to the upper lip. The fur extends right up to the margins of the whole of this horny area; but immediately adjacent to its sides, and especially margining the upper lip, it is shorter, coarser, stiffer and of a lighter colour, approximating to the character of whiskers. This has been a trifle exaggerated in pl. II., fig. 2, and insufficiently expressed in fig. 1.

The nostrils looking downwards and forwards are wider in the transverse than in the vertical direction, and are rendered very irregular in outline from the encroachment of two processes from the surrounding horny shield—one from the upper the other from the outer margin.

The mouth, ventral in position, has, when viewed from that aspect, a contour represented by two sides of a slightly obtuse-angled triangle. The extreme point of the chin is destitute of hair, but on its under surface and margining the under lip there are the same short stiff hairs as on the upper lip. The tongue, fleshy, broad at the base and tapering to a blunt point, is somewhat similar in shape to the human tongue, but relatively longer and narrower.

No eyes are visible externally, and the smallest opening

* Plate III. does this more accurately than Plate II., in which latter the colour is represented as too uniformly golden, as well as a shade too dark.

through the skin corresponding to their position cannot be detected. The ear-openings are distinct, two mm. in diameter, though almost completely concealed by the fur which grows right up to their margins. The aperture is surrounded by a ring-like fold of the integument, which very slightly raises its margin above the level of the surrounding skin, and in the interior of the meatus are thickly-set vibrissæ. Its position is 15 mm. behind and above the angle of the mouth, measured along a line which would continue the normal direction of the mouth-slit backwards.

The tail is peculiar. Hard, tough, leathery in texture and appearance for the greater part, it is marked with conspicuous annular ridges to the point. Thick at its insertion, it tapers to a blunt or even knob-like tip. On the dorsal surface, the soft fur of the body extends over it for about half its length, but the ventral and lateral surfaces are bare nearly to the anus. At about its middle there are two lateral projections or tuberosities, which give increased width to the tail in that position, causing it to be there even wider than at the point of its insertion. This is particularly marked in one specimen, but in all, indications of the same peculiarity exist. The vent is margined by a ring of very long, straight hairs.

The limbs (Pl. II., III., IV.) are short and strong, the fur extending down to the manus and pes respectively. The fore-limb terminates in a manus of most peculiar construction, the structure of which is so distorted that it can hardly be understood without previous reference to its osteology, and in the absence of this I fell into error as to the order of the digits in my first description. It is so folded, that when seen in the position assumed by the preserved specimen, the two large conspicuous claws of the third and fourth digits conceal all the other parts from view, except the blunt and broad horny nail of the fifth, which is seen projecting at the posterior part of the base of the fourth. On the inner side of these, and separated from them by a deep cleft, which opens inferiorly and posteriorly, is a tough, leathery and much wrinkled palm, from which emerge the slender claw-like nails of the pollex and second digit. Thus, owing to this folding of the hand, the digits may be described as consisting of two rows with a cleft between them; the outer comprising the third, fourth, and fifth, and the inner the first and second. The wrinkled and baggy palm, corresponding to the latter two, covers them on their outer surface as far as the roots of the claws; posteriorly it overlaps them, and extends upwards to the base of the short nail of the fifth digit. On the dorsal surface of the hand, which faces inwards, the outlines of the first and second digits are evident, and the fur, here thin and sparse, extends only to the metacarpal region. The claws of these two are long, slender, narrow and tapering, that of the first being the more so. The claws of the third and fourth are very large and strong, the former being 15 mm. x 4 mm., of uniform width and ending bluntly; the fourth, shorter but much wider at the base and triangular in shape, tapers rapidly to a point. The fifth is represented externally by a broad and stumpy nail.

The hind limbs (Pl. II., III., IV.) are also short and strong, and have the plantar surface of the pes turned almost directly outwards, so that its fifth digit lies in front. This surface is much wrinkled into several large baggy folds directed obliquely across the sole, and is covered with a leathery skin like that of the palm, which extends as far as the base of the nails, and even encroaches on their plantar surface. The claws of the hallux, second, third and fourth digit are concave on their plantar surface, and those of the third and fourth are curved both outwards and backwards. The fifth is represented by a strong and short stumpy nail, rather like that of the corresponding digit in the manus, and lies more towards the palmar surface than the others. The length of the fourth is six mm., and the others diminish in length towards the hallux. On the dorsal (inward) surface the course of the first four digits can be seen through the integument, and the skin covering them is free from hair as far upwards as the base of the metacarpals.

OSTEOLOGY.

THE SKULL.

(Pl. VI., fig. 1; Pl. VII., figs. 1 and 2.)

The outline of the skull, including the zygomata, is conical, with the occipital region expanded and well developed; anteriorly it tapers to the region of the exterior nares which are terminal, and, owing to the overhanging nasal bones, these orifices open downwards and forwards and have a quadrangular outline. The occipital plane is flat and almost vertical. Within the zygomatic arches the skull is constricted about the mid-region of the orbito-temporal fossæ, widening again considerably in the region of the juncture of the lachrymal and superior maxilla on each side. The vertex is smooth, without any median ridge and considerably flattened, and the bones throughout are exceedingly thin, papery and translucent.

The occipital foramen is almost circular, but slightly compressed laterally by the encroachment of the condyles. These also are compressed laterally and have their long axes running parallel and almost truly antero-posteriorly. From behind forwards (or from above downwards) their contour is almost semicircular, and their articular surfaces look backwards for their upper, and downwards for their lower half. A line drawn touching the most posterior parts of both condyles lies almost exactly in the occipital plane.

No indication of a separate interparietal exists, nor can the outline between the occipital and parietal bones be distinguished; but at the juncture of the occipital plane with the vertex, and defining the limits of the former area, a well-marked almost semicircular occipital ridge occurs, which disappears at the level of the posterior (or upper) margin of the occipital condyles. From the occipital tubercle a slight vertical ridge runs downwards almost meeting the occipital foramen. On the vertex of the skull, a ridge for muscular attachment runs forwards and outwards, and then downwards from the occipital tubercle, till it becomes continuous with the upper edge of the zygoma. Close behind, and parallel to this ridge, are two smaller ridges which become merged into that just described at a point before it reaches the zygoma. (Pl. VI. and VII., fig. 1.) As between the occipital and parietal bones, no delimitation between the parietals and squamosals, or between the parietals and frontal, can be distinguished.

In front of the skull, the sutures can be distinguished, and the shape and extent of the nasals, superior maxillæ, premaxillæ and part of the lachrymals are as shown in fig. 1, Pl. VI. and VII. In the position of the opening of the lachrymal canal is a well marked circular depression, due to thinning of the bone; but I am unable to detect any patent orifice. The infraorbital foramen is large and transmits a very large nerve. The malar cannot be made out as a separate bone, but, springing from the malar region, opposite the penultimate molar tooth, proceeds a well marked zygomatic arch, so much compressed laterally throughout that it forms a thin vertical lamina, very narrow in front, but gradually widening as it proceeds backwards, until, in its posterior half, it becomes relatively very wide; a portion of its hinder end enters into the formation of the articular surface for the lower jaw, and forms a marked preglenoid prominence. The junction of the arch with the squamosal is close to the cranial part of the latter, so that very little of the arch itself is formed by the latter bone. The length of the arch is to that of the whole skull almost exactly as 1 to 3.

Behind, the glenoid surface is formed chiefly by the squamosal, which projects externally in the form of a reversely placed C-shaped ridge, the lower limb of the ridge running forwards and downwards and bounding the upper and front part of the auditory meatus, then, losing itself in the tympanic part of the auditory bulla, which latter projects forward under the glenoid cavity.

The auditory bulla (Pl. VI., fig. 1; and Pl. VII., fig. 2) is large and conspicuous, but has throughout exceedingly thin and fragile walls. It extends so far backwards that it abuts against the anterior half of the occipital condyles, and reaches forwards to a point corresponding to about the middle of the zygomatic arch. Its anterior third is formed by the alisphenoid, the middle third by the tympanic, and, into the formation of the remainder, both the mastoid portion of the periotic and of the exoccipital appear to enter, but the latter cannot be, with certainty, defined from the other elements of the occipital bone.

In the anterior part of the orbito-temporal fossa, the lateral parts of the frontal and the lachrymal project outwards and somewhat backwards, forming a prominence, instead of a hollow, in the orbital region, which has exceedingly thin walls. Behind this prominence, and corresponding to about the junction of the anterior and middle third of the orbito-temporal fossa, the skull is constricted by a shallow groove passing downwards and backwards, corresponding to that which usually marks out the division between the orbital and temporal parts of the fossa. Behind this groove the cranium bulges a little, and is then again constricted by a similar groove, which runs downwards and a little forwards, nearly meeting the other above the sphenoidal fissure. (Pl. VI., and VII., fig. 1.) Behind this again, the skull broadens very rapidly towards the posterior root of the zygoma, at which point it is widest. Posteriorly the contours converge till they meet the lateral edge of the occipital plane. Sutures between the bones on the side of the skull, other than those mentioned, cannot with certainty be distinguished.

In a view of the inferior surface of the skull, almost the whole extent of the foramen magnum is seen, which thus faces very much downwards. Anteriorly, the basioccipital is completely ankylosed with the basisphenoid, though the junction is well defined by a transverse ridge. There are no paroccipital processes, and the exoccipitals have been described as forming part of the auditory bullæ.

Besides the basisphenoid, parts of the presphenoid, pterygoids and palate bones enter into the formation of the roof of the mesopterygoid fossa, which is wide anteriorly, but much narrowed behind. Its lateral walls are thin and lamelliform, curving inwards at their inferior edges, and the pterygoids end in well-marked, slender and backwardly-projecting hamular processes.

The contour line of the hard palate, including the alveolar borders, gives a markedly pyriform outline, being very wide opposite the middle of the molar series of teeth and tapering anteriorly. The bony palate has a straight posterior border, and its surface is arched transversely; at its junction with the lateral surfaces of the face a sharp edge-like alveolar border is formed, which abuts on the outer borders of the teeth. The junction between the palatal and maxillary elements cannot be distinguished, and that between the maxilla and the premaxilla only indistinctly so. Two small and slit-like posterior palatine foramina can be made out in the wet skull (spirit) which transmit small nerves, but they are not distinguishable in the dry. The anterior palatine foramina are large and elongated. Besides these there are, in the hard palate, other smaller foramina irregularly placed, as well as several small circular or oval areas where the bone is much thinned. The posterior nares are compressed in a vertical direction.

With regard to the foramina of the base of the skull, the small size of the parts and the impossibility of distinguishing the sutures make it a little difficult to be sure of their position. The condylar and posterior lacerated foramina can, however, be distinguished in the usual situation, and the large canal for the carotid artery pierces the basiphenoid and passes almost directly upwards. The foramen ovale, foramen rotundum and sphenoidal fissure are all distinct, the latter two being approximately of the same size and both larger than the first. I could detect no separate aperture corresponding to the optic foramen.

A view of the inside of the cranium, through the foramen magnum, shows a relatively large and smooth-walled cavity, of a shape conformable to the external contour of the skull—the bones of the vault being so thin that, with the aid of a hand lens, small type can be distinctly read through them. The floor of the cranial cavity, more or less flat, though rough at its hinder part, rises in front of the basisphenoid region into a well-marked eminence, which slopes away on either side. Anterior to this again, the floor is flat. The auditory bulla seems to project internally, and shows itself as a thin-walled hollow eminence lying in front of what appears to be the petrous element of the periotic, but as I have wished to preserve the specimens intact, I cannot be certain of its exact relations, or of other details of the skull which are not accessible to examination without sections.

In the mandible the rami are relatively wide, and widest in the molar region, narrowing somewhat in front and behind. The front part of the inferior border slopes gradually upwards towards the symphysis, at which the two halves are firmly ankylosed. At about the width of a molar tooth behind the last of the series, the upper border of the jaw rises almost vertically into a strong triangular coronoid process, which has an anterior surface in the form of a laterally compressed isosceles triangle, having for its base the width of the rather wide alveolar border. This surface is vertically grooved, and posteriorly to it, the process is suddenly narrowed to a flat plate. The condyloid process, long and sloping very much backward, barely rises to the level of the coronoid, and its articular facet, slightly compressed antero-posteriorly, stands very little above the level of the teeth. The posterior border, in its lower half, becomes expanded, and curls forward so as to form a well-marked masseteric fossa. The angle is continued into a conspicuous, considerably incurved angular process, wide and strong at its origin, but rapidly tapering to a styliform extremity. There is a large inferior dental foramen at the point of intersection of the long axes of the coronoid and angular processes, also a wide and very shallow mylo-hyoid groove. The dental foramen corresponds to the space between the last premolar and first molar.

DENTITION.

(Pl. VI. and fig. 2, Pl. VII.)

Some variation seems to exist in the number of the teeth, more particularly in the premolar region of the lower jaw. The following description is that of a specimen in which they appeared most complete, but it is not the same as that figured in the plate, where one tooth, described in the text, is absent from the lower jaw, as will be pointed out in the proper place, but, in all other essential particulars, the description will apply to any of the specimens.

Maxilla.—Within the premaxillary boundary there are three simple conical or peg-like teeth, the anterior being the largest in all measurements, and having its axis inclined inwards towards its fellow of the opposite side, while the hinder two are nearly vertical. In one dry skull, evidently that of an old specimen, there is a distinct "mark" in all three; in another and younger skull the cutting surface of the most anterior is marked by a groove. Between these incisors there is an interval nearly equal to the width of a tooth of the series.

Just behind the premaxillary suture there is a small tooth similar to, but rather smaller than, the hindermost incisor, the apex of which is inclined a little forward. This, from its position, must be a canine; its apex, also, shows a mark in the old skull. Behind this are two teeth differing considerably in size, but of a similar type, which is quite different from those that succeed them. These two, I take to be the premolars. The anterior and smaller, with its characteristics less well shown, has the anterior part of its crown elevated into a small but distinct cusp, from which the contour of the crown slopes upwards and backwards to its posterior border, where there is a very slight indication of a posterior cusp; the surface of the crown between the cusps is slightly concave. The succeeding tooth is about twice the length and breadth of that just described. It is compressed laterally*, and has very distinct anterior and posterior cusps, the former being much the more prominent. There is an almost semicircular valley between the two, from which a wearing surface slopes upwards on the inner and hinder face. In the closed jaw this comes in contact with the outer surface of the first molar of the mandibular set.

Four molars follow, and one description will suffice for the three anterior, which resemble one another almost exactly in size and shape; the hindermost is smaller and less complex.

Taking the first member of the series, which is that shown in Pl. VI., figs. 3—6, it is compressed antero-posteriorly and mostly so in its mid region, so that the length of the long axis of the crown, which is about twice that of the greatest width, lies exactly athwart the alveolar border. As seen externally (fig. 4), the prominent feature is a pointed, inverted triangular cusp *(a)*, of which the apex corresponds to the centre of the crown when viewed in plan. From the apex of this cusp a concavo-convex surface, showing signs of wear, trends upwards and outwards to the angles at the base, where there are two small but distinct anterior and posterior external cusps *(b* and *c)*. Between these cusps is a groove, which extends vertically to the alveolar edge. The internal face of this prominent apical cusp passes vertically upwards as a smooth rounded border to nearly the level of the palate, then spreads out internally into a concave, subtriangular, overhanging surface also showing signs of wear (figs. 5 and 6, *d)*. The concavity of this overhanging surface being due to the fact that it is bordered by a well-marked rim, which descends internally into an internal cusp *(e)*; from the apex of this, the internal contour passes upwards to the level of the palate (fig. 5, *p)* as a smooth border rounded from below upwards, and still more sharply so, from before backwards. The whole of this part of the tooth has somewhat the shape of the upper bill of a parrot, if it were much blunted and made to have a rounded end instead of a sharp point, or a better simile, perhaps, would be the peak of a military helmet. The horizontal level of this beak-shaped internal cusp is about that of the edge of the alveolar border, though, from the transversely archlike trending of the palate away from this border it stands as much below this surface as it is above the median pointed cusp.

---

* From the fact that this tooth is placed just where the narrow part of the pyriform area, marked out by the alveolar border, suddenly broadens into the wider end, the outer face of this tooth looks forward as well as outwards. Instead, therefore, of speaking of it as laterally compressed, it would be more correct to say that the axis of compression runs from a point outside and in front to within and behind; or, in other words, the long axis of the crown if continued forwards would strike the canine of the opposite side. *(Vide* Pl. VII., fig. 2.)

Between the molars, the interval is about that of the antero-posterior width of a member of the series, and is about the same as exists between the front molar and last premolar. The hindermost molar, smaller and simpler than the others, is also compressed antero-posteriorly; still, it shows rudiments of the details just described, the suppression of parts being most marked in the beak-shaped internal cusp, which is here only feebly represented by a ridge with a narrow worn surface.

Mandible.—There are two peg-like incisors of nearly equal size sloping forwards and showing a "mark." The apex of the next tooth, when the jaws are closed, passes just in front of the upper canine, and belongs presumably, therefore, to the same category (fig. 11, *c*). Behind this come three teeth, which I take to be premolars. (Pl. VI., figs. 1 and 11). The most anterior, which is not shown in the figures being absent in the specimen from which they were drawn, is about the size of the canine, but has its front border elevated into a rudimentary cusp, and a wearing surface sloping inwards. Then follows a minute styliform tooth, scarcely as thick as the shaft of an ordinary sewing needle, and about half the length of that just described. This is represented in fig. 11 immediately succeeding the canine (*c*). The hindermost premolar is a more developed type of the first, and much larger. Its anterior border is raised into a pointed cusp, from which a wearing surface slopes backwards and inwards, and bears it at its hinder extremity a small posterior cusp. A small wearing surface, also, shows on the outer face of the tooth.

The four true molars which follow resemble one another, but diminish in size from before backwards; a horizontal section is approximately triangular, with the base inwards (figs. 7—10). The external border, corresponding to the apex, rises into a sharp pyramidal cusp (*a*), and so also do the borders corresponding to the angles at the base (*b*, *c*), only they are less elevated and more rounded. Between these three cusps is a concave worn surface. An interval equal to half the width of a tooth of the series separates the teeth of this order; but from the obliquity with which the teeth are set in the alveoli these spaces are not seen when the jaw is viewed at right angles to its long axis, the outer and hinder border of one tooth overlapping the space intervening between this and the one behind.

The hindermost tooth of all is the fourth maxillary molar, the external cusp of the last mandibular molar passing between the fourth and the third of the maxillary series, the penultimate mandibular molar between the third and second, and so on The external cusps of the lower molars play up and down in the intervals between the large pointed cusps of the upper series, and the concave triangular surface between the three cusps of the lower molars can be brought to play upon the under concave surface of the beak-shaped internal cusp of the upper molars, the whole thus representing a very complicated cutting and grinding apparatus. In front of the molars the arch of the mandibular teeth lies within that of the maxillary.

According to the above description, then, the dental formula is

$$i\,\tfrac{3}{2}\quad c\,\tfrac{1}{1}\quad p\,\tfrac{2}{3}\quad m\,\tfrac{4}{4}=\tfrac{10}{10},$$

but as there are certain variations in the skulls at my disposal, and in ignorance of the succession of the teeth, it is possible that this formula may require some modification.

THE HYOID BONE.

(Pl. VII., figs. 3 and 4.)

In one specimen this bone is represented by two flattened rod-like thyrohyals, osseous for the greater part, but cartilaginous at their laryngeal extremities. In front they touch in the middle line, but are not ankylosed. They are joined by a flat, semicircular and cartilaginous basihyal. In another specimen, in which the thyroid had become largely calcified, the thyrohyals were stouter and shorter in front; these were completely ankylosed, and joined by a semicircular basihyal, as in the other case.

THE VERTEBRAL COLUMN.

Atlas (Pl. VII., fig. 5, *a*) free; neural canal almost circular; transverse and spinous processes rudimentary. The articular surfaces for the occipital condyles, concave in the dorso-ventral axis, encroach somewhat on the ventral arch, which is furnished with a semilunar facet for the odontoid process of the axis. The posterior arch bears on its hinder surface a small facet for a corresponding surface on the fused spinous processes of the five ankylosed vertebræ which follow. The rudimentary transverse process carries on its posterior surface a triangular facet for a corresponding surface of the axis.

The five succeeding vertebræ are completely ankylosed, the only indication of the component vertebræ being the intervertebral foramina for the spinal nerves, of which there are four. (Pl. VII., figs. 5 and 6 *c*.) The fused bodies form a bony mass, generally much compressed dorso-ventrally, but having its lateral borders carried considerably downwards and backwards so as to convert the under surface of the mass into a wide shallow groove; in the anterior part of this groove there is a slight median ridge. The neural arches are also ankylosed, but their fused laminæ form laterally compressed plates, pointing forwards, which are much shorter in an antero-posterior direction than the fused bodies. So also are the spinous processes completely fused into a single tuberculated prominence, which carries on its anterior surface a facet for the above-mentioned facet on the posterior arch of the atlas. The anterior border of the fused bodies is prolonged into a well-marked triangular, dorso-ventrally compressed odontoid process, of which nearly the whole of the inferior surface is marked with an articulating surface for the atlas. This anterior border carries, also, relatively large triangular or pyriform articular facets for the atlas, which extend nearly up to the base of the odontoid process.

The transverse processes of the ankylosed vertebræ are represented by a minute but distinct conical projection (omitted in fig. 5), which corresponds, in position, with the fifth and sixth, or fourth, fifth and sixth vertebræ, but it apparently contains, also, the fused representatives of all five. From this, a slender bony bar passes to a point about the middle of the lateral edge of the fused bodies, thus forming a sort of vertebrarterial canal. Posteriorly the fused mass presents a broad shallow U-shaped articular surface, which, in its central part, articulates with the body of the next vertebra, and by the lateral parts with the first rib.

The seventh vertebra (Pl. VII., figs. 5, 6 and 8) has a dorso-ventrally compressed body, which articulates with the bodies of the vertebræ in front and behind. Its neural arch is slender and ring-like, without any spinous process. The transverse process is well marked, and bears anterior articulating surfaces on the dorsal surface of its root, which face upwards. The posterior zygapophyses have their articular surfaces looking downwards.

In the eighth vertebra (Pl. VII., figs. 6 and 8) the body is similarly compressed dorso-ventrally. The spinous process is very long, and both it and the laminæ of the neural arch slope much backwards, so that a wide gap is left between this and the neural arch of the preceding vertebra, which inclines forwards. The transverse process, not so prominent as in the seventh vertebra, carries at its root an anterior articular surface which looks upwards. On its under surface, looking forwards and a little outwards, and extending inwards, so as to be continuous with the posterior articular surface of the body, is a surface for articulation with the first rib. Posterior zygapophyses, rudimentary, with their articular surfaces lying almost entirely on the internal surfaces of the root of the laminæ and, from the obliquity of these, facing much downwards as well as inwards. At the posterior part of the lateral border of the body, and continuous with its posterior articular surface, is a facet which, with a corresponding facet on the body of the next vertebra, constitutes the articulation for the head of the second rib.

Reckoning the vertebra, just described, as the first of the thoracic series, fourteen follow which bear ribs; these bear a general resemblance to the eighth, with the following modifications.

There is a gradual diminution in length of the spinous processes, and those of the tenth to the thirteenth are the most backwardly inclined; up to this latter point they are slender and rod-like, or rather bayonet-shaped, but at about the fifteenth they begin to be compressed laterally, as well as to become shorter, wider and more vertical. The spinous process of the last thoracic is nearly as wide as high.

Their transverse processes are of uniform length till the eighteenth is reached, then they become progressively shorter, till at the twenty-second, the process is represented only by a ridge. That of the eighteenth is the last, to which a rib is fairly articulated, though in the case of the rib-bearing vertebræ which follow, there are ligamentous bands which attach the neck of the rib to the transverse process. Two contiguous vertebræ provide the articular surface for the heads of all the ribs, except the first, which has a more extensive articulation that will be particularly described, and the last two or three. Each vertebra supplies an equal area in the case of the second and third rib, but, in passing backwards, the articulating surface gradually trespasses more and more on the hindermost of the two contiguous vertebræ till, in the last two or three, it is furnished by the body of a single bone.

In the twenty-first or penultimate thoracic vertebra, the posterior zygapophysis becomes more distinctly marked, and the posterior articular surface is on it, rather than on the inside of the laminæ, as in the case of the vertebræ preceding, from the eighth to the twentieth. This surface is also more markedly convex instead of nearly flat, and looks downwards and outwards, instead of nearly directly inwards; the pair fit into two very concave depressions on the anterior zygapophyses of the last thoracic, which almost meet in the middle line. A similar description applies to the last of the thoracic series.

Metapophyses are distinct on the penultimate thoracic, and become still more marked on the last. Insignificant rudiments of paired hypopophyses, also, appear on the posterior part of the body of the last one of the series.

Four lumbar vertebræ follow (Pl. VII., fig. 9) having the general type of the last thoracic. Transverse processes, small on the first, become larger in the remainder; in the last two they are long, point forward, and have their extremities somewhat hooked ventrally. They spring from the junction of the neural arch with the bodies. The metapophyses, which made their appearance in the hindermost thoracic, become here increasingly developed in serial line. The second lumbar carries a pair of ridge-like hypopophyses, but these are quite rudimentary on the vertebræ both in front and behind; and are not distinguishable on the fourth.

Reckoning as sacral vertebræ all that are ankylosed, these are six in number. The fusion is complete, but the number of the constituent vertebræ is revealed by transverse ridges on their ventral surface at the junctions of the bodies, as also by the foramina of exit of the spinal nerves.

The sacrum.—Pl. IX., figs 1—4. The conspicuous feature of the sacrum is an enormous development and fusion of the metapophyses of the constituent vertebræ, which, thus expanded and fused, form a roof, which overhangs the pelvis (figs. 1, 2 and 4 *mm).* This is widest anteriorly, where also it can be seen to be serially continuous with the metapophyses of the lumbar vertebræ; it then narrows slightly, and posteriorly, it widens into two diverging processes (fig. 2). With the under surfaces of the anterior and posterior extremities of this overhanging metapophysial roof are fused the ilia and ischia respectively.

The spinous processes (fig. 2 *s*) are also ankylosed, forming, in front, a keel-like ridge, but behind, the superior edge of this ridge expands laterally into a wide lamina, which, extending outwards, meets, or nearly meets, the fused metapophyses and thus forms either a completely closed canal, or, in the parts where the two elements have not completely met, a deep groove. Into this canal or groove, as the case may be, open large foramina for the posterior divisions of the spinal nerves. The transverse process of the first of the sacral vertebræ is like that of the last lumbar, but stouter and points rather more downwards. The remainder of these elements are fused into an arched lamina (fig. 1 *tr)* which is ankylosed with the ilium in front and the ischium behind. This lamina is perforated by large foramina for the inferior divisions of the spinal nerves.

The first sacral vertebra bears anterior zygapophyses with concave facets for articulation with the posterior zygapophyses of the last lumbar, and similarly, there are small zygapophysial processes with facets for the first of the caudal series (fig. 3 *pz.*).

The Tail.—The caudal vertebræ are twelve in number, the tenth and eleventh being nothing more than rounded nodules, and the last a plano-convex plate (Pl. V., figs. 1 and 2).

The bodies, of the first four or five, are rather elongated; the spinous process broad and distinct on the first two or three, subsequently diminishes in size to the fifth or sixth of the series, where it disappears as a distinct median process, and is afterwards represented by a minute tubercle on each side of the mid-line.

The transverse processes are flat and rather broad in the first two, then narrow, but become longer in the next two. So far, they project horizontally, but the transverse process of the fifth points considerably downwards, and has its extremity tuberculated and hooked downwards and inwards, so that it almost meets the chevron bones. The same general features prevail in the sixth, and, in the subsequent caudal vertebræ, where the process exists, it becomes gradually shorter, and terminates in a rough tuberous knob.

There are hypopophyses fused with the bodies of the second and third caudal vertebræ; and, abutting on the junction between the third and fourth is a distinct and separate chevron bone, which is perforated by a canal. These exist at each subsequent vertebral junction, being very largely developed about the middle of the caudal series, and their largely expanded ventral surfaces are rough from the presence of grooves and ridges running in the direction of the long axis of the body. The chevron bones exist quite to the end of the tail, but, corresponding to the last three or four inter-vertebral spaces, they are little more than rounded nodules.

THE RIBS.

Pl. V., figs. 1 and 2. Pl. VII., figs. 5, 6, and 8.

There are fifteen ribs, of which seven are articulated to the sternum.

The first is a remarkable bone. (Pl. VII., figs. 5, 6 and 8). Very short and strong, it forms a powerful buttress for the sternum; it is very irregular in shape, being in general terms expanded at each extremity and constricted in the middle, the constriction being due to a deep notch on the anterior border; or, the rib might be described as being very abruptly bent on itself in such a way that the sternal end points both forwards and inwards. Its large, expanded and irregularly trihedral head is directly articulated with the posterior surface of the laterally-expanded and ventrally-projecting mass of the fused cervical group, which, at this point, represents the sixth. It is also articulated with the transverse process of the eighth, of which the articulating surface encroaches slightly on the body. There is also ligamentous connection with the body and transverse process of the seventh vertebra, the rib thus being very firmly fixed to a wide extent of attachment. The sternal extremity, bent forwards and inwards, as above mentioned, is flattened and very wide, and joins the lateral edge of the presternum, along its whole length, to its junction with the first segment of the mesosternum. (Pl. VII., figs. 5 and 6.) Sometimes there is complete ankylosis at this articulation, the position of the junction being shown by a bony ridge, and in one specimen, complete ankylosis has taken place on one side only.

The fourteen ribs which follow are all slender and rod-like. Besides the first, the sternal attachment of which has been described, six other ribs join the sternum by means of sternal ribs, which meet the points of junction of the segments of the mesosternum, the union of the second rib being at the meeting of the first and second segment, and so on.

The costal cartilage of each succeeding rib, does not directly meet the sternum, but joins that of its predecessor.

The sternal ribs, in the case of the fourth, fifth, sixth and seventh, are not completely ossified in their outer segments; thus, there intervenes between the end of the vertebral rib and the ossified part of the sternal rib adjacent to the sternum, an intermediate cartilaginous segment. (Pl. VII., fig. 5 *xxxx)*. These cartilaginous parts of the sternal ribs are not, however, completely segmented off from the inner ossified parts; the failure in ossification is gradual, and the ossification, complete in the sternal extremity, becomes less and less complete in the outer segment, till eventually cartilage only stands in place of bone. The junction between the cartilaginous segment of the sternal rib and the vertebral rib is quite abrupt.

The heads of the ribs, other than that of the first, are articulated with the bodies of the vertebræ, as mentioned in the description of the spinal column; thus the head of the second rib abuts on the bodies of the eighth and ninth vertebræ, and so on. Following the first, the part in the other ribs corresponding to the tubercle is attached to the transverse processes by ligamentous union, which is close and intricate as far as the eleventh; in the remainder, the union is less close, as the transverse processes gradually diminish in prominence. As already described, the transverse process of the eighth vertebra is distinctly facetted for part of the articulation of the head of the first rib; that of the ninth is only imperfectly so, but beyond this no definite facets are evident, but merely roughened surfaces for the ligaments.

THE STERNUM.

(Pl. VII., figs. 5, 6, 7 and 8).

The sternum consists of a presternum, a mesosternum of six segments, and a ziphisternum. The presternum is remarkable on account of its strong and prominent keel, which projects downwards and forwards to an extent which is greater than its length in a fore and aft direction (fig. 6 *f)*. The lateral wings, which are slightly concave on each side of the keel, articulate (or ankylose) with the first rib, as described under that head, the posterior end of the junction coming right up to, or even encroaching upon the concave articular facet on its hinder face for the first segment of the mesosternum. The inner, or superior, surface of the presternum is smooth and concave from side to side; behind, it rises in the mid-line into a small eminence, which supplies most of the before-mentioned facet for the mesosternum, the remainder being furnished by the root of the keel.

The six mesosternal segments (fig. 6 *i*) are compressed from side to side, and slightly expanded at each end, where they articulate with one another.

The first two are of equal length, and each is nearly as long as the presternum, but the four segments which succeed are only about half as long as these. The sternal ribs abut on the junctions of the mesosternal segments, that of the second meeting the points of contact of the first and second. In the case of the second, third and fourth the abutment is directly at the side of the mesosternal junction ; while in the case of the fifth, sixth and seventh the ends of the sternal ribs lie ventral to the mesosternum, and almost meet one another in this position.

The ziphisternum (fig. 7) is a slender bony rod nearly as long as the first segment of the mesosternum, having for its terminal portion a flat cartilaginous expansion.

THE SHOULDER GIRDLE.

(Pl. VIII., figs. 1, 1a, 1b and 3b).

The scapula is narrow for its inferior, or, in its natural position in the animal for its anterior, two-thirds, but wide superiorly (or posteriorly), owing to the rapid divergence of the glenoid and coracoid borders at their posterior ends. The suprascapular border is thus of considerable extent, and the angles at its junction with the glenoid and coracoid borders, respectively, form prominent hook-like process which turn forwards and inwards (fig. 1).

The mesoscapular spine is well developed (fig. 1 *s*). Rising from almost the whole length of the bone, it is carried forward to form a long acromial process, leaving a deep notch between this and the scapular neck ; it is besides much inflected, so as to overhang the postscapular fossa.

The postscapular fossa, much wider than the prescapular, gives origin to a well-developed second spine which lies nearer to the glenoid border than to the mesoscapular spine. Near the glenoid cavity it runs almost flush with the glenoid border—indeed, at that part one might describe the glenoid border itself as being turned up to form the second spine. (fig. 1 *gb. ss).* The free edge of this second spine in parts so nearly approaches the edge of the overhanging mesoscapular spine as almost to convert the groove between them into a tube ; as it is, it is an exceedingly deep canal (figs. 1., 1a., 1b.) Approaching the scapular neck, this second spine still further rises into a marked flat process, (fig. 1 *p*) which gives attachment to a ligament passing to the hinder border of the acromion. Between this process *(p)* and the glenoid cavity is the neck.

The coracoid border terminates in a very small coracoid process (fig. 3b *c*) which blends with the margin of the glenoid fossa, and in fact may be said to share in the formation of the articular surface. It gives attachment to a coraco-acromial ligament. The subscapular fossa is slightly concave from the glenoid to the coracoid border.

The glenoid surface is subtriangular in shape, and concave.

A considerably elongated mesoscapular segment is connected with the acromial process, and continues this forwards and inwards (figs. 1, 3b *m.s.s.*). To its bevelled end is attached the clavicle.

The clavicle (figs. 1, 3b *cl.*) is a very slender, curved, styliform bone, which ends in an enlarged sternal extremity. This, however, does not reach the sternum, but it is continued onwards as a ligament about half a centimetre in length, which is attached to the anterior border of the keel of the manubrium sterni.

THE ARM AND FOREARM.

(Pl. VIII.. figs. 2—5a).

The humerus (figs. 2—3b) is a stout, strong bone, with its inferior extremity very much widened from the great extension inwards of the internal epicondyle. The head is rounded, and there are well-marked external and internal tuberosities. The ectocondylar and deltoid ridges are well-marked, and the musculospiral groove wide and deep. No supratrochlear or supracondylar foramen. The trochlear surface is almost completely divided by a deep notch into two portions, of which that for the radius is the larger. The internal epicondyle terminates in a hook-like process.

The ulna (figs. 4, 5) is remarkable for its long and much incurved olecranon process, the length of the process being nearly as great as that of the shaft. The shaft, wide above, from before backwards, and grooved on its hinder surface, tapers to a slender rod below, which curves a little outwards and backwards, and has a small blunt styloid process. In the natural position, the ulna lies behind the radius for its whole length. The surface of articulation for the humerus is deeply concave from above downwards, and its inferior lip constitutes a coronoid process. The superior lip is also prominent. Externally is a concave surface, for the head of the radius, which is bounded superiorly by a prominent lip.

The radius is about half the length of the ulna, including the olecranon. Its head is considerably expanded, and so, also, is its inferior extremity, from which proceeds a styloid process. Its articulation with the ulna and with the humerus has been sufficiently described. Below, the radius and ulna together articulate with the lunar, cuneiform, and a large bone which will be described as the scapho-carpal, the radius taking the greatest share in the formation of the joint.

THE MANUS.

The manus (Pl. VIII., figs. 5 and 5a) is so distorted, and presents so many departures from the typical structure, that I cannot, with my limited experience in comparative osteology, be quite certain of the homologies of the different parts. Its features are best seen from the palmar surface. Figure 5 represents that of the left side enlarged to two and a half times, and, in order that the details of the structure may be better shown, a large palmar sesamoid bone (fig. 5a) has been removed; the relations of this will be better understood when the other parts have been described. The central figure and most conspicuous feature of the hand is a large irregular bone which extends almost completely across the carpus, and which has its palmar surface raised somewhat above the level of the remaining bones. It is indicated in fig. 5 by *sc*, as well as by the two crosses nearest the radial side; a foramen pierces it from above downwards, the position of which is indicated by the curved arrow. Articulating with the radius on its extreme radial side, it occupies the place of the scaphoid, but from its relation to the digits, with all of which it articulates, it seems to represent also the carpalia (I—V), and I will therefore, for the sake of convenience in description, term it provisionally the scapho-carpal. Lying between it and the radius, and visible only from the dorsal side, is a small bone, not shown in the figure, about the size of a pin's head, which I take to be a diminutive lunar; succeeding this on the ulnar side, and articulating with the ulna, is a semilunar-shaped bone, which is doubtless the cuneiform *(cu)*. The scapho-carpal has on its inferior aspect, and towards the palmar surface, a small concave facet, which carries a metacarpal-like bone (fig. 5 *r)*. This supports two phalanges of the second digit, the more distal terminating in a long narrow claw. To the same metacarpal, as well as to the base of the proximal of its two phalanges, is attached, by ligamentous connection, the slender representative of the pollex, which also is composed of two segments, the terminal one ending in a claw. These are the two digits which are, as has been described, folded over towards the palmar surface of the manus, and form the inner of the two rows which bound the palmar cleft. Immediately to to the dorsal side of the facet for the bone described above as the metacarpal *(r)* common to the second digit and pollex is another for, what appears obviously, the metacarpal of the third digit *(s* and *s)*;

this is articulated to, and carries, a single phalanx, which is fused with the long claw *(c)*. Still more to the ulnar side of the scapho-carpal, articulating with it and projecting beyond it towards the ulnar side, is a bone *(t)* very wide in a radio-ulnar direction, which seems a greatly widened metacarpal, for it is articulated to, and carries, the large triangular claw of the fourth digit *(d)*.

If, therefore, I am correct in these homologies, each of the third and fourth digits possess one phalanx only, with which is firmly fused the corresponding great claw.

Articulating with that described as the cuneiform is an elongated bone, pointing superiorly, which appears to be an elongated pisiform (fig. 5 *p*). Parallel to this, and lying so much to its dorsal side that it is partially concealed by the pisiform in the palmar view represented in the figure, is an elongated metacarpal-like bone (fig. 5 *u*), which, by its proximal extremity, articulates with the scapho-carpal. This I take to be the metacarpal of the fifth digit, and it together with the pisiform support at their distal extremities a broad stumpy nail (*e*).

Lying on the palmar surface of the manus is a considerable bone before alluded to, which appears to be a palmar sesamoid. As has been stated, it is not shown in position, for it would have obscured other parts, but it is represented separately, with its palmar aspect turned towards the observer (fig. 5a). By its forked distal extremity it articulates with two facets on the large claw-bearing phalanges representing the third and fourth digits. These are marked *y.y* in fig. 5, and if, in the sketch, they appear too wide apart to correspond with the forks of the sesamoid bone, it is because the two digits have been somewhat separated to allow of better representation. By the proximal extremity this sesamoid articulates with a surface having three facets *(x.x.x)*, two of which are furnished by the scapho-carpal, and one by the pisiform. From its position it forms a sort of buttress or prop for the third and fourth digits, and in the same way the pisiform forms a support for the fifth.

THE PELVIC GIRDLE.

(Pl. IX., figs. 1, 2, 3 and 4.)

The pelvis lies very obliquely, nearly approximating to the horizontal. There is no indication of separation between its constituent bones.

The ilium is rod-like and trihedral in its middle part, with its faces looking downwards and outwards, downwards and inwards, and nearly directly upwards respectively. Anteriorly these surfaces gradually widen, and eventually the bone fuses with the body, metapophysial and transverse processes of the first, with the body and transverse process of the second, and with the transverse process, only, of the third sacral vertebra. Posteriorly, the narrow rod-like portion of the ilium widens towards the acetabulum. The pubic elements come together at a wide symphysis, and are completely ankylosed. The posterior edge of the pubic and the ischial portion of the pelvis diverge as they ascend, and the latter fuses with the metapophyses and transverse processes of the two last sacral vertebræ. The posterior outlet of the pelvis has a markedly triangular outline (fig. 4). The acetabulum is circular and deep, and has a wide cotyloid notch posteriorly; it is imperforate, but its internal wall is very thin. A round ligament exists.

The obturator foramen, nearly circular, is situated below and behind the acetabulum, and is about one-third of its diameter.

MARSUPIAL BONES.

These are two very small osseous nodules, slightly divergent anteriorly, which lie in the tendon of the external oblique muscles of the abdomen, close to their attachment to the anterior border of the pubic symphysis. They are scarcely visible without a lens, and are consequently liable to over-looked.

THE THIGH AND LEG.

(Pl. VIII., figs. 6 and 7.)

In the femur (fig. 6), the head is approximately spherical, but tapers somewhat to a blunt conical point; it is marked by a small depression for the round ligament. The neck is short and constricted, standing out almost at right angles to the shaft, and there is a small but conspicuous tubercle at the junction of the front border of the neck with the shaft.

The great trochanter is much compressed antero-posteriorly, and very broad from above downwards. The lesser trochanter is a small conical process pointing inwards and backwards, situated at the junction of the inferior and posterior border of the neck with the shaft (fig. 6 *l.t*). The latter is somewhat flattened from before backwards, and widens into an inferior extremity, which presents two condyles, separated in the posterior half of the articular surface by a deep and narrow notch. Besides articulating with the tibia a large portion of this articular surface, by its superior and front part, articulates with the large patella and the external condyle, on its outer side, also articulates directly with the fibula by a surface which is continuous with that for the tibia and patella.

The shaft of the tibia (fig. 7) is very broad, and expanded in an antero-posterior direction in the upper half, this being due to the projection forwards of the anterior border as a prominent ridge. The bone narrows gradually to the junction of the middle and inferior third where it becomes subtriangular in section. The lateral surfaces of the expanded part are slightly concave, and the upper articular surface is much elongated from before backwards and deeply grooved in its front half for the patella. In the posterior part there is an articular surface separated into two facets by a notch. The inner, and larger, is concave; the outer, and smaller, is convex, and is placed upon an outwardly projecting process. Both of these are for the femur. On the outer and under surface of the projecting process, just mentioned, and continuous with that for the femur, is a small flat facet for the fibula.

The inferior extremity articulates with the fibula, and is prolonged into an internal malleolus.

The shaft of the fibula (fig. 7) is slender, lying so far behind the tibia, as to stand almost clear of its posterior border. Its upper extremity is expanded into two flattened, and almost hook-like processes, which project fore and aft, and, on the inner surface of the bone, at the junction of the shaft with these expansions, is an articular facet looking upwards and inwards, which is partly for the tibia and partly for the femur. Of the expanded processes, the anterior comes to a point, but the posterior terminates behind in a broad slightly inflected border. Midway between the two and immediately above the facet for the superior tibio-fibular articulation is a large foramen *(o)*.

Below, the shaft expands into an inferior extremity, which is prolonged into an external malleolus, and the tibia and fibula together furnish an articulation, concave from side to side, for the astragalus.

The patella (fig. 7 *p*) is relatively very large and irregular, and generally flattened from side to side for the anterior two-thirds; in the remainder it is somewhat laterally expanded. On its posterior face it has a large flat facet, which plays upon the inferior femoral articulation, as described under that bone. The inferior border is brought to a sharp ridge, which fits into the groove, described as existing, upon the front part of the head of the tibia. The outer surface is somewhat concave from before backwards; the inner rough.

THE PES.

(Pl. VIII., figs. 8, 8a, 8b.)

The pes departs so much less from the normal type than the manus, that I need only confine myself to a description of the parts which present peculiarities.

The calcaneum extends considerably backwards as a long bony spur (fig. 8 *ca*). The scaphoid (*sc*), deeply concave towards the heel, articulates in front with a considerable internal and small middle cuneiform (*ic* and *mc*). These two carry respectively the hallux and second digit. There is a large irregular cuboid (*cu*), which may represent also the external cuneiform; it has articulating with it the second as well as the three outer digits.

The digits, five in number, all possess the normal number of bones; and their terminal phalanges bear claws, which have been sufficiently described in a previous paragraph.

The fifth metatarsal however is peculiar, and deserves special mention (fig. 8a). It is immensely expanded towards the plantar aspect, and projects also towards the heel as a flat and blunt unciform process, the hinder extremity of this projection overlaps the calcaneum for nearly half its length. On the inner side of the pes is a large flattened sesamoid bone (fig. 8b), which is attached to the foot by ligamentous union; this also projects sole-wards after the manner of a bilge-keel. This bone, together with the similar plantar projection of the expanded fifth metacarpal, converts the sole into a trough-like groove.

THE SENSE ORGANS.

THE EYE.

No trace of this organ is visible externally, or on removal of the integument, but on reflecting the temporalis muscle it shows as a nearly circular, black lens-like disc on the inner surface of the anterior part of the muscle; it lies directly on the periosteum of the lachrymal bone at a point immediately behind the exact origin of the upper margin of the zygomatic arch, which here begins abruptly with a sharp upper edge and makes a sharp curve downwards and backwards. (Pl. VI., fig. 1.) No structure resembling an optic nerve was visible with the dissecting lens, though, on reflecting the pigment spot from its bed, fine filaments, apparently of connective tissue, were observable stretching between it and the periosteum.

The diameter of the pigmented disc is about ·5 mm. Sections made through it with the Cambridge rocking microtome, show it to be composed of a mass of pigment enclosed in a capsule of fibrous tissue resembling that of ordinary sclerotic, and its innermost layers similarly contain pigment. The inner pigment is accumulated into a large opaque mass, which occupies the greater part of the interior of the capsule, particularly the peripheral region and that believed to be the anterior. In those parts where the accumulation is less dense, or where the pigment is absent, viz., in the posterior and axial parts, the mass can be seen to be made up of small granules of varying size, either darkly pigmented, or yellow and highly refracting. In these situations can be distinguished, also, numerous nuclei, staining readily with borax-carmine solution, which appear to be those of epithelium-like cells.

Closely adjacent to the fibrous capsule, and covering it to a considerable extent, is a glandular structure of the type of a serous salivary gland, which has, however, certain peculiarities of its own.

In those sections in which the effort was made, and I believe successful, to have them running truly in an antero-posterior direction, there is to be seen evidence of the existence of a relatively large cavity, sac or duct, situated immediately in front of that part of the fibrous capsule, which would correspond to the cornea in the normal eye ; in fact the front part of the capsule forms the hinder boundary of the cavity in question. This showed clear indications of an epithelial lining which thus appears to cover the surface of the front part of the capsule in the same way as the normal cornea is covered by its anterior epithilium. The antero-posterior sections passing through the central regions of the disc show the contour of the fibrous envelope to be pyriform, and the posterior and smaller end is continued backwards as a band or bundle of connective tissue, in which, however, no trace of nerve structure can be distinguished.

It should be noted that the sections were made from eyes taken from a specimen which was not in good condition, and also, that the smallness of the object made it difficult to be quite sure that the sections ran truly in the desired directions. Thus, without further investigation, I cannot be absolutely certain of its relations, or of the morphological value of its constituent parts So far, however, I believe my description is correct.

THE EAR.

From the aperture of the ear, the external features of which have already been described, a fibrous or fibro-cartilaginous tube bounds the meatus to the auditory aperture of the bony skull. As I was unwilling to damage any of the limited number of perfect skulls at that time in my possession, I have as yet made no examination of the internal ear.

SALIVARY GLANDS.

(Pl. VIII., fig. 9.)

Below the meatus externus is a large flattened parotid gland, and to the inside of this, overlapping its inner edge and extending inwards so as nearly to meet its fellow on the opposite side, is an equally large flattened submaxillary, showing five or six well-marked lobes. The two glands of both sides form an almost continuous broad band of gland tissue stretching from one meatus to the other.

MUSCULAR SYSTEM.

I have not been able to devote any of the specimens as yet examined to a detailed examination of the muscular system, nor indeed were any, except one which I have been anxious to preserve, as nearly as possible, intact for future reference, in a very suitable condition for a careful investigation of the soft parts ; but generally speaking the muscular system is very well developed, especially on the limbs, pectoral, dorsal and caudal regions. A large mass of nuchal muscles, shown by the dotted line *(l)* in Pl. V., fig. 1, passes from the trunk and reaches to the summit of the occipital region for insertion into the triple ridge described on the posterior part of the vertex of the skull. This muscular mass contributes materially to the obliteration of the neck that has been alluded to.

URINARY AND GENERATIVE ORGANS.

(Pl. IX., figs. 5 and 6.)

The long, straight and wide rectum, lying in the middle line of the body, opens into a cloaca, which receives, also, the genito-urinary products. The anal aperture of this is surrounded with long straight hairs. The urinary bladder, considerably elongated and narrowing from the fundus, lies on, and ventral to, the rectum, and into its posterior narrow extremity the ureters and vasa deferentia open close together, but the former are dorsal to the latter. From the bladder the first portion of the urethra passes posteriorly as a straight tube of considerable length, and then enters the posterior end of the penis, in which, with ordinary dissection, I was unable to distinguish separate spongy and cavernous portions. This organ shows at its root two divergent bulbs, which, coalescing into a single cylindrical body, passes backwards, lying on, and closely adherent to, the ventral surface of the rectal wall. Posteriorly, the penis terminates in a single-pointed extremity, which pierces, as it were, the cloaca, and when this is laid open the tip just appears lying retracted within a recess in its wall, which thus forms for it a sort of preputial sheath (fig. 6) ; out of this recess the organ can be drawn considerably. On the dorsal aspect of the point of the penis is the slit-like anterior orifice of the urethra, which thus perforates the whole length of the organ.

The testes are oval bodies, which lie between the muscular planes of the abdomen in a position corresponding to the anterior edge of the pubic symphysis ; they are therefore prepenial. In the specimens before me there is no trace of an external scrotum, and the organ can scarcely be felt by careful examination from the outside of the body. In the notes forwarded to me by Mr.

Benham, however, it was stated that "the testes of the male are like those of a cat," which would seem to indicate that they are a prominent external feature. There is apparently a tunica vaginalis, also an epididymis closely applied to the body of the testis, from which the vas deferens runs a nearly straight course to the point indicated in the description of the bladder; both it and the spermatic artery pass through a ring-like aperture in the peritoneum lining the abdominal cavity.

The kidneys are suboval, with smooth surface, and close to them, on the inner side, lie the adrenals of considerable relative size; the course of the ureters is sufficiently shown in fig. 5, and their termination in the bladder has already been described.

On each side of the terminal part of the cloaca, lying embedded in the surrounding connective tissue, is an oval gland, nearly as large as the testis, from which three tube-like structures pass towards the cloaca. Whether any one of these is a duct I am unable to say, nor could I with dissection with an ordinary lens detect an opening within the cloaca, but they all passed towards it, as shown in fig. 5.

Marsupium.—In Mr. Benham's notes he described the female as possessing a pouch which opens backwards, and, in my own preliminary description, I have described such as existing in the following terms :—"About 15 mm. in front of the vent there is a pouch in the integument about four mm. wide, with the opening directed backwards, and having a depth in a forward direction of from four to five mm. The surface of this pouch is devoid of hair, but the bare area is surrounded by thick fawn-coloured fur, with a slightly reddish tint." See Plate V., fig. 3. The condition of this specimen, which was apparently the only female I had then received, made all observations in reference to soft parts of doubtful value.

I am now, however, able to confirm these statements by an examination of the specimens recently obtained, for, four of these are undoubtedly females. Two possess a pouch, which is so well developed as to suggest that it has recently been occupied, and in two the organ is small and rudimentary. In that in which the pouch is largest, a groove in the integument, bounded by two well-marked pillars, begins just in front of the anus, and leads uninterruptedly forward into a *cul-de-sac*, which readily admits a glass rod 5 mm. in diameter. This pouch terminates at a point about 15 mm. in front of the anal orifice, and it thus opens backwards. Sparsely scattered over the integument, lining the interior of the pouch, are reddish hairs; but examination with a hand lens did not enable me to detect any nipple or orifice. A narrow margin of somewhat bare integument immediately surrounds the pouch, but outside of this the fur is especially dense and of a darkish red colour.

In the two specimens in which the pouch is rudimentary, a similar but much narrower groove leads forwards from the anus, and ends in a constricted *cul-de-sac*, which barely admits the end of a darning needle. The same area of dense red fur surrounds the region.

All four females are from one to two cm. shorter than the largest male in my possession; but, on the other hand, both the males of the last series are no larger than the average size of the four females.

FOOD:—The intestines of those specimens, the condition of which permitted an examination of the contents to be made, contained the debris of insects, amongst which those of ants were conspicuously recognisable.

In the preceding description of some of the organs no attempt has been made to treat the subject exhaustively. The condition of all the earlier specimens, except one, which I have desired to keep as far as possible unmutilated for future reference, rendered this difficult of accomplishment, and I have been satisfied in making out as far as I could such details as were most obvious, or of chief importance, in determining the affinities of the animal. Unfortunately, no information whatever can be given as to the brain, which, as might be expected under the circumstances, was, in every case, in a state which rendered an examination quite hopeless. As regards the later specimens, though I can plainly perceive that they are not in first-class condition, they yet appear to be much superior to all, except one, of the former series. These I have only examined superficially.

CONCLUDING REMARKS.

For the considerable delay that has elapsed since the publication in the Transactions of this Society, and subsequently in the correspondence columns of "*Nature*," of some preliminary notes on the structure of this new marsupial, I must seek the indulgent consideration of naturalists, both in Australia and in England, who have, not unnaturally, been looking forward to a more complete description of a new animal of the greatest possible interest from many points of view. No one has regretted the delay more than I have. In extenuation, I must be allowed to say that scientific workers in the old world may not quite realize the difficulties under which some of their colleagues in the new have to labour. Many of these, primarily teachers, are not only, without adequate assistance, overburdened with routine courses of lectures of inordinate length, but have also thrown upon them large administrative duties in their self-imposed efforts to found and sustain, on a creditable footing, scientific societies and institutions in countries where, as yet, science meets with little general support or sympathy, and where its pursuit is often looked upon as an amiable craze. Lastly, the imperfections and deficiencies of our Libraries and Museums—though these are rapidly improving—still leave much to be desired in the way of literature for reference and material for comparison.

Under all these unfavourable circumstances, which perhaps are to be expected in a young community, it is not surprising that those of us who are teachers of science in Australia have hitherto suffered the humiliation of seeing so much of the work on purely Australian subjects done elsewhere. The scientific prizes of the investigator, of first importance, have not unusually been, so to speak, snatched from under his very eyes.

Such being the case, in spite of a strong appeal to have the work, involved in the present investigation, done in England, I was anxious that it should, if possible, be retained in the colony in which the discovery was made.

It was possible to desire this and at the same time to admit freely that the work might have been better done if undertaken by those whose vastly superior competence must be at once acknowledged. As an additional reason for this wish, of a somewhat personal character, it is not, perhaps, out of place to say that, being, since the discovery of the animal, either a member of the Council, or President, of this Society, a feeling of loyalty towards both it and the colony, strongly suggested that I should, by the destination of the paper, gain for both whatever scientific credit might accrue from its local publication. The delay would not have been so great had I not felt bound to avail myself of very favourable opportunities that presented themselves, of visiting remote parts of New Zealand and the little known regions of Central Australia, during two successive long vacations, during which periods I have leisure to undertake independent work satisfactorily. Indeed, as previously stated, the latter journey of over 2,000 miles, of which over 1,200 had to be performed by driving, or riding on horseback or on camels, was undertaken largely with the hope of obtaining a further supply of specimens of this animal. I think I may fairly offer the sucessful result of the journey, in this respect, as an adequate compensation for some, at least, of the delay, for which I am responsible, as I shall now be able to submit examples to the examination of more competent zoologists than myself, and thus to afford an opportunity of inspection by those interested in the discovery.

As has already been stated, the generic name originally proposed was Psammoryctes (sand-burrower, Gr.), but during my absence in North Australia I was made aware through information emanating from my old friend and teacher, Professor Newton, of Cambridge, whom in this matter, as well as in many others, I have to thank for acts of kindly interest and encouragement, that this name had already been appropriated for another group of animals, viz., by Pöppig in 1836 for a genus of mammals, and again by Vejdovsky, in the Zeitschrift fur Wissenschaftliche Zoologie for 1876, for a genus of worms. Psammorycter, which is practically the same word, was used by Blanchard in 1840 for a genus of Diptera. Professor Newton suggested Notoryctes as being appropriate, in view of its Australian habitat, and this name is, I think, preferable to Neoryctes, which had been previously proposed by Dr. Sclater. Though I regret extremely that the original name is preoccupied, as its sand-burrowing habits are so eminently the characteristic feature of its life, I think the new one will be regarded as satisfactory. As to the specific name, the extremely rudimentary condition of its eyes at once recommended it as suitable.

In view of the remarkable peculiarities of structure presented by the sub-class Marsupialia, and of the fact that we find amongst it analogous representatives of most of the orders of Mammalia, it has seemed not a little remarkable that hitherto no marsupial has been found with mole-like habits. In Notoryctes we have such a form developed to an extreme degree, and I regret that the exigencies of publication and the desire not to increase the delay which has already occurred in the preparation of this paper, together with the disadvantages, under which we labour in our work, to which I have alluded, make it undesirable for me now to attempt to enter into the many questions of interest, which are suggested by the structure of so singular a type. Certain osteological comparisons with existing forms are at once obvious, but I believe these may also be made, in respect of the dentition, with that of some of the Mesozoic mammals, to which, unfortunately, I can only refer by plates. Into these important questions, however, I cannot, with the time and means at my disposal, now attempt, even perfunctorily, to enter; and I can only hope that the description, so far as I have given it, will enable others to form their own conclusions.

In a subsequent paper I hope to embody the results of a more detailed examination of the organs, for which I hope the specimens now at my disposal will provide sufficient material in a suitable condition.

In conclusion, my best thanks are due to Miss Rosa Fiveash for the very great pains bestowed upon the drawings which illustrate this paper. Accurately and carefully drawn to scale, they will in many instances supply useful information as to size and form, and render more intelligible my own imperfect descriptions. To Mr. H. Barrett, of the South Australian Government Printing Office, my thanks are also due for his careful reproduction of the plates, and to the Executive of South Australia for permitting the work of a scientific society to be done in a public institution.