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VIII.—Scottish National Antarctic Expedition: Osteology of Antarctic Seals.

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Through the courtesy of Dr W. S. BRUCE, the leader of the Scottish National Antarctic Expedition, and of the late Professor D. J. CUNNINGHAM, the skeletons of the seals collected in the Antarctic during the voyage of the *Scotia* have been placed in my hands for study, and I wish to express my gratitude to these gentlemen for their great kindness in placing all the necessary requirements at my disposal. I also wish to state that Dr BRUCE has given to the Museum of the University of Edinburgh a choice of the various skeletons, which, together with the specimens already obtained, will form a comprehensive and almost unique collection of the Antarctic seals.

The seals obtained during the stay of the *Scotia* in the Antarctic seas numbered forty-four, and embrace all the Phocidæ found there, with the exception of the elephant seal. Of the forty-four, thirty-four are Weddell seals (*Leptonychotes Weddelli*); four are saw-toothed seals (*Ogmorrhinus* or *Lobodon carcinophaga*); three are leopard seals (*Stenorhyncus leptonyx*); one is a sea-lion (*Otaria Jubata*); while two are Ross seals (*Ommatophoca Rossi*).

A most careful account of date of capture, sex, probable age, full measurements, and weight was recorded in a special log-book. In some cases the skeletons were cleaned by immersing the carcases beneath the ice, when amphipods and cushion-starfish did the work; in other cases the carcases were conveyed in special tanks and cleaned after their arrival home.

The osteology of the more common species of the Phocidæ represented in this collection, such as the Weddell seal, saw-tooth seal, sea-lion, and leopard seal, appears to have been pretty fully worked up, and especially so in a minute and careful description by Principal Sir WILLIAM TURNER; for the present, therefore, the endeavour of this work is to present a detailed description of the Ross seal, as I have not been able to find such of the skeleton of this species, with the exception of the skull. In the second place, I purpose making a summary of the large collection of other seals with regard to such points as dentition and vertebral formula, since the collection is large enough to obtain a satisfactory average.

ROSS SEAL (*Ommatophoca Rossi*).

The first specimen of *Ommatophoca* was obtained by Sir JAMES ROSS in 1840, in the pack-ice in the Ross Sea, and is now preserved in the British Museum as the type-specimen. I am indebted to the authorities of the British Museum and to Dr O. THOMAS for the privilege of examining this specimen for purposes of com-

parison. Unfortunately, it is not a complete skeleton: both fore-limbs with the exception of one scapula, both hind-feet, one dorsal vertebra, and two pieces of sternum are awanting. A description of the skull was made by Dr J. E. GREY in 1844. For over fifty years it remained the sole representative of its race in natural history collections, as not till 1899 was the Ross seal again captured by the Belgian Expedition (1898–9). Since then numerous specimens have been obtained and the skins and crania brought home by the *Southern Cross* (1898–1900), *Discovery* (1901-4), *Morning* (1902–4); while the *Scotia* captured two specimens—a male and a female, of which the male skeleton is complete with the exception of two segments of the sternum and one patella. The female skull has been unfortunately damaged, the occipital region being wanting; but a perfect set of teeth, of so much importance in *Ommatophoca*, is preserved. Further, the whole respiratory apparatus of the male Ross seal has been brought home, and is of great interest—as the voice of this animal, which has been described by Dr RACOVITZA, with the peculiar inflation of the pharynx, has attracted the notice of, and been recorded by, most Antarctic explorers.

The method of describing the skeletons is that adopted by Sir WILLIAM TURNER in *Challenger Reports*, and I wish to express my appreciation of its arrangement and carefulness.

Surface Measurements (from Log-Book).

	No. 2.	No. 43.
Date of Capture—6th February 1903.		28th February 1904.
Sex—Female.		Male.
Age—Adult.		Adult.
Length—		
Nose to tip of tail, 90″.		89·5″.
Girth—		
Anterior or neck, 41″.		38·5″.
Axillary, 52″.		55·5″.
Greatest (9 ins. behind axillary), 54″.		(12 ins. behind axillary), 56·5″.
Tail, 5″.		
Fore flippers—		
Outer edge, 16″.		17·2″.
Base, 8½″.		
Hind flipper—		
Outer edge, 16″.		18·4″.
Inner edge, 14½″.		18·7″.
Stretch, 25″.		24″.
Base, 10·7″.		11″.
Eye, 1½″ × 1″.		1·4″ × 8″.
Interorbital space, 6″.		6·5″.
Total weight, 450–500 lbs.		400 lbs.

Remarks.

Intestines of No. 43 measured from pyloric end of stomach to anus 268″. Cuttlefish beaks, pieces of cuttlefish, and what appeared to be scales of fish were found in the stomach. A great quantity of tape-worms were present in the gut.

No. 43 of Collection (Male).

The skull is characteristically short and broad. The greatest length was from premaxilla to the occipital condyles, whilst the greatest breadth was between the two zygomatic arches, just at the articulation between its two component parts—the zygomatic process of the temporal and the malar bones.

A comparison of this skull was made with those of an adult Weddell and sea-leopard in regard to length and breadth—an index being framed. Thus, the length-breadth index of the Ross skull was 72·4; of the Weddell skull, 62·13; of the leopard seal, 55·07. The nasals measured 79 mm. long, and were completely ankylosed. They articulated with the frontal and superior maxillary bones. The part between the two frontals amounted to about three-quarters of the entire length of the bones (57 mm.), and was triangular in form, while the remaining quarter between the two superior maxillary bones was quadrilateral.

The distance between anterior edge of the outer border of the nasals and the tip of premaxilla was 18 mm., the superior maxilla thus forming to this extent part of the outer boundaries of the anterior nares. "The length of the section of the boundary formed by one of these bones varies in the different specimens from 9 to 17 millimetres" (Barrett Hamilton, *Résultats du Voyage du S.Y. "Belgica,"* 1897-1899, p. 5). The anterior nares sloped downwards and forwards at an angle of 59° with the hard palate. In Weddell seal this angle was 48°, in leopard seal 35°.

The anterior nares were bounded from above downwards by the anterior border of the nasal bones, part of nasal borders of superior maxilla, and by the premaxillary bones. Looking into the anterior nares, one was struck with two points—the thickness of the meso-ethmoid, and the extremely convoluted arrangement of the turbinate bones. The anterior edge of the vomer was received between the meso-ethmoid and the premaxillary bones. The premaxillary bones supported the two incisor teeth; their palatal parts were triangular in form, and, as before mentioned, their nasal parts did not extend so high as to meet the nasal bones. The ante-orbital process of the superior maxilla was well marked, and lay in the same transverse plane as the infra-orbital foramen, below which is a definite depression from which a groove leads to the orbital floor. The widest part of the hard palate was situated well behind the last molar, and was 7 mm. in front of outer end of articulation of palatal processes of the superior maxilla and palate bone. It was almost flat, showing only a trace of a concavity. The posterior border of the hard palate was concave, and possessed a faint post-nasal spine. On the norma verticalis of the skull, at the junction of the frontal bones, *i.e.* at the seat of the anterior fontanelle in the young, is situated an opening between the bones. Its margins are irregular and spiculated (see fig. 1). As there is no history of an injury, the animal not being clubbed, but shot in the thorax, it appears to me to be a persistent anterior fontanelle. In the female Ross seal this condition is only faintly represented, but in the plate of the Ross seal of the Belgian Expedition a similar well-marked deficiency is to be

observed. The occipital bone presented occipital crests which were well marked, as also were the par-occipital processes. Two well-marked supra-occipital venous foramina were to be noticed in the middle line of the occipital squama. The condylar articular surfaces were highly convex and approached close to each other on the inferior aspect (7 mm.); above, they were distant 41 mm.

The basi-occipital was quadrilateral in form, flat and thick. The tympanic bulla was smooth and rounded. The carotid canal was separated from the jugular foramen by a thick bar of bone. In the interior of the skull the tentorium cerebelli and falx cerebri were partly ossified.

In the female skull the nasal bones were not ankylosed, and measured 55 mm. long. The distance between the anterior edge of the nasals and the premaxilla was 20 mm. on right side, 18 mm. on left.

The Lower Jaw.

The body was long and somewhat slender, due to small size of teeth, with lower border slightly incurved. The ramus formed with the body a moderate angle and possessed a well-marked sub-condyloid process. The condyle, which was convex and elongated transversely, was separated from the coronoid process by a shallow sigmoid notch. The coronoid process was short and pointed.

Dentition.

The dentition of the Ross seal is remarkably feeble, and varies more especially with regard to the number of post-canines. Dr E. A. WILSON, in vol. ii. of *Natural History of National Antarctic Expedition*, 1907, states: "The food of the Ross seal consists mainly of soft-bodied cephalopods, and to this end has developed the incisors and canines into needle-pointed recurved hooks of great delicacy and has allowed its post-canines to degenerate. The gums presumably can manipulate such food as well as could molar teeth, and so we find in some cases the post-canines are small and insignificant, whereas in others they are loose and useless, and occasionally absent altogether." He also gives a complete table of the dentition of all the Ross crania which have been brought home, and which shows the great variations one meets in the dental formula. To this list I would add the formulæ of the two specimens of the *Scotia*:—

No. 2. Female, $\frac{2.\ 1.\ 5}{2.\ 1.\ 5}$.

No. 43. Male, $\frac{2.\ 1.\ 5}{2?\ 1.\ 5?}$.

No. 2 skull presents for examination a perfect set of teeth, both upper and lower. The upper incisors are more powerful than the lower, but both present, like the canines, the well-marked recurved, needle-pointed character. The post-canines are recurved

backwards and three-cusped, the central one being longest. In all but the first the post-canines were double-rooted.

In No. 43 the teeth are not so well developed, and in the upper jaw the left outer incisor and canine are broken. The dentition is not quite easily made out. There is no fifth post-canine, but small sockets are to be observed; hence we may presume that they were present, having been partly fixed in the natural state by the fleshy gum, a condition pointed out by WEBER, BENNET, and WILSON (*National Antarctic Expedition: Natural History*, vol. ii. p. 46).

Again, in the lower jaw no central incisor is present, but the two halves of the jaw have been disarticulated. On placing the two halves together, it would seem that no room at all is left for central incisors. A comparison of the measurements of the two lower and upper jaws between outer side of canines shows:—

No. 2. Upper diameter, 44 mm.
Lower „ 30 „
No. 43. Upper diameter, 48 „
Lower „ 26 „

In No. 2, which has not been disarticulated, there is a fair amount of fibrous tissue, so it is possible to explain the difference in diameters by the absence of this. Hence, with the fibrous tissue in place in No. 43, room would be made for central incisors.

Against this may be stated the fact that the upper central incisors are very feeble, and, as the whole of the upper teeth are stronger than the lower, it is possible that the lower central incisors may not have developed.

Measurements of Skulls.

	Ross Seal, No. 43.	Ross Seal, No. 2.	Weddell Seal.	Leopard Seal.
	mm.	mm.	mm.	mm.
Extreme condylo-premaxillary length	250	...	272	394
„ inter-zygomatic width	181	...	169	217
„ width behind external meatus	167	...	177	198
Greatest width of palate	76	71	58	90
Width between outer side of base of upper canines	48	44	52	75
„ „ „ lower canines	26	30	30	50
Length of palate in line of suture to central incisor	81	82	105	157
Height of skull—basion to mid-occipital crest	83	...	84	110
Smallest interfrontal diameter	45	49	30	45
Length of nasals	79	55	61	103
Greatest width, anterior nares	43	34	36	44
Length of mandible	168	170	171	301
Width between outer end of condyle	182	168	57	205

The vertebral formula was:—

C_7 D_{15} L_5 S_3 Cd_{10}.

Cervical Vertebræ.

The bodies of the posterior six cervical vertebræ were keeled on their ventral aspect, the keel being more pronounced in the anterior than in the posterior series. On contrasting the bodies of the Ross seal with those of the Weddell and leopard seal, a great difference was noticed with regard to their length and breadth. If the 4th cervical be taken as a typical vertebra, we find the length index of the body to be:—

In the Ross seal—Length 33 Breadth 48	$\frac{48 \times 100}{33}$	= Index 145·4.
In leopard seal—Length 51 Breadth 47	$\frac{47 \times 100}{51}$	= Index 92·16.
In Weddell seal—Length 38 Breadth 38		= Index 100.

If these indices be compared with the length-breadth index of the skull, one is justified in saying that the short and broad character of the Ross skull can also be applied to the bodies of the vertebræ. The neural ring was triangular. A depth-breadth index shows much the same difference as the bodies in the three species contrasted. In the Ross seal, the index was 35·1; in Weddell seal, 54·5; and in the leopard seal, 50.

The transverse processes in all except the 7th were perforated at their roots by a vertebraterial foramen, and possessed at their extremities well-marked tubercles in all except the 2nd and 7th. The spinous processes exhibited a marked difference in the various vertebræ. Thus the axis possessed a massive spine with four well-marked tubercles—two anteriorly and two posteriorly. The 7th had a well-marked spine, not bifid; the 3rd and 4th had only a trace of a spine, while the 1st possessed a well-marked tubercle representing a spine. The 5th and 6th presented fairly prominent spines, bifid—a character not shown by either the Weddell or leopard seals. The type-specimen in the British Museum also exhibits this character. The anterior articular processes looked upwards and inwards, the posterior downwards and slightly forwards.

The atlas has powerful lateral masses supporting anteriorly deeply concave articular surfaces for occipital condyles, while the posterior articular facets for the axis were flat. The transverse processes were plate-like, and projected outwards and downwards. The lamina was perforated on each side by a foramen for the vertebral artery, which foramen was situated internal to the upper ends of the articular facets for the occipital condyles.

The axis did not present so well-marked an odontoid process as either the Weddell or leopard seal. On the inferior aspect of the odontoid process was a triangular facet for articulation with the atlas, whilst superiorly it had a small oval facet for articulation with the transverse ligament. The transverse processes were feeble and pointed, whilst their superior roots were mere spicules of bone. The ventral aspect of the body was markedly keeled.

Dorsal Vertebræ.

The bodies of the anterior four were keeled, the keel becoming less pronounced as we proceeded from 1 to 4. At the posterior end of the dorsal region, 14 and 15 presented a slight keel, more accentuated in 15 than in 14. The side of the 1st body had one and a half facets; 2 to 10 inclusive (two half-facets, 11 to 14 inclusive) a whole facet for the corresponding ribs. The 15th dorsal vertebra showed a peculiar arrangement; thus, on the right side of its body a well-marked facet was present for articulation with the 15th rib of that side, while on the left a well-marked plate-like costal process, representing the last rib, projected from the junction of the body and pedicle outwards, forwards, and slightly downwards. It measures 42 mm. in length and 25 mm. in breadth. (See fig. 5.)

The spines of the dorsal vertebræ were relatively feeble compared with those of the Weddell and leopard seals. They were low, and projected upwards and backwards as far as No. 11; while 12, 13, 14, 15 projected upwards.

The transverse processes of 1 to 10 were prominent and presented rounded facets for articulation with the tubercles of the ribs. In 11, 12, and 13 the transverse processes were feeble but possessed facets. In 14 and right side of 15 they were rudimentary and non-articular, while the character of the transverse process of left side of 15 has already been noticed. From 9 to 15 the mammillary processes were well defined, while accessory processes were faintly marked in 9 to 14.

Lumbar Vertebræ and Sacrum.

Each body of the lumbar vertebræ was elongated antero-posteriorly and was keeled on its ventral aspect. The spines were broad and more pronounced than in either the Weddell or leopard seals. The mammillary processes were rounded and directed forwards and outwards. The transverse processes were thin and flat, and curved outwards, forwards, and downwards. The sacrum was composed of three segments fused together. The ventral surface in its anterior part was broad and flat, with a faint keel, while its posterior part, corresponding to the 2nd and 3rd segments, was protuberant in the centre, concave laterally, where it presented the openings of the two anterior sacral foramina. The posterior surface showed mesially three spinous processes, while the laminæ of the three segments were only fused laterally. The fused articular processes were prominent at the junction of S_1 and S_2, less so at S_2 and S_3. The direction of the 1st posterior sacral foramen was horizontally outwards, in the 2nd and 3rd upwards and only slightly outwards. Laterally the sacrum presented a definite U-shaped articular surface for ilium, while the interval between the two limbs of the U and the area posterior to it were hollow for ligamentous attachment. The articular surface for the ilium was confined entirely to the first sacral segment.

Sacral Index.

Ross seal	108
Weddell seal	102·9
Leopard seal	114·8

The caudal vertebræ were ten in number. The posterior six were represented by elongated bodies alone—the last being cartilaginous. The 1st possessed, in addition to the body, a definite neural arch terminating above in a rudimentary spinous process. The laminæ in the 2nd did not unite superiorly, so that the neural groove was not converted into an arch. The third possessed on each side of its body rudimentary laminæ. The bodies of the first four caudal vertebræ were keeled on their ventral aspect. The sternum was incomplete, two segments being awanting. Their articulations could not be made out definitely, so I refrain from describing them.

Ribs.

The ribs were fifteen in number on the right side and fourteen on the left, this anomaly being explained in connection with the thoracic vertebræ. The 1st, 12th, 13th, 14th, and 15th ribs possessed a single facet each on their heads for articulation with the corresponding vertebræ. The 2nd to 11th inclusive possessed two facets separated by a distinct ridge. The 1st to 12th ribs inclusive possessed well-defined necks, while the 1st to 13th showed an oval concavo-convex facet for articulation with the corresponding transverse processes. In the anterior series of ribs was a slight depression, in some a roughness, on each side of the articular surface of the head, for attachment of ligamentum conjugale costarum described by Sir WILLIAM TURNER (*Challenger Reports*, vol. xxvi., Report on Seals, p. 14). The shafts of the ribs were slightly curved, the most pronounced curvatures being observed in the 2nd, 3rd, and 4th, while the greatest in length were the 8th and 9th. The last rib on the right side possessed a head with an articular facet, no neck, and a feeble shaft. Its length was 127 mm.

The Fore-Limb.

The scapula presented the well-marked sickle shape so characteristic in the Phocidæ. The anterior and superior or vertebral borders were convex and thin, the inferior or axillary was concave and rounded. On the axillary border at junction of lower and middle thirds in the Weddell and leopard seals was a prominent ridge for muscular attachment. No such ridge was present in the Ross scapulæ. The dorsum scapulæ was divided into a pre-spinous and post-spinous area by a feeble spine. This spine was relatively longer than in the Weddell and leopard seals, but not so well developed. The pre-spinous area was concavo-convex, the post-spinous was flat. There was no acromion process, but in the Weddell and leopard seals this was present although feeble. The coracoid process was rudimentary and projected forwards, measuring from the bottom of the shallow

notch at its base 18 mm. The ventral surface showed a slight subscapular angle corresponding in position to the attachment of the spinous process on the dorsal surface. Two faint muscular ridges were present, directed towards the glenoid fossa. The glenoid fossa was pear-shaped, deeply concave, with a prominent margin.

Index.

Ross seal	85
Weddell seal	82·14

In the leopard seal the epiphysis of the posterior angle was wanting, hence the index could not be ascertained.

The humerus measured 115 mm. long. The head was convex, and its articular surface was continued forwards on to the base of the lesser tuberosity, which was equally as prominent as the greater one. The shaft was slightly twisted, and presented a strongly marked deltoid ridge. The bicipital groove was in the form of a shallow groove. The lower end presented a well-marked trochlea for the ulna, a slight coronoid fossa, but no radial or olecranon fossæ. The capitellum was circular and convex. The internal condyle was more pronounced that the external, the external supra-condyloid ridge more so than the internal, which did not possess a supra-condyloid foramen or even a process.

Bones of Forearm.

In neither were the distal epiphyses fused with the shaft. The ulna measured 152 mm. and was expanded above from before backwards so as to form a long but narrow olecranon process. A coronoid process was not present. The articular surface for humerus was concavo-convex, while the facet for radius above was flat and continuous with that for the humerus. The shaft was flat, with a rounded anterior border and a sharp posterior border. The lower end was conical and articulated with radius slightly, and with cuneiform and pisiform. The radius was 135 mm. long. The head possessed a deep cup-shaped cavity for articulation with the capitellum of humerus, while the margin of the head was non-articular except on its inner side, where there was a well-marked facet for articulation with the ulna. On the neck a faint tubercle was noticed, while the shaft was paddle-shaped, with a definite roughness on its outer aspect for pronator radii teres. The lower end was grooved on its posterior aspect, and articulated with the ulna and scapholunar.

Humero-Radial Index.

$$\frac{\text{Length of radius} \times 100}{\text{Length of humerus}}$$

Ross Seal.	Sea Leopard.	Weddell Seal.
117·4	107·1	98·1

Carpal Bones.

These were seven in number, the scaphoid and semilunar being fused together to form a single bone. The carpal bones were devoid of ridges or processes. The articulations were difficult to make out, but I have referred these as follows:—

The scapholunar articulated with radius, trapezium, trapezoid, os magnum, and unciform.

The cuneiform articulated with the ulna, pisiform, and unciform.

The pisiform was a mere nodule, and articulated with the cuneiform and ulna.

The trapezium articulated with scapholunar, trapezoid, and 1st and 2nd metacarpals.

The trapezoid articulated with scapholunar, trapezium, os magnum, and 2nd metacarpals.

The os magnum was small, and articulated with the 2nd, 3rd, and 4th metacarpals, and with the trapezoid, scapholunar, and unciform.

The unciform articulated with the scapholunar, cuneiform, and os magnum, and with the 4th and 5th metacarpals.

Metacarpal Bones.

The 1st metacarpal was the longest, and possessed both a proximal and a distal epiphysis not united with the shaft. The 2nd was longer than the 3rd, 4th, or 5th, which were of about equal length, and the epiphysis for the head of each was separate from the shaft.

The Hind-Limb.

The innominate bone, measuring in length 215 mm., consisted of three parts—ilium, ischium, and pubis. The ilium was short and stunted. The ischium and pubis were long, somewhat narrow, and enclosed between them a very large obturator foramen—larger indeed than the ilium itself.

The acetabulum was circular in form, entirely articular except an elongated, hollow area at the bottom with a definite margin. The brim of the acetabulum was deficient in its lower aspect, thus forming a cotyloid notch. The ilium measured from centre of acetabulum to the highest part of the iliac crest 74 mm. The length of its crest was 102 mm. Its dorsal and ventral aspects were flattened and did not possess any definite muscular ridges. At the posterior part of the ventral surface was a U-shaped articular surface for that part of sacrum corresponding to its first segment, while there was a roughened area for the attachment of the posterior sacro-iliac ligament.

The os pubis projected backwards and slightly downwards from the acetabulum, and its junction with the ilium was marked by a prominent pectineal eminence. From this tubercle to the symphysis, which was small, the pubis measured 130 mm.

The ischium passed backwards and slightly upwards from the acetabulum, and possessed a pointed spine.

The femur measured 114 mm. long. The head was entirely articular except in its postero-superior quadrant, where there was a non-articular area continuous with the

non-articular neck for attachment of the ligamentum teres. Dr KEITH, in *Human Embryology and Morphology*, p. 385, states: "The ligamentum teres is isolated from the capsule by the development of the head of the femur, which expands as a wing on each side of the ligamentum teres, and by fusion of the wings isolates it from the capsule." In the Ross seal femur the wings have not yet met; hence, according to KEITH'S view, the ligamentum teres would still be in connection with the capsule. (See fig. 6.)

The trochanter major was a broad, rough prominence projecting from the outer side of the junction of the neck of the bone with the shaft. There was no trace of a trochanter minor, as is to be found in *Otaria Jubata*; neither was there a third trochanter.

The shaft, flat and expanded, possessed an anterior and a posterior surface, both being very slightly rounded and devoid of muscular ridges. The outer border was short and concave, the inner convex and very rough for muscular attachment.

At the posterior end of the bone, the trochlear surface for the patella was flattened and ascended as high on its outer as on the inner side. It was quite distinct from the condylar surface, but closely approximated to the external one, being separated by a very narrow groove.

The internal condylar surface was flat and circular, the outer one oval and slightly convex.

The intercondyloid fossa was shallow.

The patella was 34 mm. long and 24·5 mm. broad. It was oval in form, and its articular surface was slightly concave, and did not exhibit any subdivision into special articular areas. Its anterior end was much thicker than the posterior.

The tibia and fibula were fused together at their upper ends. The tibia measured 247·5 mm. Its upper end was elongated transversely and possessed two articular areas for the condyles of the femur, separated by a rough intermediate area. The shaft was slightly curved, flat and smooth on its ventral aspect, deeply concave on its dorsal aspect for origin of the tibialis posticus muscle. The nutrient foramen was a large one. The inner border was broad and rough, the outer one thin and rounded. The lower end was not united with the shaft, and from it projected a slight malleolus, which was non-articular. The ventral and dorsal aspects of the lower end were deeply grooved, while the articular area for astragalus was reniform and concave.

The fibula was 233 mm. in length. The upper end was fused with the tibia, whilst the lower end was grooved on the outer side by the peroneal tendons, and had on its inner aspect an oval facet for outer surface of astragalus. The shaft was straight, and its surface broad for muscular origins. The lower epiphysis was not united to the shaft.

Tibia-Femoral Index.

$$\frac{\text{Length of tibia} \times 100}{\text{Length of femur}}$$

Ross Seal.	Weddell Seal.	Leopard Seal.
217·1	203·9	213·5

Tarsal Bones.

The astragalus was the largest of the tarsal bones. It consisted of a body and two large processes. The posterior process projected backwards beyond the hinder end of os calcis, and presented a well-marked groove on its under aspect. Its anterior process or head passed as far forward as did the os calcis, and articulated with the scaphoid, cuboid, and fore-part of os calcis. The superior surface of the body presented a quadrilateral convex surface for articulation with the lower end of tibia, continuous externally with a triangular facet for fibula. Its internal surface did not articulate with the internal malleolus. The inferior surface articulated with os calcis and presented a deep groove for an interosseous ligament.

The os calcis possessed an attenuated posterior or peroneal process, and a feeble internal or sustentacular one. It articulated with the astragalus and fibula above, with the cuboid in front, and was grooved on its outer aspect by the peroneal tendons.

The cuboid presented on its inferior aspect a well-marked plantar tubercle and a deep peroneal groove. It articulated with the os calcis, astragalus, scaphoid, external cuneiform, and 4th and 5th metatarsal bones.

The scaphoid articulated with the astragalus, cuboid, and the three cuneiforms. Its posterior surface was not entirely concave, being convex in its outer part.

The internal cuneiform articulated with the scaphoid, middle cuneiform, and 1st and 2nd metatarsals.

The middle cuneiform was the smallest of the three, and was completely shut out of the plantar aspect of the foot. It articulated with the cuneiform on either side of it, with scaphoid behind and 2nd metatarsal in front.

The external cuneiform articulated with the scaphoid, cuboid, 2nd and 3rd metatarsals.

Metatarsal Bones.

The 1st was the longest, the 5th next in order, then 4th, 2nd, and 3rd, which was the shortest.

None of the epiphyses were fused with the shafts. The base of the 2nd showed the characteristic hook-shaped base.

The articulations of their bases were as follows:—

1st	with internal cuneiform and	2nd metatarsal,
2nd	with the three cuneiforms	1st and 3rd metatarsal,
3rd	with external cuneiform	2nd and 4th ,,
4th	with cuboid	3rd and 5th ,,
5th	with cuboid	4th ,,

while its base projected outwards as an elongated process.

The terminal phalanges of both fore and hind limbs were retained in connection with the skins.

Summary.

The skulls correspond in their distinguishing characters from other Antarctic seals to those tabulated by Sir WILLIAM TURNER in the *Challenger Reports* (*Voyage of "Challenger,"* Reports on Seals, p. 66).

With regard to the rest of the skeleton, one specimen alone does not provide altogether sufficient evidence; still, I note the following points which may be of interest on further skeletons being brought home and examined:—

1. Much greater length-breadth index of vertebræ.
2. Bifid character of 5th and 6th cervical spines, also present in type-specimen in British Museum.
3. Sacral index.
4. Scapular index.
5. Humero-radial index.
6. Non-articular area for ligamentum teres on head of femur continuous with non-articular neck.
7. Tibio-femoral index.

NUMBER OF VERTEBRÆ IN PHOCIDÆ.

In the *Résultats du Voyage du S.Y. "Belgica": Zoologie*, p. 7, Mr BARRETT HAMILTON states that in most seals the numbers of the thoracic and lumbar vertebræ appear to be usually 15 and 3 (5?), more rarely 14 and 6. In the Antarctic seals without exception I have found the vertebral formula in the adult to be C_7 D_{15} L_5 S_3 Cd_{10} or $_{11}$.

With a view to obtaining as large a number of specimens as possible, in order to form an average, I have made a careful examination of the seal skeletons in the University Museum here, the Museum of Science and Art of Edinburgh, British Museum of London, and give a table of the vertebral formula in 47 specimens:—

Weddell seal: 27 with formula C_7 D_{15} L_5 S_3 Cd_{10} or $_{11}$.
Crab-eating seal: 2 with formula C_7 D_{15} L_5 S_3 Cd_{10}.
Sea-leopard: 2 with formula C_7 D_{15} L_5 S_3 Cd_{10}.
1 „ „ C_7 D_{14} L_6 S_3 Cd_{11}.
Ross' seal: 1 with formula C_7 D_{15} L_5 S_3 Cd_{10}.
Sea-lion: 2 with formula C_7 D_{15} L_5 S_3 Cd_{10}.
Fur seal: 1 at C_7 D_{15} L_5 S_3 Cd_{11}.
Crested seal: 1 at C_7 D_{15} L_5 S_3 Cd_{10}.
Common seal: 2 at C_7 D_{15} L_5 S_3 Cd_{11}.
Elephant seal: 1 at C_7 D_{15} L_5 S_3 Cd_{10}.
New Zealand fur seal: 1 at C_7 D_{15} L_5 S_3 Cd_{10}.
West Indian seal: 1 at C_7 D_{15} L_5 S_3 Cd_{12}.

Grey seal: 1 at C_7 D_{15} L_5 S_3 Cd_{12}.
Bearded seal: 1 at C_7 D_{15} L_5 S_3 Cd_{11}.
Northern fur seal: 1 at C_7 D_{15} L_5 S_3 Cd_{10}.
Altogether 46 specimens with formula of C_7 D_{15} L_5 S_3 Cd_{10} to $_{12}$.
One specimen with formula of C_7 D_{14} L_6 S_3 Cd_{11}.

The number of caudal vertebræ seems to vary from 10 to 12, while in some cases one could not be positive, as frequently the terminal vertebræ are preserved in the skins.

Supra-Condyloid Foramen.

With a view to the formation of a percentage of such foramina found in the humeri of the Phocidæ, I have examined altogether 100 humeri, made up as follows:—

60 Weddell seals.
4 crab-eating seals.
6 leopard seals.
4 sea-lions.
2 Ross seals.
4 elephant seals.
4 South American fur seals.
2 New Zealand fur seals.
2 West Indian seals.
2 common seals.
2 North American fur seals.

Total, 92

In these 92 no foramen was present, but in 4 Weddell humeri there were small supra-condyloid processes.

In the following 8 humeri, supra-condyloid foramina were present:—

2 grey seals.
2 bearded seals.
2 crested seals.
2 common seals.

Total, 8

thus giving a percentage of 8.

Summary of Dentition.

As the dentition of the Phocidæ is of some importance, especially with regard to variation, I have formed a table of the dentition of the seals under my observation. I

have also examined the crania of the seals in the University Museum of Science and Arts, Edinburgh, and include such in the following list:—

Weddell seal: 21 specimens with formula . . $\frac{2.\ 1.\ 5}{2.\ 1.\ 5}$

1 specimen „ „ . . $\frac{2.\ 1.\ 6}{2.\ 1.\ 5}$

The fourth post-canine in the upper jaw was obviously split into two, thus accounting for the variation.

Sea-leopard: 5 specimens with dental formula . $\frac{2.\ 1.\ 5}{2.\ 1.\ 5}$

Crab-eating seal: 7 specimens with formula . $\frac{2.\ 1.\ 5}{2.\ 1.\ 5}$

Sea-lion (*Otaria Jubata*): 2 specimens with formula $\frac{3.\ 1.\ 5}{3.\ 1.\ 5}$

1 specimen „ „ $\frac{3.\ 1.\ 6}{3.\ 1.\ 5}$

LITERATURE.

The Zoology of the Voyage of the "Erebus" and "Terror," pp. 7–8, plates vii. and viii.
J. E. Gray, *Ommatophoca Rossi*, 1844.
Challenger Reports, vol. xxvi., Sir Wm. Turner, 1888.
Résultats du Voyage du S.Y. "Belgica," G. E. H. Barrett Hamilton, 1901.
National Antarctic Expedition: Natural History, vol. ii., E. A. Wilson.

DESCRIPTION OF PLATE.

Fig. 1.—Ross skull, No. 43. Superior aspect.

Fig. 2.—Ross skull, No. 43. Lateral aspect.

Fig. 3.—Ross skull, No. 43. Anterior aspect.

Fig. 4.—Ross skull, No. 43. Inferior aspect.

Fig. 5.—Ross seal, No. 43. 15th dorsal vertebra. Showing costal process on right side, and facet for rib on left side.

Fig. 6.—Ross seal, No. 43. Femur showing non-articular area on head.

ROBERT B. THOMSON—"Scottish National Antarctic Expedition: Osteology of Antarctic Seals."

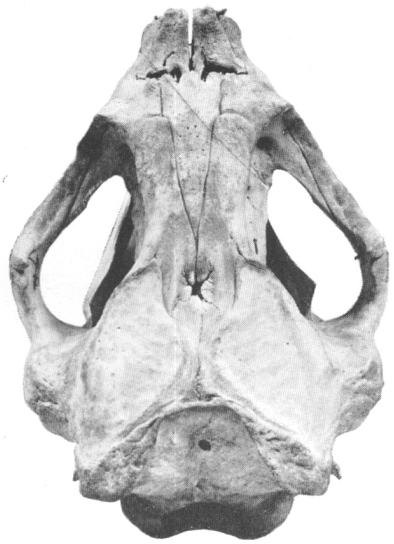

FIG. 1.

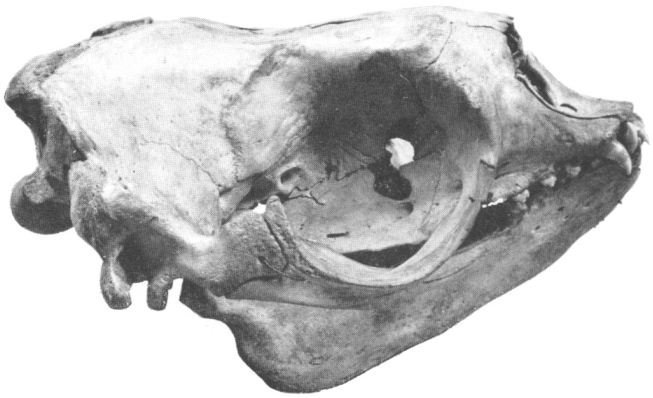

FIG. 2.

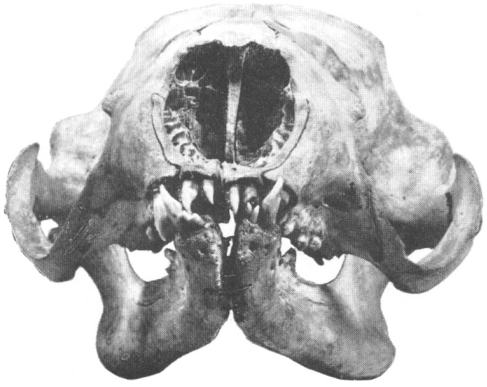

FIG. 3.

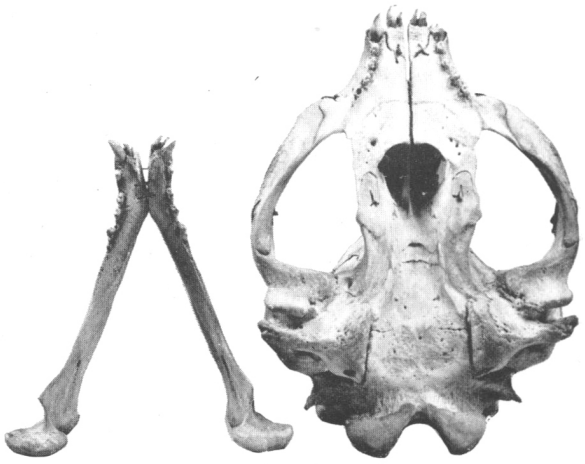

FIG. 4.

FIG. 5.

FIG. 6.