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The Ohope Skull—a new species of Pleistocene sealion from New Zealand

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Abstract An otariid skull from the Middle Pleistocene of Ohope Beach, North Island, is described as a new species, *Neophoca palatina*. The wide interorbital region is the main character that suggests *Neophoca*, but *N. palatina* differs from the extant *N. cinerea* in the smaller alveoli, wider palate and basioccipital, and a difference in the shape of the bulla.

Keywords Otariidae; Pleistocene; New Zealand; Ohope; fossils; *Neophoca palatina*; new taxa; morphology

INTRODUCTION

In March 1939 The Auckland Institute and Museum was presented with a fossil pinniped skull by Mr H. C. McCready. The skull had been found some 2 years previously at Ohope Beach, Whakatane, in the Bay of Plenty, North Island, New Zealand.

Dr J. A. Berry (1890–1962) who contributed considerably to the knowledge of the relatively few specimens of New Zealand fossil seals, worked extensively on this fossil and compared it with specimens throughout the world (Fleming 1968). At his death he left a considerable bulk of papers, including several revised versions of a description of the Ohope skull that he obviously intended publishing. Dr Berry's typescripts are not suitable to be published as they stand, and the increase in recent years both in knowledge of pinniped fossil history and in specimens available for comparison, makes it advisable that the Ohope skull be considered afresh. However, the work done by Dr Berry—his descriptions, comparisons and conclusions—have been incorporated, when appropriate, in the present paper, and my deep indebtedness to Dr Berry is here acknowledged.

Location and geological age

The skull was found just below the surface of an area of talus at the base of cliffs representing a stranded shoreline. (Grid reference approximately NZMS1 N69/466258, or about 37°58'S, 117°03'E.) The sediments from which it came have been dated palaeontologically as New Zealand Castlecliffian Stage, Middle Pleistocene. Fleming writes (pers. comm.) "The Ohope skull can in my opinion be considered between 0.45 and 0.25 million years old (nearer the older figure). Its age would fall between the earliest Pleistocene glaciations and the later ones, perhaps in a phase of warming between the first 2 glaciations and the last 3, but this is an area of uncertainty."

Preservation

Since the Ohope skull has been in my (temporary) possession, Dr Michael Archer (University of New South Wales) has been instrumental in cleaning it further. More matrix has been removed and more of the skull is visible now than when Dr Berry was working on it.

The skull is reasonably complete (Fig. 1), the major portions missing being the tip of the snout anterior to the canines, and both zygomatic arches. The anterior ends of the nasals, and both preorbital and supraorbital processes are missing. Parts of the internal wall of the orbit, and the posterior end of the left side of the palate are broken away. The sagittal and lambdoidal crests are abraded, and there are no teeth. There is no lower jaw.

The characters used for comparison have therefore had to be adapted to those present on the fossil.

Major systematic position

There is an alisphenoid canal; the bulla is formed almost entirely by the ectotympanic, and the frontal bones project anteriorly between the nasal bones. These characters indicate that the fossil belongs to the superfamily Otarioidea. Although they are broken off in the fossil, the intact skull almost certainly had supraorbital processes and thus belongs to the family Otariidae.

Size, sex, and maturity

The occipital condyles are complete but the anterior end of the skull is broken away obliquely just

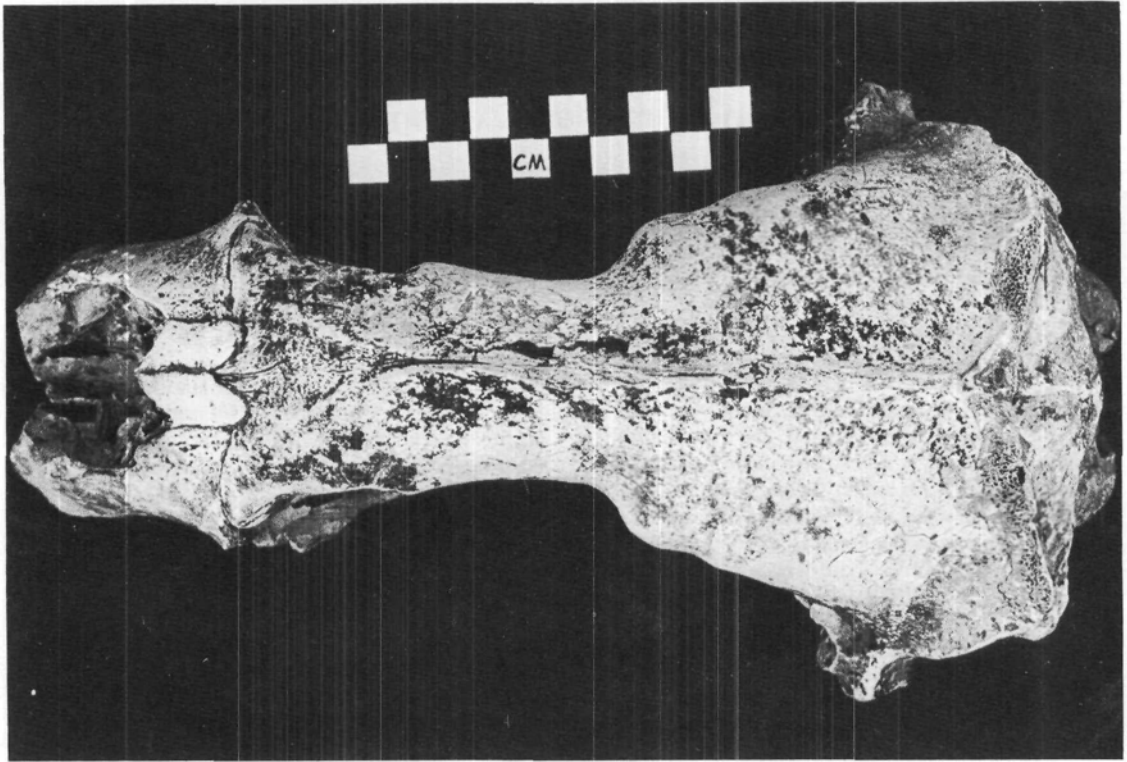


Fig. 1 (above and opposite) Dorsal, ventral, and lateral views of the Ohope skull, *Neophoca palatina*, holotype.

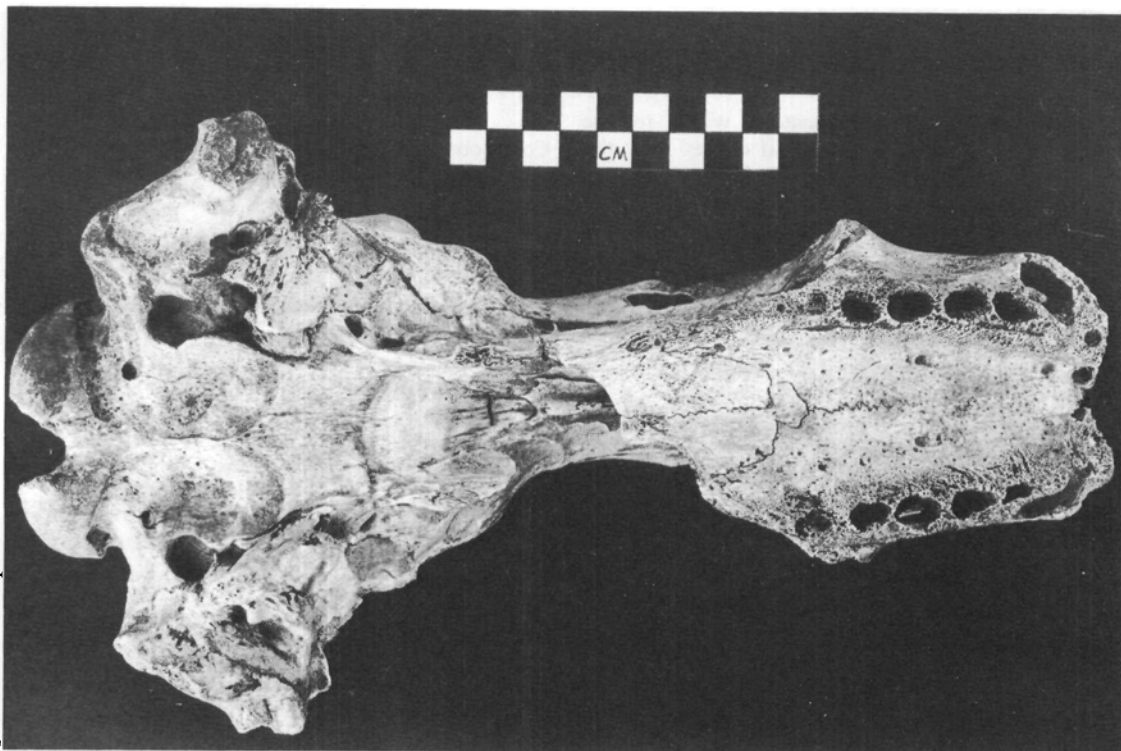
anterior to the canine alveoli. The condylobasal length of the complete skull is estimated to have been 295 mm. As the canine alveoli are broken across obliquely, their anteroposterior diameter is difficult to measure accurately, but it is approximately 20 mm. Thus the size of the canines which would occupy these alveoli, and the general appearance of the skull, make it likely that it came from a male animal.

The suture age of the specimen was estimated, using the method given by Doutt (1942). Of the 9 sutures he uses, 6 (occipito-parietal, squamosoparietal, interparietal, interfrontal, coronal, basioccipital-basisphenoid) are fully fused in the fossil. Part of the premaxilla dorsal to the canine alveoli is present, and fused to the maxilla, but the grooves on the maxillae in the vicinity of the nasals indicate where unfused dorsal parts of the premaxillae lay. A rating of 'half-fused = 2' is given to this suture. The intermaxillary suture is about half fused, but the basiphonoid-presphenoid suture is unfused. This gives a suture age of 29, which would indicate an adult, but not aged, animal.

COMPARISONS

The fossil has been compared with male skulls of the New Zealand sealion *Phocarctos hookeri*, the Australian sealion *Neophoca cinerea*, and the Australian fur seal *Arctocephalus pusillus doriferus*. These are appropriate in terms of geographical distribution and also of size. Adult male *N. cinerea* skulls reach a condylobasal length of about 308 mm, and *A. p. doriferus* skulls about 304 mm. *P. hookeri* skulls are larger, reaching a length of about 339 mm. In terms of distribution, the New Zealand fur seal *Arctocephalus forsteri* should also be considered, but this is a much smaller animal, with a condylobasal length that reaches about 254 mm. Six skulls of *N. cinerea*, 12 of *P. hookeri*, and 6 of *A. p. doriferus* were used for comparison (Tables 1 and 2).

The Ohope skull, with a condylobasal length of 295 mm, thus probably came from an animal about the size of an adult male *Neophoca* or *A. p. doriferus*—i.e., probably with a nose to tail length of 2–2.5 m.



RESULTS OF COMPARISONS

Width of skull at mastoid and external auditory meatus (Fig. 2a and b)

The percentage of the mastoid width to the condylobasal length of the fossil comes near the mean of those of *N. cinerea*, at the lower end of the range for *A. p. doriferus*, and well above the range of *P. hookeri*. At the external auditory meatus the fossil is wide and comes well within the range of *A. p. doriferus* and just at the upper limit of *Phocarctos*. *Neophoca* is narrower here, and the means of both *Neophoca* and *Phocarctos* are much the same.

Interorbital region

Measurements taken were the least width of the interorbital area just anterior to the braincase (Fig. 3c), and the least interorbital width just anterior to the supraorbital processes (Fig. 3d). Both these dimensions are expressed as percentages of the condylobasal length. These measurements and percentages demonstrate the conspicuously broad interorbital region of *Neophoca* and the relative narrowness of this area in *Phocarctos* and particularly in *A. p. doriferus*.

The fossil has a broad interorbital region and falls within the range of *N. cinerea*.

Nasals

The posterior ends of both nasals of the fossil are present but the anterior ends are broken off approximately at the level of the junction of premaxilla and nasal. The dorsal parts of the premaxillae are also missing but oblique grooves on the maxillae indicate where they lay.

The posterior ends of the nasals of the fossil extend posteriorly past the junction of the maxillo-frontal suture with the nasals for c. 5 mm (Fig. 4a). In otariids the most posterior part of the maxillo-frontal suture is usually posterior to the nasals and then bends sharply anteriorly to meet the nasals (Fig. 4b). There is, however, usually some variation in this area and a few of the modern skulls used for comparison have the nasals at maxillo-frontal suture level, or the nasals just posterior. In this respect the fossil is similar to *Thalassoleon mexicanus* a large primitive otariid from the Late Miocene of Cedros Island, Mexico (Repenning & Tedford 1977).

The widths of the nasals of the comparative specimens have been measured at their junction with the maxillo-frontal suture and at their junction with the premaxilla. The dimensions indicate that the posterior parts of the nasals are wide and almost parallel in *N. cinerea*, narrow posteriorly and starting to flare widely anteriorly in *A. p. doriferus*, and rather intermediate in *P. hookeri* (Fig. 5a and b).

Table 1 Measurements of the Ohope skull. %, percentage of estimated condylobasal length.

	Measurement (mm)	%
Condylobasal length (est.)	295	100
Mastoid width	156	52.9
Width external auditory meatus	139	47.1
Least width interorbital area just anterior to braincase	49	16.6
Least width interorbital anterior to supraorbital processes	58.2	19.7
Width nasals at junction with maxillo-frontal suture	24.9	-
Width nasals at junction with premaxillae	26.2	-
Palate length	143.5	48.6
Palate width	43.5	14.7
Palate depth	11.2	3.8
Maximum width snout at canines	69.4	23.5
Maximum width occipital condyles	66.9	22.7
Anterior-posterior length alveolus pc3	11.5	-
Height of ventral tip of paroccipital process above flat surface	10.2	-
Distance between basion and most anterior part of rectus capitis	51.2	17.4
Greatest width of basioccipital	52.7	17.9

The width of the fossil nasals puts them near the upper limits of these bones in both *Phocarctos* and *A. p. doriferus*, but near the lower limits of *Neophoca*. They are, however, fairly wide and parallel, and in this respect are more like *Neophoca*, less like *Phocarctos* and least like *A. p. doriferus*.

Palate

The palate length is taken from the most anterior point of the premaxillae to the most anterior point of the palatal curve, which may be medial or slightly lateral. Palate width is taken between the mid points of the lingual surfaces of the alveoli of pc3. Palate depth is taken in the midline between the centre of a horizontal line between pc3 and 4 on each side, at the level of the alveoli, and for all 3 measurements the percentage of the condylobasal length is obtained.

The fossil palate is short. Its proportions fall within the limits of the shorter palates of *A. p. doriferus*, but well outside those of *Neophoca*, and also well outside the majority of *Phocarctos* (Fig. 2c). In width the fossil palate exceeds all the *A. p.*

Table 2 Means and ranges of measurements and proportions of 3 modern Australasian otariids and *N. palatina*. Except where indicated, the figures are the % of the condylo-basal length.

		<i>N. cinerea</i>	<i>P. hookeri</i>	<i>A. p. doriferus</i>	<i>N. palatina</i>
Number of specimens		6	12	6	1
Mastoid width	range	49.1–57.8	45.0–51.4	52.7–59.9	
	mean	53.1	47.9	55.7	52.9
Width at external auditory meatus	range	41.2–45.5	40.9–47.3	45.8–51.7	
	mean	43.1	43.0	48.8	47.1
Least width interorbital area just anterior to braincase	range	14.3–21.3	9.4–13.5	9.3–11.2	
	mean	17.8	11.2	10.3	16.6
Least width interorbital anterior to supraorbital processes	range	18.8–22.6	15.3–19.4	13.0–16.1	
	mean	21.6	18.1	15.1	19.7
Width nasals at junction with maxillo-frontal suture (mm)	range	25.5–31.0	14.4–24.5	13.3–23.0	
	mean	27.4	20.1	18.2	24.9
Width nasals at junction with premaxillae (mm)	range	27.2–30.2	19.4–26.5	20.4–27.3	
	mean	28.3	22.9	24.0	26.2
Palate length	range	51.9–54.7	49.2–54.6	47.6–51.8	
	mean	53.3	52.4	50.0	48.6
Palate width	range	12.8–14.9	13.9–17.7	10.4–12.1	
	mean	13.7	15.4	11.2	14.7
Palate depth	range	3.7–4.5	5.2–7.3	2.9–4.6	
	mean	4.2	6.2	3.9	3.8
Maximum width snout at canines	range	23.6–26.9	21.2–27.0	21.3–23.7	
	mean	25.3	25.1	22.3	23.5
Maximum width occipital condyles	range	19.3–21.4	20.3–23.9	19.4–22.3	
	mean	20.4	21.7	21.0	22.7
Anterior-posterior length alveolus pc3 (mm)	range	12.0–14.2	12.5–14.7	10.5–12.0	
	mean	12.9	13.6	10.9	11.5
Height of ventral tip of paroccipital (mm)	range	4.7–11.6	3.1–14.7	14.3–23.7	
	mean	6.6	8.3	19.2	10.2
Distance between basion and most anterior part of rectus capitis	range	16.2–17.5	16.3–17.1	11.9–14.6	
	mean	16.9	16.7	12.6	17.4
Greatest width of basioccipital	range	15.1–17.0	11.1–14.4	14.5–16.1	
	mean	16.4	12.3	15.5	17.9

doriferus and is within range of both *Neophoca* and *Phocartos* (Fig. 3b). The figures for palate depth indicate that in this respect the fossil is 'normal' rather than very deep like *Phocartos* (Fig. 6a).

The fossil palate is thus short and wide for the size of the skull. It resembles *A. p. doriferus* in length, but in width lies within the upper range of *Neophoca*, and the lower range of *Phocartos*.

Width across occipital condyles

The fossil falls within the range of *Phocartos* and is wider than both *Neophoca* and *A. p. doriferus* in this region (Fig. 3e).

Width of snout at canines

The fossil comes within the range of all 3 modern animals, though at the upper limit of *A. p. doriferus* and the lower limit of *Neophoca* (Fig. 5c).

Teeth

There are no teeth present in the specimen, the skull anterior to the canine alveoli is broken, and the canine alveoli are broken. The size of the canine alveoli (approx. antero-posterior diameter 20 mm) suggests that the skull is from a male animal.

Posterior to the canines there are on each side 4 virtually complete alveoli. Posterior to the pc4 the bone is abraded, but there is definitely an incomplete pc5 alveolus on each side, and posterior to this, on each side, a very small indentation which could possibly be all that remains of the alveolus for pc6.

The structure of the alveoli would suggest that pc1–3 inclusive were single rooted. Alveolus 4 on the left side is somewhat hourglass shaped, and on the right side the dorsal tip of the alveolus shows that the dorsal millimetre or so of the roots were

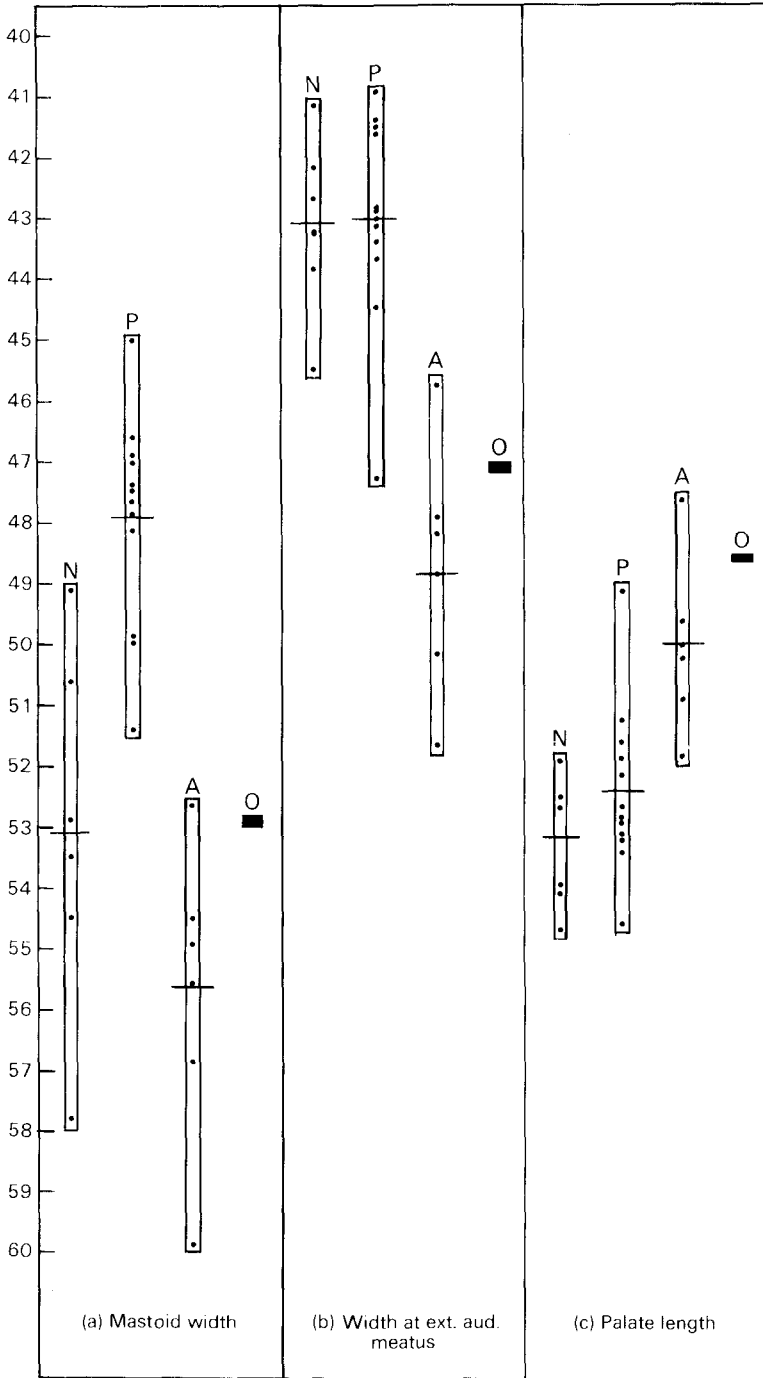


Fig. 2 Proportions of skull measurements to condylo-basal length. The range of proportions is given within the elongated rectangles, and the mean by a cross bar. N, *Neophoca cinerea*; P, *Phocartos hookeri*; A, *Arctocephalus pusillus doriferus*; O, Ohope skull.

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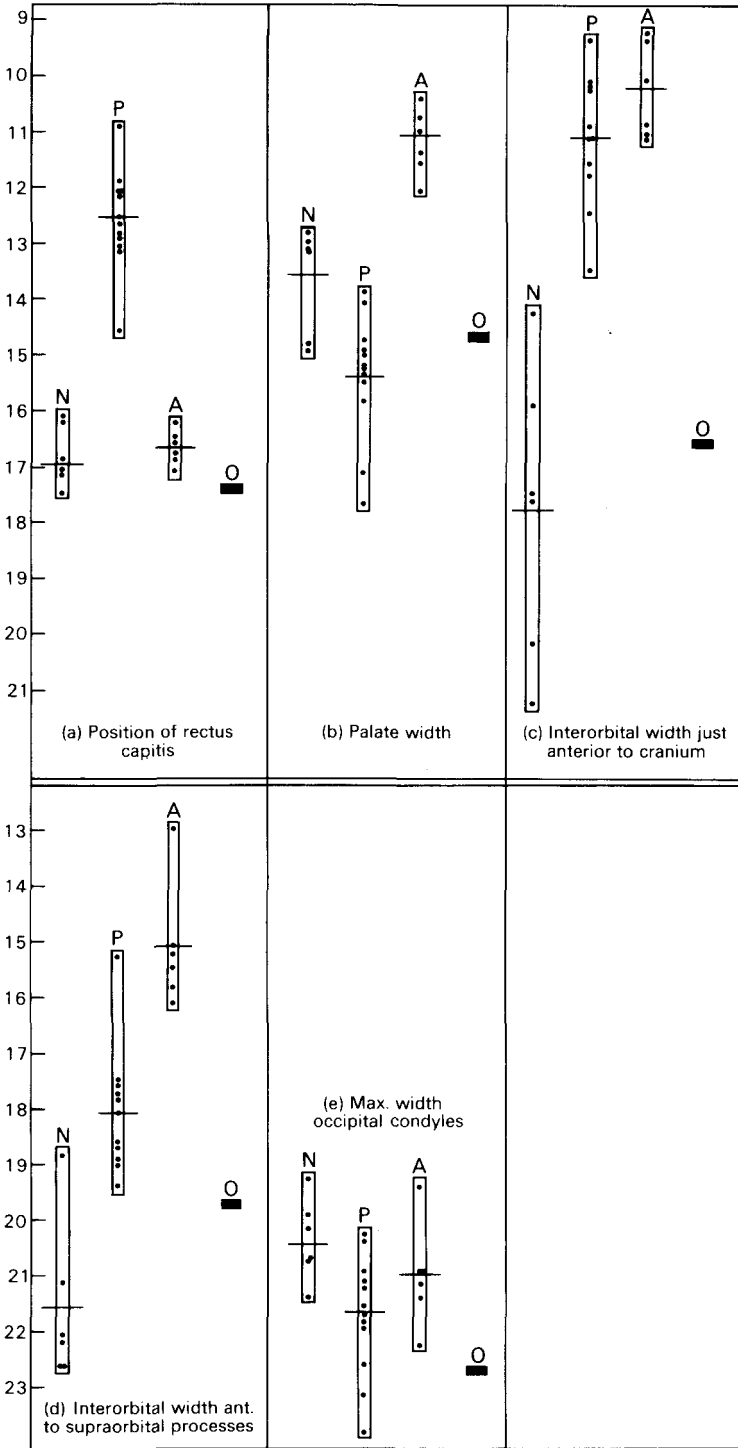


Fig. 3 Proportions of skull measurements to condylo-basal length. Conventions as in Fig. 2.

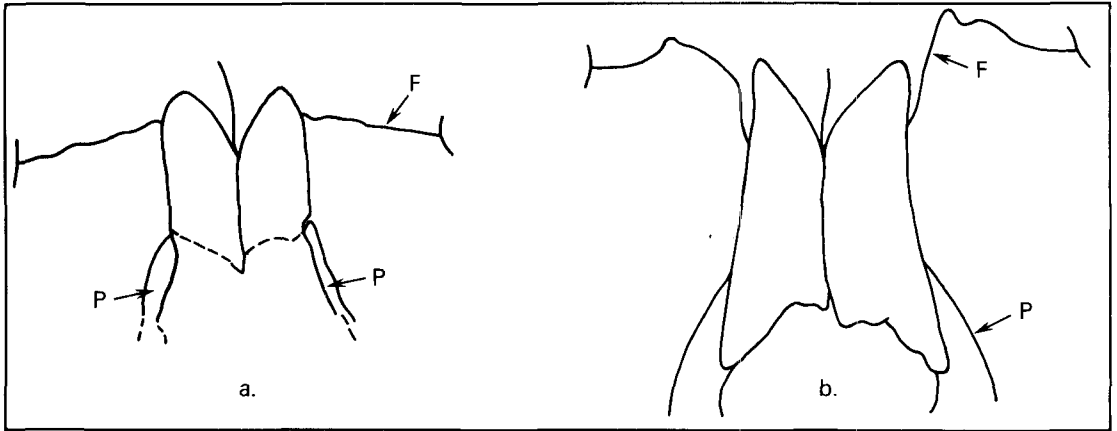


Fig. 4 (a) Nasals of the Ohope skull, showing their relationship with the maxillo-frontal suture (F), and the grooves where the premaxilla articulated (P). The anterior ends of the nasals are broken. 75% natural size. (b) Nasals of *Neophoca cinerea* M8945 (Australian Museum, Sydney) showing the maxillo-frontal suture (F), and the premaxilla-maxilla suture (P). 75% natural size.

separate, but such a situation is common in modern otariids.

The antero-posterior length of the alveolus for pc3 was measured. The length of this alveolus in the fossil indicates that it had cheek teeth approximately the size of those of *A. p. doriferus*, and not of the larger size of *Neophoca* and *Phocartos* (Fig. 6b).

Shape of mastoid

In the extant species used for comparison, the mastoid area between the paroccipital process and the external auditory meatus is short and broad, appearing rather square in *Neophoca* and *Phocartos*, but longer and narrower, appearing more rectangular in *A. p. doriferus* (Fig. 7a and b).

The occipital condyles and paroccipital processes in *A. p. doriferus* give the impression of having been lifted up, thus 'pulling' the paroccipital process away from the mastoid. The result of this 'pull' is the longer mastoid area in *A. p. doriferus* and the greater height of the occipital condyles when the skull is placed on a flat surface. In *Phocartos* and *Neophoca* the occipital condyles are much closer to the flat surface.

The 'upward pull' of the hind end of the skull of *A. p. doriferus* can also be seen in the height of the ventral tip of the paroccipital process above a flat surface, which is considerably greater in this fur seal than in the sealions. This is, in effect, the vertical distance between the ventral tips of the mastoid and the paroccipital process.

The width and length of the mastoid area and the distance between flat surface and occipital condyles are difficult to measure accurately, but the height of

the paroccipital process above a flat surface can be adequately measured (Fig. 8).

The overall shape of the mastoid area of the fossil (Fig. 7c), although slightly long, is sealion-like, rather than fur seal (*A. p. doriferus*)-like. The distance of the paroccipital process, and also of the condyles, above a flat surface is also sealion-like.

Bulla

FOSSIL

Neither bulla is complete. The posterior end of the right bulla and carotid canal is missing from about the level of the stylomastoid foramen. The left bulla is nearly complete, but there is abrasion to the most ventral portion, ventro-lateral to the carotid canal.

The bulla of the fossil (Fig. 9) can be divided roughly into 2 areas. If a line is drawn from the anterior edge of the external auditory meatus, obliquely across to the posterior opening of the carotid canal, that part of the bulla anterior to this line is very smooth, and stops with a rounded edge, leaving c. 6–7 mm of the entotympanic round the carotid canal exposed. The posterior part of the bulla is slightly roughened and seems to have no particular characteristics.

Neophoca

In juvenile specimens (condylobasal length 257 mm) the whole bulla is rather flat, but the ectotympanic extends medially almost like a shelf, covering the entotympanic of the carotid canal and overhanging the junction between basioccipital and carotid canal. In a ventral view the carotid canal is scarcely visible.

In adult specimens (of the size of the fossil) this medial 'shelf' is elaborated into spiky processes

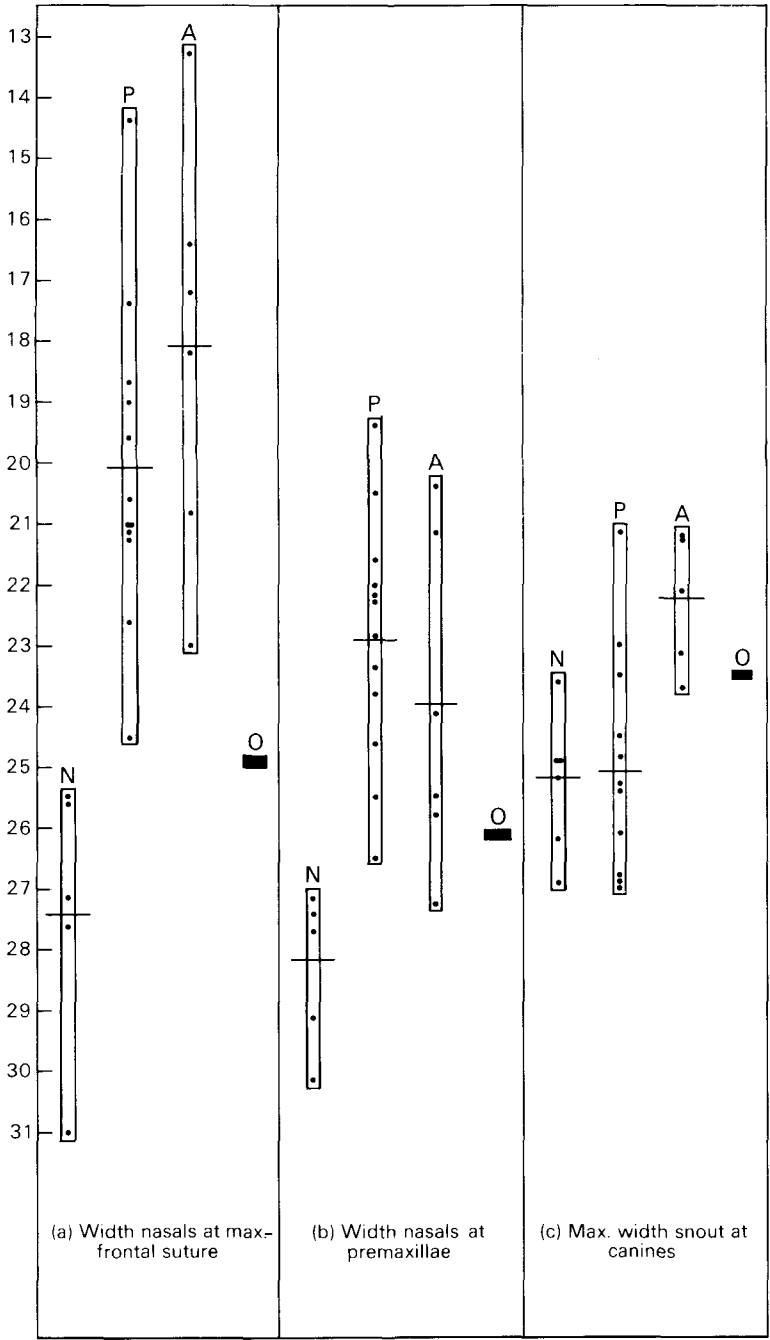


Fig. 5 Proportions of skull measurements to condylo-basal length. Conventions as in Fig. 2.

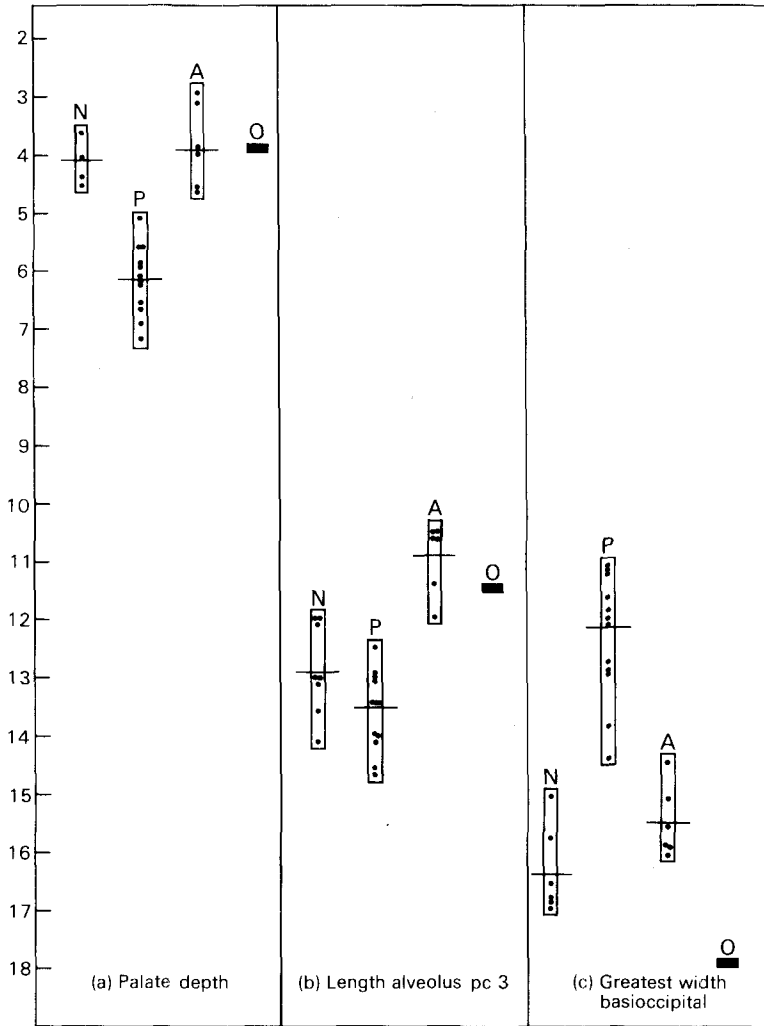


Fig. 6 Proportions of skull measurements to condylo-basal length. Conventions as in Fig. 2.

which extend ventrally or ventromedially, and are individually variable (Fig. 10).

The lack of such processes (which would be visible at least in part, even in the incomplete fossil), the very flat anterior end of the bulla, and the wide exposure of the carotid canal are characters in which the fossil differs from *N. cinerea*.

Phocarcetos

In very young pups the bulla is much as in *N. cinerea*, though possibly the medial shelving of the ectotympanic is less pronounced. In other specimens (the size of the fossil and larger), the entotympanic of the carotid canal remains exposed, and the 'creeping' of the ectotympanic is posteriorly,

resulting in the very characteristic posterior process (Fig. 11a) (King 1960). The fossil shows no sign of such a process.

In *Phocarcetos* the lateral edge of the basioccipital, the carotid canal, and the medial parts of the bulla are all approximately in 1 horizontal plane, whereas in the fossil the part of the bulla adjacent to the carotid canal is c. 5 mm more ventral to it, and in *N. cinerea* this area becomes prolonged into processes.

A. p. doriferus

The ectotympanic is slightly inflated, meeting or almost meeting the basioccipital, but not overlapping it medially as in *Neophoca*. Part of the anterior third of the carotid canal may be visible (Fig. 11b).

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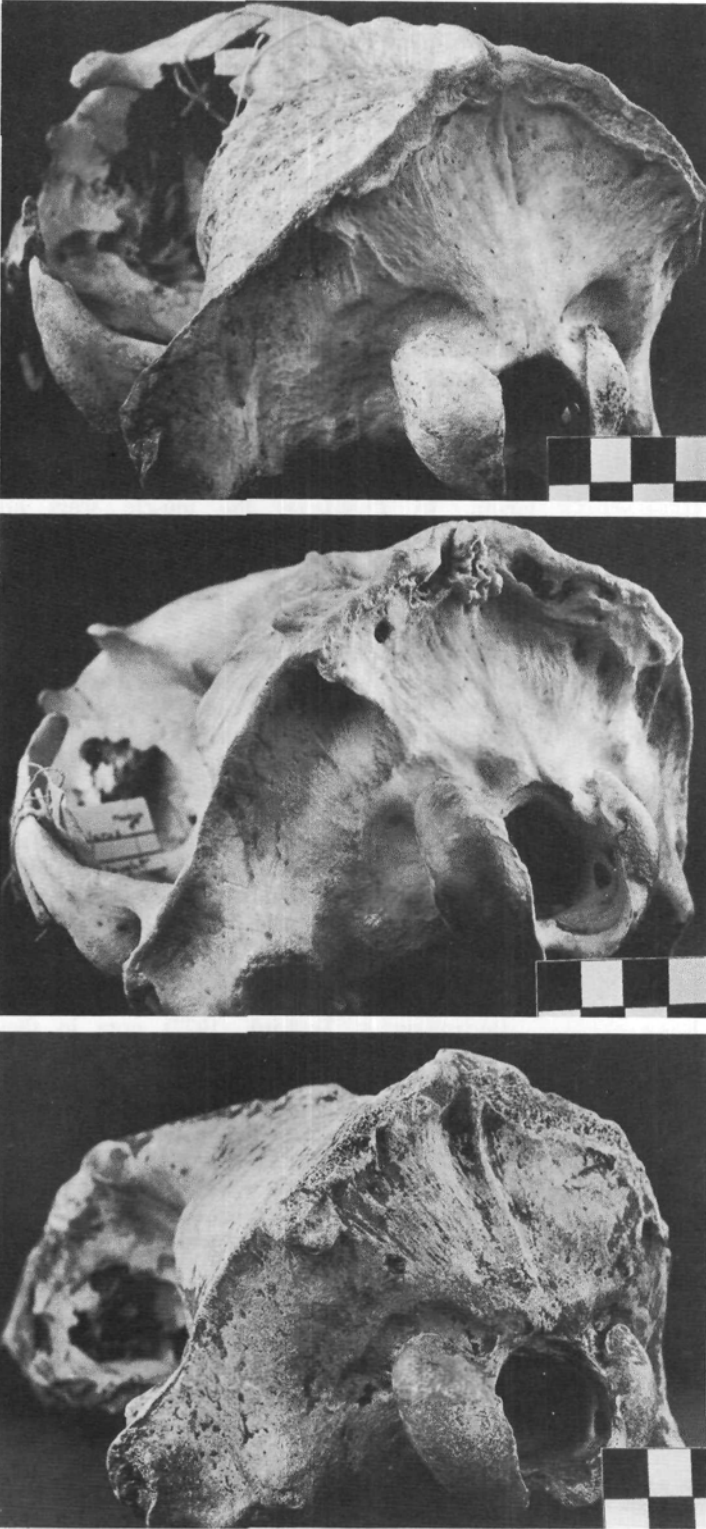


Fig. 7 Posterior views of skulls to show the shape of the mastoid area. (a) *Neophoca cinerea* M 8944 (Australian Museum, Sydney); (b) *Arctocephalus pusillus doriferus* M 4750 (Australian Museum, Sydney); (c) Ohope specimen, *Neophoca palatina*, holotype, Mamm. 175.1 (Auckland Institute and Museum)

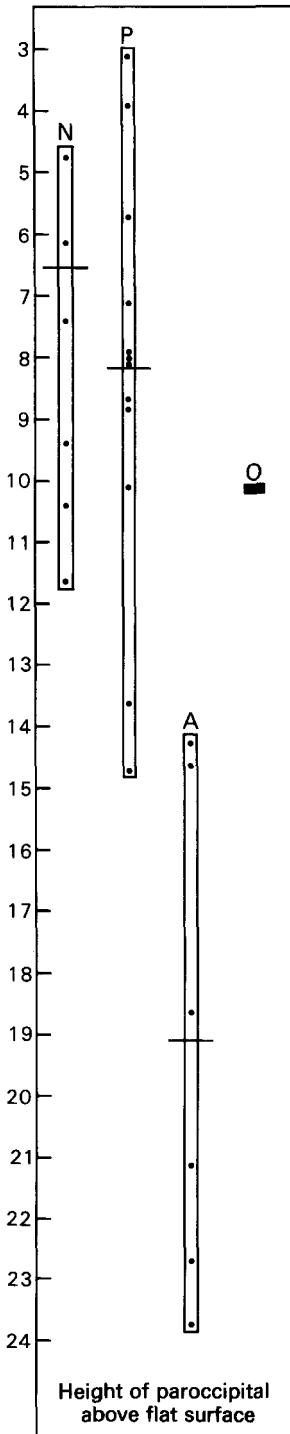


Fig. 8 Heights of paroccipitals above flat surface, as proportions of condylo-basal length. Conventions as in Fig. 2.

The fossil bulla shows some resemblances to *A. p. doriferus* in the lack of processes, but is different in the very flat nature of the anterior part of the ectotympanic and the distance between ectotympanic and basioccipital.

Rectus capitis insertion

The rectus capitis muscles are inserted on the basioccipital, forming 2 hemispherical depressions between the bullae. There is a difference in the distance of these muscle scars from the occipital condyles (Fig. 9, 10, 11a and b). The measurement was taken between the basion and the mid point of a line across the most anterior parts of the muscle scars.

In this respect *N. cinerea*, *A. p. doriferus*, and the fossil are similar, with the distance of the scars from the basion being about 16–18% of the condylobasal length. In *Phocarcetos* the muscle scars are considerably closer to the occipital condyles (12.6% of condylobasal length) (Fig. 3a).

Shape of basioccipital

In the fossil the basioccipital is widely flaring, with its maximum width at about the level of the posterior end of the carotid canal. The rectus capitis muscle scars form 2 deep saucer-shaped depressions (Fig. 9).

In *Phocarcetos* the basioccipital is more parallel-sided, and not so expanded where the muscles are inserted (Fig. 11a). *N. cinerea*, *A. p. doriferus*, and also *Zalophus californianus* have an expanded basioccipital, similar to, but less pronounced than in the fossil (Fig. 6c, 10, and 11b). In this respect the Ohope fossil seems most similar to *Thalasseoleon mexicanus*, where the expansion of the basioccipital is even more pronounced.

Repenning & Tedford (1977) note in their description of *T. mexicanus* "In ventral aspect the basioccipital is trapezoidal in form and unusually broad posteriorly compared with *Arctocephalus* and most living otariids. This bone is essentially rectangular and has parallel lateral margins in living fur seals, but comparably broad and trapezoidal basioccipital bones are present in some of the living sea lions, notably *Neophoca* and *Zalophus*."

SUMMARY OF COMPARISONS

The Ohope fossil skull is from a sealion-like animal, male and probably of a nose to tail length of 2–2.5 m. It resembles *N. cinerea* in the great width of the interorbital region, and in the parallel sides of the nasal bones. It resembles *N. cinerea* and also *A. p. doriferus* in the shape of the basioccipital, though the width is more pronounced than in either of these,

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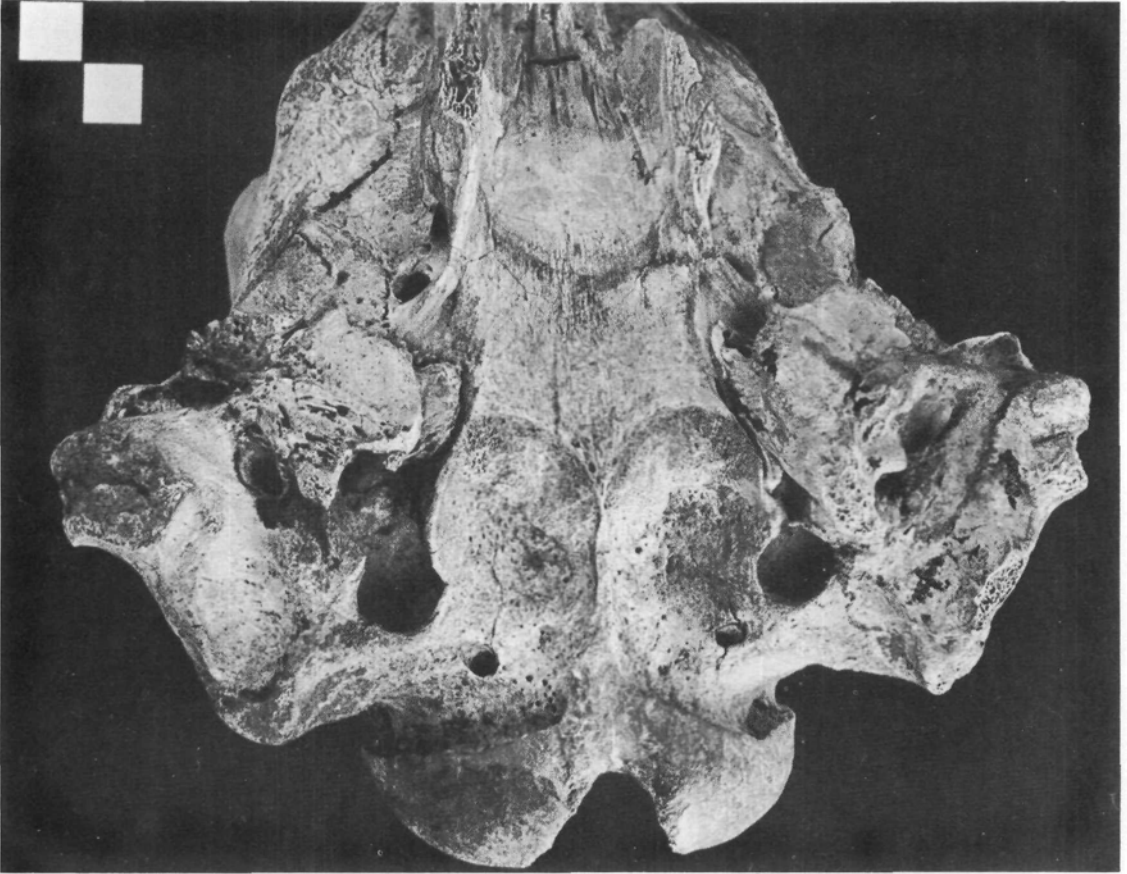


Fig. 9 Ventral view of posterior end of *Neophoca palatina*, holotype, showing the bulla, the scars of the rectus capitis muscle, and the shape of the basioccipital.

and also in the position of the rectus capitis insertion scars. The alveoli indicate postcanine teeth the size of those of *A. p. doriferus*, rather than the larger sealion-type teeth. The short and comparatively wide palate, the wide basioccipital, and the shape of the bulla are characters that seem to be particular to the fossil. Of the 3 genera used for comparison the fossil is least like *Phocartos*.

FOSSIL BACKGROUND

Little is yet known of the fossil history of otariids in the southern hemisphere. Repenning & Tedford (1977) and de Muizon (1978) have summarised what is known, and the paucity of records of specimens from Australia and New Zealand is noticeable.

Fossil *Neophoca cinerea* is known from the Upper Pleistocene of Queenscliff, Port Phillip Heads, Victoria; a skull was described from this locality

from strata thought at the time to be Pliocene. This skull, described as *Arctocephalus williamsi* by McCoy (1877) is in the National Museum of Victoria (Reg. No. P12110). It is well known to be a *Neophoca cinerea* of modern appearance, and later work suggests that it comes from the Upper Pleistocene (Gill 1968). Specimens from historic times are known from middens in Tasmania, and Matthew Flinders found these sealions in Bass Strait (Marlow & King 1974). All the above records are extensions of the modern range, which does not normally extend east of Kangaroo Island, South Australia.

Phocartos hookeri has no known prehistoric record. The specimen described as *Arctocephalus caninus* from the 'Pliocene' of Cape Kidnappers, New Zealand (Berry 1928) has been re-identified as *Phocartos hookeri* (Berry & King 1970), and its age re-estimated as probably less than 1000 years old, the specimen probably having come from a midden (Western et al. 1973).

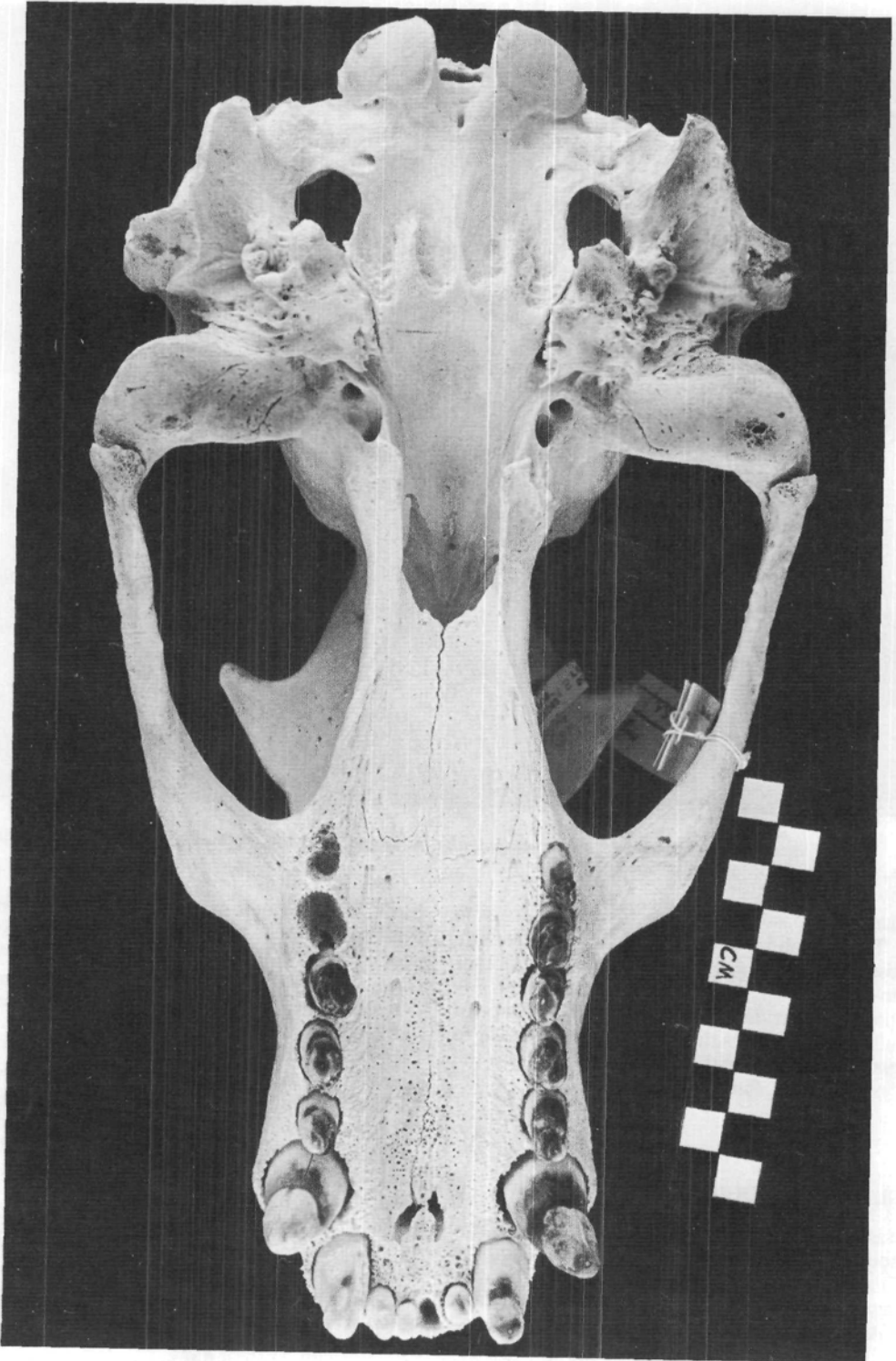


Fig. 10 Ventral view of skull of *Neophoca cinerea* M 8945 (Australian Museum, Sydney), as in Fig. 9.

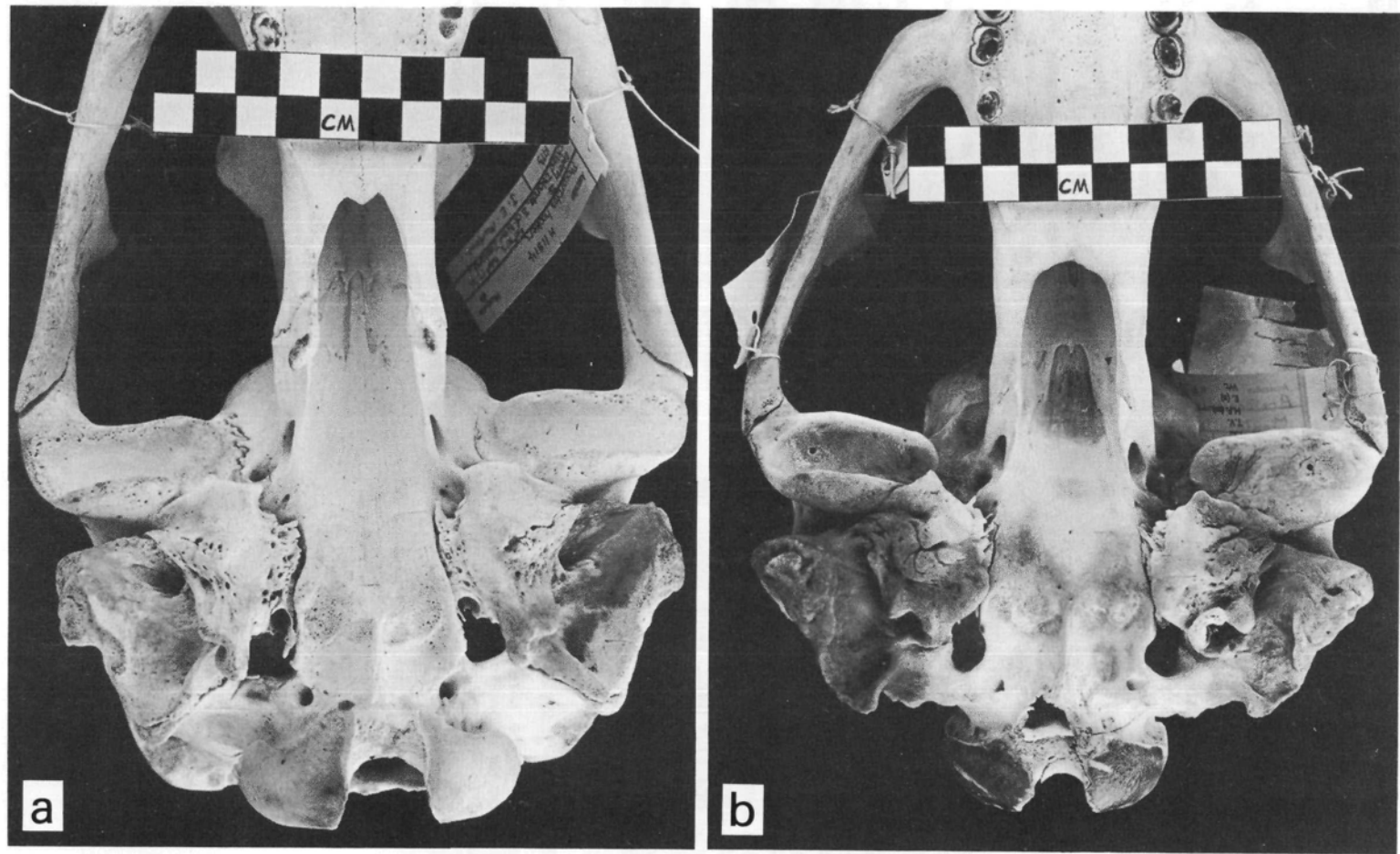


Fig. 11 Ventral views of posterior ends of skulls of *Phocarctos hookeri* M 11814 (a), and *Arctocephalus pusillus doriferus* M 4750 (b), as in Fig. 9. Both skulls from Australian Museum, Sydney.

Arctocephalus p. doriferus has no known prehistoric record in Australia.

The Ohope skull is not a Pleistocene example of an extant species of *Neophoca*, *Phocarctos*, *Arctocephalus*, or any other otariid. Of the 3 genera mentioned, it is least like *Phocarctos*, and is perhaps most like a *Neophoca*, particularly in the width of the interorbital region, but has smaller, *Arctocephalus*-like alveoli. The characters of palate and bulla suggest that the specimen is worthy of specific distinction, and Dr Berry suggested the name *Neophoca palatina* n. sp.

Neophoca palatina n. sp.

Holotype

Adult male skull, no lower jaw, found in Castlecliffian (Pleistocene) deposits at Ohope Beach, near Whakatane, Bay of Plenty, North Island, New Zealand. Grid reference approximately NZMS 1 N69: 466258, or about 37°58'S, 117°03'E. Specimen housed in Auckland Institute and Museum, Auckland, New Zealand, Registered number Mamm. 175.1., New Zealand fossil record number N69/f502.

Sealion with short palate (48.6% of condylobasal length), and rather small cheek teeth (ant.-post. length alveolus pc3 11.5 mm). Bulla without the processes of *N. cinerea* or *Phocarctos*; anterior end of bulla very flat. Basioccipital very wide (17.9% of condylobasal length).

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