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NOTES ON THE EXTINCT CHELONIAN MEIOLANIA, WITH  
A RECORD OF A NEW OCCURRENCE.

By

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(Plates xxx-xl, and one map.)

INTRODUCTION.

The somewhat complicated history of the genus *Meiolania* has been skilfully disentangled by Dr. Smith Woodward<sup>1</sup>, so that a brief statement will suffice to bring our information up to date. It was originally discovered in the Pleistocene of the Darling Downs, Queensland, and described by Owen<sup>2</sup>; this species was subsequently called *Meiolania oweni* by Smith Woodward<sup>3</sup>. A second form from Lord Howe Island was described by Owen as *Meiolania platyceps*<sup>4</sup>. In 1889 R. Etheridge, Junior, recorded fragments consisting of a small horn core, part of a caudal vertebra, and segments of a tail sheath from the Canadian Lead, Gulgong, N.S. Wales (? Pliocene)<sup>5</sup>, and again in 1893 the same author described as meiolanian two horn cores found in the superficial (Pleistocene) deposits of Coolah, N.S. Wales<sup>6</sup>.

In 1898-99 the bony ring of a tail sheath, the skull and mandible, portion of a carapace, and other fragments of a similar animal were found in the Chubut beds of Patagonia, which are probably of Eocene age. These were described by Smith Woodward as *Miolania argentina*<sup>7</sup>, and the author discussed the significance of its distribution, suggesting that, as *Meiolania* was undoubtedly a terrestrial or marsh chelonian, its occurrence in Patagonia and the Australian region offers support to the hypothesis of a former land connection between South America and Australia by way of the Antarctic. He considered it just possible, however, that "if the direct ancestors of *Miolania* were known, this remarkable chelonian would prove to have originated not on any old Antarctic continent, but in some other region of the globe, from which scattered survivors wandered into the lands now named South America and Australia, respectively."

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<sup>1</sup> Smith Woodward—Ann. Mag. Nat. Hist., (6), i, 1888, pp. 85-89.

<sup>2</sup> Owen—Phil. Trans., clxxi, 1880 (1881), pp. 1037-1050.

<sup>3</sup> Smith Woodward—Loc. cit., p. 89.

<sup>4</sup> Owen—Phil. Trans., clxxvii, 1886 (1887), pp. 471-480.

<sup>5</sup> Etheridge Jr.—Rec. Geol. Surv. N.S. Wales, i, 1889, pp. 149-152.

<sup>6</sup> Etheridge Jr.—Rec. Austr. Museum, ii, 1893, pp. 39-41.

<sup>7</sup> Smith Woodward—Proc. Zool. Soc., 1901, i, pp. 170-176, 182-183.

Dollo<sup>8</sup> regards the peculiar distribution of *Meiolania* as strong evidence of a former Antarctic connection between South America and Australia, but Tate Regan<sup>9</sup> combats this view, and also suggests that the Patagonian form, which is so much the older, belongs to a distinct genus *Niolamia*, as proposed by Ameghino<sup>10</sup>.

Reference may also be made to Huxley's paper<sup>11</sup>, in which he regarded *Meiolania* as a cryptodire allied to the chelydroids. This was controverted by Boulenger<sup>12</sup>, who classes it as a pleurodire, in opposition to Baur<sup>13</sup>, who advanced arguments for regarding it as a cryptodire resembling the Testudinidae.

To sum up, we have evidence of the former existence of a peculiar chelonian family, remains of which have been preserved in Patagonian beds of probable Eocene age, in the Pliocene (?), and Pleistocene of N.S. Wales, the Pleistocene of Queensland, and the Pleistocene or Post-Pleistocene of Lord Howe Island. Some authors recognise only one genus, others two, while Huxley and Baur regarded it as cryptodiran, and Boulenger and Smith Woodward classed it with the Pleurodires.

To the localities enumerated above must now be added another, namely Walpole Island, about one hundred miles south-east of New Caledonia, where fragmentary bones, closely resembling those of the Lord Howe Island form, *Meiolania platyceps*, have recently been found by Mr. A. C. Mackay, engineer to the Australian Guano Company, and generously presented by him to the Australian Museum. This form I describe in this paper as *Meiolania mackayi*, in honour of the discoverer.

On comparison of the Walpole Island fossil with the material from Lord Howe Island, it was found that the Museum contains a large series of the latter, some of it undescribed and of considerable interest, so that the opportunity has been taken to add something to our knowledge of *Meiolania platyceps*. At the same time, a restoration of its skull has been prepared, under my direction, by Mr. J. Kingsley, Assistant Articulator, a work which he has performed with great skill. This restoration has been rendered possible by the generous loan of specimens preserved in the collection of the Department of Mines, N.S. Wales, including the two fine skulls described by Owen<sup>14</sup>.

<sup>8</sup> Dollo—Résultats du Voyage du S.Y. Belgica; Poissons, 1904, pp. 222-224.

<sup>9</sup> Tate Regan—Rept. Brit. Antarctic ("Terra Nova") Expedition, Zoology, i, 1 (Fishes), 1914, pp. 43-45.

<sup>10</sup> Ameghino—Sinopsis Geologico-Palaeontologica, Suplem. (1899), p. 10 (quoted by Smith Woodward, loc. cit, p. 170).

<sup>11</sup> Huxley—Proc. Roy. Soc., xlii, 1887, pp. 232-238.

<sup>12</sup> Boulenger—Proc. Zool. Soc., 1887, pp. 554-555; Ann. Mag. Nat. Hist. (6), iii, 1889, pp. 138-141.

<sup>13</sup> Baur—Ann. Mag. Nat. Hist. (6), iii, 1889, pp. 54-62.

<sup>14</sup> Owen—Phil. Trans., clxxix, 1888 (1889), B, pp. 181-184, pls. xxxi-xxxiv.

For the loan of these and other specimens I am indebted to Mr. R. H. Cambage, formerly Under Secretary for Mines, Mr. E. C. Andrews, Government Geologist, and Mr. G. W. Card, Curator of the Mining Museum.

MEIOLANIA PLATYCEPS Owen.

*Meiolania platyceps* Owen, Proc. Roy. Soc., xl, 1886, pp. 315-316; Phil. Trans., clxxvii, 1886 (1887), pp. 471-480.

*Meiolania minor* Owen, loc. cit.

*Ceratochelys sthenurus* Huxley, Proc. Roy. Soc., xlii, 1887, pp. 232-238.

*Meiolania platyceps* (Owen) Smith Woodward, Ann. Mag. Nat. Hist., (6), i, 1888, p. 87.

*Miolania platyceps* Lydekker, Brit. Museum Cat. Foss. Rept. iii, 1889, pp. 160-166.

Owen's two species have been regarded as synonymous by subsequent authors, and that view is adopted here, although there are certain differences in individual skulls, and the large cranial horn cores vary considerably in size and shape.

*Occurrence.*

Lord Howe Island is situated 300 miles east of Port Macquarie, N.S. Wales, and is about seven miles long, with an average breadth of approximately one mile. It consists practically of but two geological formations, a basaltic series forming about two-thirds of the island, and a thin-bedded calcareous deposit composed of coral sand, covering the lower ground and flanking the three isolated volcanic masses, which at the south end attain a height in Mt. Gower of 2,840 ft. This coral-sand rock consists of comminuted and completely rounded coral debris, with grains of volcanic material, such as augite, magnetite, and altered lava, with occasional fragments of echinoderms, shells, foraminifera, and other invertebrates. Speaking generally, the constituents of the coral-sand rock agree very closely with the component particles of the present beach at Lord Howe Island. It varies in thickness, its greatest elevation being about 250 feet above sea-level<sup>15</sup>. It is in this coral-sand rock that the *Meiolania* remains have been found at various times since about 1880. My colleague, Mr. A. R. McCulloch, who has an intimate knowledge of the island, has kindly supplied me with notes on the occurrence of *Meiolania*, the results of his own observations and those of several residents who have been closely associated with the various finds.

<sup>15</sup> Etheridge Jr.—Lord Howe Island: Australian Museum Memoirs, No. 2, 1887, pp. 115-116, 119.

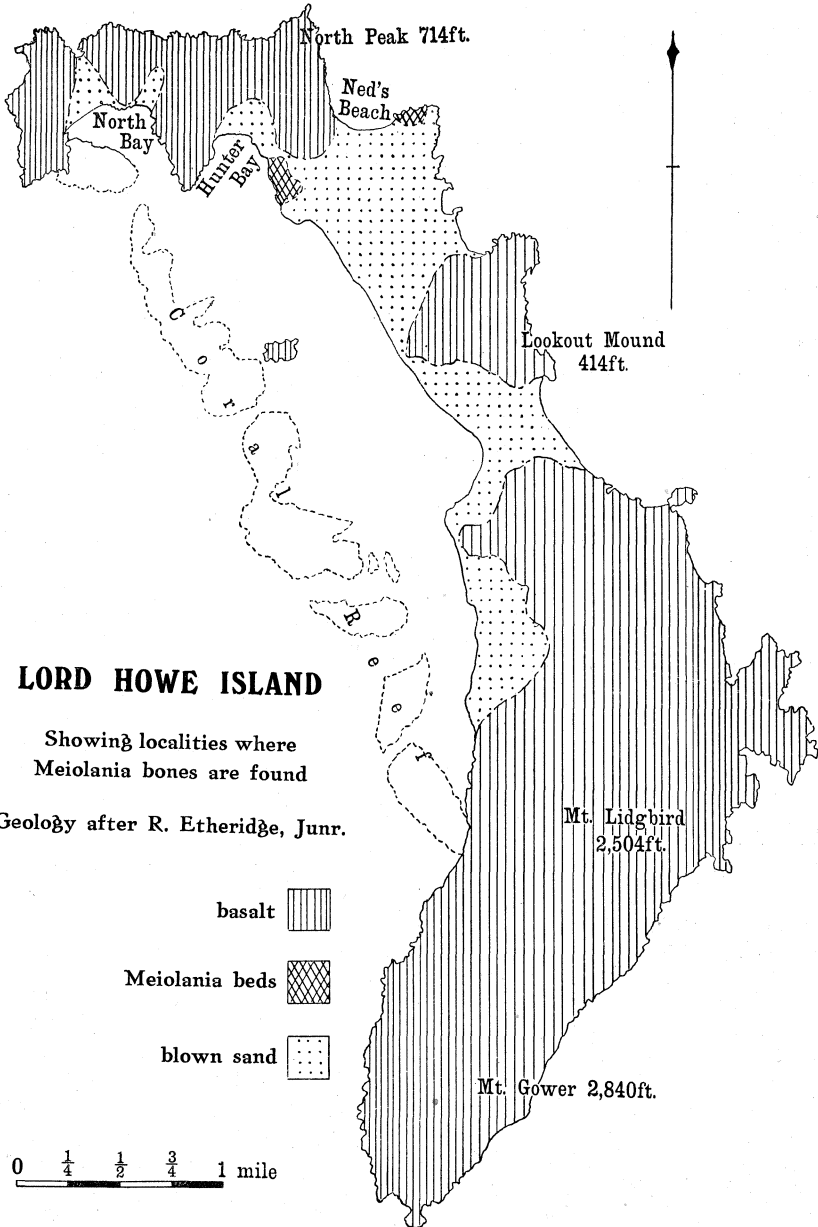
On the accompanying map, Mr. McCulloch has marked the areas where *Meiolania* bones have been discovered. It will be seen that they are restricted to two small patches close to the beach, on each side of the north end of the island.

“They are usually deeply embedded in the coral-sand rock, which in the area marked rises from below sea-level to a height of about eighty feet, where the basaltic spur on which it lies is exposed. Because of rock fractures and the crude methods usually adopted in extracting such portions as are detected, the bones secured are largely fragmentary. Disintegration of the rock, as a result of water action, accounts for the fact that outstanding portions of bones have been most commonly found in “runs” or creek beds, but, as the bones are found equally plentifully in neighbouring rock excavated during gardening operations, it is reasonable to suppose that they are fairly evenly disposed throughout much of the rock in the area marked on the map. Other bones, particularly horn cores, are frequently found lying loose in rich patches of loamy soil, which consists of decomposed basalt, coral sand, and decayed vegetable matter. These have undoubtedly become detached from the coral-sand rock during the process of disintegration.”

“There is every reason to suppose that the coral-sand rock, which may be loosely coherent or firm and solid, is of aeolian formation, as noted by Etheridge<sup>16</sup>. Shells of the large land snail *Placostylus* are commonly found in the rock, together with bones and eggs of the burrowing Mutton Bird (*Puffinus*); fragments of marine shells are exceptional, and only such as might be expected to occur on any coral-sand bank, whither they have probably been carried by birds. The coral-sand rock in which *Meiolania* bones occur has evidently been formed above sea-level, its consolidation being due to percolating fresh water. If this be correct, and it seems probable, the *Meiolania* bones found must be those of individuals which crawled out of the sea on to an old coral-sand bank, probably to lay their eggs. Various accidents, such as rolling over a bank on to their backs, caused the death of many, just as happens to-day on Raine Island and Bramble Cay, Queensland, and other nesting places of the Green Turtle, *Chelonia midas*. Their bones were doubtless disturbed by birds, which pecked at the decaying flesh, and even more so by others of their own kind, which later scrambled laboriously over the sand to excavate huge pits for the accommodation of their nests of eggs. It was evidently by such means as these that the bones now found were scattered before becoming embedded in the coral-sand rock, into which the sand bank was later transformed. It is almost certain that all loose bones found have been liberated by the disintegration of the ancient coral-sand formation in which they were originally embedded.”

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<sup>16</sup> Etheridge Jr.—Loc. cit., pp. 124-126.



Mr. McCulloch's account of the mode of occurrence is very suggestive, and would point to the belief that *Meiolania platyceps* was marine in habitat, coming ashore only to lay its eggs, of which several have been found in association with the bones. If it be the case that the bones occur only in the two small areas shown on the map, this inference is greatly strengthened, for, were *Meiolania* a land chelonian, we should expect to find its remains fairly generally distributed over the island, except in the elevated portions. It is possible, however, that the fossil is restricted to a definite horizon low down in the coral-sand series, and that this bed has been exposed only at these two spots.

It is exceedingly unfortunate that the bones are not found in association, for, with very few exceptions, it is impossible to say that any two bones are parts of the same skeleton, so that we are left more or less in the dark as to the proportions of the animal. Another difficulty is presented by the tenacity with which the matrix adheres to the bones. It was observed, however, that where these have been buried in soil the matrix had been completely removed, evidently by the slow action of organic acids. This observation suggested the use of dilute acetic acid for the same purpose, and the results were very satisfactory, as will be seen later.

#### *Shell.*

*Carapace.*—Little is known of the carapace of *Meiolania platyceps*, for only fragments have been found. What have been regarded as marginal bones are in fair abundance; these are stout and wedge-shaped, and Lydekker, from material in the British Museum, was able to say that the margin of the carapace was strongly serrated<sup>17</sup>. These stout bones were evidently from the region before and behind the bridge, for the bridge peripherals found attached to the plastron described below (Pl. xxx, fig. 1, *marg.*), are thin bones, consisting of two faces meeting at a very obtuse angle, with a feebly developed lateral carina. Portions of three associated dorsal vertebrae are preserved in the Australian Museum collection, and patches of the carapace are still in place; the bone is very thin, being about two millimetres in thickness.

*Plastron* (Pl. xxx, figs. 1, 2).—One of the most instructive specimens in the collection is a large portion of a plastron, to which were attached a nearly complete shoulder girdle and pelvis and two cervical vertebrae. The dorsal (inner) surface of the plastron was overlain by a thick layer of coral sand, which was removed and the girdles and vertebrae freed. The important discovery was made that the pelvis was not suturally attached to the plastron, indicating that *Meiolania* was not a pleurodire. It was lying almost, if not quite, in its natural position, and a distinct thin layer of the matrix intervened between it and the plastron. The girdles and vertebrae are described below.

<sup>17</sup> Lydekker—Brit. Mus. Cat. Foss. Rept., iii, 1889, pp. 164-5.

When the matrix was removed it was found that towards its centre the plastron becomes very thin, and the median portion is occupied by matrix only; in all probability there was a large median fontanelle with a digitate margin. The xiphiplastra are connected by digitations, and on the anterior lobe, which is imperfect, there is a digitate suture, apparently between the epi- and entoplastra. The bridge is of medium length, and is united to the marginals by digitate processes. The plastron is about 40 cm. wide, including the bridge, and about 50 cm. long. The bridge measures 18 cm. in fore and aft direction. There are no buttresses. The anterior and posterior lobes are very similar in shape and proportions.

The collection also contains a pair of plastral lobes, which may belong to one and the same individual, for they correspond in size. Both are much fractured and have been previously mended. On the posterior lobe there are two small symmetrically placed elevations, or tubercles, near the places where the pubes would come in contact with the plastron. As there is no evidence of the occurrence of any other chelonian than *Meiolania* in the coral-sand rock of Lord Howe Island, it is practically certain that these lobes are meiolanian. Probably these tubercles were for ligamentous attachment of pelvis to plastron. Possibly the plastron figured in Pl. xxx is that of a younger animal, the juvenile *Meiolania* having a pelvic structure of a cryptodiran type, while in the adult an approximation was made to the pleurodiran modification, as suggested by Lydekker for *Pleurosternon*<sup>18</sup>.

#### *Skull.*

No complete skull has yet been discovered, and its structure must be deduced by piecing together the evidence afforded by several more or less satisfactory specimens; its main features have been well described by Owen. The almost total absence of sutures, and the difficulty of removing the adherent matrix, have proved serious handicaps to a complete understanding of the cranial structure. By the prolonged use of dilute acetic acid, I have, however, succeeded in removing the calcareous matrix from several skull fragments without injuring the bone, and not only made possible a fairly detailed study of the cranial foramina, but also revealed certain unsuspected sutures. I have therefore been able to supplement, and in some respects correct previous descriptions.

The front portion of the skull, shown in Pl. xxxi, is splendidly preserved, though as usual no sutures can be traced. This specimen had evidently been washed out of the coral-sand matrix and buried for some considerable time in soil, for it shows no trace of calcareous matrix, and the cavities were filled with soft black earth. We see that the nostrils were separated by a narrow vertical bar of bone, recessed somewhat from the front. On the lateral margin of each nostril a process curves downwards and inwards towards the median

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<sup>18</sup> Lydekker—Quart. Journ. Geol. Soc., xlv, 1889, p. 517.



bony partition. Leading from the nasal opening a pocket extends backwards and outwards into each maxilla (Pl. xxxii, fig. 1; Pl. xxxvi, fig. 1, *mx. p.*); the significance of this structure is unknown to me. The palatal view reveals that the choanae were situated well forward. Part of the triturating surface of the upper jaw is preserved, showing a low serrated ridge, running roughly parallel to the descending alveolar plate, and a deep pit for reception of the mandibular beak; the rest of the palate is missing. A foramen (*f. inc.*) on each side of the middle line, apparently near the junction of the premaxilla with the vomer, is the *foramen incisivum*, absent in *Chelonidae* and *Dermochelys*, but present in other recent genera, and particularly prominent in the *Testudinidae*.

A fragment of the left side of the skull roof (Pl. xxxii, fig. 1), extending from the external nostril to the temporal fossa, throws some light on the structure of this part of the cranium. A wide and deep *sulcus olfactorius* (*sulc. olf.*) is separated from the orbital region by a prominent ridge, *crista orbito-sphenoidea* (*cr. orb. sp.*), the lower edge of which curves inwards in places as if to convert the *sulcus olfactorius* into a tube; the same feature is present to some extent in *Testudo*. In this figure the maxillary pocket (*mx. p.*) is well seen.

Portion of the posterior region of a skull (Pl. xxxii, fig. 2), carrying a pair of short horn cores, shows a series of ridges, which indicate the boundaries of epidermal shields. In some places these ridges have a slight groove along their apex, as if formed by the coming together of the upturned edges of two bony plates. In recent chelonians, on the contrary, the edges of the shields are marked by sulci on the surface of the underlying bony plates. Similar ridges are very clearly shown on two fine cranial horn cores, which evidently belonged to one and the same individual (Pl. xxxii, figs. 3, 4). In fig. 4 is seen the rim of the tympanic fossa (*ty. foss.*) and portion of the deeply recessed quadrate. Careful inspection of various skull fragments led to the recognition of several ridges of the same kind, and the pattern thus formed is shown in the restored model figured in Pl. xxxvi.

The occipital fragment (Pl. xxxiii, fig. 1) is of exceptional interest, for it shows fairly distinctly the suture between basi- and exoccipital, and the junction of basisphenoid and basioccipital. Evidently the pterygoids slightly overlapped the junction of basisphenoid and basioccipital, completely cutting off the former from the under surface of the skull. The skull portion figured in Pl. xxxiii, figs. 2-4; Pl. xxxiv, figs. 1, 2, consists of nearly complete occipital and otic regions, with most of the brain case and portion of the pterygoids, besides part of the outer wall of the skull and two large horn cores curving upwards and backwards. That the cranial horn cores varied considerably in size and shape may be seen by comparing this specimen with that shown in Pl. xxxii, fig. 2; whether this is explicable as due to age or sex difference, individual variation, or indicates distinct

species, are questions which I am unable to answer. This specimen was largely cleared of matrix, separated into various portions along previously mended fractures, and studied in detail.

Viewed from the under side (Pl. xxxiii, fig. 2) the occipital condyle (*cond.*) is seen to be a fairly large, strong bone, slightly concave underneath. The suture between basioccipital and pterygoid is clearly indicated, and evidently the basisphenoid does not appear at all on the base of the skull. A curious feature is the transverse intra-ptyergoid slit (*d*) which divides the bone into lower and upper lamellae. The lower lamella (upper in figure) bridges over a vacuity which Owen mistook for the posterior nares. Laterally the pterygoid extends back- and upwards, wrapping round the exoccipital. This backward prolongation of the pterygoid would indicate that *Meiolania* did not belong to the Pleurodira, in which the shortening of the pterygoid behind so that the quadrate comes into contact with the basi-cranial bones is one of the most characteristic features. The suture between the two halves of the pterygoid is indistinctly seen on the posterior part of the bone; in front it develops a median keel. When this skull fragment is viewed from the front (Pl. xxxiii, fig. 3; Pl. xxxiv, fig. 1), several important features may be observed. The anterior end of the basisphenoid falls steeply to the pterygoid, as in *Dermochelys*. The clinoid processes are feebly indicated, and just below them on the front of the basisphenoid are two foramina (*abd. c.*), probably exits for the abducent nerve. Near the middle line on each side, just above the junction of basisphenoid and pterygoid, are the anterior openings of the carotid canal (*car. c.*). Lateral to these is a bony bridge (*e*) connecting the pterygoid with the parietal region and the front of the brain case. This may be the descending parietal plate found in all recent chelonians, except *Dermochelys*, or it may be the epiptyergoid, or perhaps it represents both, the lateral ridge being the epiptyergoid, which is fused to the descending plate of the parietal. This bony bridge spans a large opening (*c. cav.*), the anterior end of the *canalis cavernosus*, or jugular canal. There are indications of a rostral process to the basisphenoid, but this has not been preserved in any of the specimens.

The tympanic region is shown in Pl. xxxiii, fig. 4, and it will be observed that the quadrato-otic mass is swollen and deeply hollowed, forming a large tympanic chamber with very thin walls. The open stapodial fissure is narrowly bridged over near the side wall of the skull, the *columella auris* gaining access to the *fenestra ovalis* through a pear-shaped opening (*f*). In this respect *Meiolania* resembles the pleurodires, as also in the concomitant closure of the tympanic fossa behind by encircling bone. This latter feature is regarded by Boulenger as evidence of its pleurodiran affinities<sup>19</sup>, but Baur attributes it solely to dermal ossification<sup>20</sup>.

<sup>19</sup> Boulenger—Proc. Zool. Soc., 1887, pp. 554; Ann. Mag. Nat. Hist., (6), iii, 1889, p. 139.

<sup>20</sup> Baur—Ann. Mag. Nat. Hist., (6), iii., 1889, p. 56.

*Cranial cavity.*—Several specimens showing the greater part of the brain case (except the roof) are in the collection, and these were carefully cleared of matrix by acetic acid alone. The process was very successful, the foramina and various passages being revealed throughout their length, and the bony labyrinth laid bare so that it could be examined just as in a recent skull.

The cranial floor is tunnelled longitudinally by a pair of canals (*g*), beginning about the middle and emerging some little distance behind the anterior margin of the basisphenoid (Pl. xxxiii, fig. 5). A little in front and lateral to their point of emergence is another pair of foramina (*abd. c.*), which tunnel the front of the brain case downwards and forwards to emerge on the anterior face of the basisphenoid; these are the supposed abducent canals previously referred to. In this specimen there are three interior openings for the hypoglossal nerve (*hy. c.*).

A similar specimen (Pl. xxxiii, fig. 6) is drawn so as to show the side wall of the cranial cavity. Here the floor in front has been removed to show that a plate of bone forms a sort of false bottom, underneath which run the two longitudinal canals referred to previously (Pl. xxxiii, fig. 5, *g*). The walls of the brain cavity are well ossified, there being no *hiatus acustica* between prootic and opisthotic, as in recent forms, or the merest indication of this feature in an oblique crescentic groove in the upper (posterior) end of which a canal pierces the side wall to enter the auditory chamber. The obliquely placed crescentic *foramen jugulare anterius* (Siebenrock<sup>21</sup>), vago-accessory foramen (Kesteven<sup>22</sup>), bounds the medial wall of the auditory chamber behind (*f. jug. ant.*). This wall is slightly convex medially, and is pierced by three foramina leading into the auditory chamber. Two of these foramina are situated in the bottom of a small pit at the anterior end of a smooth groove which runs forward from the lower edge of the *foramen jugulare anterius* in the angle between the side wall of the brain case and its floor. This pit (*int. aud. me.*) is evidently the *meatus auditorius* (Siebenrock, p. 270), *meatus acusticus internus* (Kesteven, p. 393), *fossa acustico-facialis* (Nick<sup>23</sup>), which in recent forms contains the foramina for the facial and acoustic nerves.

Looking into the *fenestra postotica* (Nick, p. 23) of the right side obliquely forwards and inwards (Pl. xxxv, fig. 1), we see near the posterior wall a recess, in the upper part of which is the *foramen jugulare*. This is somewhat constricted, roughly oval in shape, and is separated from the auditory chamber containing the bony labyrinth by a thin wall (evidently part of the opisthotic), which is pierced in its lower half by a nearly round opening (*k*), leading into the auditory

<sup>21</sup> Siebenrock—Sitz. d. k. Akad. Wiss. Wien, Math. Naturw. Cl., evi, 1, 1897, p. 252.

<sup>22</sup> Kesteven—Journ. Roy. Soc. N.S. Wales, xlv, 1910, p. 392.

<sup>23</sup> Nick—Zool. Jahrb. Anat. Ontog., xxxiii, 1, 1912, p. 31.

chamber. The *foramen jugulare posterius* is, as in *Chelonia midas* and *Dermochelys*, not enclosed by bone. The *fenestra ovalis* (*fen. ov.*) is nearly circular, and, before the matrix was removed, it was partially blocked by the inner end of the *columella auris*. This had the usual shape of a circular piece of bone, concave to the auditory chamber, with indications of a slender stalk on its outer surface, the beginning of the medio-stapedial. The auditory chamber and bony labyrinth are described in detail below. The lower lateral half of the *fenestra postotica* is occupied by a large, elongated, somewhat boomerang-shaped opening (*c. cav.*), the jugular sinus or posterior opening of the *canalis cavernosus* (Nick, p. 30), which opens on the front of the otic mass between the descending parietal plate and the basisphenoid (Pl. xxxiii, fig. 3; Pl. xxxiv, fig. 1). The bony septum between the *fenestra ovalis* and the jugular sinus is pierced near its median inferior end by the posterior opening of the carotid or pterygoid canal (*car. c.*), which runs obliquely forward to open near the median line, just in front of the brain case (Pl. xxxiii, fig. 3; Pl. xxiv, fig. 1); close to the anterior wall bounding the *fenestra ovalis*, is the lower end of the carotico-temporal canal (Siebenrock, p. 289), *canalis arteriae facialis* (Nick, p. 27), which runs a short course upwards to open into the temporal fossa (Pl. xxxiii, fig. 5; Pl. xxxv, fig. 1; *car. temp. c.*).

*Auditory chamber.*—This is the name I have used for the cavity lying between the *fenestra ovalis* and the side wall of the brain case. Viewed obliquely from the post-otic fenestra (Pl. xxxv, fig. 1), this cavity is seen to form a fairly roomy chamber. The medial wall, as previously mentioned, is complete, except for small openings serving for the passage of nerves and blood vessels. The posterior wall, as stated above, has an opening (*k*) communicating with the vago-accessory canal. In the roof of the chamber is a nearly circular opening, the canal commissure (*c. com.*) for the common limb of the anterior and posterior semicircular canals. In the upper part of the posterior wall is a recess, the opisthotic vestibular recess (Pl. xxxiv, fig. 2, *m*) for the reception of the ampullae of the posterior and the exterior (horizontal) semicircular canals. The corresponding anterior vestibular recess in the prootic is smaller. The orifices of the two vertical semicircular canals are situated in these recesses. The course of the anterior and posterior canals (*c.s. ant.* and *c.s. post.*) was revealed by cutting away the bone from above (Pl. xxxiii, fig. 5). They lie in a groove, forming a semicircle, its convexity medial. At each end of the groove is an orifice communicating with the anterior and posterior vestibular recesses, and in the middle the large opening (*c. comm.*) for the common limb of both canals.

To examine the auditory chamber from the medial direction, the inner wall was partially removed (Pl. xxxv, fig. 2). Beginning from the upper edge of the *fenestra ovalis* and running upwards and inwards is a broad, thin, bony lamella (*l*), constricted in the middle and

forming a bridge, the medial wall of the exterior semicircular canal. The tunnel thus formed opens posteriorly into the opisthotic vestibular recess, anteriorly into the prootic vestibular recess.

In the absence of sutures it is impossible to say in what bony elements the various parts of the bony labyrinth lie, but it is evident that, while simple in structure, the labyrinth is better developed than in the Testudinidae, though not so complicated in structure as in the Pleurodira.

#### *Vertebral Column.*

*Cervical vertebrae.*—One of the skulls (now in the Mining Museum, Sydney) described by Owen<sup>24</sup>, has the first and second cervicals attached. Another vertebra, regarded by Owen<sup>25</sup> as probably a dorsal, also belongs to the cervical region, as stated by Lydekker<sup>26</sup>. The biconcave vertebra figured by Owen<sup>27</sup> as the first caudal, is really the fourth cervical, as shown below.

Among the material preserved in the Australian Museum is a complete cervical series, though, unfortunately, the atlas and the eighth vertebrae are imperfect and all the processes are broken off short. This specimen (Pl. xxxvii, fig. 1) was treated with acetic acid and the vertebrae carefully separated, so that the articulations of the centra might be examined. The neck, as preserved, is 19.5 cm. in length, but making allowance for the missing parts, its probable length would be 23 cm. The individual vertebrae are short, indicating that *Meiolania* was a short-necked animal. Of the atlas only a part of the odontoid, consisting of a deep cup with its rim, is preserved. Into this cup fitted the ball of the second vertebra, which is convexo-concave. The third is also convexo-concave, the fourth convexo-convex, the fifth to seventh concavo-convex. The eighth is convex in front, but its posterior portion is missing. All the vertebrae are deeply cupped, and the ball which fits into this concavity is roughly hemispherical, or, particularly in the later vertebrae, somewhat ovoid, the longer axis being horizontal; there are no ginglymoid articulations. The zygapophyses, where preserved, show no great variation throughout the series. They are situated fairly high above the centra, the average distance from the lowest point on the base of the neural canal front to the middle point of the prezygapophysial articulating surface being about equal to the greatest vertical diameter of the centrum. The articulating surfaces of the zygapophyses form angles of about 45 degrees to the vertical.

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<sup>24</sup> Owen—Phil. Trans., clxxix, B, 1888 (1889), pl. xxxii.

<sup>25</sup> Owen—Loc. cit., pp. 184-185, pl. xxxv, figs. 1-3.

<sup>26</sup> Lydekker—Brit. Mus. Cat. Foss. Rept., iii, 1889, p. 162.

<sup>27</sup> Owen—Loc. cit., pp. 185-186, pl. xxxv, fig. 4.

The second and third cervicals are very similar. A strong lateral process (diapophysis of Owen) arises partly from the neural arch, partly from the body, and is situated well on the anterior half of the vertebra, though almost entirely behind the prezygapophysis. The bodies of these two vertebrae are flattened on the lower surface, and the postero-lateral angles are produced backwards and outwards in two well developed processes, terminating in flat or slightly concave surfaces, evidently for the support of cervical ribs; for slender bones, looking like ribs, were found associated, but not attached. The succeeding vertebrae have no inferior lateral processes of this kind. On the sixth, seventh, and eighth, below and anterior to the diapophysis, is a short, blunt process (parapophysis, Owen). There are no ventral keels on any of the centra, or only the slightest indication of such.

The presence of neural spines is indicated, but they are all injured, and give little information as to their form or size. I am, however, in a position to say that some of the posterior vertebrae at least, had fairly long spinous processes. Attached to the inner surface of the plastron described above, close to the front of the anterior lobe, were two vertebrae agreeing in all essentials with the late cervicals just described. Both have well developed neural spines (Pl. xxxvii, figs. 2, 3), a very unusual feature in chelonians, either living or extinct. These high neural spines were probably confined to the last two or three cervicals.

The general structure of the cervical vertebrae of *Meiolania* indicates that it had a short but flexible neck, which could be bent in any plane. Assuredly it could not withdraw its head under its shell; its neck was too short and the cranial horns, too, would prevent retraction. The strong lateral processes, and the presence of high neural spines on some, at least, of the vertebrae indicate considerable muscularity. Probably these are adaptive characters associated with the large size and weight of the head and the presence of cranial horns, and it may be that the latter were not merely ornamental, or an expression of exuberant growth, but were weapons of defence or offence. *Meiolania* may have had enemies, or perhaps the horns were used in combats with its fellows, as described by Captain T. Hutton, in the case of *Testudo elegans*<sup>28</sup>. One can well imagine that in such wrestling bouts the cranial horns and long strong tail of *Meiolania* would be very effective. On the other hand, it is possible that these bizarre features were of no use whatever, but were excrescences, such as frequently appear in senile types.

If the transverse processes are adaptive, as suggested above, their presence cannot justifiably be used as evidence of pleurodiran affinities. In fact it is difficult, on the evidence of the cervical vertebrae, to say whether *Meiolania* was a cryptodire or a pleurodire. The zygapophyses strongly resemble those of typical cryptodires,

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<sup>28</sup> Hutton—Journ. Asiatic Soc. Bengal, vi, 1837, pp. 693-4.

though the absence of true ginglymoid articulations, and the presence of strong transverse processes, are more characteristically pleurodiran. The diapophyses, which in living pleurodires, are wholly behind the prezygapophyses, in cryptodires almost underneath them, have in *Meiolania* an intermediate position. Baur considered that the structure of the atlas and axis vertebrae attached to the skull described by Owen is cryptodiran, but Boulenger argued that they show pleurodiran characters. It is doubtful whether the condition of the two vertebrae in question is such as to allow of a definite pronouncement one way or the other, for their structure and relations are not clearly shown. The most reasonable view would seem to be that *Meiolania* was a primitive form, in which the cervical region had not yet developed the special features which are characteristic, respectively, of Cryptodira and Pleurodira. In this respect it invites comparison with the Amphichelydian suborder, as defined by Lydekker<sup>29</sup>, and more fully by Baur<sup>30</sup>, and Hay<sup>31</sup>.

*Dorsal vertebrae*.—Portion of the dorsal region, consisting of three imperfect vertebrae, with rib heads and fragments of attached carapacial plates, is in the collection. This specimen presents no notable features except the extreme thinness of the carapace, which has been alluded to previously.

*Sacrum*. (Pl. xxxvii, figs. 4, 5).—This is of the usual chelonian type, consisting of two vertebrae. The anterior vertebra is strongly procoelous, the cup being 4.2 cm. in width and 2.8 cm. in height. It has well-developed lateral processes (sacral ribs) arising mainly from the centrum, but partly also from the neuroids. The second vertebra is similar to the first, but the ribs are more slender. The ball of the second vertebra projects boldly backwards on a neck, and is noticeably wider than high. The zygapophyses of the two vertebrae are fairly well developed, and evidently there was quite free motion between the last dorsal and the first sacral, and perhaps a slight motion of the two sacrals on one another. The presence of strong sacral ribs is evidence against pleurodiran affinity, for in these they are degenerate, the pelvis being supported by its rigid attachment to plastron and carapace. The condition of the sacral ribs is confirmatory of the observation above, that the pelvis was not suturally attached to the plastron. Boulenger has already pointed out that *Meiolania* differed from typical pleurodires in that the ilium showed a surface for attachment to a sacral rib<sup>32</sup>.

<sup>29</sup> Lydekker—Quart. Journ. Geol. Soc., xlv, 1889, p. 518; Brit. Mus. Cat. Foss. Rept., iii, 1889, p. 204.

<sup>30</sup> Baur—Amer. Nat., xxiv, 1890, pp. 534, 535; Proc. Acad. Nat. Sci. Phila., 1891, pp. 411-419.

<sup>31</sup> Hay—Bull. Amer. Mus. Nat. Hist., xxi, 1905, pp. 137-175; Fossil Turtles of N. America, Carnegie Institution, 1908, pp. 21, 43-102.

<sup>32</sup> Boulenger—Proc. Zool. Soc., 1887, p. 554.

*Caudal vertebrae*.—These have been fully described by Owen, and I need not discuss them here, except to recall their opisthocoelous character and the presence of large chevron bones, which are, in most cases, firmly ankylosed to the centra. The collection, however, contains some caudals in which the chevron bones have been detached, leaving a rough sutural surface. The tail of *Meiolania* was evidently very flexible in its anterior portion, as indicated by the deeply concave centra, but its termination was immovably enclosed in a nodose bony sheath. In this respect *Meiolania* resembled the glyptodonts.

#### *Appendicular Skeleton.*

*Shoulder girdle* (Pl. xxxviii, fig. 1).—No complete shoulder girdle has been obtained, the best example in our collection lacking the upper portion of the scapula, which, however, is known from other specimens to have been long and rod-like. The procoracoid makes a very obtuse angle with the body of the scapula proper, and stands nearly at right angles to the axis of the coracoid, which is expanded at its free end. This description is based on the nearly complete left girdle found attached to the plastron described above. The glenoid fossa is elongated in the direction of the axis of the scapula and procoracoid, and constricted in the middle. All parts are firmly united in this specimen.

*Humerus* (Pl. xxxviii, figs. 2-5).—This corresponds best with Wieland's chelic type<sup>33</sup>. Its proximal end is unlike that of a typical land tortoise, such as *Testudo*, nor does it present the features characteristic of marine turtles, such as *Chelonia* and *Dermochelys*. The head is large, ovoid, its longer axis inclined slightly upwards and forwards when the bone is held in the natural position. The ulnar process is broad and flattened, rises almost as high as the head when the bone is held with its long axis vertical, and is placed almost in the plane of the distal end. It is separated from the head by a well marked groove. The radial process is shorter and stouter, and stands nearly at right angles to the ulnar; between it and the head are two grooves separated by a ridge. There is a wide flaring digital fossa between the two processes, as in *Chelydra*. The shaft is sigmoid, but the curvature is not so marked as in the Testudinidae and Emydidae. It is compressed slightly in the plane of the distal end, the dorso-ventral being to the antero-posterior diameter as 31 to 34, about. The distal end consists of two large, almost equal, condylar surfaces, the ento- and ectocondyles, separated by a shallow groove. These articular surfaces are directed strongly downwards when the long axis of the shaft is held in a horizontal position. They are well marked off from the smaller entepi- and ectepi-condyles. The ectepi-condylar groove commences about the middle point of the shaft, runs obliquely downwards and outwards, and becomes converted into a foramen, which emerges on the ventral surface near the proximal

<sup>33</sup> Wieland—Amer. Journ. Sci., (4), ix, 1900, pp. 415-416.



edge of the entepicondyle. There is a well marked supracondylar fossa on the ventral surface of the distal end, and on the dorsal surface is a shallow depression separating the two condylar surfaces and reaching a short distance up the shaft. The humerus shown in Pl. xxxviii, figs. 2, 3, has the distal end incomplete, but allowing for the missing part it would have a length of about 14 cm. The distance from the outside of the ulnar to the outside of the radial process is 9 cm., the least diameter of the shaft 22 mm. The distal end shown in Pl. xxxviii, fig. 4, measures 9.5 cm. across the condyles in the antero-posterior direction, and another even larger is 11.5 cm. in the same direction.

On the whole, the humerus of *Meiolania* was a powerful well muscled bone. Its proximal end resembles that of *Chelydra*, *Emys*, *Chelodina*, and other river and marsh turtles, but its distal end bears more resemblances to that of the Testudinidae.

*Lower Limb Bones.*—Several bones of the fore-arm, crus, carpus, and tarsus, are contained in our collection, but they are mainly fragments, and I am not able to add anything of importance to our knowledge of these parts of the skeleton.

*Terminal phalanges.*—A number of these are in the collection. They are short and almost hoof-like, as in *Testudo*, with well developed condylar surfaces. So far as its terminal phalanges are concerned, *Meiolania* was typically terrestrial.

*Pelvis* (Pl. xxxix, figs. 1-3).—Several fragmentary pelves and one nearly complete one (found in attachment to the plastron previously described) are in the Australian Museum collection. The axis of the ilium forms a very obtuse angle with the plane of the pubes, and its upper end is expanded for attachment to the sacral ribs. The anterior branch of the pubes is broad, not slender, as in typical pleurodires. The lateral pubic (pectineal) process (*p. pr.*) is separated from the body of the pubis by a slight neck, and it has a roughened, somewhat thickened, expansion terminally where it rested on the plastron. The ischium apparently had a postero-lateral process, which, however, has not been preserved. There is a short prepubic process (*pr. pr.*). The ischiadic and pubic symphyses are connected by a broad bony bridge, separating the paired pubo-ischiadic foramina (*pb. is. f.*), as in Emydidae and Testudinidae. The pelvis presents a strong similarity to that of the Testudinidae, and is quite unlike that of existing pleurodires.

*Femur* (Pl. xl, figs. 1, 2).—This is a robust bone, strongly impressed for the insertion of muscles. Its head is large, slightly compressed in a plane perpendicular to that of the distal end, has an indistinct neck, and its axis stands out at an angle of about 130 degrees to the axis of the shaft. The two trochanters are very similar; the greater trochanter falls distinctly below the highest point of the head, and its direction is almost a continuation of the axis of

the shaft. The lesser trochanter turns slightly outwards. Both trochanters are thickened at their proximal ends, and their planes are almost at right angles to that of the distal end. There is a deep, but not wide, inter-trochanteric fossa. The shaft is nearly cylindrical at the point where its diameter is least. It flattens out considerably towards the distal end, which is composed of two condylar surfaces, separated by a pronounced ridge, and forming an obtuse angle with one another. The specimen illustrated in Pl. xl, fig. 2, is 21 cm. in length, measures 8 cm. across the two trochanters in an antero-posterior direction, the least diameter of the shaft is 2.7 cm., and the antero-posterior measurement of the distal end 9.5 cm.

#### *Eggs.*

There are four eggs in the collection which, from their size, spherical form, and mode of occurrence, are thought to be those of *Meiolania*. The figured specimen (Pl. xl, fig. 5) measures about 7.2 cm. in diameter.

#### MEIOLANIA MACKAYI *sp. nov.*

*Occurrence.*—Walpole Island, where the specimens on which this description is based were found, lies about one hundred miles south-east from New Caledonia, in Lat. 22° 38' S., Long. 168° 27' E. Mr. F. Danvers Power has described the island, the mode of occurrence of the phosphate deposits in which the bones of *Meiolania* were discovered, and the following notes are condensed from his account<sup>34</sup>. It appears to be situated on the same ridge as the Loyalty Islands, rises about 210 feet above the sea, the high land having an area of 296 acres. There is no fringing reef, but at the foot of the precipitous cliffs is a flat reef. The island appears to be composed entirely of coral rock, and has evidently continued to rise, probably in stages, for traces of at least five distinct flat reefs can be seen in the cliffs. There are two main lines of depressions in the surface of the coral rock, approximately at right-angles to one another, and it is in these depressions that the guano (containing the *Meiolania* bones) is found.

Mr. E. C. Andrews says<sup>35</sup>: "The Loyalties, together with Walpole Island, appear to have formed unstable units as compared with the main western block of New Caledonia, and they show the evidence of warping, the islands forming a crest of a land wave, while the corresponding troughs lie east and west of the island-dotted crest."

The bones are found scattered promiscuously through the phosphate, and are mostly imperfect and broken. The material comprises cranial horn cores, parts of humeri, the proximal end of a femur, and some of the lower leg bones. Scanty though the remains are, they indicate the presence of at least five individuals.

<sup>34</sup> Danvers Power—Trans. Inst. Min. Metall., 1919-1920, pp. 38-41.

<sup>35</sup> Andrews—Journ. Roy. Soc. N.S. Wales, lvi, 1922, p. 23.

*Horn Cores.*—These present a marked resemblance to those of *Meiolania platyceps*, as may be seen by comparing figs. 5 and 6 of Pl. xxxii with figs. 3 and 4. It is evident that they were directed upwards and backwards as in *M. platyceps*, not chiefly outwards as in *M. oweni* and *M. argentina*. They are more slender than those of *M. platyceps*, and, as this appears to be a constant feature, it seems to justify the erection of a new species, though it is barely possible that a larger series would show a gradation and enable the two to be united under the name *Meiolania platyceps*.

*Humerus.*—This too is very similar to that of *M. platyceps*, but it is much smaller. The proximal end (Pl. xxxviii, fig. 6) shows the wide digital fossa and the broad, flattened ulnar process; the radial process is missing. The distal end (Pl. xxxviii, figs. 7, 8) presents essentially the same features as that of *M. platyceps*.

*Femur.*—Only the proximal end is represented (Pl. xl, fig. 3). It has the deep, narrow, trochanteric fossa characteristic of *M. platyceps*, and its general form is the same.

*Tibia.*—The tibia figured in Pl. xl, fig. 4, is a slenderer bone than that of *M. platyceps*, but comparison with Owen's figure of the latter<sup>36</sup> will prove their essential similarity.

It is evident that *M. platyceps* and *M. mackayi* were very alike in skeletal structure so far as comparison can be made, and that they differed chiefly in size, *M. mackayi* being a smaller animal of less robust build. They both differed from *M. oweni* and *M. argentina* in the shape and direction of the large parietal horn cores.

#### SUMMARY AND CONCLUSIONS.

The remains of the aberrant chelonian *Meiolania platyceps* of Lord Howe Island contained in the collections of the Australian Museum and the Mining Museum, Sydney have been re-examined. Treatment of various skull portions with dilute acetic acid removed the calcareous matrix and enabled me to study the cranial foramina and the bony labyrinth in detail. At the same time certain sutures were discovered in the skull, which indicate that the pterygoid extended backwards, cutting off the quadrate from contact with the basicranial bones. A damaged plastron was found, with attached pectoral and pelvic girdles, and the discovery was made that the pelvis was not suturally connected with the plastron. These facts, together with the presence of strong sacral ribs throw doubt on the supposed pleurodiran affinities of *Meiolania*. Examination of the cervical vertebrae, of which a complete series was available, leads to

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<sup>36</sup> Owen—Phil. Trans., clxxix, 1888 (1889), B, pl. xxxvi, figs. 1-4.

the belief that *Meiolania* was unable to withdraw its head under its carapace either in a vertical or in a horizontal plane, though it could probably move its head freely in any plane. Its limbs resemble most those of river or marsh turtles, and indicate that *Meiolania* was in all probability a strong swimmer, though it lacks the special adaptations characteristic of pelagic chelonians, such as *Chelonia* and *Dermochelys*. Its terminal phalanges resembled those of a typical terrestrial form. The occurrence on Walpole Island, which is composed entirely of coral and phosphate rock, of a new species *Meiolania mackayi*, very similar to *M. platyceps* of Lord Howe Island, indicates that *Meiolania* could undertake a sea voyage. Mr. A. R. McCulloch is of opinion that *Meiolania platyceps* was marine in habitat, and came ashore only to deposit its eggs, but I am rather inclined to the view that *M. platyceps* and *M. mackayi* were partly land, partly estuarine or shore-living forms, which could, however, make short sea trips.

As regards the affinities of *Meiolania*, it presents several features which link it with the sub-order Amphichelydia, which flourished in the Mesozoic and early Tertiary. If this is a reasonable view, we must regard *Meiolania* as a "relict" form, which, becoming extinct in other parts of the world, found its last home in the Australasian region. In this respect it takes its place with the monotremes, *Sphenodon*, *Neoceratodus*, *Heterodontus*, and other archaic forms, which still linger in Australasia, "the land of living fossils."

Its distribution does not necessarily support the hypothesis that South America and Australia were once connected by a northerly extension of the Antarctic continent. *Meiolania platyceps* and *M. mackayi* probably came from Asia, passing down the arc formed by New Guinea, New Caledonia, the Loyalties, and other islands. A submarine plateau extends northwards from Lord Howe Island towards New Caledonia, and is separated from Australia by deep ocean<sup>37</sup>. As the animal could apparently cross stretches of ocean a continuous land bridge would not be necessary. Mr. Tom Iredale informs me that the migration route suggested here for *Meiolania platyceps* and *M. mackayi*, was also that followed by many birds, such as *Tricholimines sylvestris*, *Turdus xanthopus* and *Porphyrio (Notornis) albus* of Lord Howe Island, and that all the Lord Howe Island land shells are New Caledonian in origin, as also its wingless insects. *Meiolania oweni* of the Darling Downs doubtless belongs to another branch of the same family, which crossed to Australia, probably from New Guinea, and remained more purely terrestrial in habit.

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<sup>37</sup> This area corresponds approximately to Hedley's Melanesian Plateau (Proc. Linn. Soc. N.S.W. (2), vii, 1892, p. 335).

## ACKNOWLEDGMENTS.

I have pleasure in acknowledging the cordial assistance I have received from various friends during the course of this investigation. I had the great privilege of discussing the *Merolania* question with Dr. E. C. Case of Michigan during his recent visit to Australia, and his advice and criticism has been most helpful. To Mr. A. R. McCulloch I am indebted for an account of the occurrence of *Merolania platyceps*, and to Dr. H. Leighton Kesteven, Professor T. T. Flynn, and Mr. Tom Iredale for information on various points. The drawings were prepared by Misses Phyllis Clarke and Helen E. Bailey, and my colleagues Messrs. A. R. McCulloch and G. P. Whitley, the photographs by Mr. G. C. Clutton to all of whom my best thanks are due. To my colleague Mr. T. Hodge Smith I am indebted for assistance in the acetic acid treatment of the fossils, and also for the preparation of the map, which is based on Etheridge's geological map and data supplied by Mr. A. R. McCulloch.

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EXPLANATION OF PLATE XXX.

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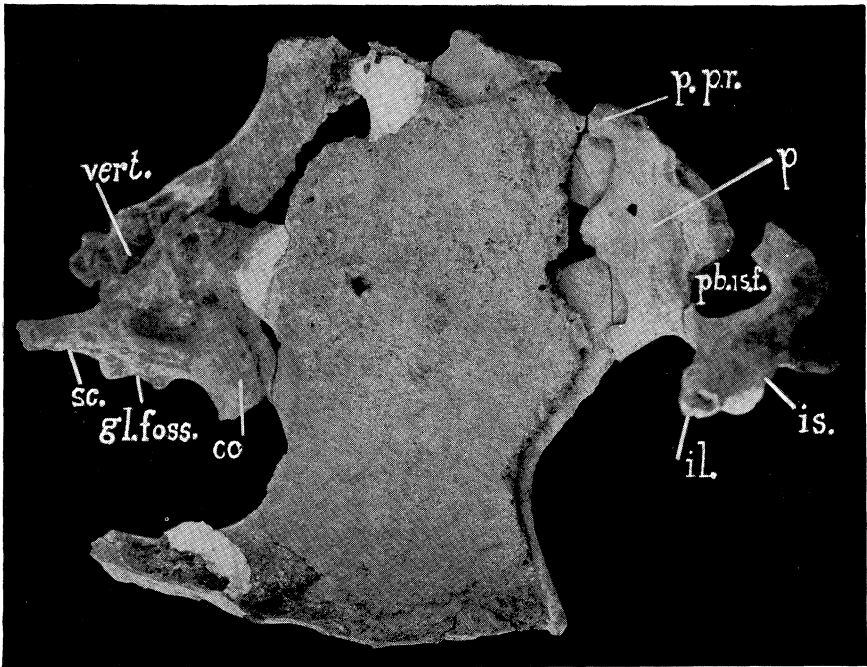
Fig. 1. *Meiolania platyceps* Owen. Plastron, ventral view. A.M.  
No. F. 1208; x 1/6 about.

„ 2. Plastron, dorsal view.

*Co.* coracoid; *gl. foss.* glenoid fossa; *il.* ilium; *is.* ischium;  
*marg.*, marginal plates; *p.*, pubis; *pb. is. f.*, pubo-ischiadic  
foramen; *pelv.*, pelvis; *p.pr.*, pectineal process; *sc.*, scapula;  
*sh.gi.*, shoulder girdle; *vert.*, vertebrae.



1



2

EXPLANATION OF PLATE XXXI.

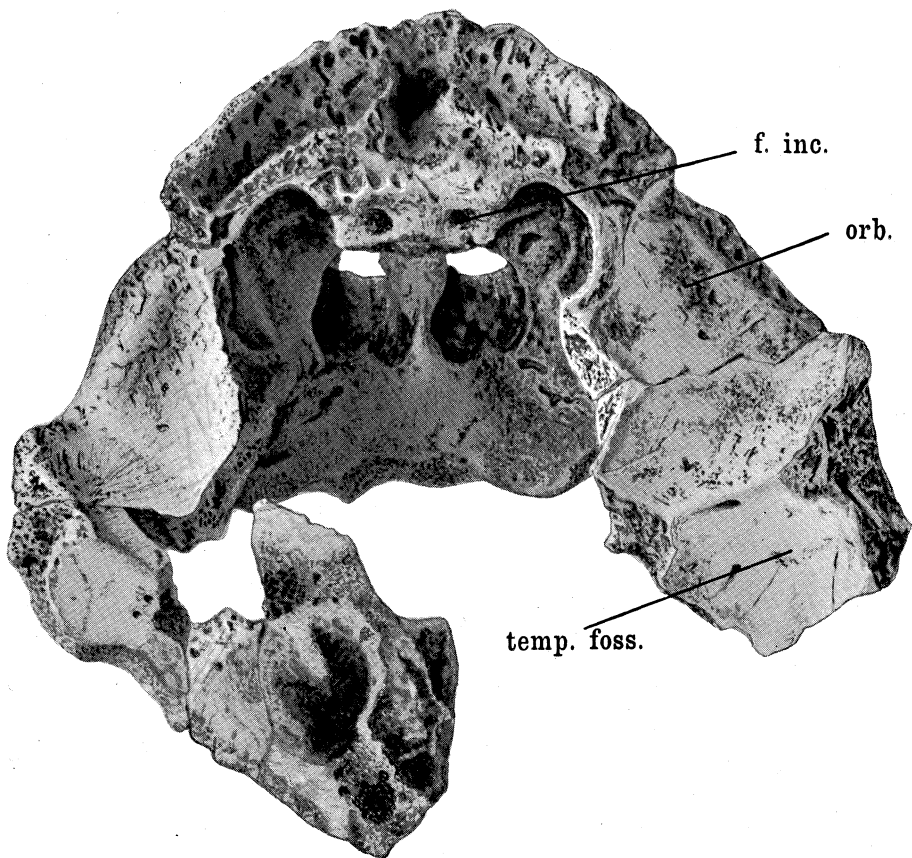
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- Fig. 1. *Meiolania platyceps* Owen. Front portion of skull. A.M.  
No. F. 398; x  $\frac{3}{4}$  about.
- „ 2. Same specimen, palatal view.
- f.inc.*, foramen incisivum; *orb.*, orbit; *temp.foss.*, temporal fossa.





1



2

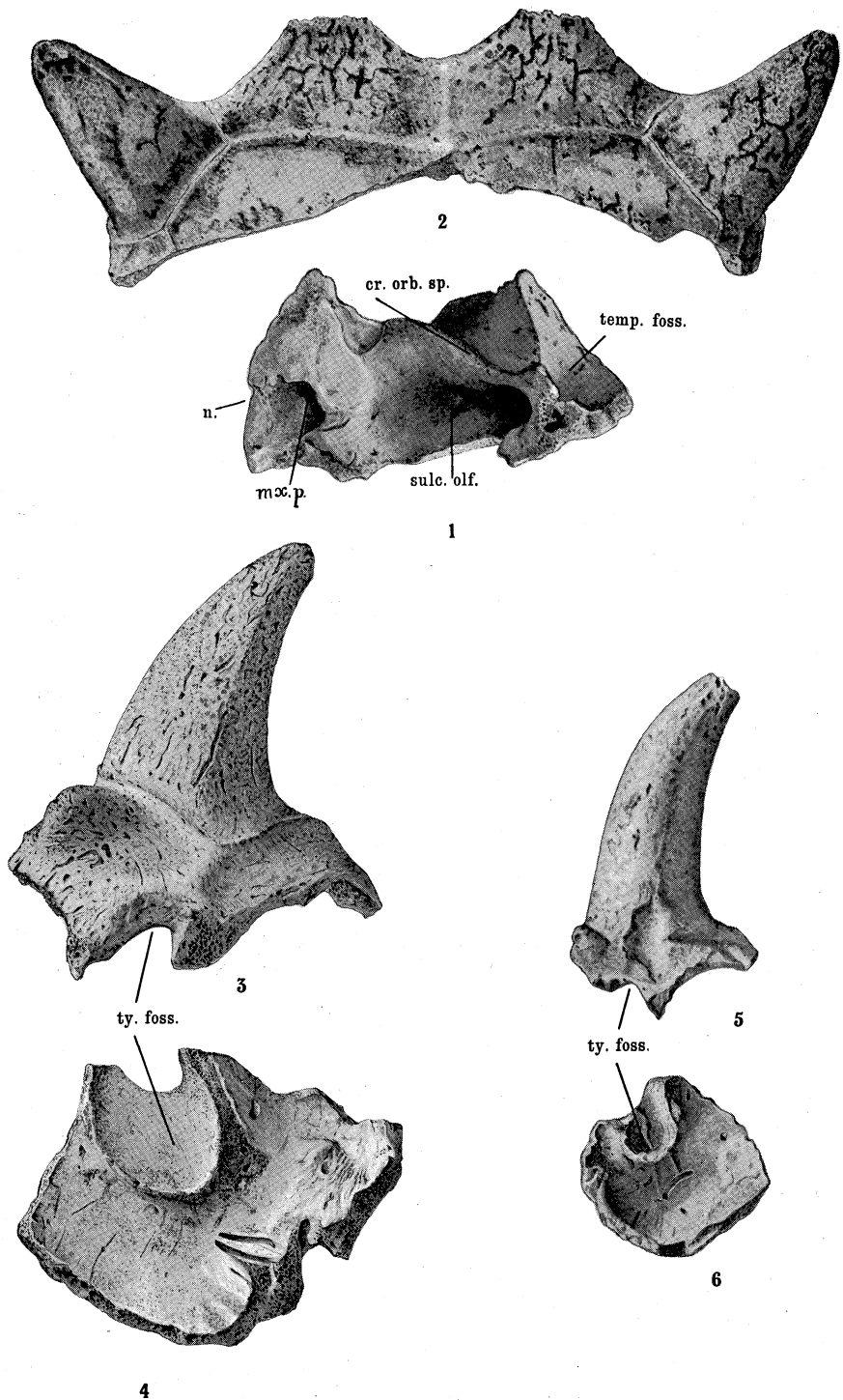
EXPLANATION OF PLATE XXXII.

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- Fig. 1. *Meiolania platyceps* Owen. Part left side of skull roof (upside down). A.M. Nos. F.5473, 1197.
- „ 2. *Meiolania platyceps*. Posterior part of skull roof from behind. Mines Department collection.
- „ 3, 4. *Meiolania platyceps*. Left cranial horn core, side and inferior views; A.M. No. F.16866.
- „ 5, 6. *Meiolania mackayi*, sp. nov. Left cranial horn core, side and inferior views; A.M., No. F17720, holotype.

*Cr.orb. sp.*, crista orbito-sphenoidea; *mx.p.*, maxillary pocket; *sulc.olf.*, sulcus olfactorius; *temp.foss.*, temporal fossa; *ty.foss.*, tympanic fossa.

All figures slightly larger than half natural size.

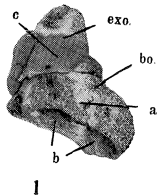


PHYLLIS CLARKE (3, 4), del.  
HELEN E. BAILEY (1, 2, 5, 6), del.

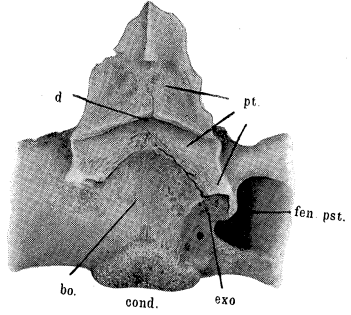
EXPLANATION OF PLATE XXXIII.

- Fig. 1. *Meiolania platyceps* Owen. Part occipital region. A.M., No. F.18363; x  $\frac{1}{2}$  about.
- „ 2. Basicranial region from below. A.M., No. F.1209; less than half natural size.
- „ 3. Front view of brain case. A.M., No. F.1209; less than half natural size.
- „ 4. Tympanic region, left side, front to left. A.M., No. F.1209; x  $\frac{1}{2}$  about.
- „ 5. Brain cavity from above. A.M., No. F.208b; less than half natural size.
- „ 6. Brain cavity from above. A.M., No. F.208a; more than half natural size.

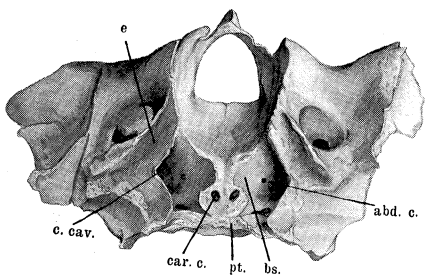
*a*, basisphenoid facies of basioccipital; *b*, pterygoid facies of basioccipital; *c*, position of foramen jugulare (vago-accessory canal); *d*, intra-ptyerygoid slit; *e*, descending parietal plate (?); *f*, opening for passage of columella auris; *g*, canal tunnelling floor of brain case; *h*, opening into auditory chamber; *abd.c.*, abducent canal; *bo*, basioccipital; *bs*, basisphenoid; *c.cav.*, canalis cavernosus; *car.c.*, carotid canal; *car.temp.c.*, carotico-temporal canal; *c.com.*, canal commissure; *c.s.ant.*, anterior semicircular canal; *c.s.post.*, posterior semicircular canal; *cl.pr.*, clinoid process; *cond.*, occipital condyle; *exo.*, exoccipital; *f.jug.ant.*, foramen jugulare anterius (vago-accessory foramen); *fen.pst.*, fenestra postotica; *hyp.c.*, hypoglossal canal; *int.aud.me.*, internal auditory meatus; *pt.*, pterygoid.



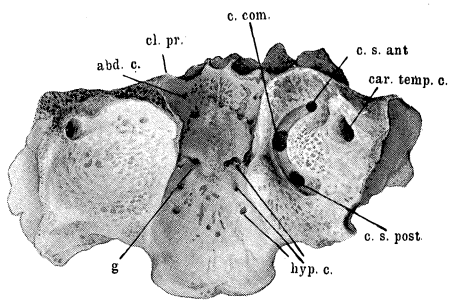
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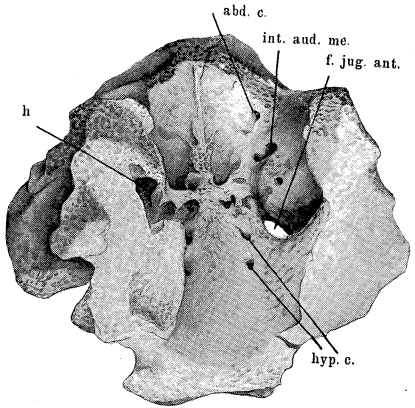
2



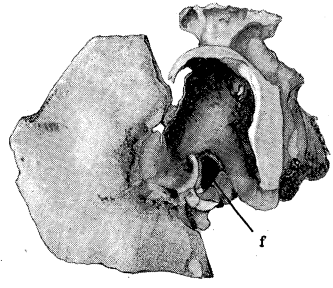
3



5



6



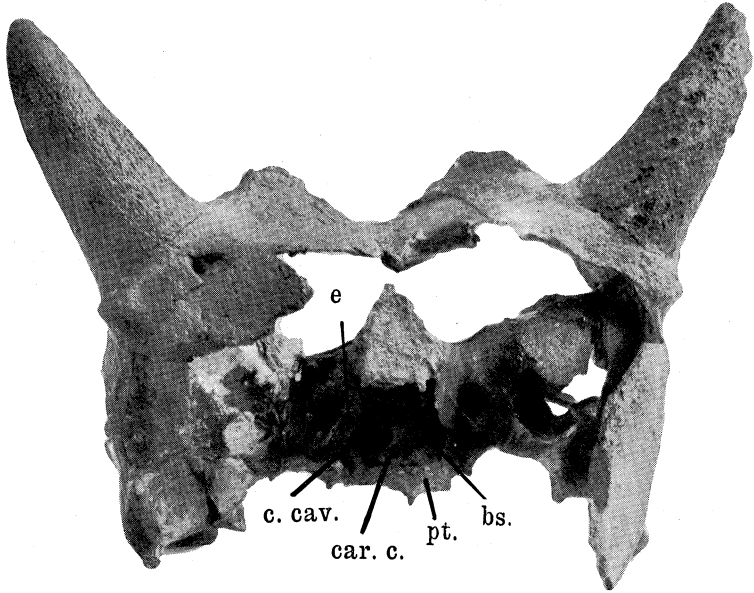
4

HELEN E. BAILEY (4), del.  
 A. R. McCULLOCH (3, 5, 6), del.  
 G. P. WHITLEY (1, 2), del.

EXPLANATION OF PLATE XXXIV.

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- Fig. 1. *Meiolania platyceps* Owen. Front view posterior portion of skull. A.M., No. F.1209; x  $\frac{1}{2}$  about.
- „ 2. Same specimen from right side; x  $\frac{3}{4}$  about.  
*e*, descending parietal plate (?); *bs.*, basisphenoid; *c.cav.*, canalis cavernosus; *car.c.*, carotid canal; *pt.*, pterygoid.



1



2

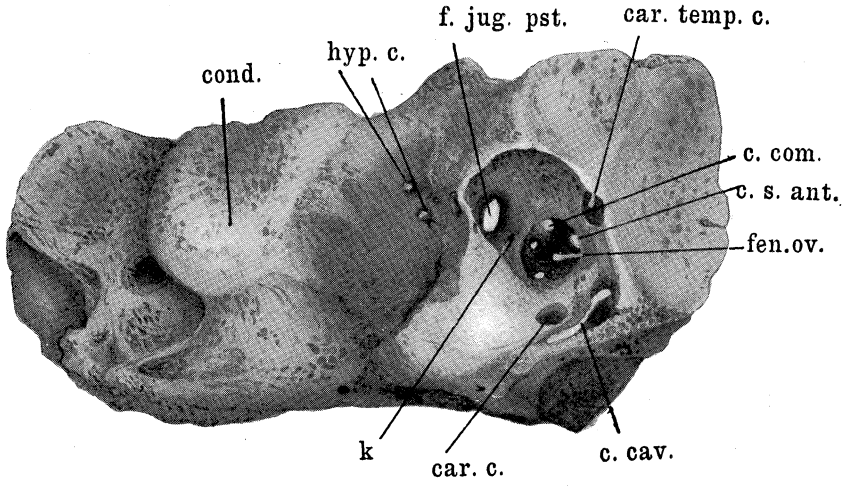
EXPLANATION OF PLATE XXXV.

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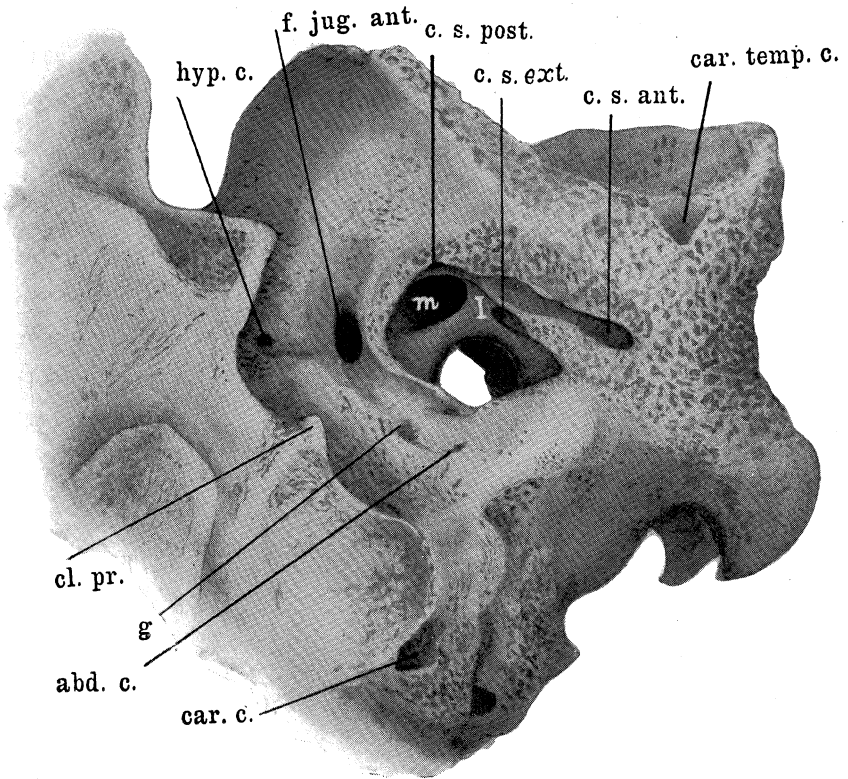
- Fig. 1. *Meiolania platyceps* Owen. Looking into fenestra postocia.  
A.M., No. F.208b; slightly enlarged.
- „ 2. Same specimen showing auditory chamber from medial  
direction; x 4/3 about.

*g*, canal tunnelling floor of brain case; *k*, opening from vago-accessory canal into auditory chamber; *l*, medial wall of exterior semicircular canal; *m*, opisthotic vestibular recess; *abd.c.*, abducent canal; *c.cav.*, canalis cavernosus; *c.com.*, canal commissure; *car.c.*, carotid canal; *car.temp.c.*, carotico-temporal canal; *c.s.ant.*, anterior semicircular canal; *c.s.ext.*, exterior (horizontal) semicircular canal; *c.s.post.*, posterior semicircular canal; *cl.pr.*, clinoid process; *cond.*, occipital condyle; *f.jug.ant.*, foramen jugulare anterius; *f.jug.post.*, foramen jugulare, posterior view; *fen.ov.*, fenestra ovalis; *hyp.c.*, hypoglossal canal.





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EXPLANATION OF PLATE XXXVI.

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*Meiolania platyceps* Owen. Model of skull prepared by J. Kingsley, Australian Museum, reproduced about one-fifth natural size.

- Fig. 1. Front view.  
„ 2. Side view.  
„ 3. Top view.  
„ 4. Back view.  
„ 5. Sagittal section.  
„ 6. Palatal view.

The plate descending from prefrontal to palatal region is more or less conjectural.

*d*, intrapterygoid slit; *e*, descending parietal plate (?); *f*, opening for passage of columella auris; *g*, canal tunneling floor of brain case; *n*, external nostril; *abd.c.*, abducent canal; *ch.*, choana; *cr.orb.sp.*, crista orbito-sphenoidea; *fen.pst.*, fenestra postotica; *f.jug.ant.*, foramen jugulare anterius; *hyp.c.*, hypoglossal canal; *int.aud.me.*, internal auditory meatus; *mx.p.*, maxillary pocket; *pst.pal.f.*, posterior palatine foramen; *st.fi.*, stapedia fessure; *sulc.olf.*, sulcus olfactorius.



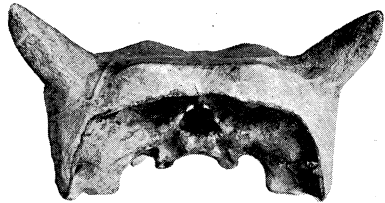
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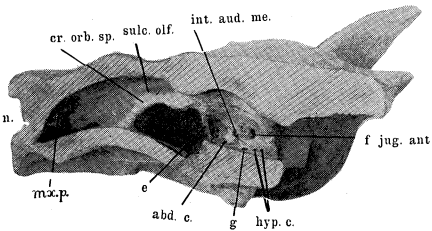
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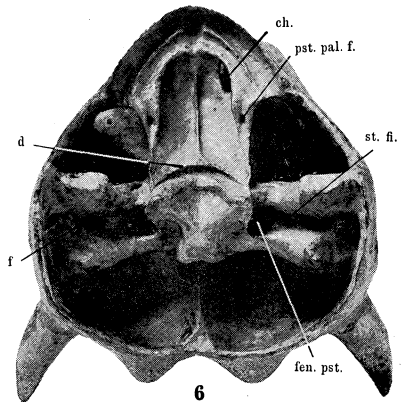
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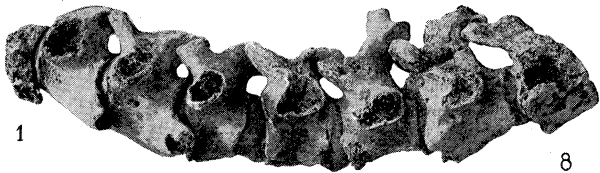


6

EXPLANATION OF PLATE XXXVII.

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- Fig. 1. *Meiolania platyceps* Owen. Cervical vertebrae. A.M., No. F.18315; less than half natural size.
- „ 2. Two late cervicals, perhaps seventh and eighth. A.M., Nos. F.18494, 18495; x  $\frac{1}{2}$  about.
- „ 3. Late cervical (eighth ?), front view. A.M., No. F.18495; slightly larger than half natural size.
- „ 4. Sacral vertebrae; A.M., No. F.9067 from below; less than half natural size.
- „ 5. Same specimen from side and above; larger than half natural size.
- di.*, diapophysis; *par.*, parapophysis.



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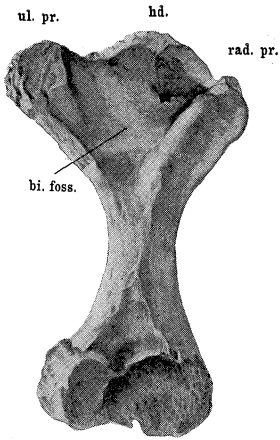
EXPLANATION OF PLATE XXXVIII.

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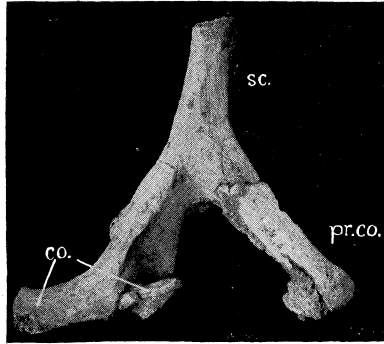
- Fig. 1. *Meiolania platyceps* Owen. Left shoulder girdle; A.M., No. F.18496.  
,, 2. *Meiolania platyceps* Owen. Left humerus, ventral view; A.M., No. F.1204.  
,, 3. *Meiolania platyceps* Owen. Same specimen from ulnar side.  
,, 4. *Meiolania platyceps* Owen. Right humerus, distal end, ventral view, A.M., No. F.405.  
,, 5. *Meiolania platyceps* Owen. Same specimen, distal end, dorsal view.  
,, 6. *Meiolania mackayi*, sp. nov. Left humerus, proximal end, ventral view; A.M., No. 17719.  
,, 7. *Meiolania mackayi*. Right humerus, distal end, ventral view, A.M., No. F.17657.  
,, 8. *Meiolania mackayi*. Same specimen, distal end, dorsal view.

*bi.foss.*, bicipital fossa; *co.*, coracoid; *ect.cond.*, ectocondyle; *ecte.cond.*, ectepicondyle; *ecte.f.*, ectepicondylar foramen; *ent.cond.*, entocondyle; *ente.cond.*, entepicondyle; *hd.*, head; *pr.co.*, procoracoid; *rad.pr.*, radial process; *sc.*, scapula; *ul.pr.*, ulnar process.

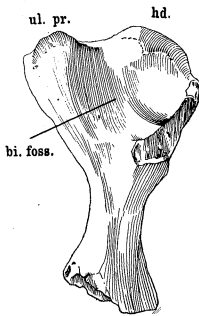
All figures less than half natural size.



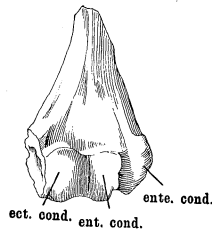
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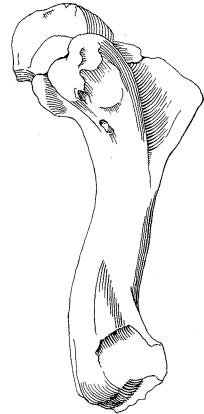
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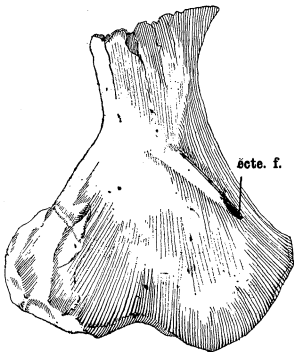
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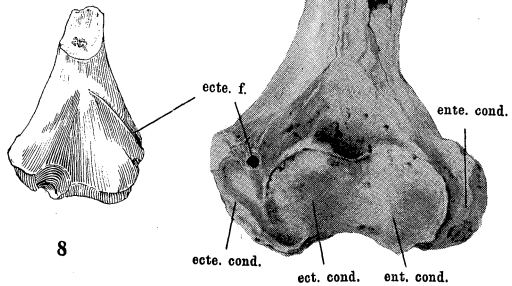
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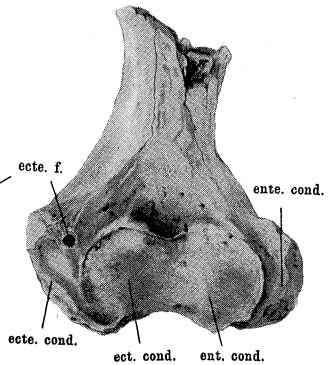
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4

HELEN E. BAILEY (2-8), del.  
G. C. CLUTTON (1), photo.

EXPLANATION OF PLATE XXXIX.

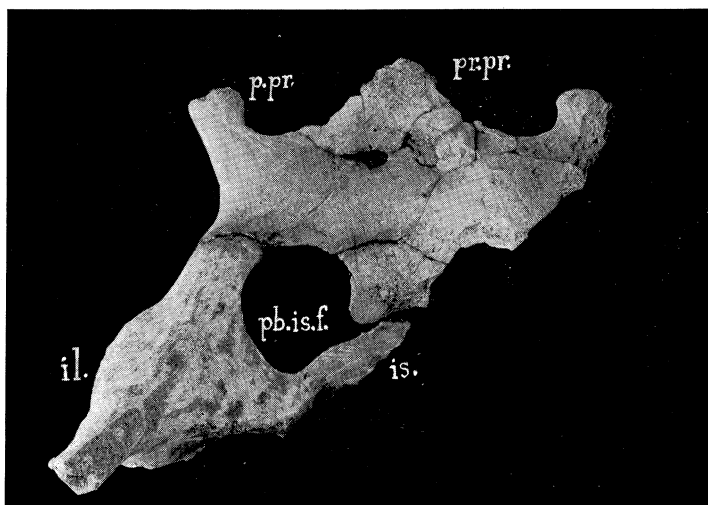
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*Meiolania platyceps* Owen.

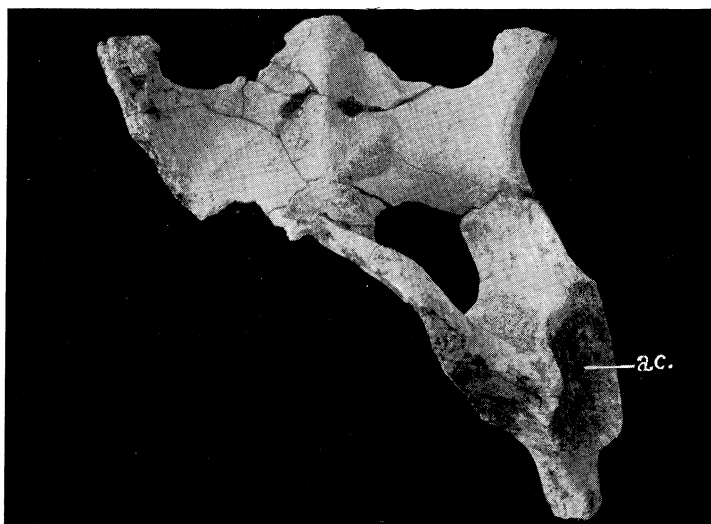
- Fig. 1. Pelvis. A.M., No. F.18497, dorsal view; less than half natural size.  
,, 2. Same, ventral view.  
,, 3. Same, from left side.

*ac.*, acetabulum; *il.*, ilium; *is.*, ischium; *pub.is.f.*, pubo-ischiadic foramen; *p.pr.*, pectineal process of pubis; *pr.pr.*, prepubic process.

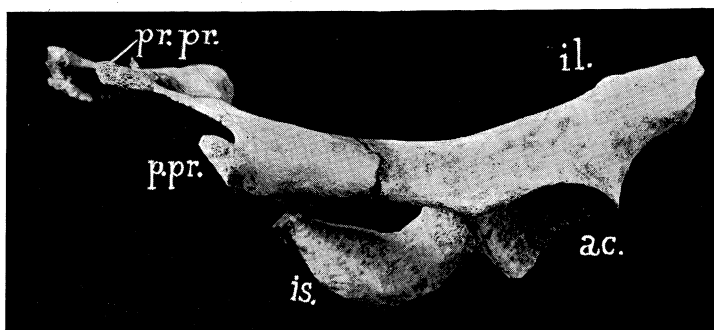




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EXPLANATION OF PLATE XL.

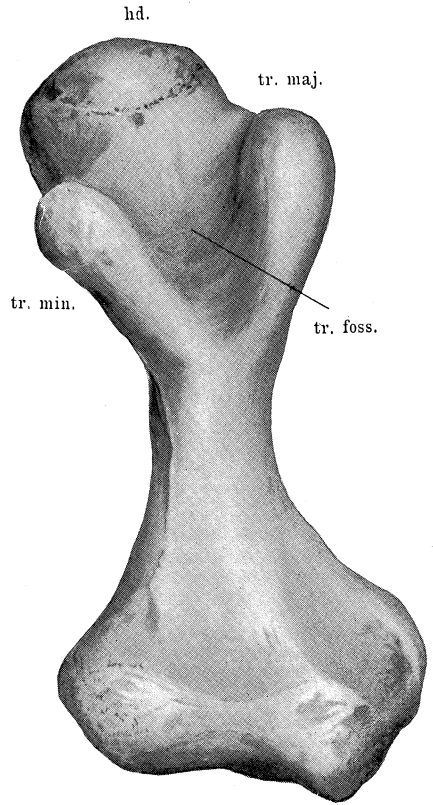
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- Fig. 1. *Meiolania platyceps* Owen. Right femur; A.M., Nos. F.1203, 16858; x  $\frac{1}{2}$  about.
- „ 2. *Meiolania platyceps* Owen. Left femur from fibular side; Mines Department collection; less than half natural size.
- „ 3. *Meiolania mackayi* sp. nov. Right femur, proximal end, A.M., No. F.17665; slightly less than half natural size.
- „ 4. *Meiolania mackayi* sp. nov. Right tibia; A.M., No. F.17660; slightly less than half natural size.
- „ 5. *Meiolania platyceps*. Egg mould, A.M., No. F.1049; slightly less than half natural size.

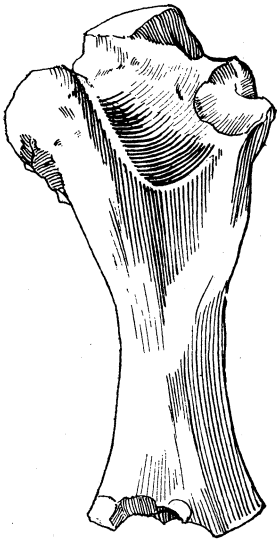
*hd.*, head; *tr.foss.*, intertrochanteric fossa; *tr.major*, trochanter major; *tr.min.*, trochanter minor.



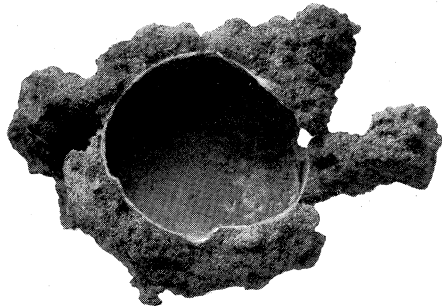
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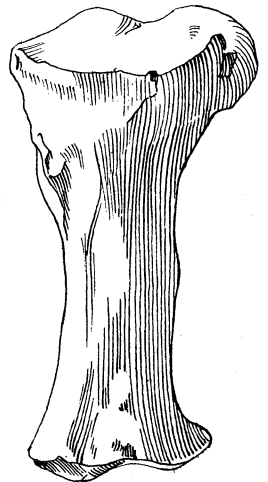
1



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4

HELEN E. BAILEY (3, 4), del.  
 A. R. McCULLOCH (1), del.  
 G. C. CLUTTON (2, 5), photo.