NEMO ME IMPUNE LACESSIT

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF S.Y. "SCOTIA."

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF S.Y. "SCOTIA"

DURING THE YEARS 1902, 1903, AND 1904,

UNDER THE LEADERSHIP OF

WILLIAM S. BRUCE,

LL.D., F.R.S.E.

Volume IV.—ZOOLOGY.

PARTS II.–XX.—VERTEBRATES, by DAVID HEPBURN, M.D., F.R.S.E.; ROBERT B. THOMSON, M.B., Ch.B.; D. WATERSTON, M.A., M.D., F.R.C.S.E.; A. CAMPBELL GEDDES, M.D.; W. A. HERDMAN, D.Sc., F.R.S.; R. S. CLARK, M.A., B.Sc.; HAROLD AXEL HAIG, M.B., B.S., M.R.C.S., L.R.C.P.; WILLIAM S. BRUCE, LL.D., F.R.S.E.; R. N. RUDMOSE BROWN, D.Sc.; W. EAGLE CLARKE, F.R.S.E., F.L.S.; L. N. G. RAMSAY, M.A., B.Sc.; C. TATE REGAN, M.A.; S. F. HARMER, Sc.D., F.R.S., V.P.Z.S.; W. T. RIDEWOOD, D.Sc., F.L.S.; and THEODORE E. SALVESEN, F.R.S.E.

62 Plates, 31 Text Figures, and 2 Maps.

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EDITORIAL NOTE.

ALTHOUGH absolutely essential in the interests of the Empire that the resources of the country should be husbanded, it was most unfortunate that, just when the Scottish Members of Parliament were unanimously resolved to press a vote for a further grant of money for *Scotia* publications through the House of Commons, it was found necessary to abandon the intention on account of urgent naval and military expenditure.

The original expedition of the *Scotia* depended to a very great extent upon the munificent support afforded by the late Mr JAMES COATS, junior, and Major ANDREW COATS, D.S.O. Thanks to the generosity of their brother, Sir THOMAS GLEN COATS, it is now possible to place before the scientific world in particular, and the public in general, this, the most comprehensive and not the least important volume of *Scotia* research yet published, and that too at a period when, owing to the great European crisis, it was scarcely possible to hope that further progress could, for the time being, be made.

It is the most complete treatise on Antarctic vertebrate fauna yet published in any country. Sir THOMAS GLEN COATS has thus helped to perpetuate the work begun by his family, and, as a Scotsman, has also emphasised the national importance of Scotland as a potent unit of the British Empire. Material for other six volumes awaits publication, and it is hoped that this good example at a critical period will stimulate others to provide the necessary funds to complete publication.

Volume IV. (Vertebrates) of the *Scotia* Reports is a contribution to Antarctic Vertebrate Zoology. It also includes the consideration of Atlantic fishes besides those of Antarctic regions.

I have to thank those who have voluntarily given their time and who have put such excellent work into its pages.

It happens that this volume is the work entirely of British zoologists—Wales, England, and Scotland having each taken part in its compilation.

In addition to the generous contribution of Sir THOMAS GLEN COATS, the cost of publication has been aided by the original Government Grant, and by a further Grant from the Common Good given by the Corporation of the City of Glasgow out of the surplus of the Scottish Exhibition of Natural History, Art, and Industry of 1911, and has also been considerably reduced by the co-operation of the Royal Society of Edinburgh, the Society having helped by bearing most of the primary cost of setting up type and illustrations, several of the communications having been passed through its *Transactions*. The Royal Society of London has paid the entire cost for the production of Mr C. T. REGAN's monograph on "Antarctic Fishes" out of the Government Publication Grant which it administers. The Carnegie Trust of the Universities of Scotland has paid the cost of Parts XI., XII., and XIII. The text figure in Mr R. S. CLARK's "Atlantic Fishes" is reproduced by permission of Mr M. J. NICOL and Messrs WITHERBY & Co. from *Three Voyages of a Naturalist*. Special praise is due to Messrs HISLOP & DAY for their excellent colour work in plates of the Ornithological Report.

Mr W. EAGLE CLARKE's contributions originally appeared in the *Ibis*. Mr R. S. CLARK's "Fishes of St Helena" appeared in the *Proceedings* of the Royal Physical Society. The other ornithological contributions by Mr L. N. G. RAMSAY, Dr R. N. RUDMOSE BROWN, and myself, as well as the greater portion of Mr R. S. CLARK's "Atlantic Fishes," Dr RUDMOSE BROWN's "Seals of the Weddell Sea," and Mr THEODORE E. SALVESEN's "Whale Fisheries of the Falkland Islands and Dependencies," are published directly by the Scottish Oceanographical Laboratory for the Reports.

Although obvious to many, the relationship between Science and Commerce must be continually insisted upon, otherwise the sources are apt to get dried up whence are drawn the funds upon which the scientist so largely depends.

As a vivid example of this relationship, Mr SALVESEN's article is of special interest in demonstrating how commercial enterprise follows scientific investigation. Mr SALVESEN is the head of a large commercial business having its headquarters in Leith, and it is a direct result of reports brought home by the *Scotia* naturalists and others that he now has such large interests in the Antarctic regions. The great whaling industry at present prosecuted in the neighbourhood of the South Shetlands, South Orkneys, and South Georgia followed directly in the wake of the scientific discoveries of the Swedish and Scottish Expeditions in the Weddell Sea. Before the *Scotia* sailed there was not a deep sounding taken south of latitude 40° S. in the Atlantic Ocean. The South Orkneys and South Shetlands were practically unvisited, and almost entirely unknown. South Georgia was little known. Now over a thousand people live under the British flag in South Georgia, and the South Orkneys and South Shetlands are a busy hive of industry during the summer months. Traders have even turned their attention to the west coast of the mainland of Graham Land, a direct result of the scientific expeditions sent out by Belgium and France, and altogether over a million pounds sterling of gross annual revenue is now taken in these regions previously considered worthless by business men.

Some of the monographs published in these scientific results have previously appeared in other publications, and as a consequence it has been suggested that although it is valuable to have memoirs such as are included in these *Scotia* volumes collected together, yet it is unfortunate that the species recorded in them are described in the work as new species. With regard to this, I may be allowed to say that many of the monographs are avowedly reprints. This is expressly stated not only in the "Editorial Note" of each volume, but also at the foot of every page, where the volume and page of the *Transactions* of the Royal Society of Edinburgh, or other scientific society, are clearly given. It has been further suggested that "Much trouble may be thus caused by the annual biological records again cataloguing these species, or of their being subsequently assigned to wrong dates." I would point out, moreover, that much expense would be incurred if the necessary alterations had to be made out of extremely limited funds already quite inadequate for the work yet to be done.

WILLIAM S. BRUCE,
Editor.

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PART II.

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SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

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(*a*) PERITONEAL FOLDS AND REFLECTIONS; (*b*) ALIMENTARY ORGANS.

By DAVID HEPBURN, M.D., F.R.S.E.,
Professor of Anatomy, University College, Cardiff (University of Wales).

Scottish National Antarctic Expedition: Observations on the Anatomy of the Weddell Seal (Leptonychotes Weddelli). By David Hepburn, M.D., Professor of Anatomy, University College, Cardiff (University of Wales). (With One Plate.)

(MS. received February 22, 1909. Issued separately May 25, 1909.)

Introductory.

The anatomy of all marine mammals presents an interesting field of observation upon their structural adaptation to a particular environment, and naturally, therefore, an extensive literature already exists in respect to these mammals, notwithstanding the many difficulties connected with their detailed examination. Their large size and the rapidity with which their tissues undergo decomposition have been serious obstacles in the way of prolonged dissection both of Cetacea and of Seals. Consequently, the examination of many parts of their anatomy has, of necessity, been more or less hurried. Accordingly, in the course of the preparations for the Scottish Antarctic Expedition, led by W. S. Bruce, LL.D., etc., arrangements were made for the preservation of mammalian specimens by the same injection methods that are now commonly used for the practical study of human anatomy, and the medical officer to the Expedition received practical instruction from myself in the application of these methods.

The animal now under consideration was preserved in the following manner:—One of the vessels between two of the toes on a hind flipper was opened and a fine canula inserted. Through this, a quantity of an arsenical preservative, containing glycerine, was introduced under gravitation, and to-day the tissues are as soft and free from putrefaction as they were on the day the creature was killed.

The animal is a young male Weddell seal (*Leptonychotes Weddelli*), one of the earless seals. It was born on or before the 29th of August 1903, and was killed by hydrocyanic acid on the 31st of August 1903, and immediately injected with the preservative solution.

Its dimensions are as follows:—

From tip of snout to end of tail	51½ ins.
,, ,, ,, hind flipper	60½ ,,
,, ,, ,, fore-limb	13 ,,
,, ,, genital aperture	39 ,,
From genital aperture to anus	8 ,,
,, anus to tip of tail	4½ ,,
Interorbital width	3¾ ,,
Axillary and greatest girth	34½ ,,
Fore flipper:—	
Length on outer edge	11½ ,,
,, ,, inner ,,	6½ ,,
Stretch (expanded)	7½ ,,

(REPRINTED FROM THE TRANSACTIONS OF THE ROYAL SOCIETY OF EDINBURGH, VOL. XLVII., PP. 57-63.)

Hind flipper :—

Length on outer edge	$13\frac{3}{4}$ ins.
,, ,, inner ,,	12 ,,
Stretch (expanded)	$13\frac{1}{4}$,,
Circumference at base	$10\frac{1}{4}$,,

Its weight was 83 lbs. A portion of umbilical cord about 3 inches in length was still dangling from the umbilicus. Its fur was greyish yellow, mottled by darker spots, suggesting leopard characters.

Abdominal Viscera.—On opening the abdomen, the general shape of the cavity was seen to be ovoid, being wider in front and narrowing behind to the well-marked inlet of the pelvic cavity. Regarded as a whole, the abdominal cavity presented a close resemblance to that of the porpoise,* of which an account appeared in the *Transactions of the Royal Society of Edinburgh*, vol. xl., part ii., p. 315.

Running forwards from the umbilicus, the umbilical vein, already nearly obliterated, formed a very distinct object, suspended as it was in the free edge of an extensive ventral mesentery constituting the falciform ligament of the liver. Running backwards from the umbilicus, the urinary bladder, with its associated hypogastric arteries, was likewise suspended in a mesial ventral mesentery whose depth from the abdominal wall to the bladder measured from an inch to an inch and a half. The bladder was long and narrow, and at the umbilicus its lumen was distinct. No part of the bladder had become obliterated to form the urachus, so that the bladder represented the entire intra-abdominal extent of the allantois.

The liver and stomach occupied the wide anterior end of the abdominal cavity, and in rear of them only the mass of coiled intestine was visible.

Peritoneal Folds and Reflections.

At first glance there was no sign of a great omentum, but on separating the coils of intestine from contact with the stomach, the great omentum was found crumpled up against its attachment to the greater curve of the stomach. Its greatest depth from the stomach to its free margin was 3 inches. It was devoid of visible fat, and was therefore an extremely thin and translucent membrane. There was a well-marked gastro-hepatic or lesser omentum presenting the usual gastric and hepatic connections. The gastro-splenic omentum was also well marked, and by it the spleen was attached to the great curve of the stomach. From the dorsal aspect of the spleen the peritoneal membrane extended to the dorsal wall of the abdominal cavity without coming into relation with the left kidney, which was situated opposite to its fellow and considerably further back in the abdomen.

The liver was attached to the sub-diaphragmatic surface by the usual suspensory, coronary and lateral peritoneal ligaments, to which further reference will be made in describing the liver.

* Hepburn and Waterston, *loc. cit.*

The duodenum was suspended in a dorsal mesial mesentery whose base of attachment measured nearly 5 inches, and this represented the distance between the pylorus (gastro-duodenal junction) and the duodeno-jejunal junction which was situated close behind (tailwards of) the superior mesenteric vessels and immediately to the left of the mesial plane. To the right side of the duodenal mesentery there was a large peritoneal recess whose right boundary was formed by a tailed lobe of the liver extending backwards along the dorsal wall in intimate association with the inferior vena cava.

At the first glance there appeared to be no naked-eye distinction between the small intestine and the colon. At no point were tænia coli, sacculations, or appendices epiploicæ visible.

As measured from the duodeno-jejunal junction or flexure, 46 feet of gut were suspended from the dorsal wall in a mesentery practically corresponding to the entrance of the superior mesenteric vessels. A closer examination revealed a distinct lateral diverticulum rather more than 1 inch in length but of the same calibre as the gut, situated on that part of the gut, which was suspended in the mesentery and at a point 9 inches from the hinder end of the mesentery. This diverticulum evidently represented the cæcum and the vermiform appendix in their most primitive form, and in the same condition as I have formerly described in the case of the grey seal (*Halichærus grypus*).* We may therefore conclude that this diverticulum marks the commencement of the colon.

Consequently the first 9 inches of the colon are suspended in the same mesentery as the small intestine, exclusive of the duodenum. The remainder of the gut, *i.e.* colon, was suspended in a dorsal mesial mesentery extending tailwards to the entrance of the pelvis, while through the greater part of the pelvic cavity a dorsal mesial mesentery supported the pelvic part of the colon, *i.e.* the rectum.

The foramen of Winslow was very distinctly defined in relation to the free right border of the gastro-hepatic omentum. Similarly the lesser sac of the peritoneum was equally distinct, although the great omentum was not in any sense a gastro-colic structure.

The inlet of the pelvis measured 1 inch in the transverse diameter and 3 inches in the conjugate diameter. Its lateral boundaries were well defined by the hypogastric (umbilical) arteries, each of which was supported in a peritoneal sling or ligament attached to the dorsal wall along the pelvic inlet.

The pelvic peritoneal pouch extended backwards between the gut and the bladder to a distance of $3\frac{1}{2}$ inches from the pubic crest, and so reached a point posterior to the bulb of the urethra, *i.e.* to a point which corresponded with the central point of the perineum. On the ventral abdominal wall, 1 inch to the outer side of the hypogastric arteries, there was the opening which led into the inguinal canal (see fig.). Each opening was circular and half an inch in diameter. It led into a circular peritoneal tube which extended through the abdominal wall in relation to the hinder free border of the musculus transversalis abdominis and the musculus obliquus internus abdominis. At

* HEPBURN, "The Grey Seal (*Halichærus grypus*)," *Jour. Anat. and Phys.*, vol. xxx.

the plane of the musculus obliquus externus abdominis, and close to its pubic attachment, the peritoneal tube passed through a muscular slit corresponding to the external inguinal ring and thereafter terminated in a blind end situated close to the posterior end of the testis. The length of this tube of peritoneum was $2\frac{1}{4}$ inches, and its testicular part formed the tunica vaginalis testis.

Each vas deferens entered the abdomen through the internal inguinal ring, being suspended from the ventral wall in a short mesentery or peritoneal sling by which each vas was carried across the abdominal aspect of the hypogastric artery to the pelvic surface of the urinary bladder about the level of the pubic crest. These two mesenteries for the vasa deferentia formed a free transverse fold of peritoneum on the pelvic surface of the urinary bladder at the level indicated. From this level the vasa deferentia passed backwards on the pelvic surface of the bladder under cover of the peritoneum. On the pubic aspect of the bladder there was a triangular non-peritoneal surface extending forwards from the pubic crest for $1\frac{3}{4}$ inches, at which point the ventral mesentery of the bladder commenced and continued to the umbilicus.

Alimentary Organs.

The *stomach* (see fig.) presented a single chamber situated with its long diameter in the axis of the trunk. The œsophagus entered the stomach slightly to the right side of the most prominent or anterior part of the fundus. The greater convexity or curve was well defined, and measured 17 inches from the œsophagus to the pylorus. The distance between the same points along the lesser curve was 10 inches. Each of these curves was associated with the usual omenta. A very sharp bend occurred in the lesser curve, 5 inches in a straight line from the œsophagus and 3 inches from the pylorus. The sides of this bend were held in close apposition by the peritoneum, and the general appearance produced was that of a constriction in the course of the cavity of the stomach. The greatest width of the stomach on the œsophageal side of this bend was $5\frac{1}{2}$ inches, whereas on the pyloric side of the bend the greatest width was 4 inches, and opposite the bend the width was $2\frac{1}{2}$ inches. The practical result of the infolding of the stomach wall was therefore to produce two chambers communicating with each other by an aperture considerably narrower than either of the chambers. A second slight constriction was present in the pyloric section, and thus as a whole, from œsophagus to pylorus, the stomach suggested three imperfectly separated compartments or chambers.

The contents of the stomach consisted of a quantity of a thick pasty substance of a somewhat light earthy colour. It was uniformly smooth, and contained no evidence of bones. In all probability it represented partially digested coagulum of milk.

The *pylorus* was placed in the mesial plane, and was recognisable both to the eye and to the touch as a constricted ring.

The *duodenum* extended from the pylorus in the form of a horse-shoe loop 12 to 13 inches long. It was attached dorsally in the mesial plane by a mesentery. The proximal and distal ends of the loop were from 4 to 5 inches apart. To the right side of the duodenal mesentery there was a large peritoneal recess or pouch the mouth of which was directed anteriorly, and to which reference has already been made.

The duodeno-jejunal flexure lay immediately to the left side of the vertebral column and marked the beginning of the mesentery proper and of the small intestine suspended in it. This mesentery had a very short base which practically corresponded to the entrance of the superior mesenteric vessels. It was twisted to the right and supported the jejunum and ileum, which together measured almost 46 feet in length.

The cæcal diverticulum formerly referred to as representing the combined cæcum and vermiform appendix, was taken to indicate the termination of the small and the beginning of the large intestine. This primitive developmental form of the cæcum and vermiform was rather more than an inch in length, while in calibre it corresponded with the gut. From this diverticulum to the end of the gut there were no other external evidences of any distinction between small and large intestine.

From the cæcum the large intestine or *colon* pursued the first 9 inches of its course suspended in the same mesentery as the small intestine. Thereafter the colon assumed a mesial position and, as far as the pelvic inlet, *i.e.* for a distance of 18 inches, it was suspended in a dorsal mesial mesentery. The pelvic portion of the colon was also placed mesially, and the greater part of it was also suspended in a dorsal mesentery. From the pelvic inlet to the anal aperture the gut measured nearly 10 inches, so that the entire length of the colon from cæcum to anus was practically 3 feet. Thus the total length of the gut from pylorus to anus was :—

Duodenum	1 foot.
Small intestine	46 feet.
Colon	3 ,,
Total	50 ,,

The *liver* (see figs.) was large and deeply fissured, thereby presenting very distinct lobes. It was intimately associated with the diaphragm, and occupied the anterior end of the abdominal cavity from side to side. It was provided with the usual peritoneal ligaments. The falciform and coronary ligaments presented no special features as regards their arrangement, but the left lateral ligament extended from the sharp left margin of the liver whereas the right lateral ligament was short and extended from the smooth surface of the right aspect of the right lobe. The diaphragmatic surface of the liver was smooth and convex, adapting itself to the abdominal surface of the diaphragm and presenting right and left lobes in relation to the suspensory or falciform ligament. The right lobe was divided into mesial and lateral portions by a deep dorso-ventral fissure, and the left lobe was imperfectly divided by dorsal and ventral notches which, however, did not meet each other.

On its visceral aspect the liver was much subdivided, particularly in relation to the right lobe. The right and left lobes were marked off from each other by the ligamentum teres (obliterated umbilical vein) on the ventral aspect of the hilum, and by the hepatic sinus on the dorsal aspect of the hilum. The right lobe presented the same mesial and lateral portions which were noted on the diaphragmatic aspect. The mesial portion was divided into dorsal and ventral parts by the hilum. To the ventral portion the gall-bladder was attached, and this part of the right lobe was connected to the left lobe by a pons hepaticæ. The dorsal portion was to a large extent concealed by the large hepatic sinus. The lateral part of the right lobe was also divided into dorsal and ventral segments by the extension of the hilum across its visceral aspect.

A tailed lobe extending from the dorsal segment of the mesial portion of the right lobe passed backwards on the ventral surface of the inferior vena cava, which was thus embedded in the liver substance. This tailed lobe expanded so as to conceal a considerable length of the inferior vena cava, and into this hidden part of the cava there opened directly the hepatic veins from this particular lobe, as also the hepatic veins from the lateral part of the right lobe.

The inferior vena cava itself opened into the large hepatic sinus situated close to the diaphragm and extending right and left of the suspensory ligament. This sinus received the hepatic veins from the right and left lobes of the liver, with the exception of those veins already mentioned as opening directly into the inferior vena cava. The interior of this sinus was imperfectly divided into right and left parts by a crescentic partition which was situated to the right side of the line of attachment of the suspensory ligament, so that the part of the sinus to the left side of the crescentic fold was the larger. The inferior vena cava opened into the hepatic sinus on the right side of the imperfect partition, while on its left side it received the mouth of the ductus venosus.

The hepatic sinus narrowed for the purpose of passing through the diaphragm in order to enter the right auricle of the heart, but the general size of its lumen was so much greater than that of the inferior vena cava that it is more accurate to say that the inferior vena cava opened into the sinus and the sinus joined the auricle.

The conditions presented by the hepatic veins afford some interesting light upon the question of their development. Clearly the large hepatic sinus has resulted from the fusion of the two embryonic venæ revehentes, although, from the position of the imperfect crescentic partition, it is evident that the left vena revehens was the larger of the two and therefore received the smaller or right vena revehens. This arrangement would therefore appear to provide a variation upon the current statement that "the left vena revehens loses its connexion with the sinus venosus and opens into the right vena revehens" (*Cunningham's Text-Book of Anatomy*, 2nd ed., p. 935). Again, the ductus venosus is described as passing directly "from the left vena advehens to the right hepatic vein" (*vide ibid.*), whereas, in the liver under consideration, the mouth of the ductus venosus opens to the left side of the crescentic fold, which appears to represent the remains of a fusion between the right and left hepatic veins. Further, to quote again from the same authority, "The upper part of the inferior vena cava is developed as an outgrowth from the common trunk formed by the fusion of the ductus venosus with the right hepatic vein." From the present dissection the inferior vena cava would appear to arise from the right hepatic vein independently of the ductus venosus, more especially in view of the fact that the inferior vena cava receives direct tributaries from the caudate lobe adherent to its ventral aspect.

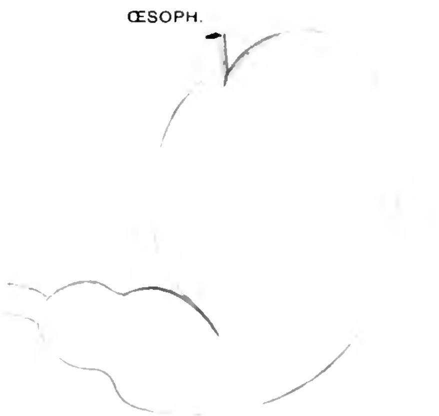
The *gall-bladder*, which was empty, occupied a fossa on the visceral aspect of the mesial portion of the right lobe of the liver. It thus lay to the right side of the ligamentum teres, from which it was separated by a projecting portion of liver substance, connected to the left lobe by a pons hepaticæ. This portion of the liver corresponded in general position with the quadrate lobe of the human liver.

The *cystic* duct passed towards the hilum of the liver and, having been joined by hepatic ducts corresponding in number with the three chief lobes of the liver, the common bile-duct was formed. This duct pursued its course on the ventral aspect of the foramen of Winslow and, immediately after passing this foramen, *i.e.* just before reaching the duodenum, it was joined by the pancreatic duct. The duct thus resulting came in contact with the duodenum a little more than half an inch from the pylorus. It perforated the duodenal wall very obliquely, and opened on the summit of a papilla at a distance of 2 inches from the pylorus.

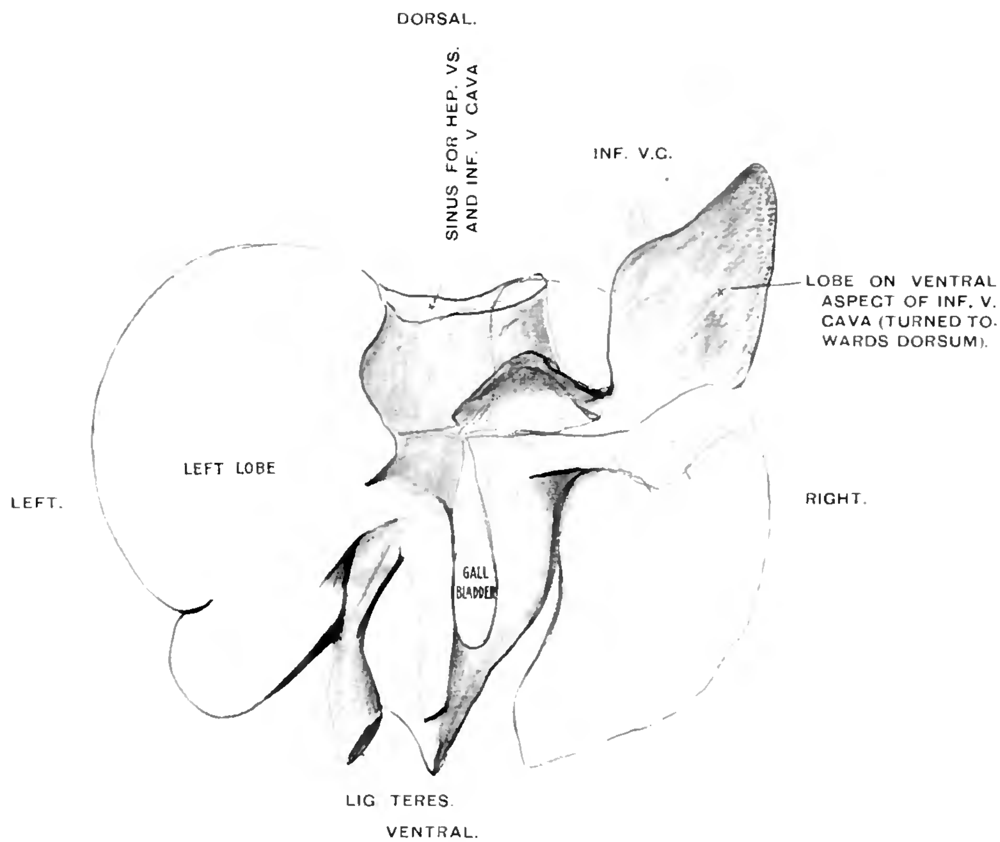
The *pancreas* presented a characteristic appearance. A small part of this gland was found within the duodenal mesentery, but the greater part of the organ extended headwards behind the lesser peritoneal sac. The pancreatic duct emerged from the substance of the organ on the cephalic (anterior) side of the foramen of Winslow (not from that part within the duodenal mesentery), and, extending to the right side, it formed a junction with the common bile-duct on the cephalic side of the foramen of Winslow and fully 2 inches from the common orifice by which both ducts pour their contents into the duodenum.

The *spleen* measured from 9 to 10 inches in length, from 1 to 6 inches in width, being narrow anteriorly and wide posteriorly. It was extremely thin, being not more than a quarter of an inch in thickness. It was situated between the stomach and the dorsal wall, being attached to the former by the gastro-splenic omentum and to the latter by a dorsal mesial mesentery. There was no intimate relation between the spleen and either of the kidneys, because these organs were removed from all immediate association by reason of their situation considerably nearer to the pelvic region. The tail end of the pancreas extended into the posterior splenic mesentery but did not come in contact with the spleen.

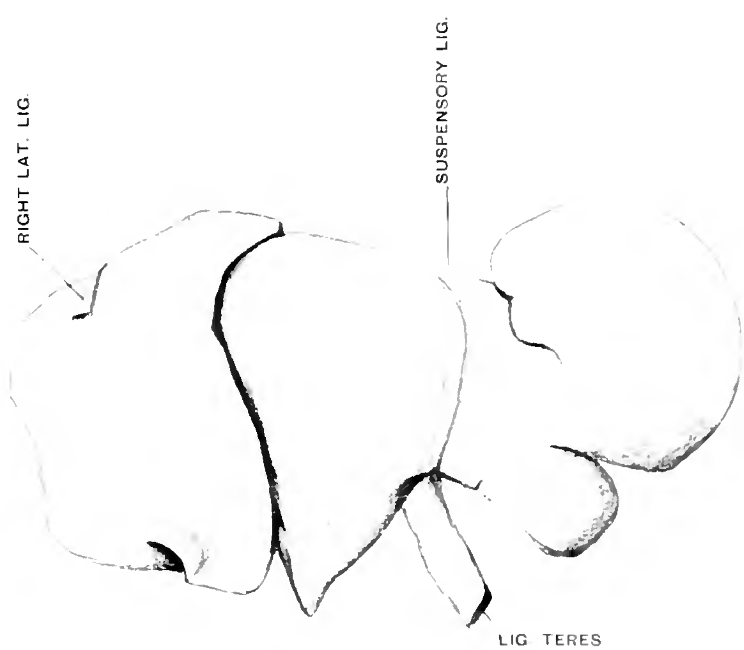
Prof. David Hepburn on "Observations on the Anatomy of the Weddell Seal."



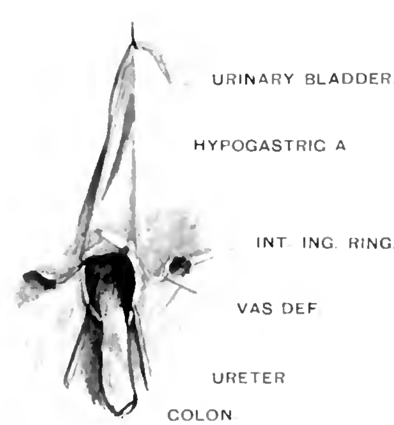
Stomach.



Liver of seal. View from abdominal aspect.



Liver of seal (seen from ventral aspect).



Pelvic cavity of seal (seen from pelvic inlet).

PART III.

S E A L S.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

III.—OSTEOLOGY OF ANTARCTIC SEALS.

By ROBERT B. THOMSON, M.B., Ch.B., University of Edinburgh.

(*WITH ONE PLATE.*)

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:—

$C_7 \quad D_{15} \quad L_5 \quad S_3 \quad Cd_{10}.$

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 ,, ,,	$\frac{3.\ 1.\ 6}{3.\ 1.\ 5}$

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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.

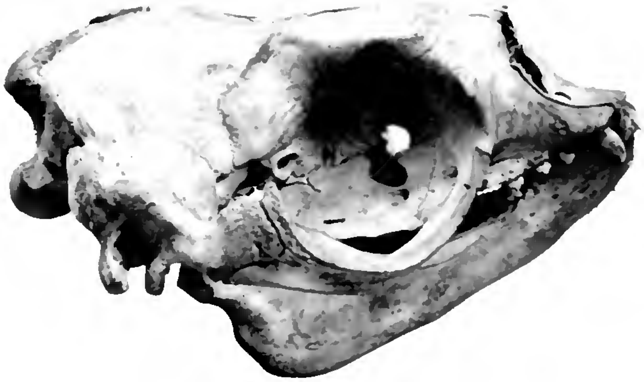

FIG. 2.

FIG. 3.

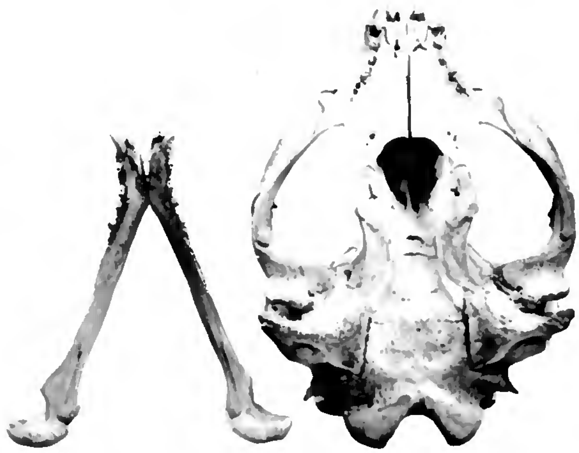

FIG. 4.

FIG. 5.

FIG. 6.

PART IV.

PENGUINS.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

IV.—ANATOMY AND EMBRYOLOGY OF ANTARCTIC PENGUINS.

By D. WATERSTON, M.A., M.D., F.R.C.S.E., and
A. CAMPBELL GEDDES, M.D.,
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(*WITH THREE PLATES.*)

Report upon the Anatomy and Embryology of the Penguins collected by the Scottish National Antarctic Expedition, comprising: (1) Some Features in the Anatomy of the Penguin; (2) The Embryology of the Penguin: A Study in Embryonic Regression and Progression.

By D. Waterston, M.A., M.D., F.R.C.S.E., and A. Campbell Geddes, M.D. (From the Laboratory of the Anatomical Department, The University, Edinburgh.) (With Three Plates.)

(MS. received March 11, 1909. Read February 3, 1908. Issued separately October 21, 1909.)

Among the specimens collected by the Scottish National Antarctic Expedition and brought back to this country was a series of the embryos of penguins of various species, collected at different stages of development by Mr R. N. Rudmose Brown and Dr J. H. Harvey Pirie. These embryos were, for the greater part, of the species Gentoo (*Pygoscelis papua*, Forst.), the remainder of the species Adelia (*Pygoscelis adeliæ*, Hombr. and Jacq.). Two Emperor penguins, which had been preserved for examination by the injection of the blood-vessels, were also brought home. Through the kindness of Dr W. S. Bruce these specimens were entrusted to one of us (D. W.) for examination and report, but as the work involved in this proved to be very extensive, Dr A. Campbell Geddes was asked to undertake a share in it, and this he agreed to do.

This report contains the results of the combined investigations.

PART I.

ON THE ANATOMY OF THE ADULT PENGUIN.

Introductory.

Upon the return of the *Challenger* Expedition to this country, the late Professor Morrison Watson had handed over to him the valuable collection of adult penguins which had been made. Upon these he based his classical memoir, "A Report on the Anatomy of the Spheniscidæ collected during the Voyage of H.M.S. *Challenger*" (*Challenger Reports*, vol. vii. p. 1). To that report little, if anything, can be added. There are, however, two points which a detailed dissection of the adult penguin has brought to light, which seem to us to be worthy of being placed on record. These are, first, the peculiarities of the cervical portion of the vertebral column; second, some points in connection with the arrangement of the fascial layers in relation to the pectoral muscles. In all the other points illustrated by our dissections we can merely corroborate the description given by Professor Watson.

(Reprinted from the Transactions of the Royal Society of Edinburgh, Vol. XLVII., Part II., pp. 223-244.)

Section I.—Some Peculiarities of the Cervical Portion of the Vertebral Column.

The cervical vertebræ are thirteen in number: the portion of the vertebral column which they make up is remarkable for the development of its antero-posterior curves. In the lower half there is an extraordinary antero-posterior curve the convexity of which is directed forward; in the upper half there is a second antero-posterior curve the convexity of which is directed backward.

These curves are present in all birds; in none, however, do they approach in intensity the curvatures found in the penguin. The lower curvature is so pronounced that the bodies of the vertebræ come in contact with and fill up the angle formed by the limbs of the clavicle, and, in the living bird, actually cause a projection on the front of the neck. As a result the trachea and œsophagus, instead of passing into the thorax in front of the vertebral column, are pushed away to the right side and actually lie on a plane posterior to the vertebræ of the convexity. The knowledge of this extraordinary condition is not new; it is fully described by Professor Watson, but the point seems to have been entirely overlooked, for in all the specimens in museums that we have had the opportunity of seeing the cervical vertebræ are incorrectly mounted.

Professor Morrison Watson was of opinion that these curvatures were associated with the maintenance by these birds when on land of the erect attitude, and that they served to bring the centre of gravity of the head and neck over the base of support formed by the feet. To us it appears more probable that the curvature is useful to the bird when in the water, giving it a greatly increased displacement forward and reducing to a minimum the fatigue of carrying the head and heavy beak in the long ocean voyages which it undertakes. These may apparently be very prolonged, for the birds have been seen no less than 600 miles from land.

Section II.—Some Peculiarities in the Arrangement of the Fascial Layers in Relation to the Pectoral Muscles.

The most striking feature with regard to the pectoral muscles is their enormous size and power. There are four muscles belonging to this group: first, the pectoralis major; second, the dermo-humeralis (*muscle des parures*); third, the pectoralis medius; fourth, the pectoralis minor. The origins and insertions of these muscles are given in detail and with great accuracy by Professor Morrison Watson. Their action is not without interest. The *pectoralis major* is divided into two distinct parts: an anterior which arises from the clavicle and from the outer surface of a strong aponeurosis which separates it from the medius and is inserted through a special tendon into the whole length of the anterior or radial margin of the bones of the wing, and by an aponeurotic extension from the tendon which covers both surfaces of the wing and conceals the blood-vessels and nerves, and a posterior which terminates in a V-shaped tendon inserted into the humerus. These two portions have different actions; the anterior carries the wing forward to a position at right angles with the trunk, while the posterior draws the limb back in the effective part of the swimming stroke, and by its insertion into the anterior margin of the humerus it "brings about that rotation of the wing round its long axis which, combined with the backward stroke, gives rise to the screw-like motion of the organ observable when the bird is progressing through the water." *

The nerve supply is provided for by a special branch from the large cord of the brachial plexus.

The *dermo-humeralis* arises from a strong fascia which covers the external oblique muscle; at the posterior margin of the sternum it is reinforced by a number of fibres arising from the subcutaneous tissue covering the knee joint. It passes forward parallel to the outer border of the pectoralis major to be inserted along with the posterior fibres of that muscle into the anterior margin of the humerus. Its action apparently is to co-operate with the external part of the pectoralis major in depressing the wing. It is supplied by a twig from the nerve to the pectoralis major.

The *pectoralis medius* passes over a pulley formed by the bones of the shoulder and acts as the great elevator of the wing; by some authors it has been called levator humeri. It also is supplied by a twig from the nerve to the pectoralis major.

The *pectoralis minor* is inserted into the outer margin of the tricipital fossa; its chief action appears to be to rotate the humerus in a direction opposite to that of the rotation produced by the action of pectoralis major. In addition, however, it must help in producing the effective, propulsive stroke of the wing. Its nerve of supply is a twig from the nerve to pectoralis major.

The arrangement of the fascia in regard to these muscles is striking and peculiar. Tracing the deep fascia of the neck downwards, it passes deep to the clavicle, to which it is lightly attached; and, passing to the thoracic region, it lies superficial to the pectoralis medius and minor and becomes continuous with the strong fascia which covers the external oblique. Superficial to this fascial layer lie the pectoralis major and dermo-humeralis, and from it they both obtain a portion of their origin. The superficial aspects of pectoralis major and dermo-humeralis are in close contact with skin—so close, indeed, that they are marked by regular rows of pits which accommodate the rounded ends of the feather quills.

From this arrangement it appears to us possible that the dermo-humeralis, pectoralis major, and clavicle are in reality cutaneous structures. That the dermo-humeralis is in series with the dorsal cutaneous muscle and panniculus carnosus is certain; that it is closely associated with the pectoralis major in position, in action, and nerve supply is also certain; but whether the pectoralis major can justly be associated with the same group is, on the present evidence, not certain, although it appears to us probable. Unfortunately the evidence from nerve supply is so weakened by the association of pectoralis medius and minor with the same nerve as to be valueless.

* Quoted from Professor MORRISON WATSON's memoir.

The suggestion that the pectoralis major is in reality a cutaneous muscle seems to us to be not without interest in view of the occasional occurrence in man of the abnormal muscle, *sternalis*. Sir WILLIAM TURNER has suggested that it is to be regarded as a vestige of the panniculus carnosus. Professor D. J. CUNNINGHAM has pointed out that there is considerable evidence to show that it is formed by a deviation or dislocation of a portion of the pectoralis major; Mr F. G. PARSONS has shown that in rodents the panniculus carnosus possesses two strata, and that there is evidence to show that in man the deeper stratum of the panniculus forms the fascial sheath over the external oblique and that possibly a portion of the sterno-mastoid is derived from the same stratum. He has also shown that there are good reasons for regarding the pectoralis major as derived from the panniculus. To these observations we now add the facts of the anatomy of the penguin, which appear to us to suggest that the apparently antagonistic views of Sir WILLIAM TURNER and Professor CUNNINGHAM are in reality not opposed, but complementary.

PART II.

ON THE EMBRYOLOGY OF THE PENGUIN.

INTRODUCTORY.

As has been shown, the anatomy of the adult penguin has been previously very completely described, and little remains to be added to complete our knowledge of it.

Of the embryology, on the other hand, the existing knowledge is incomplete, owing presumably to the great difficulty in bringing back the necessary material in a condition which allows of a detailed examination being made. A small number of embryos was collected by the *Challenger* Expedition, but the condition in which they were received by Professor MORRISON WATSON rendered them useless for description.

The material which was put into our hands consisted of a number of specimens each one of which had been removed from its egg upon a different day of incubation. It would, therefore, appear that we had a specimen for each 24 hours of development. In one sense this was so, in another not. The method of collection which was of necessity adopted was as follows:—The nest was watched, and the eggs were marked with the date of their first appearance and were subsequently collected upon the desired day. The difficulties of so doing and the fallacies necessarily attendant upon it are obvious. First, it was quite impossible for the observer to know in which of the 24 hours preceding the marking the egg had been laid; secondly, it is known to be no uncommon thing for the males and females to fight for possession of their egg and for the privilege of incubating it. In the course of these struggles the eggs are apt to be dropped and to lie for some time directly upon the ice. The result of this must be to retard for a time the processes of development, and therefore, although an egg may have been laid for 3, 6, 9, or 12 days, it does not follow that the development has been proceeding for the same number.

Be this as it may, we found it necessary, especially in dealing with the early specimens, to revise the sequence of specimens so as to avoid the absurdity of embryos of an obviously earlier stage of development being classified as older than specimens of a later stage. The number of days of incubation is, according to the series of specimens, thirty. This is surprisingly short, and as there are some obvious gaps in the series, we are not prepared to express an opinion as to whether it is correct or not.

The embryos were preserved in $2\frac{1}{2}$ per cent. formalin, and we desire to place on record our sense of real obligation to the collectors for the care and trouble which they took, and for their great skill in packing the specimens, which alone is responsible for the excellent state of preservation in which many of these exquisitely delicate specimens were when put into our hands.

As a result of the long time which elapsed between the date of collection and examination and of the prolonged immersion of the specimens in formalin, it has not been possible to carry out, satisfactorily, any very fine histological examination nor to determine with absolute accuracy the exact date of the first appearance of the primary ossific centres, the formalin, apparently, having exercised a slight decalcifying action. Our investigations have, therefore, of necessity been somewhat restricted, and many important problems in connection with the development of the penguin remain unsolved.

In dealing with the embryology of the penguin the following points seemed to us important :—

1. The enormous length of time through which the penguin has persisted without undergoing important modification. In the *Quart. Journ. Geol. Soc.*, vol. xv. p. 670, Professor Huxley described a penguin of large size whose remains were obtained from the pliocene strata of New Zealand. For the reception of this bird he established the genus Palæeudyptes.

It is exceedingly doubtful whether the establishment of a new genus was necessary, and Professor Morrison Watson in his report on the anatomy of the Spheniscidæ (*Challenger Report*, vol. vii. p. 46), expresses the opinion that this pliocene bird might very well be regarded as belonging to a species of the existing genus Eudyptes.

From the outset, therefore, we were prepared to meet with some peculiarities of development of a more primitive avian type than that obtaining in modern birds.

2. The enormously high specialisation undergone by the forelimb of the penguin in the course of which it has been transformed from an organ of ærial to an organ of subaqueous flight.

3. The modification undergone by the cervical spine to secure sufficient water displacement anteriorly to carry the head and heavy beak without fatigue during the long ocean voyages which the penguins undertake.

4. The skeletal arrangements necessitated by the quasi-erect attitude.

Methods of Examination.

The earlier specimens were prepared for examination by being stained in borax carmine or alum carmine and mounted entire. Duplicate specimens for examination by section were not available. The later specimens were cleared so far as possible, but owing to the long immersion in formalin the clearing did not yield very satisfactory results. A figure illustrating the development of the limb bones is included among the illustrations (fig. 26). The decalcifying action of the formalin has, unfortunately, made any definite statements as to date of appearance and order of appearance of the ossific centres impossible, and we have had to content ourselves with the negative observation that no unusual or abnormal processes or sequences were to be observed, although such were looked for as carefully as the material available would permit.

In order to carry out a comparison regarding the dates of acquisition of the external adult features and the progressive development of the limbs and trunk during the later stages of development, we found it necessary to provide a control by carrying out observations on the same lines upon the embryo of another genus of birds.

Data for this purpose were not available in the literature, and we therefore prepared and examined, by methods identical with those used for the penguins, a series of duck embryos at every 24 hours of incubation. The period of incubation in the duck (28–30 days) approximates sufficiently closely to that of the penguin (30–32 days ?) to enable comparisons to be drawn with accuracy between embryos of corresponding age taken at each 24 hours.

The data which we obtained appear to be new, and we have, therefore, included an account of the external form and the measurements of the embryo-duck with those of the penguins.

Section I.—Early Stages of Development.

EMBRYOS SHOWING EARLY STAGES, COMPRISING SPECIMENS UP TO THE TWELFTH DAY.

Specimen I.—In the first of these, which was the youngest specimen examined, there was an oval area pellucida measuring 3 mm. in length on the surface of the blastoderm. This specimen illustrates the earliest stage after the close of segmentation before the formation of the primitive streak, and it closely resembles in size and shape the corresponding area in the ovum of the chick and the duck. No area opaca could be made out, nor was there any sign of the embryonic shield. The shape of the area pellucida is comparable to that seen in the blastoderm of the chick at about 18 hours, but in the absence of primitive streak and embryonic shield it resembles the chick blastoderm at the commencement of segmentation.

Specimen II. (fig. 1).—The second specimen showed a more advanced stage. The germinal area was somewhat pear-shaped. At its wider end was a narrow, semicircular, deeply marked line running round the periphery of the clear area. This line appeared to be the commencement of the amniotic fold. Behind this line was a narrow area in which there were a few dark spots, which marked apparently an early stage of the formation of a vascular area. This area, in turn, merged into a crescentic clear area which was limited on the opposite side by a short crescentic dark line parallel to the first line. This line occupied the central part of the wider end of the clear area, and lay across it, and it appeared to be the rudiment of a commencing head fold. From the concavity of this fold a darker streak passed for a short distance backwards towards the narrow part of the clear area, and this structure appeared to us to be an indefinite stage in the formation of the primitive streak.

Specimen III. (fig. 2).—This specimen resembled that of the chick of 22 hours. The head fold was well formed, and behind it lay the medullary folds. These diverged from one another at their posterior extremity, and behind them lay the remains of the primitive streak stretching to the posterior end of the clear germinal area. The primitive streak had the form of two narrow dark lines, enclosing between them a narrow clear streak.

Specimen IV. (fig. 3).—Labelled as 3 days.—The embryo was now 3 mm. in length and presented well-formed medullary folds, a notochord, seven pairs of somites, and also the remains of the primitive streak which was separated by a narrow clear area from the posterior end of the notochord and extended for a distance of 1 mm. behind it. The appearances were very similar to those of the chick at 25 hours. The medullary folds were as yet ununited, but showed at the cephalic end evidence of distinct thickening, while at the posterior ends they diverged from one another in a V-shaped manner. The notochord could be traced as far forward as the cephalic enlargements (but this part of the embryo was rather damaged), while posteriorly it terminated in a club-shaped enlargement.

Specimen V. (fig. 4).—The succeeding specimen, labelled as being 5 days, showed a slightly more advanced stage of the same condition, closely similar to the chick at 26 hours.

The embryo measured 3·5 mm. in length, and nine pairs of somites were present. The posterior end of the notochord was enlarged and shaped like an Indian club, and extended beyond the termination of the medullary folds, which diverged outwards on either side of it. Behind this extremity was a clear area, and behind it again lay two short parallel dark lines, the representatives of the primitive streak.

The cephalic ends of the medullary folds were considerably enlarged, to form the cerebral vesicles. These vesicles were not distinctly marked off from one another, but the anterior part was bent forwards, to form the earliest cephalic flexure. In front of this again was a narrow clear crescentic area—the pro-amniotic region.

Specimen VI. (fig. 5).—Labelled 6 days.—The next specimen was somewhat larger, measuring 6 mm. in length. Twelve pairs of somites were present, and the neural folds were larger, and had apparently united with one another at the fourth somite. The folds approached one another closely at the posterior end, and in that region they enclosed a clear area, shaped like an arrow head, in which lay the expanded posterior end of the notochord. The end of the notochord projected backwards beyond the medullary folds in the form of a bulbous extremity. Behind it there was no distinct evidence of a primitive streak. The whole of the posterior portion was enclosed in a clear oval area. The somites were well formed, and their internal structure showed them to consist of a clear central portion and a periphery or cortex arranged in columns radiating outwards.

At the outer margin of the somites was a clear area in which lay a narrow darker line, extending along the side from the third anterior somite backwards to beyond the hinder somites.

In position this structure corresponds to the primitive cardinal vein.

The neural folds showed evidence of segmentation, being constricted opposite the centre of the somites, and they were united about the middle. The specimen described was one said to be of the sixth day, and the subsequent specimens, which showed stages of gradual advance, were in harmony with this statement.

If these dates be accepted, it is obvious that the early changes in the penguin embryo are very much slower than the corresponding changes in the chick, for the same degree of development is shown in the chick of 40–44 hours.

Specimens VII., VIII., IX., and X. (fig. 6).—Labelled 7–11 days.—These specimens showed that the next stages of development are very similar to corresponding stages in the development of the chick, and do not require detailed description, except in so far as they show differences from it. The head and trunk show gradual increase in length and in thickness.

At the hinder end of the notochord a dark area shaped like a spear-head persists for some time, but eventually becomes merged in the hinder end of the trunk.

Figs. 7, 8, and 9, which illustrate the development of the duck at 5, 6, and 7 days, are introduced for comparison with fig. 6, which is a photograph of a penguin embryo labelled as 8 days.

Section II.—Rate of Growth of the Trunk and Limbs from the Twelfth Day onwards.

Our observations were directed first to an examination and measurement of the developing trunk and limbs.

The observations begin with the twelfth day of incubation, which is the date of appearance of the limb buds upon the surface of the body.

The details of the measurements are recorded in the appended table (Table No. I.).

Notes upon and Comparison of the Measurements.

The measurements were analysed along several different lines.

1. *General Growth of the Trunk.*

A. Penguin.—The vertex to coccyx length of the specimen of 12 days (fig. 10), taken as it lay in the egg, *i.e.* in a flexed position, was 15·5 mm., while that of the duck of corresponding age was practically twice as great, namely, 30·6 mm. In the penguin the rate of growth from this date onwards was fairly uniform and progressive, and the largest embryo, that of 30 days, measured 61·2 mm. in the same position. The specimen labelled as being 24 days was larger than those of 25 and 26 days, and among the other specimens similar anomalies were present. Taking the maximum measurements of specimens which seemed to be typical in their rate of growth, we found that the length attained at 12 days was doubled at 19 days and doubled again at 27 days, the progression being thus almost in geometric ratio.

The same ratio is found to exist when measurements of the breadth of the specimen are taken. The maximum breadth attained at 12 days was rather more than doubled at 19 days, and rather less than doubled again at 27 days.

B. Duck.—The maximum length of the embryos of this species was uniformly greater than that of the penguin of same age. Even the largest fully developed penguin embryo was smaller than the largest duck embryo. At 12 days (fig. 20) the duck embryo was almost exactly twice as long as that of the penguin of corresponding age. The rate of growth from this date onwards, as ascertained by the same criteria as in the case of the penguin, was, however, much slower than in that creature.

At 19 days the length had increased only by rather less than one-half, *i.e.*, was 4·36 cms. as against 3·06 cms., and not until the 23rd day of incubation was the length doubled, and from this time until the end of incubation the increase again was rather more than half, from 43·6 mm. to 76·8 mm. The breadth figures showed a rate of growth very similar to that found in the penguin. The breadth at 12 days was 10 mm., and this figure was practically doubled at the 19th day and almost doubled again at the end of incubation.

2. *Rate of Growth of Different Segments of the Trunk.*

Penguin.—Analysing the rate of growth of the different segments which make up the vertex to tail measurement, the head segment is found to increase slowly at first, but grows rapidly in the last few days, while the neck increases rapidly through all stages.

The growth of the trunk and tail follows the general rate of the whole body, the length attained at 12 days being doubled at 19 days, and doubled again at 27–28 days.

The figures for the head are modified by the fact that measurements were taken

TABLE

		Days 12		13		14		15		16		17		Adelia. 18		Adelia. 18	
		P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.
Vertex to coccyx length, flexed		1·55	3·06	1·94	3·36	1·93	3·32	1·94	4·07	2·42	3·95	2·58	4	3 35	...	2·86	4·45
Maximum breadth		·64	1·28	*1·5	1·41	*·89	1·6	*·91	1·5	1·09	1·8	1·53	1 8	1·46	...	1·35	2·42
Length of head		·76	1·47	·34	1·24	1·01	1·3	·94	1·34	1·05	1·23	1·49	1·6	1·25	...	1·21	2·1
,, neck		·48	1·4	·56	1·65	·68	1·5	·63	1·24	·67	1·32	·82	1·35	1·06	...	1·28	1·74
,, trunk, including tail		1·32	2·22	1·44	2·65	1·41	3·09	1·35	3·55	2·01	3·74	2·13	3·82	2·71	...	2·42	4·45
Cloaca to furcal angle		·78	1·5	1·08	1·82	1·14	1·92	·98	2·12	1·36	2·5	1·44	2·45	1·92	...	1·65	3·29
Head	Tip of beak to occiput	·78	2·05	1·21	2·38	1·29	2·6	·98	2·63	1·68	2·86	1·93	3·96	2·28	...	2·06	3·23
	,, ,, to ear	·52	1·59	·7	1·82	·82	2·04	·7	2·1	1·13	2·34	1·43	2·3	1·76	...	1 39	2·7
	,, ,, to post angle of eye	·63	1·44	·86	1·64	·84	1·7	·74	1·87	·97	1·97	1·33	2	1·53	...	1·3	2·11
	,, ,, to mouth	·25	·7	·43	·92	·29	1·05	·29	1·1	·61	1·2	1·78	1·17	·99	...	·78	1·23
	,, ,, to nostril	...	...	...	·6	No N.	·7	No N.	·64	No N.	·74	...	·8	No N.	...	No N.	·87
	Breadth between eyes	·64	1·23	1·5	1·34	·89	1·35	·91	1·35	1 09	1·35	1·33	1·45	1·46	...	1·35	1·64
	,, ,, ears	·35	·84	·55	·74	·46	·9	·54	1·13	·68	1·07	·87	1·1	·97	...	1·04	1·5
Neck	Length	·48	1·4	·56	1·65	·68	1·5	·63	1·24	·67	1·32	·82	1·35	1·06	...	1·28	1·74
	Width	·31	·33	·43	·45	·38	·44	·31	·57	·37	·73	·54	·78	·56	...	·53	·9
Fore-limb	Upper arm, anterior border	·11	·44	·19	·44	·23	·46	·18	·5	·37	·56	·35	·55	·54	...	·35	·64
	,, ,, posterior ,,	...	·39	·11	·61	·15	·57	·12	·64	·21	·7	·26	·7	·33	...	·28	·75
	Forearm, anterior border	·29 incl. Hand	·37	·41	·38	·45	·47	†·41	·6	†·79	·6	†·91	·73	†1·21	...	†1·04	·75
	,, posterior ,,		·57	·58 incl. Hand	†·6	†·52	·62	†·48	·82	·84	·78	1·1	·8	1·25	...	†1·19	·87
	Elbow, width	·13	·31	·16	·44	·17	·53	·16	·53	·24	·57	·26	·55	·23	...	·31	·63
	,, thickness	·08	·19	·09	·25	·07	·22	·08	·26	·09	·12	·09	·27	0·9	...	·09	·28
	Length of hand	...	·72	...	·72	..	·86	...	·9	...	1·21	...	1·3	...	..	...	1 23
	Width ,, ,,	...	·19	...	·21	...	·18	...	·19	...	·2	...	·32	...	...	...	·35
	Length of pollex	...	·18	...	·18	...	·34	...	·24	...	·35	...	·37	...	...	...	·23
Leg, anterior border		‡·54	1·04	‡·72	·98	‡·73	1·05	‡·61	1·03	·57	1·23	·55	1·35	·77	...	·86	1·55
,, posterior ,,		...	·53	...	·42	...	·52	...	·74	·21	·82	·18	·86	·28	...	·22	1·12
Foot	Plantar, heel to end of third phalanx	...	1·16	...	1·45	..	1·52	...	1·65	·54	1·97	·69	2·08	·91	...	·78	2·57
	Plantar, length of phalanges	...	·55	...	·65	...	·73	...	·75	·28	·96	·28	1·15	·45	...	·37	1·23
	Plantar, web between outer and middle	...	...	...	·41	...	·42	...	·47	·18	·5	·17	·7	·19	...	·17	·75
	Plantar, web between inner and middle	...	...	...	...	...	·45	...	·4	·12	·64	·14	·65	·14	...	·12	·63
	Dorsal, ankle to tip of nail of middle toe	...	1·04	...	1·3	...	1·35	...	1·6	·64	1·82	·54	1·94	·82	...	·78	2·25
	Dorsal, length of nail	...	...	...	...	...	...	...	·1	...	·14	...	·13	·1	...	·09	·28

* Over eyes † Elbow to tip. ‡ Knee to tip.

I.

19		20		21		22		23		24		25		26		27		28 ?		30 ?	
P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.	P.	D.
2·99	4·36	3·37	6·25	3·62	5·93	3·49	5·05	4·09	6·39	4·64	7·04	4·13	6·06	3·99	7·68	6·07	...	5·71	...	6·12	...
1·45	2·35	1·52	2·73	1·75	2·95	1·68	2·8	1·89	3·22	2·24	3·35	2·21	3·8	2·18	4·46	2·35	...	3·05	...	3·03	...
1·2	1·3	1·18	1·2	1·35	1·43	1·24	1·55	1·48	1·97	1·47	2·43	1·54	2·35	1·55	1·95	1·91	...	2·55	...	2·89	...
1·09	2·05	·99	1·94	1·23	1·95	1·4	2·15	1·66	2·34	1·63	2·62	1·58	2·93	1·39	2·88	1·92	...	1·85	...	1·92	...
2·7	4	3·2	5·25	3·47	5·01	3·38	5·4	4·06	6·02	4·16	6	3·55	5·83	3·91	6·32	4·91	...	5 51	...	5·35	...
1·84	2·6	2·24	4·16	3·66	3·46	2·52	3·13	3·21	4·56	3·41	4·41	2·81	4·61	3·38	4·4	4·15	...	...	...	...	...
2·31	3·1	2·43	3·45	2·77	5·53	2·69	3·64	2·81	3·9	3·2	4·02	3·12	4·01	3·19	4·4	3·43	...	3·98	...	4·21	...
1·7	2·34	1·89	2·78	2·18	2·73	2·08	2·75	2·26	2·9	2·57	2·95	2·48	3	2·48	3·27	2·72	...	3·07	...	3·28	...
1·44	2	1·59	2·3	1·79	2·43	1·71	2·25	1·85	2·5	1·93	2·47	1·97	2·56	1·95	2·87	2·07	...	2·39	...	2·56	...
·92	1·25	1·1	1·43	1·23	1·41	1·28	1·43	1·29	1·58	1·5	1·6	1·44	1·66	1·38	1·82	1·66	...	1·91	...	2·01	...
No N.	·83	No N.	·91	·43	·97	·52	·9	·57	·94	·58	1	·58	1·02	·9	1·18	·59	...	·7	...	·88	...
1·45	1·45	1·52	1·54	1·66	1·57	1·72	1·53	1·7	1·6	1·88	1·77	1·8	1·58	1·82	1·64	1·87	...	2·02	...	1·96	...
·98	1·22	1·15	1·4	1·15	1·45	1·13	1·43	1·27	1·52	1·54	1·66	1·42	1·54	1·32	1·73	1·69	...	1·83	...	1·89	...
1·09	2·05	·99	1·94	1·23	1·95	1·4	2·15	1·66	2·34	1·63	2·62	1·58	2·93	1·39	2·88	1·93	...	1·85	..	1·92	...
·7	·7	·77	1	·83	1·1	·63	1	·8	1·08	1·09	1·05	·88	1	·91	1·2	1·23	...	1·25	...	1·31	...
·46	·69	·51	1	·64	·53	·65	·5	77	·78	1·11	·56	·58	·64	·72	·74	·79	...	·77	...	·93	...
·32	·82	·45	·96	·46	·64	·41	·83	·47	1	·57	·8	·58	1·27	·72	1·43	·58	...	·81	...	·96	...
†1·23	·76	†1·34	·97	†1·52	·93	†1·45	·64	†1·65	1·14	†1·87	·9	†·73	1·08	†1·73	1·18	†2·17	...	·65	...	·68	...
1·34	1·07	1·44	1·23	1·59	1·07	†1·51	·96	†1·72	1·07	‡2·07	1·1	†1·84	1·23	†1·93	1 32	‡2·13	...	1·01	..	·91	...
·32	·53	·35	·6	·4	·52	·44	·51	·18	·56	·56	·78	·58	·55	·57	·74	·64	...	·76	...	·83	...
·1	·27	·11	·23	·12	·25	·12	·23	·16	·26	·14	·34	·27	·29	·15	·39	·22	...	·23	...	·36	...
...	1·5	...	1·5	...	1·55	...	1·3	...	1·46	...	1·75	...	1·75	...	1·83	...	...	1·38	...	1·5	...
...	·26	...	·42	...	·4	..	·37	...	·43	...	·52	...	·34		·52	...	...	...	...	...	...
...	·38	...	·43	..	·5	...	·21	...	·56	...	·73	...	·64	...	·64	...	...	...	...	...	...
·89	1·18	·91	2·3	1·01	2·15	1·07	2·3	1·21	2·53	1·6	2·8	1·42	2·96	1·57	3·18	1·61	...	2·18	...	2·12	...
·3	1	·4	1·54	·37	1·4	·32	1·68	·45	1·55	·46	2·22	·46	1·88	·78	2·14	·66	...	·73	...	·66	...
·89	2·45	1·12	3·56	1·31	3·24	1·15	3·42	1·25	4·2	1·73	3·93	1·5	4·28	1·56	4·61	1·85	...	2·32	..	2·43	...
·43	1·14	·54	1·9	·63	1·47	·59	1·55	·61	1·93	·8	1·73	·66	2·03	·2	2·03	·93	...	1·01	...	1·07	.
·29	·85	·34	1·17	·41	1·18	·35	1·25	·34	1·46	·55	1·54	·47	1·52	·54	1·7	·65	...	·81	...	·83	...
·21	·8	·22	1·16	·29	1·18	·23	1·25	·23	1·46	·31	1·54	·28	1·52	·42	1·72	·41	...	·53	...	·52	...
·82	2·2	·93	2·9	1·15	3·07	1·08	3·23	1·34	3·62	1·53	3·64	1·47	3·62	1·32	4·1	1·79	...	2·02	.	2·3	..
·11	·26	·14	·33	·15	·34	·19	·35	·25	·38	·29	·44	·26	·43	·22	·47	·39	...	·46	...	·41	...

* Over eyes. † Elbow to tip. ‡ Knee to tip.

from the tip of the beak, and consequently the increase in total length is found to be greatest in the last few days, when the beak elongates rapidly, while the figures obtained for the growth of the head in width show a more gradual and regular increase, comparable to the rate of growth of the trunk.

3. *Growth of the Limbs.*

A. Penguin.—Fore Limbs.—The first appearance of the fore limb had the form of a bud-like projection from the lateral aspect of the trunk (fig. 10). This process at first was somewhat spatulate, and then rather bulbous at its free end (figs. 11 and 13). This shape was in turn soon lost, and the limb rudiment assumed the characteristic sickle-shaped form found in the adult bird (figs. 15 and 17, 19 and 23). The two segments of the arm were soon clearly to be recognised and were separately measured.

The measurements taken were those of the anterior border of the upper segment, together with the anterior border of the forearm from the elbow to the tip. At 12 days the total length was 4 mm., made up of 1·1 mm. of upper segment and 2·9 mm. of the lower.

At 19 days the length was 13·9 mm. and at 27 days 29·7 mm. The rate of growth, therefore, had been such that the length of the limb was more than trebled in the first period, and was more than doubled in the second. Both segments shared the growth, and did so in fairly equal proportions throughout.

Lower Limb.—The portion of the lower limb which was free from the coverings of the trunk was measured in one or in two pieces, as the size permitted. At 12 days it measured 5·4 mm., at 19 days 18·1 mm., and at 27 days 36·2 mm. In the first period the length was more than trebled, and in the second it was again doubled, showing a rate of growth almost exactly similar to that found in the upper limb.

B. Duck.—In the duck corresponding measurements showed that at 12 days (fig. 20) the fore limb measured 15·3 mm. and was nearly four times as long as in the penguin. At 19 days the length was almost doubled (28·5 mm.), and at the end of incubation it had only added one-third to its length (37·5 mm.). The lower limb, measured in a similar way at 12 days, was 22 mm. in length, again four times as long as in the penguin, and in the specimen of 20 days it was more than doubled, and at the end of incubation it was almost doubled again.

If the proportion which the length of the limbs bears to the total length of the body be examined, it is found that in the penguin the fore limb at 12 days is almost one-fourth of the body length, that it increases rapidly for a few days until it measures nearly one-half of the length of the body, and maintains approximately this ratio till near the end of the incubation period, when it progresses rapidly and assumes a ratio of rather more than two-thirds of the body length.

In the duck the ratio at 22 days was one-half, and this proportion became rather larger, but eventually again became nearly one-half.

Table II.—Vertex to Coccyx Length, the Length of Limbs and the Ratio between them, the Former being taken as 1.

Days.	Vertex to Coccyx Length.		Length of Upper Limb.		Index.		Length of Lower Limb.		Index.	
	Penguin.	Duck.	Penguin.	Duck.	Penguin.	Duck.	Penguin.	Duck.	Penguin.	Duck.
12	1·55	*3·06*	·40	*1·53*	·25	·50	·54	*2·20*	·34	·71
13	1·94	*3·36*	·60	*1·54*	·30	·45	·72	*2·43*	·37	·72
14	1·93	*3·32*	·68	*1·79*	·35	·53	·73	*2·57*	·37	·77
15	1·94	*4·07*	·59	*2*	·30	·49	·61	*2·68*	·31	·65
16	2·42	*3·95*	1·16	*2·37*	·47	·60	1·11	*3·20*	·45	·80
17	2·58	*4*	1·26	*2·58*	·48	·64	1·26	*3·43*	·48	·85
18	2·85	*4·45*	1·75	*2·62*	·61	·58	1·71	*4·12*	·60	·92
19	2·99	*4·36*	1·39	*2·95*	·46	·67	1·81	*3·63*	·60	·83
20	3·37	*6·25*	1·85	...	·54	...	1·84	*5·36*	·54	·85
21	3·62	*5·93*	2·16	*3·01*	·59	·50	2·42	*5·39*	·66	90
22	3·49	*5·05*	2·10	*2·24*	·60	·44	2·38	*5·72*	·68	1·13
23	4·09	*6·39*	2·42	*3·38*	·59	·52	2·62	*6·73*	·63	1·05
24	4·64	*7·04*	2·98	*3·21*	·64	·45	3·52	*7·73*	·76	1·09
25	4·13	*6·06*	...	*3·47*	...	·57	...	*7·19*	...	1·18
26	3·99	*7·68*	2·45	*3·75*	·61	·48	3·21	*7·79*	·80	1·01
27	6·07	...	2·97	...	·48	...	3·62	...	·59	...
28	5·71	...	3·53	...	·61	...	4·71	...	·82	...
30	6·12	...	4·24	...	·69	...	4·79	...	·78	...

Synopsis of Results from Comparison of the Measurements of the Penguin and Duck.

1. *Length of Trunk.*

At early stages the length of the trunk of the penguin is much less than that of the duck of corresponding age—the proportion being that the penguin at the 12th day is almost exactly one-half of the length of the duck at the same age.

As development proceeds the penguin grows more rapidly, until at the end of incubation the penguin is only fractionally shorter than the duck.

2. *Length of Fore Limb.*

At corresponding dates after the limbs first appear the fore limb of the penguin is only about one-fourth of the length of that of the duck.

Its growth subsequently is much more rapid, and at the three weeks it is almost the same size, and at the end of incubation it exceeds in length the duck's fore limb, in some specimens by as much as one-quarter.

3. *The Ratio of Length of Upper Limb to Trunk.*

At the 12th day of incubation the fore limb of the penguin measures approximately in length one-fourth (index, ·25) of the length of the trunk, while in the duck the limb is equal to one-half of the length of the trunk (index, ·50). The ratio of growth of the fore limb in the penguin is continuous and progressive in relation to the ratio of growth of the trunk.

Towards the end of the third week it measures one-half of the length of the trunk (index, 21st day, ·50), and at the end of incubation it measures two-thirds (index, ·69) of the length of the trunk.

In the duck, on the other hand, the length at first increases relatively to the trunk, attaining in one specimen, at the end of the third week, a maximum ratio of over two-thirds (index, 19th day, ·67) ; but thereafter it slowly loses ground, and at the close of incubation the fore limb is less than one-half the length of the trunk.

4. *Hind Limb.*

A. Absolute Length.—In the penguin at the 12th day of incubation the hind limb is also one-fourth of the length of the hind limb of the duck, the ratio being very similar to that between the upper limbs of the two animals. In the penguin's limb, however, growth is more rapid, with the result that at the end of the third week the hind limb has reached a length equal to nearly one-half of the length of the hind limb of the duck of corresponding age, and at the end of incubation it is rather more than half as long as the corresponding part in the duck.

5. *Ratio of Length of Lower Limb to that of the Trunk.*

At the 12th day in the penguin the length of the lower limb is approximately one-third of the length of the trunk (index, ·34), but the rate of growth is more rapid, so that at the end of incubation it is nearly as long as the trunk (index, 28th day, ·82).

In the duck the limb at 12 days is rather more than two-thirds of the length of the trunk (index, ·71), at the 18th day it is nearly as long as the trunk (index, ·92), and thereafter it continues to increase at a rate relatively rather greater than the trunk, so that at the end of the third week it becomes actually longer (index, 22nd day, 1·13), and retains this superiority to the end of incubation.

In this respect, *i.e.* in the rate of growth from the 18th day, it is the exact reverse of the fore limb—it continues to increase in length relatively to the trunk, whereas the fore limb actually shows a relative decrease.

Analysis of Results.

Among the four limbs examined there are, therefore, two types of development.

First. there is a progressive type, and to this the development of the fore and hind limbs of the penguin and of the hind limb of the duck belongs.

Second, there is a partially regressive type, and to this the development of the fore limb of the duck belongs.

Now, if it be true that ontogeny is an abbreviated recapitulation of phylogeny we are forced to conclude that the fore limb of the penguin is a progressive structure, the fore limb of the duck, partially at least, a regressive. The reason for this, doubtless, is that the mesoblastic portion of the duck's wing has, with the advancing specialisation and adaptation of the epiblastic structures, become less valuable. To all flying birds feathers, not bone and muscle, are of prime importance in securing wing spread for aerial flight: for the penguin, on the other hand, a rigid bony paddle has been evolved, adapted to resist the pressure of the water to which it is subjected when the bird's great pectoral muscles are in strenuous action.

And we thus are led to the interesting conclusions:—

1. That the mesoblastic structures in the penguin's "wing" are progressive, the epiblastic regressive.

2. That the mesoblastic structures in the duck's wing are regressive, the epiblastic progressive: for in the development of the duck we find that the developmental energy is suddenly on the 17th day switched off, as it were, from the mesoblastic structures on to the epiblastic; for from that day onward the down rapidly develops and the mesoblastic framework loses ground.

With regard to these developmental facts the question arises:—

Is the duck's or the penguin's wing the more direct descendant of the common ancestor; or have they both diverged from the common stock approximately equally, but in opposite directions?

Embryology alone cannot answer this question, but the evidence is clear in this, that the fore limb of the penguin in its development goes through a progressive and continuous series of stages along one unbroken line. The mesoblastic portion of the fore limb elongates, but its characters do not alter. It elongates, however, with a relatively greater rapidity towards the end of development, whereas the duck's fore limb, after being relatively longer than the penguin's ever is, regresses rapidly. So that the answer to our question, so far as the embryological evidence is concerned, must be that the wings of both these birds are different from the ancestral wing, and that the differentiation has been in opposite directions and that the common ancestor was a flying bird of a somewhat primitive type depending in large measure for the spread of its wing upon bone and muscle.

Section III.—External Configuration of the Embryos from the Twelfth Day onwards.

1. *Gentoo Penguin Embryo*, 12 *Days*. (Fig. 10.)

The embryo was not fully formed, the brain was covered by the thinnest of membranes, the beak was short and soft, the eyes were very prominent, with dense white opaque pupils. The fore limb well developed; the elbow flexure completely marked.

It ended in a somewhat spatula-shaped extremity. The hind limb formed a spatula-shaped protrusion.

Duck Embryo, 12 *Days*. (Figs. 16 and 20.)

The embryo was fully developed, the integument was strongly marked, and there were down papillæ on two short lines at either side of the tail. The eye prominences were very marked; the head and beak were soft and pliable except at the point of the beak, where there was a small white nodule of keratin. The fore limb showed distinct division into upper arm, forearm and hand. The pollex was prominent.

2. *Gentoo Penguin Embryo*, 13 *Days*. (Fig. 11.)

The embryo was not fully formed. The head was soft and the brain showed through it. The beak was short, the eyes were prominent, the fore limbs were short, but showed plainly the elbow joint, and had a flattened, spade-like tip: to the naked eye there was no sign of digitation. The hind limbs were short, the ankle was unformed, the end was spatular and showed signs of three digits, the tail was relatively long and was much curved ventrally.

Duck Embryo, 13 *Days*. (Fig. 18.)

The embryo was fully formed. Down was appearing in lines on the back and sides of the embryo, and laterally on the neck; otherwise as for 12 days.

3. *Gentoo Penguin Embryo*, 14 *Days*.

The embryo was not fully formed, the head was soft, the brain showing through it. The beak was short, the eyes prominent; the fore limbs short, but well formed; the hind limbs were short, spatular protrusions. The heart showed distinctly, shining through the thin anterior wall of the thorax. The tail was relatively long and much curved ventrally.

Duck Embryo, 14 *Days*. (Fig. 21.)

Down papillæ were seen all over the embryo, especially along the dorsal tracts and on the tail. The eyes were widely open.

4. *Gentoo Penguin Embryo*, 15 *Days*. (Fig. 13.)

The embryo was small, the beak was beginning to grow forward. The fore limbs were small and soft, but fully formed. The hind limb showed no division into the toes, but ended in flat, spatular extremities. There was no sign of the fourth toe independent of the flattened extremity. The tail was relatively long and curved ventrally.

Duck Embryo, 15 *Days*. (Fig. 22.)

Down was appearing upon the head along a well-defined tract which looped round the eye from behind.

5. *Gentoo Penguin Embryo*, 16 *Days*. (Fig. 14.)

The embryo was small, the nails were not developed, so far as could be seen on naked-eye examination. There was a well-marked ridge down the centre of the abdomen and thorax. The toes did not appear beyond the web, but looked more as if they were embedded in it. The fourth toe appeared as if the web were continued round it.

Duck Embryo, 16 *Days*.

As for 15 days. Down more marked.

6. *Gentoo Penguin Embryo*. 17 *Days*. (Fig. 15.)

The embryo was in good condition and the fully formed integument was complete. The skin was marked by papillæ regularly arranged. On either side of the tail there were several down fibres varying from 1·7 mm. in length to a length just visible to the naked eye.

Duck Embryo, 17 *Days*.

The down was well developed.

7. *Gentoo Penguin Embryo*, 18 *Days*. (Fig. 19.)

This specimen was somewhat macerated.

Duck Embryo, 18 *Days*.

Embryo completely down-covered.

8. *Adelia Penguin Embryo*, 19 *Days*.

The embryo was fully formed, the integument was complete. There was a well-marked median groove over the abdomen and thorax, and from it on either side extended twelve transverse grooves. The body was completely naked except for eight fibres on the tail (four on either side of the median line).

9. *Gentoo Penguin Embryo*, 19 *Days*.

The embryo was fully formed, and the integumentary covering was complete. There were no transverse grooves on the abdomen.

10. *Gentoo Penguin Embryo*, 20 *Days*.

The embryo was fully flexed and completely devoid of down. The integument over the abdomen was not quite complete. A bare area in length ·28 cm. and in breadth at base ·07 cm. extended forward in front of the umbilicus. There were no transverse grooves on the abdomen.

11. *Gentoo Penguin Embryo*, 21 *Days.*

The embryo was completely flexed; the limbs were completely formed. The integument over the abdomen was incomplete; a triangular area 1·23 cms. in length, ·07 cm. in breadth, extended forward in front of the umbilicus and was continued over the front of the thorax as a well-marked groove from which on either side extended twelve transverse grooves.

12. *Gentoo Penguin Embryo*, 22 *Days.* (Fig. 17.)

The limbs of the embryo were complete; the integument over the abdominal regions was incomplete. An area 1·04 cms. in length and ·09 cm. in breadth at the umbilicus, gradually tapering to a point, was undeveloped. The head and body were entirely naked. The eye prominences were very marked; the skull and beak were soft and pliable. There were five transverse grooves on the abdomen. Flexion was incomplete.

13. *Gentoo Penguin Embryo*, 23 *Days.*

The embryo was not quite fully developed, the integument being incomplete. On the anterior abdominal region—anterior to the umbilicus—a very acute isosceles triangle persisted uncovered, the sides of which measured 1·19 cms., the base ·12 cm. The eye prominences were very marked, the skull and beak were soft and pliable. A few short pieces of dark down had developed on the head; the rest of the body was absolutely naked. There were no transverse grooves on the abdomen; flexion was incomplete.

14. *Gentoo Penguin Embryo*, 24 *Days.* (Fig. 23.)

The embryo was fully developed. The prominence of the eye-balls was well marked and the eye-slit was open, 18 cms. long; its width at its broadest part when stretched was ·08 cm. The head was covered with dark down, and on the back and body there was a sparse covering of light-coloured down considerably more than on the 25-days' embryo. The middle line of the front of the abdomen showed a deep groove from which extended across the abdomen, on either side, six well-marked transverse grooves. The feet and tail had now assumed the adult relations, and formed the peculiar flat base which is characteristic of the adult bird and permits of its adopting the quasi-erect attitude habitual to it.

15. *Gentoo Penguin Embryo*, 25 *Days.* (Fig. 24.)

The embryo was fully formed. The prominence of the eye-balls was well marked. The eye-slit was small, the beak was soft, and the head was sparsely covered with short black down on the back. The body was fully flexed; the spine formed a semicircle from tail to head. There was a well-marked median groove on the front of the abdomen and thorax, from which extended transversely on either side eight well-marked grooves.

16. *Gentoo Penguin Embryo, 26 Days.*

The embryo was fully formed; the eyes looked large and prominent; the beak was soft. The head was covered with short black down; the rest of the body was practically naked. Along the middle line of the abdomen, from the umbilicus to the root of the neck, was a well-marked groove.

17. *Gentoo Penguin Embryo, 27 Days.* (Fig. 25.)

The limbs of the embryo appeared fully formed. The feet were flexed over the front of the abdomen, plantar surface outwards. The upper limbs lay close to the side and over the abdomen under cover of the feet. The neck was flexed so that the beak lay along the right side of the abdomen immediately internal to the right superior extremity. Down was plentifully present on the head and back, shading from almost black over the head to a light slate grey over the sacral region. The down on the abdomen and anterior aspect of the thorax was sparse and light in colour. The middle line of the body in front was marked by a very evident ridge in the lower part, flanked on either side by a groove. These grooves coaleseed in the upper part of the abdomen and were continued over the thorax as a median depression. This could be traced as high as the root of the neck, where it was lost.

18. *Gentoo Penguin Embryo, 28 Days.*

The embryo appeared fully formed and was in a fully flexed position, so that the under surface of the mandible was pressed firmly against the thorax and abdomen; the beak lay in a groove formed by the right fore limb and left hind limb. The head was covered with a dark grey, almost black, down; the back with slate coloured, the abdomen with white. The back of the head had been flattened by pressure.

Duck Embryos, 19–28 Days.

The advance was purely one of body bulk. The amount and directions of growth are shown by the measurements of the specimens. (See Table I.)

19. *Gentoo Penguin Embryo, 30 Days.* (The specimen in fig. 25 closely resembled this older specimen, but was rather smaller.)

The embryo appeared fully formed and was in a fully flexed position, so that the under surface of the left side of the head was pressed against the thorax, the beak lying to the right side of the abdomen between the right fore limb and the foot of the left hind limb anteriorly and the right hind limb posteriorly. The head and back were covered with slate-coloured down, the belly with white down. In the flexed position the greatest length was 5·71 cms., the greatest breadth 3·05 cms. In the extended position the length from the crown of the head to the tip of the tail was 8·41 cms. When measured separately the head was 2·55 cms. in length, the neck 1·85 cms.; the body and tail together 5·51 cms.—giving a total length of 9·91 cms. The 1·5 cms. of difference (9·91 cms. – 8·41 cms.) is accounted for by the marked spinal curves which immediately asserted themselves on extension, a lumbo-thoracic curve ventrally concave, a cervical curve dorsally concave.

Summary and Conclusion.

Part I.—Anatomy of the Adult Penguin.

1. The cervical portion of the vertebral column is possessed of a curve of extraordinary convexity which causes the vertebral bodies to form a visible bulging on the front of the neck. This convexity we regard as useful to the birds by increasing water displacement anteriorly and permitting of the head and beak being carried without undue fatigue on the long ocean voyages which the birds undertake. The furcal angle being occupied by the vertebral bodies, the trachea and œsophagus enter the thorax on a plane posterior to the cervical spines. This curvature of the column and arrangement of the viscera is permanent and characteristic of the adult bird.

2. The arrangement of the fascial layers in relation to the pectoral muscles suggests that the pectoralis major and clavicle are in reality cutaneous structures. It was found impossible from the embryological material at our disposal to prove or to disprove this suggestion.

Part II.—Embryology of the Penguin.

1. The number of days of incubation is, according to the series of specimens, thirty. This is surprisingly short, and as there are some obvious gaps in the series, we are not prepared to express an opinion as to whether it is correct or not.

2. The early stages of development are exactly comparable to the corresponding stages of the chick or duck, though, if the dates of our specimens be correct, they take place more slowly.

3. The later stages of development are exactly comparable to the corresponding stages of the duck except with regard to the down, the fore limb, and the foot.

4. The foot of the penguin is, throughout its development, exceedingly clumsy and primitive, as is the foot of the adult; the foot of the duck, from its earliest appearance, assumes a lighter and neater appearance, and is adapted as a paddle, which the foot of the penguin is not.

5. The fore limb of the penguin is, in its mesoblastic structures, definitely progressive, whereas the mesoblastic portion of the duck's wing is relatively regressive. Both, however, have varied from the ancestral type, but their variation is in opposite directions: the wing of the penguin has required rigidity to subserve its function as a paddle, and it has acquired it, throughout its length. The wing of the duck, on the other hand, has required lightness, and it has acquired it—the reduced spread of bone being compensated for by an increased development of feathers.

6. The evidence from embryology is in favour of the early divergence of the Aptenodytidæ from the main stem of the flying birds, and of the common ancestor of both having been a flying bird, though of a clumsy type.

7. We were unable to verify the facts recorded by other observers in the ossification of the limbs, as we were handicapped by the decalcifying action of formalin even in weak solutions, so that our observations in this direction could not be considered altogether satisfactory.

ILLUSTRATIONS.

Plate I.

Fig. 1. Gentoo penguin, embryonic area, early stage.

Fig. 2. Gentoo penguin, within first 24 hours, showing head fold, medullary folds, and primitive streak. This stage resembles that of the chick at 22 hours.

Fig. 3. Gentoo penguin, said to be 3 days. This stage of development resembles the chick at 24 hours.

Fig. 4. Gentoo penguin, said to be at 5 days. The stage of development resembles the chick at 26 hours. The photograph shows specially the cephalic flexure, the hinder ends of the medullary folds enclosing the bulbous extremity of the notochord, and the remains of the primitive streak.

Fig. 5. Gentoo penguin, said to be 6 days. Comparable to the chick at 40 hours. The photograph shows the bulbous expanded posterior end of the notochord, and evidence of a segmentation of the neural folds.

Fig. 6. Gentoo penguin, about 7 days.

Plate II.

Fig. 7. Duck embryo of 5 days. Compare fig. 4 of penguin of same age.

Fig. 8. Duck embryo of 6 days. Compare fig. 5 of penguin of same age.

Fig. 9. Duck embryo of 7 days. Compare fig. 6 of penguin of same age.

Fig. 10. Gentoo penguin embryo of 12 days. Both upper and lower limbs have appeared on the surface of the trunk.

Fig. 11. Gentoo penguin embryo of 13 days.

Fig. 12. Duck embryo of 8 days. Compare character of limbs with those of penguin of 13 days (fig. 11).

Figs. 13, 14, and 15. Successive stages of Gentoo penguin embryos at 15, 16 and 17 days, to illustrate stages in the development of the sickle-shaped fore limb of the adult.

Fig. 16. Duck embryo of 12 days, *in situ*, to show how the embryonic attitude is maintained, and is not dependent upon external pressure.

Fig. 17. Gentoo penguin embryo of 22 days, to show advancing change in the position of the feet. Compare figs. 15 and 23, which show other stages in the development of the peculiar flat base of the adult.

Plate III.

Fig. 18. Duck embryo of 13 days.

Figs. 19 and 20. Gentoo penguin embryo of 18 and duck embryo of 12 days, photographed to the same scale, to show altering characters of the limbs, when the trunks are of the same size.

Fig. 21. Duck embryo of 14 days.

Fig. 22. Duck embryo of 15 days. Compare with fig. 15 of gentoo penguin embryo of the same age.

Fig. 23. Gentoo penguin embryo of 24 days. Notice the character of the fore limb, and the attitude of the hind limb and tail.

Fig. 24. Gentoo penguin embryo of 25 days.

Fig. 25. Gentoo penguin embryo of 27 days, to show the stage of development reached before leaving the shell.

Fig. 26. Photograph of fore limbs of gentoo penguin embryo of 22 days, to show ossification.

The clear portions of the shafts are composed of bone, and the dark extremities are of cartilage. Both extremities of the radius and ulna are cartilaginous. Beyond them is a darkish area, in which are the cartilaginous rudiments of the carpus.

Beyond that region are the metacarpal bones and phalanges.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

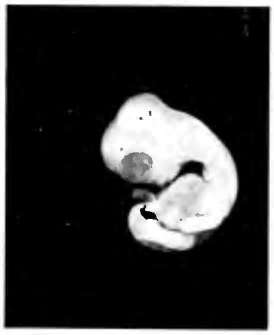

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

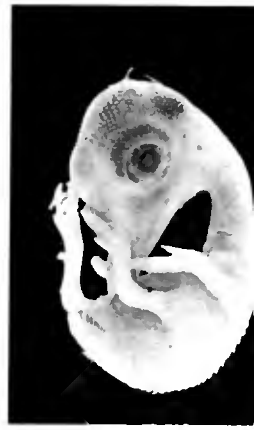

Fig. 20.

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

PART V.

S E A L S.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

V.—ANATOMY OF THE WEDDELL SEAL (*LEPTONYCHOTES WEDDELLI*)

(2) GENITO-URINARY ORGANS.

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Scottish National Antarctic Expedition: Observations on the Anatomy of the Weddell Seal (Leptonychotes Weddelli). By David Hepburn, M.D., C.M., F.R.S.E., Professor of Anatomy, University College, Cardiff (University of Wales). Part II.*

(MS. received December 4, 1911. Read January 8, 1912. Issued separately January 19, 1912.)

Genito-urinary Organs.

In my former contribution I gave a general summary of the animal under consideration, and discussed in detail the peritoneal arrangements of its abdominal cavity and the naked-eye anatomy of its alimentary organs. In the present paper I shall give an account of the genito-urinary system.

The kidneys were situated on each side of the dorsal mesial mesentery. Each was covered on its ventral aspect by the peritoneum forming the dorsal wall of the greater peritoneal sac. The right kidney was quite free from contact with the liver and the duodenum, while the left kidney was equally free from contact with the spleen. Both kidneys were therefore situated well back towards the pelvic end of the abdominal cavity. Each kidney measured 5 inches in the longitudinal diameter and 2 inches in the transverse diameter. The hinder or caudal end of each reached a point two inches from the pelvic inlet, which, as formerly described, was narrow and well defined by the course of the hypogastric (umbilical) arteries.

The surface of the kidney indicated lobulation, but the lobules were not separated from each other. The hilum was placed ventro-mesially, and at its point of emergence from the surface of the kidney the ureter was nearer to the caudal than to the cephalic end of the organ. On opening up the hilum, the ureter was seen to result from the union of two main tributaries, each of which, in its turn, was formed by the junction of several smaller rootlets, which corresponded more or less closely in number to the number of the kidney lobules. There was no distinct pelvis to the ureter, which was gradually formed by the junction of smaller ducts in the manner indicated. Nevertheless, the widest point of the ureter was found at the junction of its two main tributaries. The ureter and its chief tributaries lay on the ventral (anterior) aspect of the renal vessels, and not on their dorsal (posterior) aspect, as is the case in man.

The size of the ureter suggested a vessel about half the diameter of an average human radial artery. The ureter followed a course along the dorsal wall of the abdomen towards the pelvic inlet; and half an inch beyond the termination of the abdominal aorta, or, in other words, at the point where the common iliac artery divided into its external and internal branches, the ureter crossed to the mesial side of the internal iliac and hypogastric arteries, and continued its course along the margin of the pelvic inlet. In this position the ureter and the hypogastric artery were both in their turn crossed

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by the vas deferens, which now assumed the mesial position to both of the others. Up to this point the ureter had not entered the pelvic cavity, and about three-quarters of an inch onwards, that is, in the direction of the tail, the ureter, still lying close to the pelvic brim, entered the lateral aspect of the urinary bladder, travelling between the folds of a lateral vesical mesentery or peritoneal ligament. Thus, as a consequence of the great obliquity of the pelvic inlet, the ureter was able to reach the bladder by skirting the pelvic brim, and at no point did it require to enter or sink into the interior of the pelvis.

The urinary bladder was placed mesially, and was attached to the ventral wall of the abdomen by a ventral mesial mesentery composed of peritoneum, which, as formerly described, closely invested the bladder except on its pubic aspect. The apex of the bladder extended to the umbilicus, where it still presented an open lumen. There was no obliterated part or urachus, and throughout its entire length it presented a uniform calibre, suggestive of an empty portion of small intestine. Developmentally, it may be said to represent an enlarged and patent allantois; but as this animal was only two days old at the time of its death, probably a sufficient period had not elapsed for the closure of the umbilical end of the organ.

The hypogastric arteries were carried along each lateral aspect of the bladder, suspended in peritoneal folds half an inch in width, so that these arteries were not in contact with the wall of the bladder until they reached a point between 2 and 3 inches from the umbilicus, where the peritoneal folds disappeared, and the arteries closed in upon the sides of the bladder.

The length of the bladder from the umbilicus to the prostate gland was 10 inches. The prostate gland lay close to and on the abdominal side of the symphysis pubis.

The interior of the bladder was lined by a mucous membrane, presenting numerous rugosities, which to a large extent lay parallel to each other, and in the longitudinal axis of the bladder. Towards the outlet the mucous membrane became comparatively flat and smooth.

The orifices of the ureters were longitudinal oblique narrow slits 2 mm. in length and 5 mm. apart. The lateral margins of each of these openings were continued towards the outlet as slight ridges for a distance of 10 mm. These ridges met in the mesial plane, thus forming a mesial longitudinal ridge or uvula vesicæ. The actual trigonum vesicæ was therefore a triangular area 5 mm. wide at its base and 10 mm. long on each side.

The uvula vesicæ was continued into the urethra, and became continuous with the crista urethræ, which attained its greatest prominence 20 mm. from the apex of the trigonum vesicæ. The sinus pocularis was represented by a very small mesial aperture opening on the distal side of the summit of the crista urethræ.

The prostate gland did not attract attention, and at first sight one would have doubted its presence. Certainly in cutting into the urethra from its pubic aspect no variation in consistence was detected. Still, there was a definite thickening of the pubic wall of the urethra corresponding to the general position of the urethral crest. On the other hand, on the rectal or pelvic aspect of the urethra, and in relation to the urethral crest, there was a mesial longitudinal thickening of firm consistence, from 5–6 mm. in length. Into the hinder end of this denser part the vasa deferentia entered. The pelvic portion of the urethra was therefore not surrounded by visible prostatic tissue at its vesical end, and the prostatic tissue was not prolonged in relation to the urethra as far as the sub-pubic pelvic wall, because, whereas the prostate was only from 5–6 mm. in length, the pelvic urethra measured from 35–40 mm. long. No doubt the extreme youth of the animal accounts for the primitive condition of the prostate, but it is interesting to note that the part readily recognisable is the mesial longitudinal lobe. A portion of the prostatic part of the urethra, along with the surrounding tissue, was prepared for microscopic examination. Definite glandular prostatic tissue was revealed in relation to the pubic and lateral aspects of the urethra. On the rectal aspect of the urethra dense fibrous tissue was displayed. The two vasa deferentia were visible, each quite distinct from the other, so that their close proximity and apparent fusion previous to their entering the prostate on its rectal aspect was not a real fusion. The urethral crest presented the section faces of the bifurcated end of the uterus masculinus (Müllerian ducts).

Each testis was lodged in its own peritoneal pouch, which was situated to the outer side of the pubic body, in the depression between the *pubis and the head of the tibia*. These pouches were completely separated from each other by the keel-like projection of the pubic symphysis, and thus they did not form any object comparable to a scrotum. The testes had descended through the abdominal wall on the ventral aspect of Poupart's ligament, *i.e.* through the inguinal canal, and not through the crural canal, notwithstanding the novel position occupied by the testis in relation to the limb as a whole. The tunica vaginalis testis was in open communication with the sac or cavity of the abdominal peritoneum, and thus the whole condition might fairly be said to resemble two imperfectly descended testes, although in this case there was no scrotum into which they could have descended, nor was it possible for them to descend any farther. Each testis was considerably flattened, and measured 25 mm. long by 14 mm. wide.

No hydatids of Morgagni were visible. The epididymis presented a globus major and a globus minor. It did not lie close to the testis, but was supported by a mesentery, which at its deepest measured 10 mm. The vas deferens was similarly supported, and therefore it presented itself clear from the epididymis at the distal end of the testis, instead of lying close to it as far as the proximal end of the testis, as in man.

The vas entered the inguinal canal in the usual way and crossed the iliac fossa, running superficial to the external iliac vessels and the hypogastric artery. Thereafter it hooked round the hypogastric artery, and, passing to its mesial side, it proceeded backwards, *i.e.* tailwards, towards the base of the urinary bladder, taking its place to the mesial side of the ureter on its course. As the vas approached the proximal or pelvic end of the prostate gland it came into such close contact with its fellow of the opposite side that their adjacent walls became firmly blended together. This produced the appearance of an enlargement common to both of them, but there was no dilatation or ampulla on each one. There was no trace of seminal vesicles.

The penis was constructed on familiar lines. A strong, flexible cylindrical structure was present in the body of the penis extending 7 mm. from the base of the glans penis backwards. A portion of this structure was removed for microscopical examination. In transverse section it presented a circular outline, and was equally associated with the two corpora cavernosa penis. Its resistance to the knife suggested young bony tissue, and accordingly it was decalcified. Afterwards sections were cut out of paraffin, mounted, and stained in hæmatoxylin and eosin. Under the microscope it presented the distinctive characters of cancellated bone, being more spongy towards the centre of the section and denser towards the surface, where it was closely enveloped in a fibro-vascular sheet of membrane, comparable to periosteum. Numerous bone-cells were embedded in the developing processes of bone. No trace of hyaline cartilage could be detected. No doubt this short cylindrical piece of young bone is comparable to the much larger os penis of the walrus, as well as to the furrow-shaped and partly bilateral os penis of the fox and the dog. The bulb on each corpus cavernosum penis was situated in relation to the crus penis, and not on the penile portion of the organ. From the region between the bulb of the corpus spongiosum penis and the rectum, *i.e.* corresponding to the central point of the perineum, there were two parallel bands of tissue running forwards towards the distal end of the body of the penis. These were similar to muscular bands which I have elsewhere* described in connection with the penis of the porpoise. Probably these act as retractors of the penis. As in the case of the porpoise, a microscopic examination of sections cut longitudinally and stained after Van Giesen's method revealed unstriped muscular fibres, with fibrous tissue bundles. Since there is no scrotum in the porpoise, whose testes are situated intra-abdominal, and since in the seal under consideration each testis occupied a recess placed under the integumentary layers in relation to the inner side of the head of the tibia, it seems not unfair to consider these non-striped muscular bands as being homologous to the tunica dartos layer of an ordinary scrotum, more especially as the muscular fibres of the tunica dartos are of the unstriped or involuntary variety.

* "The Anatomy of the Genito-urinary Apparatus of the adult male Porpoise," HEPBURN and WATERSTON, *Trans. Royal Physical Society, Edinburgh*, 1902.

PART VI.

SEALS.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

VI.—ANATOMY OF THE WEDDELL SEAL (*LEPTONYCHOTES WEDDELLI*).

(3) THE RESPIRATORY SYSTEM AND THE MECHANISM OF RESPIRATION.

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Scottish National Antarctic Expedition: Observations on the Anatomy of the Weddell Seal (Leptonychotes Weddelli). By **David Hepburn**, M.D., C.M., Professor of Anatomy, University College, Cardiff (University of Wales). Part III.

(MS. received March 28, 1912. Read June 3, 1912. Issued separately July 18, 1912.)

The Respiratory System, and the Mechanism of Respiration.

In the specimen under consideration there were fifteen pairs of ribs, of which nine pairs were vertebro-sternal. The costal cartilage associated with each of these was long and very flexible. The articulation of the first pair of costal cartilages with the sternum was effected by means of a short but strong band of fibrous tissue, which permitted considerable freedom of movement and did not form a junction of the more or less rigid character seen in man.

The chondro-sternal joints of the second, third, and fourth costal arches were of the diarthrodial variety, each joint being divided into two separate cavities by an inter-articular ligament. The fifth, sixth, seventh, eighth, and ninth chondro-sternal joints presented diarthrodial joints without interarticular ligaments.

The sternum was long, narrow, somewhat like a four-sided rod, and divided into segments (suggestive of vertebral centra) by amphiarthrodial joints which were placed opposite the chondro-sternal joints from the second to the ninth. A suprasternal tapering cartilage extended towards the head for a distance of two inches, while the ensiform cartilage extended backwards to a similar distance and ended in a broad semi-lunar expansion.

The intercostal muscles were well developed, being thick and fleshy, presenting little or no fibrous intersection. They were arranged so as to present an external and an internal muscle in each intercostal space, and the direction of their fibres was similar to that seen in man; but the fibres of the external muscle were continued between the costal cartilages close up to the margin of the sternum without the intervention of an intercostal membrane.

The triangularis sterni muscle arose from the deep surface of the sternum on its own side of the mesial plane. It consisted of a number of slips, which were wide enough to give the appearance of a complete sheet of muscle. These were attached to the sternum from the level of the third costal cartilage backwards to the level of the ninth. The fibres ran forward and outwards to be inserted into the deep surfaces of the costal cartilages from the second to the ninth inclusive, and into fibrous bands which passed from one cartilage to the other. The general line of insertion into the costal cartilages was near to the series of costo-chondral joints, each of which, except that of the first rib, formed a diarthrodial joint. On the ninth costal cartilage this muscle interdigitated with the attachment of the diaphragm. This large, well-developed muscle was supplied by a series of twigs derived from the intercostal nerves in relation to which it was attached.

The sterno-mastoid muscle extended from the anterior end of the sternum and from the side of its pointed suprasternal cartilage to the mastoid process. There being no clavicle, this muscle appeared narrow.

The sterno-hyoid and sterno-thyroid muscles arose from the sternum under cover of the previous muscle. They formed a thin continuous sheet which probably included the omo-hyoid muscle along its lateral border in the vicinity of the hyoid bone. The entire sheet was innervated from the hypoglossal nerve, and the insertion of fibres into the thyroid cartilage and into the hyoid bone suggested the character of its constituent parts. A thin band of muscle fibres occupying their usual position formed the thyro-hyoid muscle.

There were two well-defined scalene muscles, both of which were situated on the dorsal side of the subclavian vessels and cervical nerves, and may therefore be regarded as the representatives of the scalenus medius and scalenus posticus muscles.

The musculus scalenus medius was inserted into the costal cartilage of the first rib close to the costo-chondral articulation.

The musculus scalenus posticus was inserted into the lateral aspects of the third, fourth, fifth, and sixth costal cartilages close to the costo-chondral articulations. At each insertion the pointed attachment interdigitated with similar attachments of the musculus obliquus externus abdominis, whose digitations extended to the cartilage of the first rib.

Regarding the skull and the cervical column as providing the more fixed or rigid attachment for the scalene and sterno-mastoid muscles, it is fairly evident that these muscles may act as elevators of the ribs and sternum by drawing them towards the head.

The diaphragm was well defined in all its parts, but its dorso-lateral portions were very thin, and in the absence of a central tendon of the trefoil type it presented appearances deserving detailed description, more especially in regard to the important position occupied by this muscle in the mechanism of respiration. Its strongest part was the mesial or vertebro-sternal element, which presented two well-marked, pointed crura attached to the lumbar vertebræ. From this origin the muscular fibres passed in a ventral direction on either side of the abdominal aorta until they reached the ventral aspect of this vessel, where to a small extent their fibres intermingled; but for the most part the fibres of the right crus were on the ventral side of those of the left crus.

This distinction between the fibres of the two crura was maintained as they continued towards the œsophagus, along the lateral aspects of which they passed, thereby forming the œsophageal opening, which was practically in the mesial plane. A short distance on the ventral side of the œsophageal opening the muscular fibres were inserted into a circular tendinous ring placed slightly to the right of the mesial plane, and through this ring the inferior vena cava passed. From the ventral face of this tendinous ring strong muscular bands extended to the deep face of the broad ensiform cartilage.

From each side of the dorsal segment of the fibrous ring surrounding the inferior vena cava there extended a narrow tendinous septum in the dorso-lateral direction. Neither of these septa reached the ribs, although the one on the right side was more strongly marked than that on the left side. Into the dorsal faces of these septa there were inserted muscular fibres derived from the lateral aspects of their respective crura, as well as a small, feeble muscular slip from the ventral surface of the second last rib (the 14th) near its head.

From the ventral aspects of the tendinous septa under consideration, a sheet of muscular fibres passed outwards to be attached by slips or digitations into the ribs close to their junction with cartilages from the 8th to the 13th inclusive. The digitation belonging to the 13th rib was attached just in front of the angle of the rib. This ventro-lateral part of the diaphragm was very thin. Areolar tissue occupied the intervals between digitations attached to the 13th and 14th ribs, and also between the 14th rib and the lateral margin of the crus. The association of the diaphragm with the 15th rib was so feeble as to be doubtful. Probably these weak places may be regarded as corresponding to arcuate ligaments, although in the human sense these structures were undefined. At any rate, these arched ligaments had no other representation, neither could the slight intermingling of crural fibres on the ventral aspect of the aorta be regarded as other than a very feeble median arched ligament. Altogether the dorso-lateral development of the diaphragm was extremely feeble. Those muscular fibres attached to the 8th rib were in close contact with the mesial part of the diaphragm between the sternum and the fibrous ring enclosing the inferior vena cava.

From what has been described it will be evident that there was no central tendon of the trefoil pattern, but in its place a vena caval ring, from which there extended two dorsal-lateral septa, of which the right was the stronger marked. The shortness of the left septum permitted a greater mingling of the fibres belonging to the left crus with those forming the rest of the left half of the diaphragm.

The general arrangements within the chest cavity do not call for special discussion. The two pleural sacs and the mediastinal interval followed the customary disposition. It may, however, be noted that the mediastinal layers of pleural membrane were in close apposition from the second segment of the sternum backwards to the hinder end of the sternum, and that consequently the ventral or anterior section of the mediastinum was a mere chink, in its sternal relations.

The lungs were extremely dark in colour, brown almost to black. They were quite soft, but yielded no feeling of crepitation on pressure, so that they suggested a complete absence of air.

When they were removed each was placed in water, and they sank as if solid. A small portion cut from the lung also sank in water, so that this tissue had entirely lost its buoyancy. It is not quite easy to account for such a complete absence of air from the substance of the lung. The animal is known to have lived for some days, because it was killed by poisoning with hydrocyanic acid after an attempt had been made to rear it by artificial feeding. The carcase was preserved by injecting an arsenical solution. Neither of these processes would account for the absence of air from the lung tissue. We must therefore assume that either the natural elasticity of the lung tissue has produced the condition noted, so that the expiratory apparatus of the animal is able to produce a practical deflation of the lungs, which is doubtful; or that, partly owing to the length of time they have been preserved and partly owing to the preservative solutions, the air has practically all passed into solution and disappeared.

A portion of the lung was prepared for microscopic examination, and, notwithstanding the number of years that have elapsed since the animal was embalmed, the different tissues were easily recognisable, but to staining agents such as hæmatoxylin and eosin they reacted very slowly and not very satisfactorily.

The hyaline cartilage of the bronchioles was cellular, and very similar to the cartilage in the ear of the mouse.

The lobules of the lung were very clearly defined by interlobular tissue, which was continuous with the sub-pleural tissue, and throughout this tissue there was a well-marked amount of elastic fibres.

All the air spaces were shrunken, *i.e.* collapsed, almost to the point of obliteration, but they were free from exudation. The capillary blood-vessels in the walls of the air spaces were crowded with blood corpuscles, which may have been the result of the preservative injection.

There is some reason, therefore, for considering that the normal elasticity of the lung in this seal was much greater than that of man, and that, consequently, the air would be much more effectively expelled from the lungs of the seal during expiratory movements.

Attention may be drawn to certain of the body muscles whose attachments and disposition were such as to add to their expiratory value. The panniculus carnosus muscle was a thin sheet enveloping the trunk from the hinder end of the abdomen to the face, and on the face and head forming a cowl modified for facial or expression muscles in relation to the various apertures in that region. The fore limbs were in effect pushed through this axial sheet. The disposition of its fibres showed dorso-lateral and ventro-lateral directions, separated from each other by a lateral aponeurosis, and attached by aponeurotic fibres to the dorsal and ventral mesial lines such as may be seen in the porpoise, but less distinct. The direction of the muscle fibres in the dorso-lateral section was obliquely from before (cephalic) backwards (caudal), whereas in the ventro-lateral section their direction was obliquely from behind forwards. The general effect of the contraction of this sheet would be to expel the air from the very elastic and flexible thorax, as well as to compress the abdomen.

The musculus obliquus abdominis externus showed no attachment to the ilium. By one end it was attached through digitations to the entire series of costal arches from the first to the fifteenth. Its fibres were directed obliquely backwards towards the ventral mesial line, and, having given place to a thin aponeurotic sheet, many of these fibres interlaced with those from the opposite side to form the linea alba.

The hinder part of the muscle, however, did not form any attachment to the ilium, but as a muscular arch, equivalent to the ligament of Poupart, they were attached to the ventral aspect of the body of the pubis. Near to the pubis a slit in the muscle sheet served the purpose of an external inguinal ring, in which the spermatic cord was situated. A muscle so attached could clearly act as a very powerful expiratory muscle provided the glottis were open.

The musculus obliquus abdominis internus was attached dorsally to the lumbar aponeurosis and to the crest of the ilium, while ventrally it was inserted into the hinder borders of the last four ribs and also through its aponeurosis into the linea alba. The greater proportion of its aponeurotic fibres passed ventrally to the rectus abdominis muscle along with those of the external oblique, but a few of them blended feebly with the aponeurosis of the transversalis abdominis muscle. This muscle (transversalis) presented lumbar and iliac attachments as well as a series of digitations on the hinder seven or eight ribs. Its mesial attachment to the linea alba was by an aponeurotic sheet placed on the deep side of the rectus abdominis muscle. The hinder or inguinal margins of these two last muscles were very closely, almost inseparably, blended together, and both were much thinner than the external oblique muscle.

The rectus abdominis muscle occupied an abdominal sheath whose composition has already been indicated. It was attached posteriorly to the body of the pubis, and extended anteriorly to the first costal cartilage, to which, as well as to all the other sternal cartilages, it was attached by tendinous slips. Here again we can see that this muscle, acting from a rigid attachment to the pubis, may act as a powerful expiratory muscle in association with an open glottis.

The lungs, beyond what has already been said, do not call for detailed description. Each presented a great oblique fissure, and thereby an apical and a basal lobe. In addition the right lung possessed a transverse fissure, and therefore a middle or ventral lobe. Furthermore, the right lung had an azygos lobe on its mediastinal aspect in relation to the margin between diaphragm and pericardium.

On several occasions I have had the opportunity of making a detailed examination of the respiratory mechanism of mammals whose habitat is either partly or entirely marine, and on each occasion I have been impressed by the remarkable flexibility of their thoracic wall, with the associated peculiarities in the attachments of certain of the muscles. Attention has already been drawn to some of these peculiarities in the descriptions given above, and it is almost impossible to avoid the conclusion that respiration necessitates a more flexible chest-wall in the case of mammals surrounded by water than in those which are surrounded by air, apart from the fact that the normal attitude of the latter may be horizontal, as in the case of quadrupeds, or vertical, *i.e.* erect, as in the case of man.

On the other hand, this flexibility of the chest becomes not only a drawback, but may be an actual source of danger when the marine mammal comes on shore either by intention or as the result of accident. Thus it is well known that a cetacean dies when it runs aground, not necessarily by starvation, but because it is suffocated, since the flexibility of its chest-wall renders respiratory movements impossible under the superincumbent weight of its body.

The leader of the Scottish National Antarctic Expedition made very careful observations on the attitude of seals when they left the water and resorted to the ice, and he noted that they do not assume positions which would hamper their chest movements. Thus they recline on the side when asleep so as to leave the movements of one side of the chest unimpeded, while at other times their common attitude is to lie prone with the chest raised off the ground by the short fore limbs. Considerations of this kind lead to the conclusion that respiration, but more especially the act of inspiration, can be seriously impeded or even rendered impossible by the weight of the animal's own body. That free inspiratory movement of the chest-wall in man may be hampered by the weight of his body may be readily observed in the case of an operatic singer who, by the exigencies of his performance, is called upon to sing in the supine position; for although in this position he can fill his lungs sufficiently for ordinary respiration, yet he cannot inspire deep enough for effective vocalisation. Clearly, therefore, the respiratory mechanism is affected by the attitude of the individual as well as by the surrounding medium, air or water, in which the animal performs the necessary respiratory movements.

There can be no doubt that, whatever the natural attitude of the mammal may be, or whatever its habitat, the ordinary movements of inspiration and expiration are carried out with the minimum expenditure of effort consistent with the amount of air required for each respiratory act. On the other hand, special circumstances may call for additional or extraordinary efforts both as regards inspiration and expiration. The discussion of respiratory movements is usually left, and by many observers considered properly left, to the physiologist; but as these movements are entirely dependent upon a definite mechanism in which the muscular arrangements play an important part, they cannot fairly be excluded from the province of the anatomist, and it is from the standpoint of structure that I propose to offer some observations which seem warranted by the conditions I have seen in the seal under consideration, as well as in the porpoise.

It may be well in the first instance to deal with the lungs themselves; and, as the condition in which I found them has already been stated, it will only be necessary to add that, except for the presence of the azygos lobe on the right side, they corresponded with the human lungs so far as the number and arrangement of fissures and lobes was concerned. There is no reason to suppose that during the act of inspiration they would inflate in a manner different from the lungs of man. Now, among the many interesting, elaborate, and ingenious attempts to explain the respiratory act, none is more suggestive than that of KEITH,* who approaches the discussion of the subject more as an anatomist than as a physiologist.

It is not my intention to follow Professor KEITH in detail and offer a criticism of the conclusions arrived at by him. At the same time, some of his statements appear to me to overlook certain of the anatomical facts. Perhaps the most important fundamental statement made by KEITH is in reference to the lungs when he says "the upper lobe is normally expanded by one mechanism, the lower by another," and as a consequence he insists that "the great fissure, which divides the upper from the lower lobe, is functional in its significance." Supposing this view to be correct, it would follow that since there is a third lobe in the right lung of man and a fourth or azygos lobe in the right lung of a quadruped, with the fissures required for their delimitation, the mechanism for expanding the right lung must differ from that required for the left lung. Further, as regards the apical or upper lobe, KEITH maintains that because of the impressions of certain ribs upon the lateral and anterior aspects of the upper lobe, but not upon "the dorsal surface of the upper lobe," there is "a constant relationship between ribs and spaces" for that part of the lobe which presents impressions, but a "downward and upward" movement of the dorsal unmarked part, in which it follows the movement of the lower lobe, because "the lower lobe and the dorsal part of the upper lobe are chiefly expanded by a diaphragmatic mechanism." The argument for a functional significance for the great oblique fissure seems to me unnecessary if the substance of the apical lobe is to expand in two different ways simultaneously, for, at least as far as the dorsal part is concerned, the presence of the fissure does not seem to confer any advantage.

I am not disposed to maintain that the fissures of the lungs have no significance, although to my mind it is rather structural than functional. Even "the obliteration of the pleural cavity by adhesions has so little apparent effect on the respiratory movements that their presence cannot be detected during life," any more than the obliteration of the lobulated character of the kidneys interferes with their functions. After all, the outstanding requirement is that the lungs shall expand to the capacity corresponding to the immediate muscular effort that is being performed, and naturally, therefore, the capacity undergoes constant variation. With this end in view, I cannot but think it is best to consider the muscular mechanism of inspiration *as a whole*, and the muscular mechanism of expiration *as a whole*, since it is their co-ordinated and not their individual action that we depend upon. Probably, in quiet ordinary breathing, no animal, any more than the human individual, employs the full scope of its inspiratory mechanism, and hence in man it has become customary to employ such terms as "thoracic" and "abdominal" to indicate the character of the inspiratory effort which is most noticeable in the female and in the male respectively. At the same time, there is no record of this distinction in the inspiratory act among the sexes of the lower animals, nor between the human sexes during infancy and early adolescence. It

* "The Mechanism of Respiration in Man," by ARTHUR KEITH, pp. 182–207, in *Further Advances in Physiology*, edited by LEONARD HILL, published by Edward Arnold, London, 1909.

appears to me, therefore, that the double mechanism which KEITH supports for the expansion of the apical and basal lobes of the lung is more apparent than real, and that the so-called *types* of breathing in man are rather the result of the erect attitude whereby, from the natural configuration and diameters of the diaphragmatic section of the thoracic cavity in the two sexes, it is with less muscular effort that the male expands the lower part of his chest and the female expands the upper part of her chest in order that each may obtain the amount of air necessary for ordinary quiet breathing. When additional efforts call for more air, or when, as in the supine position, the easy movement of the chest is impeded, then there is an immediate departure from the characteristic method; but I do not think that we must postulate a double inspiratory mechanism.

The key to the whole mechanism of inspiration is undoubtedly the part performed by the contraction of the diaphragm. We cannot, therefore, overestimate the importance of its attachments and structure; nor must we forget that, like any other muscle, its action is the result of the contraction of its fibres, whereby its attached ends are brought more or less near to each other. The most favourable method of examining the diaphragm is to consider the adult structure from the point of view of its development.

The first part of the diaphragm to appear in the embryo, and the part which may be considered the most powerful in the adult, is its mesial or vertebro-sternal portion, whose vertebral ends or crura arise from the lumbar vertebræ and constitute its axial or fixed end. These muscular fibres having adapted themselves to the positions of the abdominal aorta and the œsophagus, by a certain amount of intermingling of the fibres from opposite sides of the mesial plane, become inserted into the central tendon, whose shape varies from the trefoil tendon of man to the vena caval ring with its lateral septa as seen in the Weddell seal. From the ventral aspect of these tendinous structures a second set of muscular fibres extends to the deep surface of the lower or hinder end of the sternum. The mesial part of the diaphragm is therefore in reality a digastric muscle pursuing an arched course from the vertebral column to the sternum. The arched character of its course is more pronounced in its dorsal segment, while in its ventral or sternal segment the arched character is lost, being replaced by a straight or flat course. This change in the curve of the two segments is due partly to the disposition of the abdominal viscera and partly because the vertebral attachments are some distance farther tailwards than a point which would correspond with the hinder end of the sternum.

By its contraction two results may follow:—(1) the lower (hinder) end of the sternum is either drawn closer to the vertebral column or else prevented from being projected ventrally (forwards) by other influences; (2) the arched dorsal segment between the vertebral column and the central tendon becomes more or less flattened, and in consequence the adjacent abdominal viscera are pushed towards the ventral abdominal wall. At the same time its restraining or bracing action upon the hinder end of the sternum becomes correlated to the restraining action of the first costal arches upon the manubrium sterni, whereby the manubrium sterni is maintained at a relatively fixed distance from the vertebral column. By reason of the somewhat rigid character of the first costal cartilages in man, as well as from the fact that they are frequently encased in an ossified shell, the restraining nature of the connection between the first pair of ribs and the sternum is very well marked; but even in the Weddell seal, where a short and powerful fibrous ligament takes the place of the first costal cartilage, the manubrium is very firmly retained in its relation to the backbone.

The next part to be added to the diaphragm developmentally constitutes its ventro-lateral segments. In the adult these are composed of muscular fibres which arise from the ventral and lateral aspects of the central tendon. From this position they extend in a fan-shaped manner to be inserted into the deep surfaces of the costal arches by digitations which correspond very closely in number with those ribs that do not reach the sternum directly through their costal cartilages—that is to say, the false or vertebro-abdominal series of ribs.

This thin sheet of muscle becomes more and more arched as its slips sink lower on the series of ribs. When therefore it contracts, each digitation will either draw its own particular rib nearer to the central tendon or else maintain the ventral end of its rib at a more or less definite distance from the central tendon.

In this way the ventral ends of the false ribs are provided with temporary or intermittent fixed points, fixation by the contraction of the diaphragm being substituted for fixation by the sternum, as is the case with vertebro-sternal ribs. In fact, the series of ribs could with effect be classified as vertebro-sternal and vertebro-diaphragmatic.

The flattening of the arched surfaces of the diaphragm must increase the available thoracic space, but under ordinary conditions the addition so provided cannot of itself be very great, and only becomes important as the central feature of a larger movement.

Developmentally, the last part to be added to the diaphragm is also its weakest part both in man and in the Weddell seal. This is the dorso-lateral segment, which consists of muscular fibres forming a delicate sheet extending between the dorso-lateral aspects of the central tendon and the ligamenta arcuata externa and interna, and through these with the vertebral column on the one hand and the last rib on the other. The arched course of these fibres in man must enable them to aid the flattening of the dorsal parts of the diaphragm and thereby again assist in pushing the abdominal contents in a ventral direction, but in the seal they are so feebly developed that the effect of their contraction must be practically negligible. I do not doubt that contraction of the diaphragm may produce some depression of the central tendon, more especially at its dorsal side, but I doubt whether the depression of the central tendon can take place on its sternal side or be so pronounced as a whole as to give the "piston action" described by some observers. My reasons for holding this view may be shortly summarised. The pericardial bag rests by its base upon the diaphragm, and, when a central tendon of the trefoil pattern is present, the fibrous bag and the central tendon are intimately united to each other, but the ventral surface of the pericardium is attached to the manubrium sterni by a sterno-pericardial ligament which is described by MACALISTER * as strong and rounded. A similar ligament of weaker character attaches the pericardium to the ensiform cartilage. These ligaments, especially the former, would resist the traction of the pericardium in the abdominal direction, and so resist the depression of the central tendon. Again, the normal liver presents indented grooves corresponding to, and resulting from apposition with, the ribs which cover it, and these grooves indicate a fairly constant relation between the liver and the ribs, since they could not be formed by any plunging or piston action communicated to the liver from the diaphragm. If, on the other hand, the flattening of the dorsal portion of the diaphragm pushed the liver ventrally towards the ribs, and at the same time the contraction of the ventro-lateral portions of the diaphragm drew the lower ribs towards the liver or even maintained them in a position to resist the liver, then the liver markings would be at once accounted for. Further, STARLING † states that during ordinary respiration the central tendon of the diaphragm is practically motionless, but that as soon as respiration becomes laboured there is an actual downward movement of the diaphragm, and that during laboured inspiration the breathing is mainly thoracic in both sexes, "and the abdomen recedes with each inspiration." Apparently, therefore, according to this observer, it is fair to conclude that a laboured inspiration, by calling for more powerful action of the diaphragm, results not only in greater flattening and depression of the dorsal segment of the arched diaphragm, but also in the lower ribs being drawn closer to its central tendon than during ordinary breathing, which is just what an examination of the muscular attachments would lead one to expect. I therefore arrive at the general conclusion that the diaphragm is the keystone in the inspiratory mechanism, and that its chief action consists in resisting the ventral (forward) movement of the hinder (lower) end of the sternum and of those ribs which are not directly articulated to the sternum. As a result of this controlling action the whole series of ribs may participate uniformly in a general lifting or elevating movement which characterises their position at the end of inspiration as contrasted with their sunken or depressed position at the end of expiration. Such an elevation of the ribs does not call for any rotation of their shafts, and indeed, from the nature of their capitular and tubercular articulations with the vertebral column, rotation of the shaft would be impossible. But the chondro-sternal as well as the articulations just mentioned are from the nature of their ligaments adapted to the movements of elevation and depression of the rib as a whole, and even a small amount of such movement at the vertebral end of a rib would tend to be magnified by the length and obliquity of its shaft. In fact, the capsules of the costo-transverse articulations are sufficiently long to permit of the gliding action necessarily associated with such elevation and depression.

In the seal there are two muscles whose attachments are only readily comprehensible when considered as part of the mechanism for depressing the ribs after they have

* MACALISTER, *Text-book of Human Anatomy*, 1889.

† E. H. STARLING in Schafer's *Text-book of Physiology*, vol. ii. pp. 276 and 280.

been elevated. These are the musculus obliquus externus abdominis and the musculus rectus abdominis. Both of these muscles are attached to the pubis, *i.e.* to the unyielding or rigid pelvis, and between them they provide slips or digitations of insertion into nearly all of the ribs, even extending to the first. Further, the musculus obliquus abdominis externus has no attachment to the ilium—in other words, both of these powerful muscles were pubo-costal in their attachments. With a distended chest and a glottis firmly closed so as to render the chest wall fairly rigid, these muscles by their contraction could clearly compress the abdominal contents; but in association with an open glottis, of necessity they must pull their rib attachments towards the pubis—in other words, they must act as depressors of the ribs and thus as powerful expiratory muscles. Such a depressor action compels one to presume and to accept an elevated position of the ribs during inspiration.

There is nothing in the mechanism which seems to require one mode of action for inspiration by the vertebro-sternal ribs and another mode of action by the vertebro-abdominal ribs. Of course, the first costal arch, from the nature of its sternal articulation, is, even in the seal, capable of less elevation than those ribs whose shafts and costal cartilages are longer and whose sternal articulations permit greater freedom of movement; but, in order to secure a uniform method of elevation throughout the series of ribs, it is necessary to provide some more rigid line or *point d'appui* for the start of the movement, and the combination of the first costal arch with the manubrium sterni, together with their powerful scalene and sterno-mastoid muscles, provides such a line. Moreover, in man the clavicle is added to this line by the sterno-mastoid and trapezius muscles as well as by such ligaments as the costo-clavicular and the sterno-clavicular. Again, it will be found that those ribs which elevate most readily are just those whose *heads* are provided with an interarticular ligament passing between the head and the intervertebral disc. Such a powerful structure would be unnecessary unless there were a tendency for the head of the rib to be drawn away from the vertebral column as the dorso-ventral and transverse thoracic diameters increased owing to the elevation of the ribs in full inspiration. There is no ordinary form of inspiration which requires a larger amount of air under regulated control than the inspiratory movement performed by the trained singer, and one of the approved methods of obtaining this result aims at the expansion of the large dorsal surface of the lungs by cultivating the upward movement of the ribs in relation to the dorsal surface of the chest, as being not only easier than, but preferable to, a forced action of the diaphragm. An examination of the mechanism of respiration leads me to the conclusion that, in all forms of respiration, this mechanism acts in the same way, but not, in all its parts, to the same extent, for any particular respiratory act; that ordinary and laboured respiration differ in degree rather than in kind; that the degree of respiration depends upon the amount of air required for any particular form of exertion; that the difference between the respiration of the quadruped and the respiration of man results from differences in their attitude (horizontal and erect), whereby each cultivates that form of chest movement which requires the minimum of muscular effort. The differences between the adult human male and female types of breathing are adaptations due to the avoidance of severe muscular effort so long as a smaller effort will serve the purpose, and in my opinion they result from the normal differences in the lower or diaphragmatic diameters of the thoracic cavity in the two sexes. To a large extent these differences may be accounted for by the width of the female false pelvis as compared with that of the male. Since the abdomen proper (*i.e.* excluding the true pelvis) contains no organs which are not common to both sexes, it follows that a wide false pelvis, by providing increased accommodation in the lower abdominal regions, is naturally associated with a reduction in the dimensions of the upper or diaphragmatic end of the abdomen. These conditions make elevation of the sternal ribs more necessary in the female than in the male, whose larger diaphragmatic thorax permits of ordinary breathing without the pronounced or visible elevation of his sternal ribs, although their movement may become visible whenever the supply of air required calls for an extension of the elevating movement.

In either sex, a change from the erect attitude to the horizontal (*e.g.* to the supine) position is usually followed by the introduction of more or less of the respiratory features of the opposite sex, owing to the temporary interference with the amount of rib movement in common use when the ribs are unobstructed.

PART VII.

TUNICATA.

VII.—THE TUNICATA OF THE SCOTTISH NATIONAL ANTARCTIC EXPEDITOIN.

By W. A. HERDMAN, D.Sc., F.R.S.,
Professor of Zoology in the University of Liverpool.

(*WITH ONE PLATE.*)

The Tunicata of the Scottish National Antarctic Expedition. By W. A. Herdman, D.Sc., F.R.S., Professor of Zoology in the University of Liverpool. (With One Plate.)

(MS. received January 8, 1912. Read February 19, 1912. Issued separately July 3, 1912.)

So far as regards number of individuals, and their size, this is one of the largest collections of Ascidians brought back in recent years from Antarctic seas. It contains almost exactly the same number of species of Ascidiacea (*Ascidiæ Simplices* + *Ascidiæ Compositæ*) as the *Discovery* collection—viz. fifteen or sixteen—but whereas in the latter collection nearly all the species were represented by single specimens, in the *Scotia* collection most species can show long series of individuals—in all there are about two hundred specimens, as against the thirty-three brought home by the *Discovery*.

The sixteen species in the present collection represent almost as many genera, and half a dozen families. The systematic arrangement is as follows:—

ASCIDIACEA.

Family Molgulidæ.

Paramolgula gregaria (Lesson).
Paramolgula horrida (Herdman).

Family Cynthiidæ.

Boltenia legumen, Lesson.
Fungulus antarcticus, n. sp.
Halocynthia setosa, Sluiter.

Family Styelidæ.

Styela lactea, Herdman.
Styela paessleri, Michaelsen.
Synstyela incrustans, Herdman.
Polyzoa opuntia, Lesson.
Goodsiria placenta, Herdman.

Family Ascidiidæ.

Ascidia charcoti, Sluiter.

Family Distomidæ.

Colella pedunculata (Q. and G.).
Holozoa cylindrica, Lesson.

Family Polyclinidæ.

Polyclinum complanatum, Herdman.
Amaroucium distomoides, Herdman.
Amaroucium sp.

It is interesting to notice how greatly some of these recent collections from the far South differ from one another in the species represented. The following table—which gives only the sixteen species in the *Scotia* collection—shows that only one form (*Halocynthia setosa*) from that collection was also taken by the *Discovery*, whereas ten species were taken by the *Challenger*, eight by the Hamburg Magellanic and South Georgia Expedition, and five by the French Antarctic Expedition under Charcot. This can be explained to some extent, at least, by the precise localities visited: the *Scotia*, the *Challenger*, and the Hamburg collections were largely made in the Magellan and Falklands neighbourhood, while the other three collections were mainly from farther south.

"Scotia" Species.	"Discovery."	"Challenger."	Charcot.	"Southern Cross."	Magellan and South Georgia.
Paramolgula horrida,		×			×
" *gregaria*,		×			×
Boltenia legumen,		×			×
Fungulus antarcticus,	("Scotia" only)				
Halocynthia setosa,	×		×		
Styela lactea,		×	×	×	
" *paessleri*,					×
Synstyela incrustans		×			×
Polyzoa opuntia,		×			×
Goodsiria placenta,		×			
Ascidia charcoti,			×		
Colella pedunculata,		×	×		×
Holozoa cylindrica,		×	×	×	×
Polyclinum complanatum,	In collection of Australian Museum, Sydney.				
Amaroucium distomoides,	In collection of Australian Museum, Sydney.				
Amaroucium sp.,	In collection of Australian Museum, Sydney.				

Although only one of the *Scotia* Tunicata requires to be described as new to science, several of the species are of considerable interest, and most of them add something to our knowledge either in the characters and variation of the species or in distribution. The one new species (*Fungulus antarcticus*) is a very remarkable form belonging to the deep-sea genus *Fungulus*, known only from a single species obtained during the *Challenger* Expedition between the Cape of Good Hope and Kerguelen Island.

This collection shows again what I remarked upon more than twenty years ago in the case of the *Challenger* collection, that the Ascidian fauna of the far South is characterised by the abundance and the large size of the individuals of a comparatively few species. *Halocynthia setosa* and *Holozoa cylindrica* are the two largest species, the one simple and the other compound, and both are represented by a large number of specimens. I have, however, written on this matter, and also on the number of Antarctic as compared with Arctic species, so recently in my report * upon the *Discovery* collection that these matters need not be discussed further here.

Family Molgulidæ.

Paramolgula gregaria (Lesson). (Plate, fig. 9.)

Cynthia gregaria, Lesson, *Cent. Zool.*, p. 157.
Molgula gregaria, Herdman, *Challenger* Report on Tunicata, Part I., p. 73.

Locality.—Station 118, on hulks, Stanley Harbour, Falkland Islands, January 16, 1903.

There are over forty specimens of this species in the collection, ranging in size from 2 × 1·5 cm. up to 6·5 × 5 cm. The majority are about 4 cm. in diameter. They have

* *National Antarctic Expedition: Natural History*, vol. v., "Tunicata," 1910.

the characteristic smooth test and translucent grey tint, and they also agree closely in internal details with the *Challenger* specimens from shallow water off the Falkland Islands.

MICHAELSEN has suggested that this species and *Paramolgula gigantea* (Cunningham) are the same. No doubt they are related forms; both belong to the restricted genus *Paramolgula*, having only broad, ribbon-like longitudinal bars but no true folds in the branchial sac (a fact I overlooked in drawing up my "Revised Classification of the Tunicata" in 1891, as MICHAELSEN has pointed out), but I do not consider them as identical. In addition to differences in the external appearance—the shape and the condition of the test—the branchial sacs are not alike in detail, and the dorsal tubercles differ widely. I give here a figure of the dorsal tubercle (Plate, fig. 9) of *P. gregaria* from the *Scotia* collection for comparison with that of *P. gigantea* figured in the *Challenger* Report.

LESSON figures his species with five lobes round each aperture, but that is no doubt an error. The branchial aperture has six and the atrial four lobes.

Paramolgula horrida (Herdman) (?). (Plate, figs. 10 and 11.)

Locality.—Station 118, on hulks, Stanley Harbour, Falkland Islands.

I have very little doubt that this single large specimen (measuring 7·5 cm. in length and 5·5 cm. in breadth) belongs to the same species as the specimen from "off the Falkland Islands, 5–12 fathoms," which I described in the *Challenger* Report as *Molgula horrida*. They both fall within the more modern genus *Paramolgula*, separated off from *Molgula* by TRAUSTEDT because of the absence of true folds in the branchial sac. As the *Challenger* description was drawn from a single specimen, and as this *Scotia* specimen differs a little in detail, it may be well, in the interests of a fuller knowledge of the species, to add a few of the characteristics of the individual before me.

The shape is irregularly ovate, and flattened, and the colour is a very dark brown. The other external characters can be seen from the figure (Plate, fig. 10). The Test is leathery and rough on the surface. It is thin but tough, and dark but smooth and glistening on the inner surface. The Mantle is dark brown and opaque. It is thick, but soft and not muscular, or at least the muscles do not form obvious bands.

The Branchial Sac has on each side seven wide longitudinal vessels which look like narrow folds. Between the distant wider transverse vessels, narrower intermediate ones branch in all directions in a dendritic manner, so as to form rounded and oval and variously shaped meshes in which the stigmata lie. The stigmata are also rather irregular in arrangement, being in some parts in spirals and in other places side by side in rows (see fig. 11).

The Tentacles are of different sizes, there being eight larger much branched, with some smaller ones between.

The Dorsal Tubercle has its long axis antero-posterior and its opening at the side. The horns form two close spirals, both coiled inwards. Whether *P. patagonica* of MICHAELSEN is also the same species as *P. horrida* is very doubtful. I am inclined to regard it as distinct.

Family CYNTHIIDÆ.

Boltenia legumen, Lesson.

Locality.—Station 118, on hulks, Stanley Harbour, Falkland Islands, about twenty specimens; and eight specimens from 6 fathoms, Port Stanley, February 2, 1904.

There are over two dozen specimens of this species in the collection, and they range in size from 1·5 to 7 cm. in greatest length of body—about the same range as in the case of those in the *Challenger* collection. All of these specimens of *B. legumen* belong to the "forma typica" of MICHAELSEN'S system * of subdivision of this species, and agree in character with the *Challenger* specimens from the same locality. In some cases the little bristles on the surface of the test are more abundant and more prominent than in others, but there are all gradations between. This is evidently a very common Ascidian in shallow water at the Falklands.

Fungulus antarcticus, n. sp. (Plate, figs. 15 to 18.)

A single specimen which clearly belongs to the rare and interesting genus *Fungulus* was obtained at Station 301 from a depth of 2485 fathoms, on March 13, 1903, at lat. 64° 48′ S., long. 44° 26′ W.; temp. 31°·02. The genus was established in 1882 for another solitary individual found in the Southern Ocean during the *Challenger* Expedition, at Station 147, between the Cape of Good Hope and Kerguelen Island, lat. 46° 46′ S., long. 45° 31′ E.; depth, 1600 fathoms, on a bottom of Globigerina ooze. The two localities are thus nearly 3000 miles apart, but agree in that both are in the far south and in very deep water.

The *Scotia* specimen, although closely related to the *Challenger Fungulus cinereus*, Herdman, cannot be placed in the same species. The general appearance and anatomy, and especially the remarkable structure of the branchial sac, are the same; but the relation of the peduncle to the apertures and the details of structure are different in the two forms. The description of *F. antarcticus* is as follows:—

The body is club-shaped (fig. 15), like a rounded knob about 1·5 cm. in diameter on the summit of a short, stout peduncle, which is also about 1·5 cm. in length and from 4 to 6 mm. in thickness. The peduncle is continuous with the ventral edge of the body, while the dorsal edge projects markedly. The surface is smooth and the

* "Die Holosomen Ascidien des magalhaenisch-sudgeorgischen Gebietes," *Zoologica*, Bd. xii., Heft 31, Stuttgart, 1900, p. 109.

colour pale yellowish grey. The branchial aperture is a little way along the ventral edge of the anterior end, and appears to be bilabiate or elliptical rather than lobed. The atrial aperture is in the middle of the dorsal surface, and is a square or four-lobed opening. In *F. cinereus*, the branchial aperture was described as triangular, and the atrial as bilabiate, but the figure of the former in the *Challenger* Report is not very different from the figure now given (fig. 16) from the *Scotia* specimen.

The Test is thin and membranous, but tough. Under the microscope it is seen to be finely roughened all over the outer surface. In minute structure the test agrees with that of *F. cinereus* as described in the *Challenger* Report. The Mantle is very thin and inconspicuous, but muscular. It is penetrated by numerous, very fine, closely placed muscle bundles which, in the tubular extension of the mantle which occupies the hollow peduncle, run longitudinally parallel to one another.

The Branchial Sac is remarkably delicate, and is, in fact, merely a very loose wide-meshed net with folds at intervals where the longitudinally-running vessels are crowded together (fig. 17). The transverse vessels are of two sizes, occurring alternately. The looseness of the branchial sac and the minute undulations in practically all the muscle bundles of the mantle give the impression that when alive and filled with sea-water the animal had the power of expanding to a considerably larger size than it now shows. Possibly the test when alive was of a gelatinous consistency and capable of being dilated.

There are no spicules in the vessels of the branchial sac. The endostyle is narrow but conspicuous; there are no spicules in its wall. The branchial tentacles are few and only slightly branched. The alimentary canal is relatively small, and is confined to the posterior end of the left side close to the top of the peduncle (fig. 18). The stomach wall has a number of close-set longitudinal folds.

The gonads are one on each side, rather long and irregular, with the narrower end pointing to the atrial aperture (fig. 18).

This new species differs from *Fungulus cinereus*, Herdman, in the shape and proportions of the body (see figures) and in the much paler colour of the test; in the details of position and shape of the branchial and atrial apertures; in having the transverse vessels of the branchial sac distinctly of two sizes; in having a well-marked stomach with longitudinal folds; and in the length and shape of the gonads.

Halocynthia setosa, Sluiter.

This very striking and characteristic species was obtained by the *Scotia* in considerable quantity at the South Orkneys. It was originally described by SLUITER * from two specimens obtained by the French Antarctic Expedition under Dr JEAN CHARCOT at "Ile Booth Wandel, 40 mètres"; but as the figures in the report on the Charcot Expedition did not seem to me to be characteristic, I gave a supplementary description, with figures,

* *Bull. Mus. Hist. Nat. Paris*, 1905, No. 6, p. 472; and *Expéd. Antarct. Franç. (Charcot)*, "Tuniciers," p. 40.

of the species in my report upon the Tunicata of the *Discovery* Expedition.* The *Discovery* obtained in all five specimens from the east end of the Barrier and the neighbourhood of the winter quarters in M^c^Murdo Bay, in 10–20 fathoms.

The more abundant material obtained by the *Scotia* gives us still further information in regard to the characteristics and variation of the species. Some of the *Scotia* specimens, measuring up to 11 × 7 × 5 cm., are the largest yet obtained; and some of them show a short peduncle at the place of attachment, a feature not previously observed. The characteristic spines on the test reach in some of these larger specimens to a length of 21 mm. and a breadth of about 1 mm. at the base. In some of these specimens the musculature of the mantle is remarkably strong, and consists externally of circular siphonal sphincters, beyond which is an oval sphincter, of numerous fibres, enclosing both siphons, while more internally radial muscles formed of exceedingly stout and strong fibres run outwards from the base of the siphons. Connective tissue permeated by fine fibres covers and unites all these various muscle bundles.

Of the six folds on each side of the branchial sac, the largest is the one next to the dorsal lamina on each side, and the smallest is generally the third counting from the dorsal to the ventral edge. The transverse vessels are of four different sizes, and the stigmata are from nine to twelve in a mesh. One dorsal tubercle examined measured 4·8 mm. from side to side and 3·2 mm. antero-posteriorly.

The nerve ganglion is extraordinarily narrow and elongated, and may reach 9·5 mm. in length, with two nerves diverging from each end which can be traced with the eye round the sphincters of both siphons. The subneural gland is in the form of a thin layer over the ganglion.

A strong band of muscle fibres lies under the dorsal lamina and extends from the mantle into the wall of the branchial sac near the posterior end of the nerve ganglion.

Two of the specimens had Amphipods in the branchial sac. The specimens were obtained as follows:—

I. Station 325,† 9–10 fathoms, Scotia Bay, South Orkneys, July 1903.
  (1) 9 × 6 × 6 cm. (on a short peduncle).
  (2) 9·5 × 6·5 × 3 cm. (very short peduncle).
  (3) 8 × 5·5 × 4 cm.

II. Station 325, 9–10 fathoms, June 1903; temp. 29° F.
  (1) 4 × 4·5 × 2·5 cm. (test only).
  (2) 8 × 5·5 × 4 cm. (with a smaller one attached).

III. Station 325, 9–10 fathoms, August 1903; temp. 29° F.
  (1) 6 × 5 × 4·5 cm. (also four empty tests).

IV. Station 325, 9–10 fathoms, May 1903; temp. about 28° F.
  (1) 7·4 × 5 × 5 cm.
  (2) 6 × 4 × 4 cm. (also four empty tests).

* *Report National Antarctic Exped.: Nat. Hist.*, vol. v., "Tunicata," London, 1910.

† The whole of Scotia Bay is termed Station 325; consequently, depths vary.

V. Station 325, 9–15 fathoms, April 1903; temp. 28° to 29° F.

About a dozen specimens ranging from $11 \times 7 \times 5$ cm. down to $5{\cdot}5 \times 5 \times 3{\cdot}2$ cm. (one empty test).

VI. Station 325, 9–15 fathoms, December 26, 1903; temp. 31°·4 F.

(1) $4\frac{1}{2} \times 3 \times 3$ cm.

Family Styelidæ.

Styela lactea, Herdman. (Plate, figs. 1–8.)

Styela lactea, Herdman, *Challenger* Report on Tunicata, Part I., p. 156.
Styela flexibilis, Sluiter, *Charcot Exped.*, "Tuniciers," p. 36.
(?) *Cynthia verrucosa*, Lesson, *Cent. Zool.*, p. 151.

Localities.—(1) Station 118, on hulks, Stanley Harbour, Falkland Islands.

(2) Scotia Bay, South Orkneys, Station 325, February 2, 1904.

(3) Attached to *Holozoa cylindrica*, thrown up on beach, Scotia Bay, January 17, 1904.

(4) Station 118, shore pools, Port Stanley, January 1903. (Two elongated specimens.)

The specimens from the Falkland Islands are about twenty in number, ranging from little globular spiky balls (see figs. 3, 4) of 1 cm. in diameter to irregular barrel-shaped masses (fig. 1) of 8 cm. in length and 5 to 6 cm. in breadth. The specimens from Scotia Bay attached to the compound Ascidian *Holozoa cylindrica*, Lesson (= *Distaplia ignota*, Herdman), are small and globular, bristling with short pointed spikes, and of a pure white colour (fig. 2); while the remaining specimen from Scotia Bay (February 2) is much larger, roughly cylindrical in shape, less spiny, and of a duller colour (fig. 1). Still, all transitions in shape and appearance can be found between the extreme forms, so there can be no doubt that all belong to the one species, *S. lactea*, found by the *Challenger* Expedition at Kerguelen Island, and by the *Southern Cross* Antarctic Expedition at Cape Adare.

The largest *Scotia* specimens correspond closely with Sluiter's *S. flexibilis*, found during the Charcot Expedition at "Ile Booth Wandel." That species agrees in internal characters with *S. lactea* so closely that I have no doubt that the two are the same, and that *S. flexibilis* must be regarded as a synonym of *S. lactea*. It is, I think, possible also that the *Cynthia verrucosa* of Lesson, found attached to Fucus on the shores of Malonines Islands, Antarctic, which is figured as having five lobes round each aperture, is really this same species. If so, the number of lobes shown by Lesson is, of course, erroneous.

The following additional characters, taken from the larger *Scotia* specimens, may be useful to compare with the descriptions of other specimens:—

Size $7 \times 4 \times 3{\cdot}5$ cm. Barrel-shaped, attached by flat area at posterior end about 3·5 cm. in diameter. Colour pale creamy white with a pinkish tinge in places. Test thin, leathery, raised at intervals to form little pointed tubercles, the larger of which are echinated (fig. 5). Mantle muscular, with regular circular and longitudinal bands. Branchial Sac with four large folds on each side. There are six to nine bars on a fold, and four in the interspace. Dorsal lamina a broad plain membrane. There are about thirty very long simple tentacles and some intermediate smaller ones. The dorsal tubercle has both horns coiled inwards to form short spirals (fig. 8). There are two or three long gonads on each side, and many endocarps. Fig. 7 shows the arrangement of the alimentary canal.

In the smaller, more globular specimens the conical spiny tubercles on the test are relatively more numerous and more closely and regularly placed (see figs. 2, 3, 4, and 6). The *Challenger* specimen figured, from Kerguelen, was intermediate in size to the larger and the smaller *Scotia* examples, and was smoother in character of test.

Styela paessleri, Michaelsen. (Plate, figs. 12 to 14.)

This species was described by Michaelsen in 1900 from specimens obtained in the Straits of Magellan. The *Scotia* specimens from the Falkland Islands seem to be rather larger on the whole, but agree in essential characters.

The following description, from the *Scotia* material, may be useful:—There are about twenty specimens, varying in size from 1 cm. to 3 cm. in length by 1·5 cm. in average breadth, obtained from Station 118, at the Falklands, depth 6 fathoms; and a couple from Port Stanley, February 2, 1904, 6 fathoms.

The colour varies from a creamy white to a yellowish brown, and the surface of the test is in most places closely wrinkled. The branchial sac has four folds on each side, the largest being those adjacent to the dorsal lamina, with ten bars each, while the others have usually six bars. Fig. 12 gives the plan of both sides of the branchial sac as seen in section, with the number of bars and of rows of stigmata shown by the figures. The folds have from five to ten bars, and there are from two to five (usually four) bars in the spaces between. These numbers agree fairly well with those given by Michaelsen. The transverse vessels are of three sizes arranged with regularity: 1—3—2—3—1, and having a narrow horizontal membrane in addition crossing the meshes (fig. 13). Most of the meshes are square, with five to seven stigmata in each. The extreme dorsal and ventral meshes are more elongated transversely, and contain a greater number of stigmata.

The dorsal tubercle is of curious form (fig. 14), a simple crescent with the horns anterior and having a globular excrescence in the concavity. The dorsal lamina is a plain membrane. The tentacles are crowded and number about a hundred. They are of two sizes, roughly fifty of each. Michaelsen records only sixty tentacles, but as the specimens he examined were smaller than ours, the difference need not be regarded as important.

Although some of the above characters do not agree precisely with those given by Michaelsen, still the differences are not, I think, greater than what may reasonably be ascribed to individual variation within the limits of a species. The dorsal tubercle is perhaps the feature that shows most divergence, but MICHAELSEN himself remarks in the original description that it is probable that other specimens might show a different form of tubercle.

Polyzoa opuntia, Lesson, subspecies *coccinea*, Cunningham.

Goodsiria coccinea, Cunningham, *Trans. Linn. Soc. Lond.*, xxvii.

Several specimens of this common species were obtained at the Falklands:—

(1) Station 349, shore pools, Cape Pembroke, January 1903 to January 1904. One large, lobed colony and a couple of small ones. This is part of collection made on behalf of *Scotia* by Mr PEARSON, Cape Pembroke lighthouse-keeper, during twelve months.

(2) Station 118, rock cod trap, Stanley Harbour, $3\frac{1}{4}$ fathoms, January 1903. One elongated colony, about 26 cm. in length

Goodsiria (Gynandrocarpa) placenta, Herdman.

Several specimens that seem to agree closely with this South African species were obtained at the Falklands, as follows:—

(1) Station 118, Stanley Harbour, January 7, 1903. One small colony.

(2) Station 118, rock cod trap, Stanley Harbour, $3\frac{1}{4}$ fathoms, January 1903. Part of a large colony which probably measured 10 or 12 cm. across.

(3) Station 118, Port Stanley, 6 fathoms, February 1904. One colony measuring about 10 by 5 cm.

Synstyela incrustans, Herdman.

(?) *Allæocarpa zschaui* (Michaelsen).

Locality.—Station 118, on hulks, Stanley Harbour, Falkland Islands.

There are about a dozen colonies of this species, ranging in size from 1 or 2 cm. up to 5 or 6 cm. in diameter. Most of them were adhering in masses along with the larger specimens of *Paramolgula gregaria*.

In detailed characters these specimens agree well with the *Challenger* specimens of *Synstyela incrustans* obtained in the Straits of Magellan, but they also agree with MICHAELSEN's description of *Allæocarpa zschaui* from South Georgia; and when mature, the Ascidiozooids show the male unisexual polycarps on the left, and the female on the right-hand side of the mantle, which is a character of MICHAELSEN's proposed generic division *Allæocarpa*. As, however, he names my species *Synstyela incrustans* as the type form of *Allæocarpa*, and as he apparently does not in his system retain *Synstyela* as a genus, but substitutes the name *Allæocarpa* for it, I must point out that *Synstyela*, Giard, has the prior claim and must be retained as the name of the genus, even when, as happens to be the case, our knowledge of the internal characters has been increased and the definition added to since the genus was originally created. Consequently I must regard MICHAELSEN's *Allœocarpa zschaui* as a *Synstyela*, and furthermore I find myself unable to distinguish it as a species from *S. incrustans* of the *Challenger* Report. In MICHAELSEN's "Revision der compositen Styeliden oder Polyzoinen,"* where both species are described, in his table on p. 73 he distinguishes them by the proportions of the oviduct and the number of internal longitudinal bars in the branchial sac, as follows:—

S. zschaui having the oviduct broader than long, and having sixteen to seventeen bars on each side; and

S. incrustans having the oviduct longer than broad, and having twelve to fourteen bars on each side of the sac.

Now, in the first place, with a soft, easily deformed structure like the oviduct it is almost impossible to be sure of the true proportions; and secondly, I find them varying considerably in my specimens; so that I cannot say they agree more in this character with the one species than with the other. Then as to the number of longitudinal bars, on dissecting out and mounting a branchial sac from a *Scotia* specimen I find the number of bars to be fifteen on each side. According to MICHAELSEN, if it had sixteen the species would be *zschaui*, and if it had fourteen it would be *incrustans*. Under these circumstances, and as I find the specimens before me agree equally well with the descriptions of these two species, I think there can be little doubt but that *A. zschaui*, Michaelsen, is a synonym of *Synstyela incrustans*, Herdman.

Diandrocarpa monocarpa (Sluiter) is certainly not the same species as *Synstyela incrustans*, although it is probably a *Synstyela*. The number of longitudinal bars in the branchial sac is very much smaller than in the present species.

Family ASCIDIIDÆ.

Ascidia charcoti, Sluiter.

Locality.—Station 325, in shore pool, Scotia Bay, South Orkneys, February 2, 1904.

The single large *Ascidia* in the collection clearly belongs to SLUITER's *A. charcoti*, a species found by the Charcot Expedition to be abundant at "Ile Booth Waudel." The *Scotia* specimen measures 8·5 × 5·5 × 2 cm., and was attached by a small area in the middle of the left side. The branchial aperture has only seven lobes, a curious little detail in which it agrees with SLUITER's description. The atrial has the usual six lobes characteristic of the genus. The test reaches a thickness of 2 to 3 mm., but has not the red colour mentioned by SLUITER; and the mantle is unusually thick and spongy

* *Mitteilungen aus dem Naturhistor. Museum*, xxi., Hamburg, 1904.

for an *Ascidia*. The branchial sac is also thick, and both mantle and branchial sac are of a distinctly pinkish colour which may be the remains of the orange-red that SLUITER records. There are twelve moderate-sized tentacles, and the horse-shoe shaped dorsal tubercle is very large, reaching up to the base of the tentacles. It seems larger than in SLUITER's specimens, in which, however, the dorsal tubercle is recorded as being rather variable.

SLUITER states that no teeth are present on the dorsal lamina; but I find that in the *Scotia* specimen the dorsal lamina has marked denticulations along its free edge, amounting in one part to short tentacular languets. But still I have no doubt that my specimen belongs to SLUITER's species, and that the dorsal lamina must be regarded as somewhat variable in character. The viscera on the left side of the body are unusually large and opaque.

Family DISTOMIDÆ.

Colella pedunculata (Quoy and Gaimard).

? *Sycozoa sigillinoides*, Lesson.
? *Colella tenuicaulis*, Herdman.
? *Colella umbellata*, Michaelsen.

One colony having a stalk bifurcated near the top and bearing two "heads" was found at Station 346 on Burdwood Bank, 56 fathoms, on December 1, 1903, and presents to some extent characters recalling all the species named above. In the branching of the peduncle it is like MICHAELSEN's *C. umbellata* from the Falklands; in the general appearance of the "head," however, it is more like QUOY and GAIMARD's *C. pedunculata*, found by the *Challenger* at the Straits of Magellan, the Falkland Islands, Kerguelen, etc. The long slender stalk recalls the Australian *C. tenuicaulis*; and it is possible that LESSON's *Sycozoa sigillinoides* may be identical with one or more of these other named forms. Both the "heads" are, unfortunately, in the single colony in a very ragged condition—possibly dead when collected—so that the more minute characters of the Ascidiozooids cannot be determined.

Holozoa cylindrica, Lesson. (Plate, fig 2.)

———(?) *ignotus*, Herdman, *Challenger* Report, ii., 1886, p. 251.
Julinia australis, Calman, *Quart. J. Micr. Sci.*, 1894, p. 1.
Distaplia ignota, Herdman, *Report on "Southern Cross" Tunicata*, Brit. Mus., 1902, p. 197.
Holozoa cylindrica, Less.—Hartmeyer, in Bronn's *Tier-Reichs*, "Tunicata," 1909.

This large and apparently abundant Antarctic species was obtained by the *Scotia* Expedition at the following localities:—

1. Station 346, Burdwood Bank, 56 fathoms, December 1, 1903. Seventeen fragments from 10 to 30 cm. in length by 2 to 4 cm. in diameter. All in bad condition, soft and partly macerated, with many other animals, Hydroids, Polyzoa, etc., entangled in the irregular, ragged surface.

II. Station 325, Scotia Bay, April 1903. One specimen, $30 \times 4 \times 3$ cm., bad condition.

III. Station 325, Scotia Bay, South Orkneys, December 6, 1903; temp. 29·8°; floating on surface. 80 cm. $\times$ 2 (tapering to 1) cm.

IV. Station 325, Scotia Bay, South Orkneys, December 26, 1903; temp. 30·7°.
(1) 85 (incomplete) $\times$ 1·5 (tapering to 1) cm.
(2) 75 cm. (incomplete) and two fragments.

V. Station 326A, Brown's Bay, South Orkneys, November 1903. Two specimens: (1) 55×2 to 3 cm; (2) 40×2 cm.

VI. Scotia Bay, South Orkneys, January 17, 1904; temp. 32·5°; thrown up on beach. One colony, 20×5 cm., with several *Styela lactea* attached; in bad condition; most of Ascidiozooids lost.

VII. Scotia Bay, South Orkneys, January 3, 1904; temp. 31·5°; thrown up on beach. Two very long specimens: (1) over 100×2 cm.; (2) over 150×2 cm.

VIII. Scotia Bay, South Orkneys, November 25, 1903; surface. Three small colonies, 20 to 30×1 to 1·5 cm.

IX. Scotia Bay, March 25, 1903. One small colony, 10×2 cm.; bad condition; most of Ascidiozooids gone.

Most of these specimens are, unfortunately, in very bad condition, and were probably dead or decomposing when collected. The *Challenger* specimens were in such a rotten condition that it was impossible to determine even the genus. But from the rather better material brought home by the *Southern Cross* Expedition I was able to determine that the *Challenger* specimens—evidently the same species—belonged to the genus *Distaplia*. What CALMAN described as *Julinia australis* in 1894 is again the same.

SLUITER, in his report on the Charcot Tunicata, thinks that "*Julinia*" may be recognised as an independent genus because of the elongated form of the colony; but *Distaplia clavata* (Sars), from Arctic seas, although it does not attain to such a length, has the same elongated form—and therefore it cannot be said that a *Distaplia* with this habit of growth is unknown.

The colony found floating on the surface in Scotia Bay, December 26, and measuring about 85 cm. in length, is the best preserved specimen in the collection, and I think the best preserved that I have seen in any collection brought back from the Antarctic. The colony, although soft, does not seem to be rotten. The Ascidiozooids are distinct and large and closely placed throughout its length. Their exposed ends measure about 2 mm. across, and are of an opaque pale yellow colour, in contrast to the translucent grey of the test in which they are embedded. Throughout the greater part of the colony the Ascidiozooids appear to be in long meandering lines, but here and there one comes upon a circular, elliptical, or more irregular group (fig. 2), reminding one of the arrangement in a *Botrylloides*. Both ends of the colony are incomplete, and at the upper end the Ascidiozooids appear to be dropping out of the test.

Some of the Ascidiozooids in this colony are the best preserved I have seen in all the various samples of this species that have passed through my hands, and their anatomical and histological characters agree in detail with the excellent account of "*Julinia*" given by CALMAN. In fact, I can agree with CALMAN in every respect save that of bestowing a new name on the genus. It is evident from his remarks that he recognised the close affinity to *Distaplia*, and the only mistake he made was in not referring the species to that genus.

I agree, however, with HARTMEYER* that it is practically certain that this form had a distinctive generic name applied to it at a still earlier date. The "*Holozoa cylindrica*" of LESSON (*Voyage* "*Coquille*," Zool., ii. p. 439; 1830) agrees in all the points that are mentioned in the brief description with our form. It is said to have a "holothuriform" body, eylindrical, with rounded ends, free and floating (which is apparently the condition in which our form is usually picked up), of mucous appearance, with a whitish fibrous centre composed of tubes coming from the ends of the animals (= Ascidiozooids). It was found "30 leagues from Terre-des-Etats," at the southern extremity of America. I notice that MICHAELSEN (*Hamburger magalhaensische Sammelreise*, "Tunicaten," 1907, p. 40) has also suggested with a (?) that LESSON's *Holozoa cylindrica* is the same as "*Julinia*" (or *Distaplia*) *ignota*.

Family POLYCLINIDÆ.

Polyclinum complanatum, Herdman (?).

The species was described† from a specimen obtained at Port Jackson, Australia. The *Scotia* material was taken at Station 483, at the entrance to Saldanha Bay, on May 21, 1904, from a depth of 25 fathoms. It consists of four fragments, cut probably from the same colony, the largest of which measures about 6 cm. by 2. The colony was apparently flattened, and had much the same shape and colour as the Australian one. The Ascidiozooids also have the same type of structure. The post-abdomen is rather longer than in the Australian specimens, but that is a matter that varies with the reproductive condition. The specimens are, however, so fragmentary, and there is so little that is distinctive, that I cannot be certain as to the identity of the species; but there is nothing in the microscopic details to negative the view that the Falkland Islands specimens belong to this Australian species.

Amaroucium distomoides, Herdman (?).

I refer one large colony and a few small fragments in the *Scotia* collection to this Australian species.‡ The original specimen came from Port Jackson; the *Scotia*

* In the new edition of the "Tunicata" of BRONN's *Tier-Reichs*.

† See HERDMAN, *Descriptive Catalogue of the Tunicata of the Australian Museum, Sydney, N.S.W.*, 1899, p. 81. On the plate (Pol. I. figs. 9–12) it is referred to as "*Polyclinum depressum*."

‡ See HERDMAN, *ibid.*, p. 75.

material is from Port William, Station 349, Falkland Islands, February 6 to 8, 1903, 6 fathoms. The large colony measures about 14 cm. by 3 cm., and is attached along the length of a Laminaria-like Alga. The test is dark greyish brown, and the small yellow Ascidiozooids show all over the surface as closely placed dots or streaks of a lighter colour. In further details this specimen agrees well with the description of the Australian one. One zooid was, however, noticed with an eight-lobed branchial aperture. The stomach has longitudinal folds. The stigmata are large. The dark colour of the test is due to dense crowding with small test-cells. The *Scotia* colony was evidently taken at the reproductive season, as it contains abundance of embryos in various stages of development up to the tailed larval stage ready to be set free.

Amaroucium sp. (?).

Some small colonies, a few millimetres to about 1 centimetre across, which were found attached to groups of *Styela paessleri* and other Ascidians from the Falkland Islands, belong to the genus *Amaroucium*, but may be only young colonies of some larger form such as *A. distomoides*, or *A. pallidulum* obtained by the *Challenger* Expedition at Port William.

It may be remarked in regard to the three last species of Compound Ascidians that they require re-examination in the living state. Many of the Compound Ascidians are scarcely determinable from the contracted and bleached specimens in preserved collections. It may well be that one or other of the above Polyclinids had in the living state a bright colour or some other characteristic appearance that is now wholly lost.

THALIACEA.

(MS. received March 13, 1912.)

Family SALPIDÆ.

The very large collections of Thaliacea, which were obtained at the South Orkneys and other Antarctic localities (some from under the ice), were found on examination to belong entirely to the genus *Salpa* and to represent two species only; and in fact all the specimens, except a single one, are different conditions and sizes of the common and widely distributed species, *Salpa runcinata-fusiformis*.

Salpa runcinata-fusiformis, Chamisso-Cuvier.

Station 432, surface, March 30, 1904; temp. 31·8°. Nearly one hundred specimens, from 3 cm. to 6 cm. in length, all of the aggregated form, and many of the larger ones showing echinated ridges on the test. Most of them showed embryos projecting into the peri-branchial cavity, one in each.

Station 427, from coarse tow-net, March 26, 1904. About one hundred specimens, from 3 cm. to 5 cm. in length. In other respects they resemble those from the last locality, except that the nuclear mass has more of a canary-yellow tint in these, and was a pinker colour in the others.

Station 325, trap-hole, surface, June 4, 1903, Scotia Bay, South Orkneys. A dozen specimens, all rather large, up to 6 cm., and having some red pigment on the nucleus.

Station 416, taken by trawl lowered to 2370 fathoms, but probably captured at surface, March 17, 1904, lat. 71° 22′ S., long. 18° 15′ W. About forty specimens, much smaller, up to 4 cm. in length at most, all with a pale yellow-coloured nucleus.

Station 422, vertical net, surface to 800 fathoms, March 23, 1904; temp. 31·1°; lat. 68° 32′ S., long. 12° 49′ W. This jar contains a large matted mass of Salpæ, Medusæ, Macrurous Crustacea, and small fish, also a large species of Sagitta. It looks as if it had at one time become dry. The Salpæ seem to be all of the aggregated form of this species, and are of medium size.

Station 391, "Tunicate," water-bottle on sounding wire (depth of sounding, 2630 fathoms), February 27, 1904. A single, very large specimen of the solitary form, fully 8 cm. in length, but rather damaged, with a chain measuring at least 4 cm.

Surface otter trawl, February 24, 1904. One specimen, aggregated form.

Station 325, "Doliolum," trap-hole, surface, June 1903, Scotia Bay, South Orkneys. About twenty specimens of the chain form.

"Doliola?," while sounding, March 22, 1904. Three specimens.

Station 325, surface, June 1903, temp. 28·9°, Scotia Bay, South Orkneys. About ten specimens.

Station 325, surface, June 1903, temp. 29°, Scotia Bay, South Orkneys. Three specimens.

Station 430, vertical net, March 28, 1904, temp. 31·0° F. About fifty specimens, badly preserved, along with some Medusæ.

Station 432A, surface, March 30, 1904, temp. 31·8°. Half a dozen specimens.

Station 325, surface, June 1903, temp. 29°, Scotia Bay, South Orkneys. One damaged specimen.

Station 409, "Tunicate," vertical net, fathoms 0–100, March 5, 1904, temp. 30°. One damaged specimen.

Station 391, evening, while sounding, February 27, 1904. One damaged specimen.

Salpa scutigera-confederata, Cuv.-Forsk.

Station 535, on Gulf weed, surface, June 27, 1904, "Doliolum." One badly preserved specimen, which had probably been dried at one period, solitary form of the species.

ADDENDUM.

As this paper was going to press I received from Dr BRUCE a couple of tubes containing the following:—

Polyzoa pictonis, subspecies *patagonica*, Michn. One poor specimen from shore, Port Stanley, Falklands, January 1903. Station 118.

Lissamaroucium magnum, Sluiter. One colony about 3·5 cm. in diameter, trawled from Station 346, 56 fathoms, December 1, 1903, Burdwood Bank.

Amaroucium sp. (?). One colony about 3 cm. in diameter from same haul as the last species. Station 346.

EXPLANATION OF THE PLATE.

Fig. 1. *Styela lactea*, Herdman. Large barrel-shaped specimen. Nat. size.

Fig. 2. Part of large colony of *Holozoa cylindrica*, Lesson, with three small specimens of *Styela lactea* attached. Nat. size.

Fig. 3. Globular specimen of *Styela lactea*, showing the positions of the branchial and atrial apertures. Nat. size.

Fig. 4. Anterior end of similar specimen, showing the branchial aperture. Nat. size.

Fig. 5. One of the echinated spines of *Styela laclea*. Enlarged.

Fig. 6. Small, globular and very spiny specimen of *Styela laclea*. Nat. size.

Fig. 7. Alimentary canal of *Styela lactea*. Slightly enlarged.

Fig. 8. Dorsal tubercle and tentacles of *Styela laclea*. × 40.

Fig. 9. Dorsal tubercle of *Paramolgula gregaria*, Lesson. Enlarged.

Fig. 10. *Paramolgula horrida*, Herdman, right side. Nat. size.

Fig. 11. Part of branchial sac of *P. horrida*. × 40.

Fig. 12. Diagrammatic plan of both sides of branchial sac of *Styela paessleri*, Michaelsen, supposed to be cut through the endostyle and spread out; I. to IV., branchial folds. The number of bars on the folds and in the interspaces is shown.

Fig. 13. Small part of branchial sac of *Styela paessleri*. × 40.

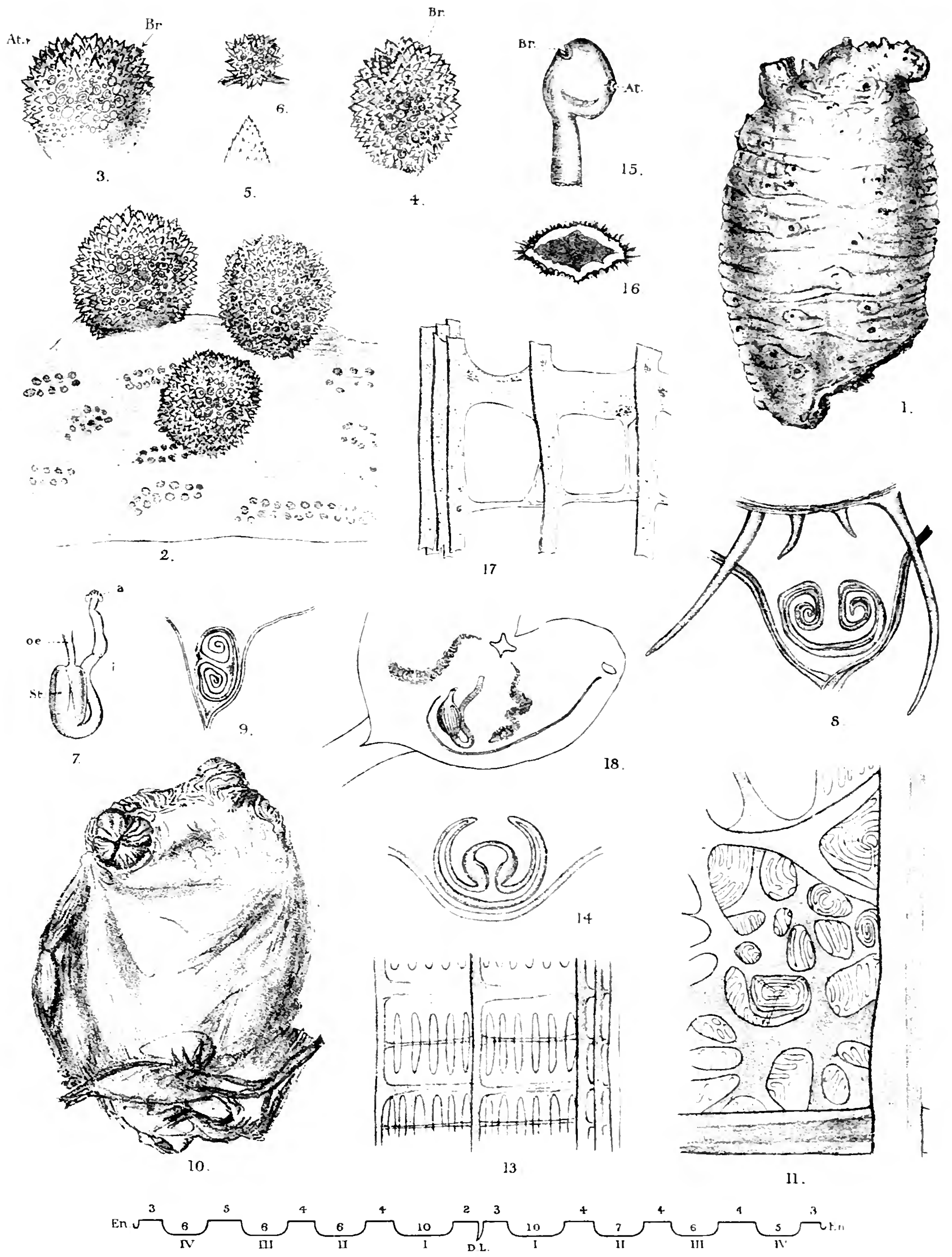
Fig. 14. Dorsal tubercle of *Styela paessleri*. × 40.

Fig. 15. *Fungulus antarcticus*, n.sp., from the left side. Nat. size.

Fig. 16. Branchial aperture of the same. Enlarged.

Fig. 17. Part of branchial sac of same species, from the inside. × 40.

Fig. 18. Dissection of *Fungulus antarcticus*, to show alimentary canal and gonads. A little enlarged.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PART VIII.

F I S H E S.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

VIII.—FRESHWATER FISHES FROM BUENOS AIRES.

By R. S. CLARK, M.A., B.Sc.,
Scottish Oceanographical Laboratory, Edinburgh.

(*WITH ONE PLATE.*)

Scottish National Antarctic Expedition: Notes on some Fresh-water Fishes from Buenos Aires. By R. S. Clark, M.A., B.Sc., Scottish Oceanographical Laboratory, Edinburgh.

(Handed in July 2, 1912. Issued separately August 12, 1912.)

The six fishes here described were brought home by Dr W. S. Bruce in 1904. They were taken, with one exception, from the Government Dry Dock at Buenos Aires in January 1904, while the *Scotia* was undergoing repairs there, immediately after her return from her first voyage to the Antarctic. All six have been previously described, though one—*Plecostomus laplatæ*, Eigenmann—only as late as 1907, three years after the capture of the two *Scotia* specimens.

The system adopted in describing the species is that outlined by Dr Günther in the *British Museum Catalogue*; the *fundamentum divisionis* being the body-length—tip of snout to root of middle caudal rays. On account of the considerable variations shown by each species at different stages of its growth, the work of identification has been rendered extremely difficult. In this connection, I tender my grateful thanks to Mr C. Tate Regan (*British Museum*) for his invaluable assistance.

The result of the following investigations has been to corroborate substantially the statement put forward by Eigenmann in *Proc. Wash. Acad. Sciences*, to the effect that the fresh-water fish fauna of Buenos Aires is essentially Amazonian.

The species are:—

Siluridæ.

Pimelodus nigribarbis Boulenger.
Pimelodus albicans Cuv. and Val.

Loricariidæ.

Plecostomus laplatæ Eigenmann.

Characidæ.

Prochilodus argenteus Agassiz.

Sciænidæ.

Micropogon undulatus Linnæus.

Gymnotidæ.

Rhamphichthys blochii Bloch and Schneider.

Pimelodus nigribarbis Boulenger (Pl. fig. 3).

? *Pimelodus valenciennis* Lutken.

D. I, 6. A. 17. V. 6. P. I, 8.

This specimen is undoubtedly similar to BOULENGER's two type specimens from the Camapuam River, and described by him in *Ann. Mag. Nat. Hist.*, iv., 6th ser., 1889. It differs from *Pimelodus valenciennis*, Lutken (*Occ. Papers Cal. Acad. Sci.*, i., 1890), in the lengths of anal and adipose dorsal fins. In *valenciennis* these are equal, but in the *Scotia* specimen the adipose dorsal is five-sixths of the anal.

Length of specimen, 167 mms.

Pimelodus albicans Cuv. and Val.

Arius albidus, Val., *Voy. d'Orb.*, 1847.
,, *albicans*, Cuv. and Val., *Hist. Nat. Poiss.*, xv., 1840 (Buenos Aires).
Piramutana albicans, Günther, *Ann. Mag. Nat. Hist.*, 1880, vi., 5th ser. (Rio Plata).
Arius moroti, Val., *Voy. d'Orb.*, vi., 1847 (La Plata).
Piramutana blochii, Cuv. and Val.
Pimelodus albicans, Eigenmann and Eigenmann, *Proc. Cal. Acad.*, i., 1890 (Rio Plata).
,, ,, Eigenmann, *Proc. Wash. Acad. Sciences*, March 4, 1907.

D. I. 6. P. I, 10. V. 6. A. 11.

EIGENMANN's description in *Proc. Cal. Acad.*, 1890, adequately covers the characteristics of the *Scotia* specimen. There are no pterygoid teeth, and those on the palate are reduced to two small separate patches on the vomer. The maxillary barbel reaches the root of the caudal fin, "as in young specimens 6 to 8 inches long, though it reaches only to the anal fin in specimens 10 inches long" (GÜNTHER).

Length of specimen, 235 mms.

Plecostomus laplatæ Eigenmann (Pl. figs. 1 and 1*a*).

Plecostomus laplatæ, Eigenmann, *Proc. Wash. Acad. Sciences*, March 4, 1907.

D. I, 7. A. I, 14.

The two specimens are certainly EIGENMANN's *laplatæ*, described by him in 1907 as a new species. The number of scutes in a longitudinal series is 31 + 1 caudal scute. Smooth patches between pectoral and ventral are well marked. Head and abdomen are covered with small dark spots, while anterior part of body has larger spots. Fins, except caudal, spotted. Alternating pale and dark longitudinal bands on body.

Two specimens. Lengths, 283 and 420 mms.

Prochilodus argenteus Agassiz.

P. argenteus, Cuv. and Val., xxii. (Rio San Francisco, Brazil).
,, Günther, *B.M. Cat.*, v. (Brazil).

D. 11 (12). A. 10. Lat. line 45, lat. transv. $\frac{9\text{–}10}{9\text{–}10}$.

Six excellent specimens were brought back by the *Scotia*. They average in length

39 cms. The scales are iridescent, greenish above, and yellow below the lateral line, while each bears a distinct cross-mark on its surface.

Micropogon undulatus (Linnæus).

Perca undulata, Linnæus, *Syst. Nat.*, 12th ed., 1766.
Micropogon undulatus, Günther, *Chall. Rep. on Shore Fishes* (Monte Video).
,, ,, Günther, *Ann. Mag. Nat. Hist.*, 5th ser., 1880 (Rio de la Plata).
,, ,, Günther, *B.M. Cat.*, ii p. 211.
,, ,, Cuv. and Val. (New Orleans).
,, ,, Perugia, *Ann. Mus. Civ. Stor. Nat. Genera*, x., 1890 (Monte Video).
,, ,, Berg, *Anal. Mus Nac. Buenos Aires*, iv., 2nd ser., 1895 (Bahia Blanco, Mar de Plata, Monte Video, Maldonado).
,, ,, Evermann and Kendal, *Proc. U.S. Nat. Mus*, xxxi., 1907 (Argentine).
,, ,, Berg, *Ann. Mus. Nac. Buenos Aires*, iv., 2nd ser., i., 1895 (Embocodura del Rio de la Plata, Monte Video).

D. X. I, 28. A. II. 8. Lat. line 52 + 3 caudal. Lat. transv. $\frac{7}{15}$.

One specimen was caught on the line in Rio de la Plata, while the other was taken from the Government Dry Dock at Buenos Aires. The respective lengths are 27 and 31 cms. The comparative measurements of the *Scotia* specimens agree with those given by Evermann and Kendal in *Proc. U.S. Nat. Mus.*, xxxi., where the specimens are of the same size. The colour is silvery. There are dark grey spots on back, while below the lateral line these have a tendency towards striation.

Rhamphichthys blochii (Bl. and Schn.) (Pl. fig. 2).

Gymnotus rostratus. Bl. and Schn., 522, t. 106.
Rhamphichthys blochii, Kaup, *Apod.*, p. 133, fig. 9.
,, *rostratus*, Mull. and Trosch.
Carapus rostratus, Cuv., ii p. 357.
Rhamphichthys blochii, Gunther, *B.M. Cat.*, viii. 5, 1860 (Para).

Kaup attributes the original of this species to Bloch, but comments on the imperfection of the description. The number of anal rays is 365, as in the *Scotia* specimen, though Bloch gave 292. Anus accompanied by a genital papilla which lies behind the vertical line through the posterior margin of the eye. Snout tubiform and slightly more than half the length of the head. Small round spots on the head and body. Irregular black lines and spots on the fins. Between the anal fin and the lateral line runs an interrupted series of oblique bars.

Length, 296 mms.

EXPLANATION OF PLATE.

Fig. 1. *Plecostomus laplatæ*, side view, reduced (about $\frac{3}{5}$).

,, 1*a*. ,, ,, ventral aspect, reduced (about $\frac{2}{5}$).

,, 2. *Rhamphichthys blochii*, side view, reduced (about $\frac{1}{2}$).

,, 3. *Pimelodus nigribarbis*, side view, reduced (about $\frac{2}{5}$).

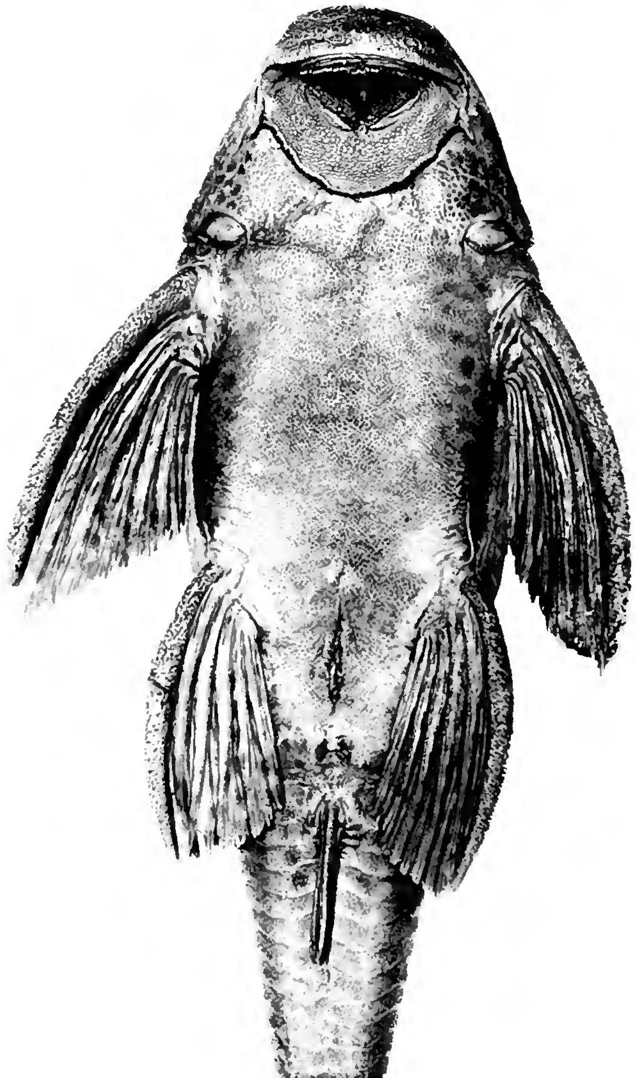

Fig. 1a.

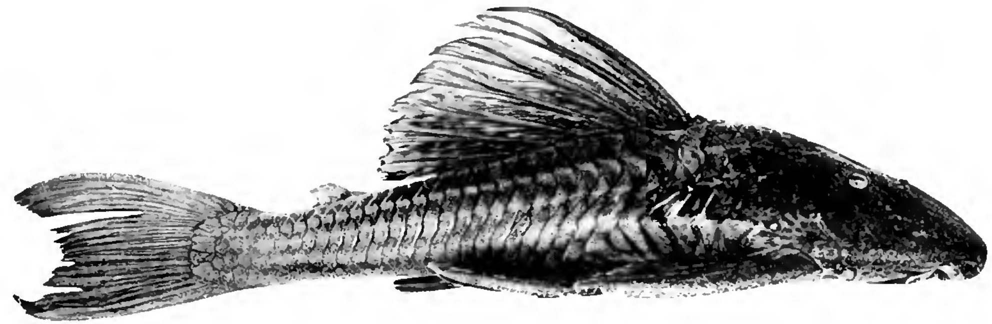

Fig. 1.

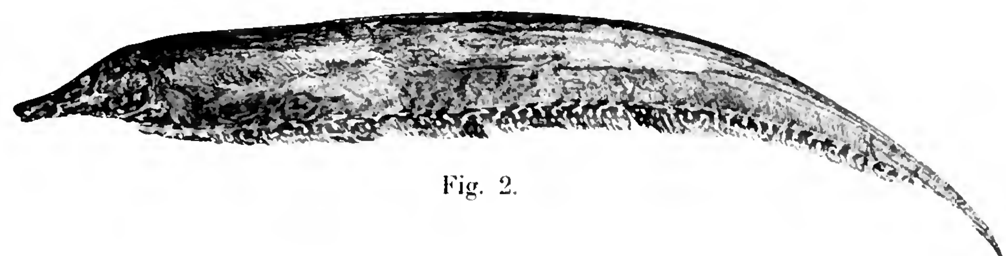

Fig. 2.

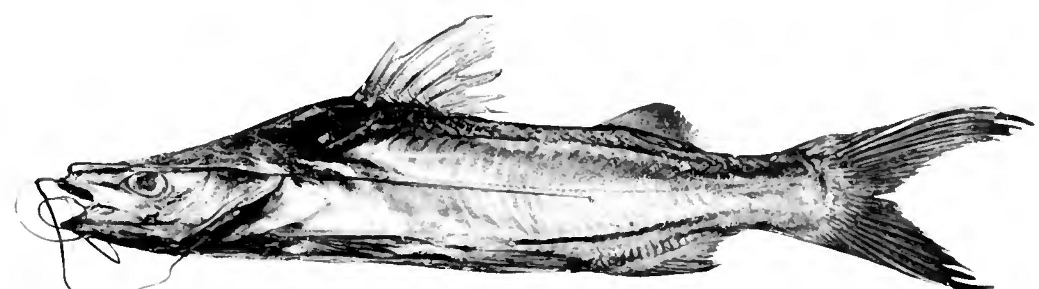

Fig. 3.

Fig. 1. Plecostomus laplatæ. Fig. 1a. Plecostomus laplatæ. Fig. 2. Rhamphichthys blochii. Fig. 3. Pimelodus nigribarbis.

PART IX.

SEALS.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

IX.—ANATOMY OF THE WEDDELL SEAL (*LEPTONYCHOTES WEDDELLI*).

(4) THE BRAIN.

By DAVID HEPBURN, M.D., C.M.,
Professor of Anatomy, University College, Cardiff (University of Wales).

(*WITH ONE PLATE.*)

Scottish National Antarctic Expedition: Observations on the Anatomy of the Weddell Seal (Leptonychotes Weddelli). Part IV.: The Brain.

By David Hepburn, M.D., C.M., Professor of Anatomy, University College, Cardiff (University of Wales). (With One Plate.)

(MS. received June 18, 1912. Read December 2, 1912. Issued separately February 8, 1913.)

The material placed at my disposal for the purposes of this paper comprised the brains of four adult specimens of the Weddell seal, in addition to the brain of the young animal which has formed the subject of my former contributions.* The four adult brains having been removed at the time the animals were killed, and preserved in a solution composed of spirit (90 per cent.) 6 pints and formal (2 per cent.) 4 pints, were, with one exception, in a firm and satisfactory condition for detailed anatomical examination. The body of the young seal had been preserved with a view to ordinary dissection, and therefore its brain was not in the firm state of the adult specimens; but as I had the opportunity of removing this brain from the skull, I was able to observe the disposition of the dura mater to the hemispheres of the cerebrum and cerebellum. While the dura mater presented, as a whole, its usual arrangements, it was noteworthy that the falx cerebri did not act as a septum between the two hemispheres of the cerebrum except to a very slight extent, and certainly for not more than one-third of the distance between the vertex of the cerebrum and the dorsal surface of the corpus callosum. As a result, in the region referred to the opposing mesial surfaces of the two hemispheres lay not only in close apposition with each other, but their convolutions were intimately adapted to each other. Similarly, the tentorium cerebelli only extended a short distance between the cerebrum and the cerebellum, and, as the occipital ends of the cerebral hemispheres fell considerably apart from each other, there was space for the accommodation of the well-developed vermis of the cerebellum as well as for the bulbous pineal body, which occupied a position upon its dorsal aspect. As I removed the brain from the skull the stalk of the pineal body gave way, and probably the same thing had occurred during the removal of the adult brains, for, while different lengths of the stalks had been preserved, there was only one complete specimen of its bulbous extremity. Looked at from the vertex, the general outline of the whole brain was that of a four-sided figure with rounded angles, and the cerebral hemispheres concealed the cerebellum except where the vermis was exposed between them at their occipital ends. The frontal ends of the hemispheres were not rounded into frontal poles; but, on the contrary, they almost formed flat frontal surfaces. Similarly, the occipital ends were rounded and not pointed to form occipital poles. There was a small amount of difference in the absolute size of the adult brains, and the largest specimen measured 120 mm.

* Part I., *Trans. Roy. Soc. Edin.*, vol. xlvii. p. 57, 1909. Part II., *Trans. Roy. Soc. Edin.*, vol. xlviii. p. 191, 1912. Part III., *Trans. Roy. Soc. Edin.*, vol. xlviii. p. 321, 1912.

(REPRINTED FROM THE TRANSACTIONS OF THE ROYAL SOCIETY OF EDINBURGH, VOL. XLVIII., PP. 827–847.)

in its fronto-occipital diameter; 115 mm. in its greatest transverse diameter at a point well forward on the temporo-sphenoidal lobes; and 71 mm. in vertical height, measured from the pons varolii to the vertex of the cerebrum. Thus, apart from the peculiarity of its general outline in total size, it was only slightly less than an average human brain. Throughout the anterior two-thirds of their extent the cerebral hemispheres were, as already indicated, in very close apposition, and the falx cerebri only dipped into the pallial or superior longitudinal fissure to a slight extent; but in its posterior third this cleft opened to form a wide interval, measuring 65 mm. in the transverse direction at its hinder end and narrowing as it ran forwards towards the posterior end of the corpus callosum. In the deep level of this interval the pineal body and the upper surface of the vermis were visible, as well as part of the upper surface of the cerebellar hemispheres. It should be stated that the backward extension of the occipital lobes of the cerebrum carried them 2 mm. beyond the cerebellar hemispheres.

In its essential features the basal aspect of the brain conformed to current descriptions of the mammalian brain; but it presented many special points of interest, to which reference will be made in the course of my survey.

I. Cerebral Convolutions and Fissures.

Regarded as a whole, the cerebral convolutions (gyri) were large and well defined from each other by deep, well-marked fissures (sulci), and yet many furrows not deep enough to be regarded as sulci were seen crossing the surfaces of convolutions. Invariably these shallow furrows were in the position of blood-vessels ramifying in the pia mater, and it was clearly demonstrable that the furrows were produced by the blood-vessels. In appearance they resembled the arterial grooves upon bony surfaces, and their presence upon the surface of the brain suggested either arterial pulsation or resistance to brain growth as their determining cause. Indeed, from the distinct character of many of them it would not be difficult to credit these vessels with the possibility of determining the position of new fissures in a rapidly expanding hemisphere. In their chief and outstanding characters the two hemispheres corresponded with each other; but in the matter of intimate detail they presented a considerable amount of asymmetry, although neither hemisphere could be said to be more elaborately convoluted than the other.

The general plan of the convolutions and fissures was not simple or easy to determine. In fact, the whole arrangement bore very little if any resemblance to that presented by the brain of a typical member of the carnivora, *e.g.* the dog; and this is somewhat remarkable and unexpected when we remember that the seals are themselves carnivores notwithstanding their numerous adaptations to an aquatic habitat. Partly for this reason, and partly because my observations do not altogether harmonise with those of Murie * in his description of another seal (*Otaria jubata*, the sea-lion), nor with those

* Murie, *Trans. Zool. Soc. Lond.*, vol. viii., 1874.

of Sir WM. TURNER * in his account of the brain of the elephant seal, I propose to deal at some length with the arrangement of the convolutions and fissures and the possibility of dividing the cerebral surface into subordinate lobes, after the manner adopted in describing the human brain.

The complexity of the convolution pattern of the brain of seals has led observers to devise such an elaborate terminology for the description of the separate convolutions and fissures that it is a matter of considerable difficulty to correlate the different terms. Consequently, bearing in mind the variations which specimens of these brains present among themselves, as well as their divergence from the ordinary type of carnivore brain, I have preferred to restrict the use of terms as much as possible, and to limit the attempt to establish homologies to such characters as were fairly comparable to those presented by the human brain.

1. *The Lateral Surface of the Hemisphere.* (Fig. 1.)

On this aspect the convolutions and fissures were well developed both as regards their size and their numbers, and yet any underlying "pattern" resulting from the disposition of the primary fissures was most elusive and difficult to decide. Fortunately, there was no uncertainty with regard to the *fissure of Sylvius* (sulcus Sylvii). Its commencement in relation to the locus perforatus anticus on the basal surface of the brain, and its position between the orbital and temporo-sphenoidal parts of the hemisphere on the same surface, fixed the position of its main stem without any doubt, and so by its outer end it provided one fixed point from which to unravel the complexity of the lateral surface. TURNER found this fissure traceable on the lateral aspect of the hemisphere "upwards and backwards for 32 mm. on the side of the right hemisphere, but not so far on the left." Nevertheless, for some time I found great difficulty in deciding which, and how many, of the fissures upon the lateral surface were entitled to be accepted as its direct continuations, although, as the dissection proceeded, the decision arrived at in the first instance was verified as correct. My initial difficulty was increased by the fact that in the lateral view of the hemisphere of the brain of the dog, as may be seen in the figure given by WIEDERSHEIM and PARKER,† the fissure of Sylvius is represented as a "closed" fissure, *i.e.* one provided with "opercula," forming an "arcuate gyrus" which surrounds the fissure on all aspects except the basal segment of the fissure. Further, in the brain of the dog, this "arcuate gyrus" is repeated twice, so that altogether on the lateral aspect of its hemisphere, to quote WIEDERSHEIM and PARKER, "In carnivores, cetaceans, and ungulates, three gyri arch over the Sylvian fissure, one above the other, and are separated by the so-called *arcuate* fissures."‡ Certainly this was not the manner in which the convolutions and fissures were disposed on the lateral aspect of the hemisphere of the Weddell seal in relation to the fissure of

* TURNER, *Challenger Reports*, vol. xxvi., *Zoology*: *Report on Seals*.

† WIEDERSHEIM and PARKER, *Comparative Anatomy of Vertebrates*, 3rd ed., 1907, p. 224.

‡ *Ibid.*, p. 228.

Sylvius. On the other hand, in Murie's * paper already referred to, there is a fairly close resemblance shown in pl. lxxviii. fig. 40, between the brain of the sea-lion and that of the Weddell seal under consideration (fig. 1), so far as the general position of gyri and sulci is concerned; although, having verified my interpretation of the surface appearances by dissection of the interior of the hemisphere, my conclusions differ considerably from those arrived at by Murie, and so far as carnivora in general are concerned I am of opinion that at least the Weddell seal presents a very novel arrangement of the fissure of Sylvius, but still one which is quite compatible with, and readily explainable by, reference to the mode of its development from the embryonic to the adult condition. As is well known, the Sylvian fissure, in the course of its embryonic development, results from the more or less close apposition of those portions of the cerebral cortex which, as derivatives from the orbital, frontal, fronto-parietal, and temporal portions of the cortex of the hemisphere, and under the term "opercula," extend beyond so as to overshadow and gradually conceal from lateral observation that portion of the cortex called the central lobe or island of Reil, and thus ultimately the surface of the island of Reil may become completely hidden by convolutions which are no longer upon the same superficial plane as those of the insula. Further, until these "opercula" practically come into contact with each other, not only does the insula remain more or less visible, but the lateral segment of the fissure of Sylvius is represented by a gap or interval of varying width. Again, if the growth of the insula kept pace with the growth of the surrounding "opercula," then the insular convolutions would continue to present themselves upon the same superficial plane as that of the "opercula," and thus instead of a fissure of Sylvius we should find in its place the sulcus which limits and marks off the island of Reil from the surrounding cortex, viz. the limiting sulcus (sulcus insulæ). In other words, we should find the island of Reil presenting or protruding between the "opercula" by whose apposition the fissure of Sylvius derives its lateral characteristics.

In my opinion, that is the interpretation of the condition which is presented by the brain of the Weddell seal. As a result there appear to be two sulci extending from the basal stem of the fissure of Sylvius, and between them the greater part of the island of Reil not only presents itself, but is to a large extent upon the same superficial plane as that of the surrounding gyri.

The convolutions upon the surface of the insula were irregular, and neither upon different brains nor upon the two sides of the same brain were they closely repeated; but I have given in fig. 1 a drawing of the brain in which they showed a tendency to radiate from the basal end of the fissure of Sylvius, and I have done so because in the human brain a radiating arrangement is their normal characteristic. From all this it will be evident that the fissure of Sylvius as such is not represented on the lateral surface of the brain of the Weddell seal; but that in its place there is a vallecula, wide anteriorly and narrower posteriorly, which is occupied by the convoluted surface of the island of

* Murie, *loc. cit.*, pl. lxxviii., fig. 40.

Reil, whose boundaries are indicated by the limiting sulcus which almost completely separates the insula from the surrounding cortex.

In my opinion, this interpretation of the appearances is in conformity with the facts elucidated by a dissection of the corpus striatum, as well as with the facts of development, although I am not aware that it has hitherto been advanced by any of the observers who have described the brain of the seal. Indeed, in his description of the brain of the elephant seal, TURNER says: "I can make no definite statement as to the presence of the island of Reil, unless the concealed part of the anterior limb of the Sylvian fissure be regarded as representing it." Again, in reference to the brain of the walrus, the same observer says: "I could not speak with any precision of the island of Reil, unless the concealed part of the anterior limb of the sylvian convolution passed deeply into the fissure and was concealed by the anterior limb of the supra-Sylvian convolution, which for some distance therefore formed the anterior lip of the fissure of Sylvius." (In the first of these quotations the reference is to the concealed part of the Sylvian fissure, and in the second to the concealed part of the Sylvian convolution, but probably this is by inadvertence.)

The Plates which illustrate the papers of MURIE and TURNER, if compared with fig. 1 of the present communication, will show how much minor variation the brains of this group of marine mammals may present, while to my own mind they emphasise the interpretation which I have ventured to put forward. It is difficult to conceive a brain of the dimensions of those under consideration *without* an island of Reil; and as this part of the convoluted surface of the hemisphere corresponds more or less exactly to the surface aspect of the corpus striatum, the presence of the latter practically compels us to account for the former.

My next endeavour was to determine which of the sulci could be accepted as the fissure homologous to the fissure of Rolando (sulcus centralis), because of its importance as a guide to the position of the sensory-motor area and its value as a dividing line between the frontal and parietal lobes of the cerebrum. Reference may again be made to the brain of the dog, in which the *sulcus cruciatus* is an outstanding feature, and to WIEDERSHEIM and PARKER's* description of the fissure, where the following occurs: "Along the lateral surface of the hemisphere, the *cruciate* sulcus (the homologue of the central sulcus or *fissure of Rolando* of primates) extends upwards to the pallial fissure." Now, in the Weddell seal the cruciate sulcus is well marked; but, as may be seen by reference to figs. 1 and 2, it is situated so far forwards that, if it be accepted as the homologue of the fissure of Rolando, practically not only is there no frontal lobe remaining, but the parietal lobe is carried forwards to a position *in front of* the basal limb of the fissure of Sylvius, both of which contingencies are so serious as to compel us to doubt whether the homology be correct in the case of this seal, in view of the importance of the Rolandic area as a sensory-motor centre. For these reasons, therefore, so far as the Weddell seal is concerned, I am driven to accept as the fissure of Rolando that fissure

* WIEDERSHEIM and PARKER, *loc. cit.*, p. 228.

whose lower end will be seen resting upon the fronto-parietal operculum of the insula, and I have marked it by this name in fig. 1. In this respect my drawing and its interpretation are more in agreement with MURIE's * account of the sea-lion, although in his drawing the fissure of Rolando is represented as much more extensive than it appears to be in the Weddell seal.

TURNER describes the cruciate fissure of the elephant seal as seen from the front and not from the norma verticalis, and states that "a large sigmoid gyrus was bent around its outer end." To some extent this description would apply to the Weddell seal, although in the latter the cruciate fissure was visible from the norma verticalis, but it was much more effectively seen from the norma frontalis, while its outer end was blocked by an arched gyrus (fig. 1).

I could not find any satisfactory evidence of a homologue for the external parieto-occipital fissure, and therefore no fixed indication of a limit between the parietal and occipital lobes of the cerebrum on its lateral aspect, or between the occipital and tempero-sphenoidal lobes on the same aspect, for the reason that these areas were freely connected with each other by *annectant* gyri.

The Convolutions on the Lateral Surface.

The frontal lobe having been delimited in the manner described, its convolutions resolved themselves into a pre-central (ascending frontal); the frontal contribution to the opercula of the insula; and two or three short convolutions running forwards from the pre-central convolutions towards the sulcus cruciatus.

The elongation of these short convolutions in a forward, *i.e.* frontal, direction would have the effect of forcing the sulcus cruciatus forwards and downwards towards the roof of the orbit, and would thus bring the cruciate fissure into position as a kind of boundary line between the frontal and orbital aspects of the frontal lobe. It appears to me that the blunt frontal end of the brain of the Weddell seal is due in some measure to the presence of convolutions, which in the human brain would be found in relation to the roof of the orbit. Further, in the human brain there may sometimes be seen a fissure which runs transversely from the pallial fissure across the frontal lobe and close above the orbital margin of the hemisphere. In my opinion this is a fissure which may fairly be regarded as corresponding with the sulcus cruciatus.

In the figure given by MURIE, and already referred to several times, there is, on the *frontal* side of the fissure which is marked "Rolando," a convolution named in three places as the antero-parietal convolution (AP); and I cannot but think that this was an unfortunate term to introduce at such a place so long as the fissure of Rolando is accepted as a boundary line *between* the frontal and parietal lobes of the highly elaborated brain of man.

From the fissure of Rolando (fig. 1), and beginning at a point about its middle, a well-marked fissure ran backwards towards the occipital end of the hemisphere. This

* MURIE, *loc. cit.*, pl. lxxviii., fig. 40.

fissure, which was deepest at its ends and shallowest about half way between them, divided the parietal region of the brain into an upper and a lower lobule, and it might quite fairly be termed the *intra-parietal sulcus*. Each of the lobules above and below the intra-parietal sulcus presented in its turn a short and less defined fissure whose course was roughly parallel to that of the intra-parietal sulcus, but neither of these short fissures opened into the fissure of Rolando. Thus the frontal ends of the convolutions both above and below the intra-parietal sulcus were united together, with the result that the arrangement suggested an interrupted post-central (ascending parietal) gyrus.

It has already been stated that there was no definite guide which could be selected as a demarcation between the parietal and occipital lobes, and therefore I can only say that, as a whole, the convolutions in the occipital region ran from behind forwards, and more or less parallel to each other, to make connections with the parietal and temporo-sphenoidal convolutions. One of these connections seems worthy of special notice. It joined the hinder end of the island of Reil and the hinder end of the temporo-sphenoidal operculum to one of the occipital convolutions. In this relation it should be remembered that the Sylvian fossa (which ultimately becomes the posterior limb of the Sylvian fissure in the primate brain) is shallowest in this region during the process of its development.

The lateral aspect of the temporo-sphenoidal lobe, which provided one of the opercula of the island of Reil, was situated below and behind the Sylvian fossa. It presented two fairly well defined convolutions, an upper and a lower, separated by a definite sulcus, with irregular sulci of smaller dimensions, suggesting the possibility of further subdivision.

2. *The Mesial Surface of the Hemisphere.* (Fig. 2.)

This aspect of the hemisphere presented considerable elaboration and complexity as regards the structures belonging to the pallium, but in the basal region it was simpler and more easy of interpretation. As on the lateral surface, the convolutions and fissures were large and well defined, although the determination of their homologies was a matter of considerable difficulty.

The *corpus callosum* measured 5 cms. in length and 4 mm. in vertical depth over the greater part of its length. The *genu* was 10 mm. long and 9 mm. in vertical depth, while the vertical depth of the *splenium* was 5 mm. From the anterior end of the genu to the frontal end of the hemisphere the distance was 2 cms., and from the posterior margin of the splenium to the occipital end of the hemisphere the distance was 4 cms. Therefore, as a whole, the corpus callosum was situated nearer to the frontal end of the brain. The *rostrum* of the corpus callosum was very short, but the *lamina terminalis* (lamina cinerea), extending from the rostrum to the optic chiasma, was a well-defined object.

The *callosal sulcus*, which separated the dorsal surface of the corpus callosum and the anterior aspect of the genu from the surrounding convoluted surface, commenced at the *locus perforatus anticus*, which to a considerable extent encroached upon the mesial aspect of the hemisphere and presented itself in front of the lamina terminalis below the genu of the corpus callosum. Several shallow extensions of the callosal sulcus, in relation to the anterior half of the corpus callosum, ran forwards and upwards into the superincumbent convolution, thereby complicating the appearance of that gyrus.

The *sulcus cruciatus* was visible upon this aspect of the frontal lobe, and here it divided into several branches, of which the hindermost was the longest.

There also appeared on this surface the fissure which I have accepted as the *fissure of Rolando*, and it extended from the superior margin of the hemisphere downwards and backwards to a point almost half way to the dorsal surface of the corpus callosum.

The *calloso-marginal sulcus* was much interrupted by the invasion of other fissures, so that it was composed of not only the fissure on the dorsal aspect of the callosal gyrus, but also of a branch from the cruciate sulcus anteriorly, and a branch from a fissure situated posterior to the callosal gyrus (fig. 2).

The mesial aspect of the occipital lobe was reduced to comparatively small dimensions in comparison with the size of the hemisphere, a condition which resulted from the fact that occipital structures, which in a human brain of corresponding magnitude would have been visible on its mesial face, were in this seal's brain turned to the inferior or cerebellar aspect of the occipital lobe. For this reason there was very considerable difficulty in selecting a fissure which could be regarded as homologous with the *internal parieto-occipital* sulcus. As the result of a later dissection, which determined the position of the calcarine fissure, I concluded that the fissure which is immediately posterior to the callosal gyrus, and whose course is upwards and forwards towards the supero-mesial border of the hemisphere (fig. 2), should be regarded as the internal parieto-occipital sulcus. Apparently this is the splenial fissure of some authors.

The *callosal gyrus* started by rising gradually from the locus perforatus anticus immediately below the genu of the corpus callosum. It ran forwards, and growing larger as it proceeded it wound round the anterior end of the genu, forming several well-marked folds situated between the callosal and cruciate sulci. Thereafter it passed backwards in a straighter or less elaborate form above the posterior two-thirds of the corpus callosum and between the callosal and calloso-marginal sulci. Posterior to the splenium it turned abruptly towards the basal aspect of the hemisphere, constituting what is known in human anatomy as the *isthmus* of the limbic lobe. Subsequently (fig. 3) it curved along the infero-lateral aspect as the hippocampal gyrus, which steadily expanded as it proceeded forwards to terminate in a wide flattened extremity situated close behind the locus perforatus anticus, but separated from it by the basal segment of the Sylvian fissure. In a later stage of the dissection the *uncus* was found in connection with the hippocampal gyrus.

So far, therefore, as the essential elements which enter into its formation are concerned, the *limbic lobe* in all its parts was fully represented; and only at its frontal end, where several definite sinnosities appeared, and at the widely expanded end of the hippocampal gyrus were there any marked deviations from the much simpler appearances presented by the limbic lobe of the human brain.

3. *The Inferior or Basal Aspect of the Hemisphere.*

As may be seen by reference to fig. 3, the general appearance and the interpretation of this surface were relatively simple in comparison with the other surfaces, except in the occipital region, where again there was considerable complexity due to the fact that so much more of the convoluted surface of the occipital lobe was directed towards the tentorium cerebelli than towards the falx cerebri, with the result that objects which appear on the mesial aspect in the primate brain were found upon the tentorial aspect in that of the seal.

In the mesial plane the two hemispheres were divided from each other in the frontal region by the pallial fissure as far back as the lamina terminalis, below and behind which the *optic chiasma* was situated. The *inter-peduncular space* presented the usual boundaries, viz.: anteriorly, the optic chiasma; antero-laterally, the optic tracts; postero-laterally, the crura cerebri; posteriorly, the pons Varolii. The structures forming the floor of the space were the tuber cinereum, provided with a short infundibulum to which the hypophysis cerebri was attached, this latter being a large object in proportion to the size of other structures; the corpora mammillaria; and the locus perforatus posticus. The occulo-motor nerves emerged from the mesial aspect of the crura cerebri.

The basal surface of the frontal lobe was clearly defined posteriorly by the fissure of Sylvius and the locus perforatus anticus. This surface presented the following fissures:—the *olfactory sulcus*, which was occupied by the olfactory tract (fig. 3), pursued a straight course from the locus perforatus anticus forwards towards, but not quite up to, the orbital margin; the *rhinal sulcus* commenced a short distance in front of the Sylvian fissure and ran forwards in a curved manner, following the lateral contour of the orbital surface, but separated from the margin by a convolution, then, winding round the anterior end of the olfactory sulcus, it turned backwards between the olfactory and pallial sulci, and terminated as a shallow groove upon the gyrus rectus.

The convolutions on the orbital surface were the following:—the *gyrus rectus*, situated between the olfactory sulcus and the mesial orbital border; the *posterior orbital gyrus*, forming the anterior boundary of the Sylvian fissure and the orbital operculum of the island of Reil; a *triangular gyrus*, occupying the space between the olfactory and rhinal sulci; and a long *curved gyrus*, situated between the rhinal sulcus and the lateral margin of the orbital surface. The triangular and curved gyri were both connected with the posterior orbital gyrus behind and with the gyrus rectus in front, but otherwise they were separated throughout their length by the rhinal sulcus. The general arrangement of their surface suggested the possibility of the rhinal fissure being the foundation for the more elaborate fissures which characterise the orbital surface of the higher brains.

The *olfactory tract* presented two distinct roots, separated from each other by a large area of the locus perforatus anticus. Of these, the mesial root came into view from the mesial surface in relation to the anterior end of the callosal gyrus of the limbic lobe. The lateral root emerged from under cover of the expanded end of the hippocampal gyrus. Closely adhering to the locus perforatus anticus, these roots converged and fused to form the olfactory tract, which occupied and moulded itself to the olfactory sulcus.

In all my adult specimens the *olfactory bulb* had been broken off, so that I am not able to state its size, frontal relations, etc.; but it was present in the young specimen as an ovoid enlargement 17 mm. in length and 6 mm. in breadth. It turned upwards upon the frontal surface of the hemisphere, to which it was closely applied.

Behind the fissure of Sylvius, the basal surfaces of the occipito-temporal lobes were much more expanded in the lateral direction than is the case in the primate brain; and, as a consequence, convolutions and sulci which are not found on this aspect in the human brain were visible in the brain under consideration. At the same time, it presented sulci which do not occur in a human brain, and therefore it is not easy to suggest a nomenclature for some of these sulci, nor to be quite certain that they should be accepted as providing boundaries between the occipital and temporal sections of the surface.

The *dentate* and *collateral sulci*, situated respectively on the mesial and lateral aspects of the hippocampal gyrus, were distinctly indicated. Towards the hinder end the collateral sulcus was interrupted by a bridging gyrus, behind which the sulcus corresponded to the general position of the *eminentia collateralis* in the lateral ventricle, as was afterwards revealed by dissection. Further, with the same part of the sulcus, *i.e.* posterior to the annectant gyrus, just mentioned, other two well-marked sulci communicated. Of these, one was directed backwards towards the occipital end of the hemisphere, and the other diverged backwards and outwards towards the infero-lateral margin of the hemisphere in its occipital area. Thus a large segment of the occipito-temporal surface, situated between the collateral sulcus and the infero-lateral margin of the hemisphere, was divided into three wedge-shaped gyri whose bases were directed towards the infero-lateral margin and whose apices converged towards the annectant gyrus above referred to. Indeed, this annectant gyrus connected the anterior and the middle of the three wedge-shaped gyri with the middle portion of the hippocampal gyrus. The posterior one of these three wedges presented a free apex, but the surfaces of each of the three showed indications of further subdivision by additional sulci.

The callosal and hippocampal gyri were united to each other by a narrow gyrus which curved round behind the splenium of the corpus callosum and the crura cerebri.

In the human brain this gyrus is named the *isthmus* of the limbic lobe, and I have used the same term for its description in this account of the brain of the Weddell seal.

Posterior to the isthmus, a distinct deep fissure entered this region, *i.e.* the basal aspect of the occipital end, as the continuation of a fissure well defined upon the mesial aspect of the hemisphere. Upon the basal aspect it was cut off from junction with the hinder end of the collateral sulcus by an annectant gyrus, whereupon it turned abruptly backwards towards the occipital end of the hemisphere (fig. 3). It appears to me that that part of the fissure immediately behind the isthmus should be regarded as the continuation of the internal parieto-occipital sulcus (fig. 2), and that its extension towards the occipital end of the hemisphere is the *calcarine sulcus* (by some observers called the post-horizontal fissure). My reasons for this view will be further elaborated in connection with the description of the posterior cornu of the lateral ventricle, but meantime I may state that the *calcar avis* or *hippocampus minor* was closely related to the position of the deep anterior end of what I have named the calcarine sulcus. Resulting from appearances verified by dissection as well as by transverse section of the posterior cornu of the lateral ventricle (fig. 4), I feel warranted in concluding that the narrow gyrus which is situated on the *lateral* aspect of the calcarine fissure and connected with the hippocampal gyrus must be regarded as the *lingual gyrus*, while the larger gyrus situated on the *mesial* aspect of the calcarine fissure and posterior to the internal parieto-occipital fissure (fig. 3) must be regarded as the foundation for the *cuneate* lobule, which is found in a corresponding position on the mesial surface of the human cerebrum.

Although the foregoing account shows that there was great deviation from the convolution pattern characteristic of a typical carnivore brain on the one hand, and by the human cerebrum on the other, yet the internal appearances exposed by dissection underwent an entire change and became simplified to a remarkable degree. So much was this the case that, in consideration of its size and with certain points of exception as to the details, the various objects were as readily recognised as they are in a human brain.

II. Dissection of the Cerebrum.

The method of procedure followed was that adopted in the dissection of the human brain.

In the first place, the hemisphere was divided by a horizontal transverse section at about 4 mm. distance above the mesial free surface of the corpus callosum, in order to expose the white core or *centrum ovale minus*, which, considering the total size of the hemisphere, was smaller than one expected. The reduction in the size of the central white core could be explained by the depth of the sulci. Many of the sulci at the frontal end were 2 cms. in depth, and at the occipital end some were 2·3 cms. deep. As, of course, all the sulci were bounded by a zone of grey matter, the general effect was a reduction in the apparent size of the central white core.

Another unexpected result was, that at the level mentioned, viz. about 4 mm. above the corpus callosum, the section opened into the cavity of the lateral ventricle, which therefore rose to a higher level than the mesial surface of the corpus callosum, and consequently there must be a corresponding deviation from the horizontal direction of those fibres of the corpus callosum which form the roof structures in relation to the body of the cavity of the lateral ventricle. This upward extension of the ventricle, taken in conjunction with the large size of the convolutions as indicated by the depth of the fissures, shows that notwithstanding its superficial dimensions the brain of the seal falls considerably short of a human brain of similar size as regards the amount of grey and white matter.

In addition to what has already been stated with regard to the corpus callosum, the following additional facts may be noted. The mesial faces of the two hemispheres were so closely in apposition that opposing gyri practically interlocked with each other, and therefore the dorsal surface of corpus callosum was entirely concealed. When this surface was exposed it showed feeble *striæ longitudinales mediales* and still feebler *laterales*. The *cingulum* was present, but much smaller than the size of the surrounding gyri led me to anticipate. The *forceps major* and *forceps minor* were easily dissected and were of characteristic appearance.

On removing the roof of the lateral ventricle and of its cornua I was impressed by the apparent simplicity of the basal ganglia, which were large, and at the first glance suggested strongly such appearances as one is familiar with in the human brain. Taking into consideration the somewhat elaborate and intricate condition of the convolutions of the pallium, the simple nature of basal objects was remarkable. The *anterior* or *frontal cornu* of the lateral ventricle was very shallow. Its course was outwards and forwards into the substance of the frontal lobe, where it terminated in a blind recess. Its relations to the *septum lucidum* and to the *caput* of the *nucleus caudatus* were similar to the arrangements seen in the human brain.

The *middle* or *descending cornu* likewise followed the human plan in its chief features and direction. On its floor there were the *choroid plexus*, the *fimbria hippocampi*, and the *hippocampus major* terminating in the *pes hippocampi*. The choroid plexus was continuous with the pia mater of the dentate sulcus, and thus, as in man, the termination of this cornu was situated on the lateral aspect of the crus cerebri and closed by the ependyma ventriculorum. The choroid plexus, however, was wider than in man, and spread itself out so as to form a vascular sheet which separated the objects in the roof of this cornu from the other structures on its floor. Further, the hippocampus major and the fimbria, with the overlying choroid plexus, were pressed upwards against the roof of the cornu, where they adapted themselves to a deep furrow which was bounded mesially by the optic tract and laterally by the tail of the caudate nucleus. Again, on its *convex* margin the hippocampus major was separated from the *floor* of the cornu by a deep fissure which almost completely detached this object from the floor of the cornu. Indeed, the connection between the hippocampus major and the floor of the cornu was reduced to a narrow band in close relation to the concave margin of the hippocampus. Consequently, in the brain of this seal the hippocampus major could not be described as the *reverse* or ventricular surface of the sulcus hippocampi.

Again, the *pes hippocampi* terminated as a rounded end, only slightly wider than the general body of the object and not expanded or notched as in man.

The *fimbria hippocampi* occupied the concavity of the hippocampus major, but it only spread over the surface of the hippocampus major for about a fourth of the width of the latter. Both the concave and convex margins of the fimbria were free, so that it only adhered to the surface of the hippocampus to a slight extent. So far as could be seen, the fimbria became continuous with the lower end of the gyrus dentatus and the adjacent part of the gyrus hippocampi close to the uncus.

The *posterior cornu* was not narrow and pointed towards its occipital end as in man. Indeed, it appeared more like a wide backward extension of the middle cornu, for at its commencement it was 2 cms. wide, and at this place the *eminentia collateralis* appeared as a large well-defined elevation indented anteriorly by the convex face of the hippocampus major, but these two objects were separated from each other by the upward extension of the fissure already referred to on the floor of the middle cornu. On the mesial aspect of the cornu, and above the eminentia collateralis, there were two strongly defined convex ridges, the one above the other. Both of these ridges appeared from under cover of the hinder end of the corpus callosum, with which they were continuous. The *lower* of the two was directed outwards and backwards. It descended to the floor of the cornu, and ceased to be an elevated object immediately behind the eminentia collateralis. As already indicated in an earlier part of my description, this elevation corresponded to the general position of the calcarine fissure on the inferior aspect of the occipital lobe of the cerebrum, and for that reason I have regarded the elevation just described as the *calcar avis* or hippocampus minor. The *upper* of the two elevated ridges seen in the posterior cornu was the larger at its commencement, but it narrowed down rapidly, and disappeared on the floor of the cornu behind the calcar avis. This object may be taken as the *bulb* of the posterior cornu. Fig. 4 shows these two structures in relation to the calcarine fissure, and it will be observed that the bulb of the cornu has a more direct relation to the calcarine fissure than the calcar avis has. The posterior cornu extended backwards for a distance of 2 cms., and terminated in a blind rounded extremity which, from the size of the eminentia collateralis, appeared to dip downwards. Certainly it showed no tendency to bend towards the mesial surface of the occipital lobe.

The *body* of the lateral ventricle was roofed over, as already stated, by the tapetal fibres of the corpus callosum. On its floor the following structures were noted:—

Anteriorly the *nucleus caudatus*, which was particularly well shaped; to the mesial side of its tailed part, there was the choroid plexus of the velum interpositum, and this choroid plexus was spread out sufficiently to entirely conceal the tænia semicircularis; behind the choroid plexus there lay the widely expanded lateral half of the body of the fornix, which, although attached to the under side of the corpus callosum in the mesial plane, nevertheless was spread outwards as far as the tænia semicircularis, thus forming a complete layer above the velum interpositum and the optic thalamus, of which, indeed, no part was visible until the fornix was removed.

At the hinder and outer end of the optic thalamus, the fornix was raised from below by a subjacent object so that it appeared as if the fornix itself contained a rounded mass of material in the position just stated. However, this underlying rounded projection was the corpus geniculatum externum of the optic thalamus, which would have been visible in the floor of the lateral ventricle but for its concealment by the expanded overlying base of the triangular fornix. The *foramen of Monro* was clearly defined and occupied its customary position.

The *fornix* was remarkably well developed and of large size as compared with that of man; but, as in man, its body or central portion was triangular in shape and flattened from above downwards. By its upper or callosal surface it was attached to the under surface of the corpus callosum along a narrow mesial line which extended from Verga's ventricle posteriorly to the septum lucidum in front. Elsewhere the cavity of the lateral ventricle on each side extended between the corpus callosum and the fornix. The lateral margins of the fornix were sharply defined and free. The deep surface of the fornix rested upon the velum interpositum, but no vessels could be seen passing between the two structures. The two anterior pillars of the fornix followed their usual course towards the base of the brain, curving round in front of the foramen of Monro. The two posterior pillars were wide like the body from which they started. Each entered the descending horn of a lateral ventricle having its anterior margin closely adapted to the concave margin of the hippocampus major, so as to form the fimbria hippocampi in the manner already described. A closer examination of its disposition now revealed a somewhat remarkable fact which had so far escaped observation—viz. the surface of the hippocampus major, although rounded and solid in appearance, was now found to consist for the most part of the fibres of the posterior pillar of the fornix arranged somewhat like an incomplete hollow tube, within which there lay concealed a much smaller ridge of grey substance representing the grey matter of the hippocampus major, which became continuous with the isthmus of the limbic lobe at a point below the splenium of the corpus callosum.

It is probable, therefore, that the longitudinal fibres of the posterior pillars of the fornix are distributed to the hippocampus major; to the hippocampal gyrus with its uncus, as well as to the gyrus dentatus. Further, such an increase of the amount of grey matter in the hippocampus major as would deepen the sulcus dentatus would also probably lead to the obliteration of the fissure on the floor of the descending horn and to a thinning out of the fibres of the posterior pillar of the fornix, and thus produce appearances which are characteristic of the brain of man without materially increasing the total size of such a hippocampus major as is presented by the brain of the seal.

The *velum interpositum* was chiefly notable on account of its large choroid fringes and for its extreme thinness under the body of the fornix, where it covered the optic thalami and formed one of the roof structures in relation to the mesial or 3rd ventricle, for which it likewise provided the usual choroid plexuses. It transmitted numerous vessels into the upper or dorsal surface of the optic thalamus, to which it was closely adherent, but especially so at the hinder part.

The third ventricle was situated as usual between the optic thalami, and its most noteworthy character was the large size of the middle commissure (fig. 2). The position of its anterior and posterior commissures did not call for special comment, and the structural arrangements and composition of its boundaries were not in any way peculiar.

The *optic thalami* formed large well-developed masses, and, as already described, no part of their upper surfaces was visible within the lateral ventricles until the fornix and velum interpositum were removed. When the upper surface of the optic thalamus was fully displayed, it presented certain very interesting features. At its postero-lateral end—that is, close to the entrance to the descending horn of the lateral ventricle, but upon the upper surface of the optic thalamus—the *corpus geniculatum externum* constituted a well-marked elevation which was related to the fornix as previously explained. Along the mesial margin of its upper surface, a flattened ridge—the *tænia thalami* or stalk of the pineal body—ran backwards towards the anterior end of the mesencephalon above the posterior commissure of the 3rd ventricle and the entrance to the aqueduct of Sylvius, where it was joined by its fellow from the opposite thalamus, and thus formed the peduncle of the pineal body.

The *pulvinar* was situated between the corpus geniculatum externum and the tænia thalami. It formed a flattened area which did not project backwards with an overhanging border as in man. The *habenula* was situated partly to the lateral side and partly to the mesial side of the tænia thalami. In other words, the tænia thalami ran across the surface of the habenula. Considered as a whole, the habenula formed a narrow pyriform projection whose wider end was directed backwards and presented itself on the lateral wall of the 3rd ventricle high up in the interval between the middle and posterior commissures.

The *corpus striatum* was displayed by making horizontal transverse sections from the surface of the insula towards the mesial plane so as to include the caudate nucleus, but it was not until the lower levels of the island of Reil were reached that definite evidence of striation was observed. The grey substance of the surface convolutions and that of the caudate nucleus were always distinctly seen, but it was only after the sections had been subjected to the staining influence of a saturated solution of bichromate of potash for forty-eight hours that the other grey masses were clearly visible.

The *lenticular nucleus* occupied its usual position on the postero-lateral aspect of the head of the caudate nucleus. Its mesial border was convex and separated from the caudate nucleus and the optic thalamus by the *internal capsule*. This band was quite definite, but very narrow; and it presented the characteristic anterior and posterior limbs with an intermediate genu. The lateral margin of the lenticular nucleus in its higher levels presented the ridges and depressions which are the characteristic of the claustrum, and it was only after the sections had passed below the level of the general mass of the lenticular nucleus that the claustrum was seen as a separate structure, with a definite external capsule between it and the more deeply placed grey mass. Indeed, the appearance of striation, which was directed forwards and outwards, was more definite below the level at which the lenticular nucleus still retained its biconvex outline and while the striated substance intervened between the claustrum and the head of the caudate nucleus. The effect of this disposition of the grey and white masses of the corpus striatum was to suggest that the differentiation of the *external capsule* was incomplete and had not advanced to the stage of separating the claustrum from the lenticular nucleus.

A band of white substance intervened between the cortical grey matter and wavy margin of the claustrum, and, since the claustrum is usually regarded as a detached and submerged portion of the grey cortex of the insula, it would appear the white fibres which separate the grey cortex from the claustrum are developed earlier than those which, in the higher brains, separate the claustrum from the caudate nucleus and are known as the external capsule. In TURNER's account of the elephant seal, it does not appear that he submitted his specimen to this dissection. The grey nature of the tail of the caudate nucleus was always distinct, and an extension of the sections through the optic thalamus revealed quite plainly its grey substance, bounded laterally by the posterior limb of the internal capsule. The grey matter, however, did not resolve itself into the subordinate nuclei (anterior, mesial, and lateral) which characterises the human brain.

The Pineal Body.—I was able to examine three specimens of this interesting object, and in each case it presented widely different characters. Indeed, the differences were so pronounced that they were not easy to reconcile and certainly not easy to explain.

In the brain which I removed from the skull of the seal which was two days old at the time of its death, the pineal body was a large prismatic object resting upon the vermis of the cerebellum and wedged into the interval between the occipital ends of the cerebral hemispheres. It projected about 27 mm. behind the splenium of the corpus callosum. The peduncle broke in the process of removal, but it was very short and apparently just sufficiently long to permit the expanded part to clear the splenium. The dimensions of the expanded, prismatic part were as follows:—greatest length, 27 mm.; width, 18 mm.; vertical depth, 12 mm.

In a second specimen, belonging to one of the adult brains, the peduncle was again broken, but the expanded part still occupied its natural position. In this case the peduncle was cylindrical and the expanded end was pyriform in shape, its measurements being:—length, 20 mm.; width, 15 mm.; vertical depth, 9 mm. It showed no signs of faceting by pressure from surrounding structures, as might have been expected, supposing the reduction in its size as compared with the young specimen to have resulted from the effects of preservative solutions. In the third specimen, also that of an adult brain, the complete object was in an undisturbed position. The peduncle was very thin, flattened from above downwards, and measured 6 mm. in the transverse direction. It was closely enveloped in the pia mater, and extended backwards on the vermis of the cerebellum to terminate in a disc-like expansion 12 mm. in width. The discoid part was flattened upon its cerebellar surface, while it was slightly conical on the opposite side. From the commencement of the peduncle to the extreme edge of the disc it measured 25 mm., of which the peduncle represented 15 mm. and the disc 10 mm. Numerous vessels travelled between the pineal body and the pia mater. These two adult brains had been preserved in precisely the same way, and therefore it would appear as if the pineal body of the Weddell seal underwent a gradual reduction in size subsequent to birth, but that the shrinkage is not accompanied by any marked shortening in the total length of the object. Similar facts have been recorded by TURNER in connection with the pineal body of the elephant seal, in which the measurements were:—length, 16 mm.; greatest breadth, 8 mm.; greatest vertical diameter, 6 mm. In two specimens taken from the walrus the dimensions were, in one case, 30 mm. long and 18 mm. wide; in the other case, 29 mm. long and 13 mm. wide. There is thus satisfactory evidence that, so far as the seals are concerned, the pineal body attains an unusual size as compared with other mammals; although in the case of *Otaria jubata*, described by MURIE, the size of this structure may not have been so noteworthy as in the specimens above detailed, otherwise such a competent observer could scarcely have confined his account of its size to the statement that it was "relatively large."

The *optic tract* followed the usual course from the optic chiasma backwards and outwards to wind round the lateral aspect of the crus cerebri. Thereafter—owing to its relations to the hippocampus major, as already described—it became compressed into a somewhat triangular band upon the under side of the thalamus, and sweeping past the *corpus geniculatum internum*, with which it became closely associated, it continued its course, spreading out certain of its fibres towards the *pulvinar*, but reserving a bundle of considerable bulk for the *corpus geniculatum externum*. So far as the eye could judge, some of the fibres also reached the *superior* of the *quadrigeminal* bodies, but it did not divide into the *brachia* which characterise its human arrangement.

III. THE MESENCEPHALON.

The mesencephalon presented the *corpora quadrigemina* on its dorsal aspect, and each one of these was quite distinctly defined from the other by longitudinal and transverse furrows. On its ventral surface the *crura cerebri* were also well marked. Latterly, the *corpus geniculatum internum* constituted a large oval elevation, larger than either of the corpora quadrigemina and separated from them by a deep furrow through which many vessels entered the brain substance. The *aqueduct of Sylvius* (fig. 2) was a fairly wide canal, and was not reduced to a T-shaped chink as in man.

IV. The Hind Brain.

(*a*) *The Cerebellum.*—As is usual among carnivores, the cerebellum possessed a relatively large *vermis* in proportion to the size of the *hemispheres.* When examined in longitudinal section (fig. 2), the relation of the vermis to the 4th ventricle and the other constituents of the hind brain presented a great similarity to the corresponding appearances seen in the human brain.*

The *central lobe* rested upon the *superior medullary velum* and possessed a *lingula.* The *culmen* and *declive* were similarly recognisable, as were also the *nodule* and the *tonsil* upon the inferior or ventricular aspect of the vermis. The *pyramid*, the *tuber valvulæ*, and the *folium cacuminis* were not so easily determined in the brain of the seal as they are in the brain of man, because, whereas in the latter these structures are turned towards the floor of the skull, in the former they were turned more towards the hinder end of the vermis.

The *hemispheres* were small and practically impossible of the detailed subdivision which is customary in the descriptions of the human cerebellum, and any attempt to do so would introduce unnecessary risks of error. In a measure, the points of entrance of the *middle cerebellar peduncles* from the pons Varolii provided a guide to what might be regarded as the dorsal and ventral portions of the cerebellum. On this assumption, the *biventral lobe* and the *tonsil* projected laterally some distance beyond any other part of the hemisphere, while the *flocculus* formed a mass of considerable size which overlapped the middle peduncle from behind. If we accept the position of the middle cerebellar peduncle as a sufficiently reliable guide from which to continue the great horizontal fissure by means of which the upper and lower aspects of the human hemisphere are located, then in the brain of this seal all that remained of each hemisphere, in addition to the objects already mentioned, occupied the same aspect and was directed towards the tantorium. Nevertheless, it was divided into two clearly defined areas by a fissure which commenced at the point where the middle peduncle entered from the pons Varolii. If, now, we name these lobes respectively *superior-anterior* and *superior-posterior*, then all the parts of the cerebellum of the seal have been accounted for. It may be noted that the part which I have just named the superior-anterior lobe is reduced to a single folium in relation to the vermis, and it is this folium which is named the folium cacuminis (fig. 2).

Compared with the human cerebellum, it would appear that whereas in the seal the vermis and its subordinate parts are well developed, and the flocculus, biventral lobe, and tonsil are produced on a large scale, the remainder of the hemisphere is much reduced in proportion. On the other hand, in man the hemisphere proper has become much expanded and thickened, with corresponding reduction in the size of the flocculus, the biventral lobe, and the tonsil. In fact, a theoretical enlargement of the superior-anterior and superior-posterior lobes of the hemisphere of the seal, accompanied by their

* *Text-Book of Anatomy*, edited by Cunningham, 3rd ed., p. 512.

expansion backwards as well as laterally, and a reduction in the size of the flocculus, biventral lobe, and the tonsil, would be capable of producing a cerebellum with practically the same superficial characters as that of man.

The *pons Varolii* was well developed, and measured 25 mm. from its anterior to its posterior border in the line of its very definite basilar groove. The anterior and posterior borders converged upon each other so rapidly, as they travelled outwards to form the middle cerebellar peduncles, that the outline of the posterior border was interrupted by the emergence of the large root of the 5th cranial nerve. As a result of this arrangement, the greater part of this nerve-root made its appearance from the side of the medulla oblongata between the olivary eminence and the pons, but of course close up to the latter. In the elephant seal TURNER notes that the 5th cranial nerve arose from the pons Varolii and not from the bulb, whereas, in describing the same nerve in the walrus, he remarks that some fibres of the sensory root "passed backwards between the facial and auditory nerves to the anterior and outer part of the medulla oblongata."

The *medulla oblongata* was wide at its upper end, where it measured 40 mm.; but it narrowed rapidly towards the lower end, and instead of being conical it was markedly flattened in the dorso-ventral direction. Its upper or "open" part was associated with the 4th ventricle, while the "closed" or lower part contained the central canal in its unexpanded condition. Its bilateral character was indicated by the anterior and posterior medium fissures, the former shallow and terminating in relation to the posterior border of the pons Varolii at the foramen of Vicq d'Azyr. On each side of the anterior median fissure or groove the *pyramid* formed quite a distinct tract. The point of emergence of the 6th cranial nerve was not between the pyramid and the pons as in man, but from a flattened area situated external to the pyramid, so that the nerve-stem made its appearance close to the mesial side of the large medullary root of the 5th nerve and without any fibres of the pons intervening between them. The 7th and 8th cranial nerves emerged from the side of the medulla oblongata close behind the 5th and 6th nerves, but slightly nearer the dorsal or ventricular aspect of the bulb.

The *olivary eminence* was small and not so prominent as in man, but it distinctly separated the 9th and 10th cranial nerves from the 12th or hypoglossal nerve.

The closed part of the medulla oblongata presented the general appearances and proportions of the adjacent part of the spinal cord as regards its fissures and main columns. Posteriorly, the *funiculus gracilis* with the *clava* at its upper end, the *funiculus cuneatus* with its upper expansion, the *cuneate tubercle*, and also the *tubercle* of *Rolando* were all definitely recognisable. They turned outwards in a common bundle from a point immediately below the *obex*, and skirting the infero-lateral margin of the 4th ventricle they entered the cerebellum as the restiform body or *inferior cerebellar peduncle*. The visible *decussation of the pyramids* began at a point 32 mm. from the hinder margin of the pons Varolii, so that we may consider the total length of the bulb to be distinctly less than its width at its upper end.

The *rhomboid* or *4th ventricle* was distinctly lozenge-shaped, but neither in regard to its size nor in regard to the detailed modelling of its floor was it so well marked as in man. The floor presented a median furrow, as well as an inferior and a superior *fovea* in relation to each quarter of the lozenge. Associated with the *fovea inferior*, the *trigonum hypoglossi* and the *trigonum vagi* formed quite recognisable elevations. The *area acusticæ* was likewise a well-marked elevation on the floor, but its surface was smoother than in man because of the absence of visible striæ on its free surface. The *eminentia teres* was placed to the mesial side of the *superior fovea*, but it was prolonged upwards as well as downwards by a longitudinal ridge which ran upwards along the floor of the aqueduct of Sylvius in the one direction, and downwards to join the trigonum hypoglossi in the other.

The *obex* was a distinct object in the roof of the ventricle in relation to its inferior angle, and the *ligula* could be seen extending from it on each side.

Summary.

In making a general summary of the naked-eye anatomy of the brain of the Weddell seal, the features which have impressed me most and seem most deserving of special reference are the following :—

1. Its angular appearances in association with its large size, suggesting that the general fish-like outline of the entire animal has to a certain extent influenced the shape of its skull, and thereby the shape of the brain within the cranium.

2. The size and elaborate ramification of the cerebral convolutions, together with the considerable amount of asymmetry in the details of the arrangement of the convolutions of the one hemisphere as compared with the other.

3. The width of the interval between the two hemispheres posterior to the hinder end of the corpus callosum.

4. The marked departure from the arrangement of the cerebral convolutions in such a typical carnivore as the dog.

5. The presence of those convolutions belonging to the island of Reil upon the same superficial plane as that of the surrounding convolutions which form the opercula.

6. The definite and complete character of the limbic lobe.

7. The position of the calcarine fissure, and thereby of the visual area upon the inferior aspect of the occipital end of the hemisphere.

8. The large size of the fornix, and particularly of its posterior pillars, in association with a well-marked hippocampus major, of which the greater part is composed of fornix fibres and only a small part of grey substance.

9. The long stalk and the large size of the pineal body and its position upon the vermis of the cerebellum, in the open interval between the cerebral hemispheres.

10. The well-developed but, on the whole, simpler characters of the basal structures as compared with the elaboration of the pallium.

11. The relatively simple character of the mesencephalon.

12. The small size of those parts of the cerebellar hemispheres which in man would constitute their main bulk; and the large size of those objects in relation to the vallecula, which in man would be relatively small.

13. The reduction in the posterior margin of the pons Varolii, which thereby permits the bulbar root of the 5th cranial nerve to emerge directly from the side of the medulla oblongata.

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DESCRIPTION OF PLATE.

Fig. 1. The left cerebral hemisphere, natural size.

F. Sy. Fissure of Sylvius.
F. Ro. Fissure of Rolando.
S. P-c. Pre-central sulcus.
S. Cr. Sulcus cruciatus.
S. I-p. Intra-parietal sulcus.
I. R. Island of Reil.

Fig. 2. Mesial surface of the right cerebral hemisphere.

S. Cr. Sulcus cruciatus.
F. Ro. Fissure of Rolando.
I. P-o. Internal parieto-occipital fissure.
Op. C. Optic commissure.
C. C. Corpus callosum.
Hy. C. Pituitary body.
P. Var. Pons Varolii.
Pin. Pineal body.

Fig. 3. Basal surface of cerebral hemisphere.

Rh. f. Rhinal fissure.
F. Sy. Fissure of Sylvius.
S. Col. Sulcus colateralis.
C. f. Calcarine fissure.
P. o. Parieto-occipital fissure.
S. D. Sulcus dentatus.
O. T. Olfactory tract.
Op. N. Optic nerve.
Hy. C. Pituitary body.
Cr. C. Crus cerebri.
Is. Isthmus.
Cun. Cuneus.
G. L. Gyrus lingualis.

Fig. 4. Vertical transverse section through the posterior horn of the lateral ventricle of the right hemisphere, viewed from behind.

C. f. Calcarine fissure.
V. Lateral ventricle.

Hepburn: Brain of Weddell Seal.

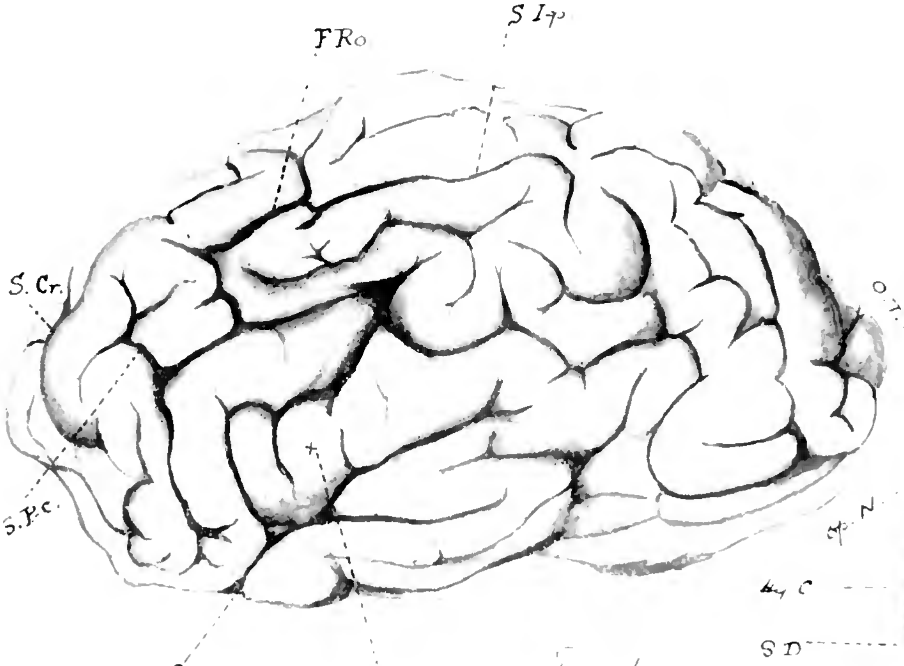

Fig. 1

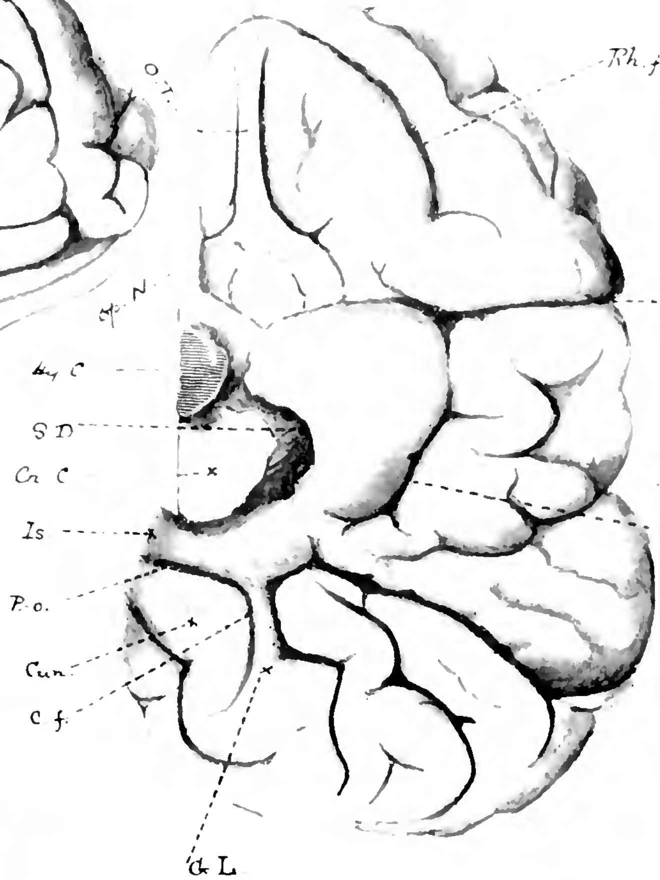

Fig. 3.

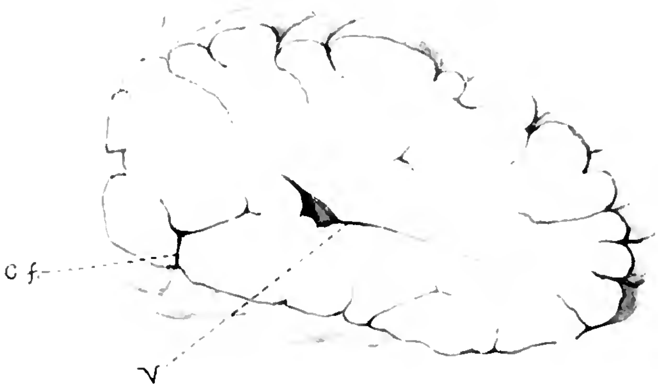

Fig. 4

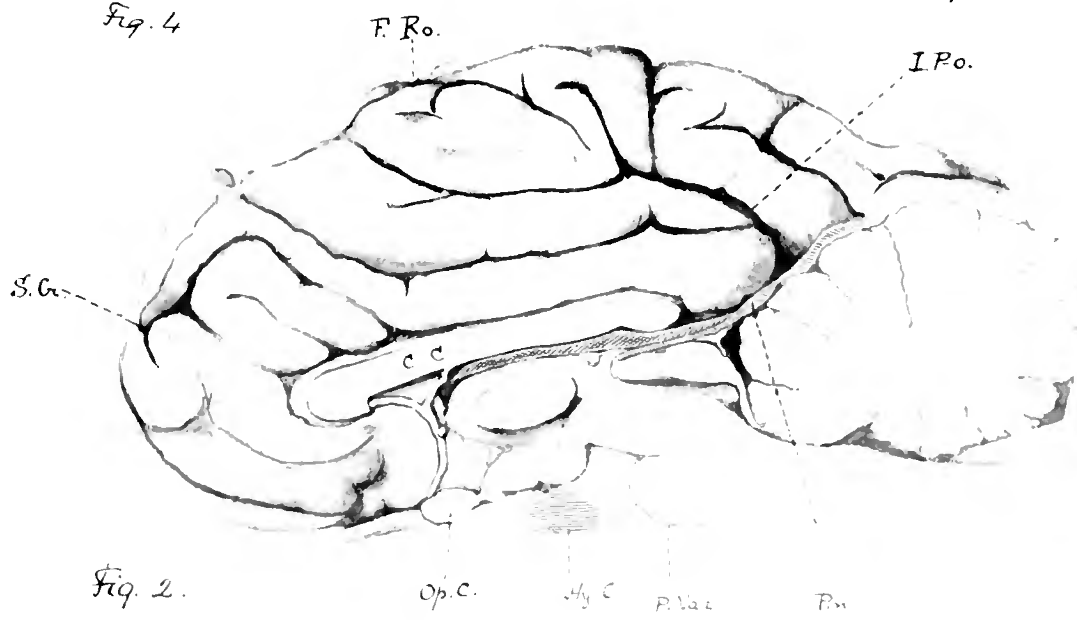

Fig. 2.

D. Hepburn del.

PART X.

S E A L S.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

X.—HISTOLOGY OF THE CENTRAL NERVOUS SYSTEM OF THE WEDDELL SEAL (*LEPTONYCHOTES WEDDELLI*).

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(*WITH TWO PLATES AND NINE TEXT FIGURES.*)

Scottish National Antarctic Expedition: A Contribution to the Histology of the Central Nervous System of the Weddell Seal (Leptonychotes weddellii).

By **Harold Axel Haig**, M.B., B.S. (Lond.), M.R.C.S. (Eng.), L.R.C.P. (Lond.), Lecturer in Histology and Embryology, University College, Cardiff. *Communicated by* Dr W. S. Bruce. (With Two Plates and Nine Text Figs.)

(MS. received June 18, 1912. Read December 2, 1912. Issued separately February 17, 1913.)

CONTENTS.

PART I.

Introductory and Practical Details.

The specimens submitted for examination were:

(*a*) Portions of the brain (labelled Specimen XXXI.).
(*b*) Portions of spinal cord (labelled Specimen XXIV.).

Both were in excellent condition as regards fixation and hardening, having been preserved for many years in a fluid composed of formol and 95 per cent. alcohol (the fluid was also injected into the cerebral vessels). They were, previous to histological examination, submitted to the following processes:—

i. Comparatively thin slices were taken from various regions and placed for twenty-four hours in absolute alcohol.
ii. Then transferred to acetone for twelve hours.
iii. Placed in xylol until permeated.
iv. Embedded in paraffin of melting-point 52° C. Sections were then taken with an improved form of the Cambridge rocking microtome, and fixed to slides by means of the albumen method.

Staining of the Sections.

The best stain for differentiating the grey and white matter was found to be *Weigert's method* with acid fuchsin, used alone, or subsequent to treatment with Delafield's hæmatoxylin. Other stains were tried (Bismarck brown with acid fuchsin as counterstain, aniline blue-black, hæmatoxylin and orange-G., etc.), but acid-fuchsin

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alone appeared to give the best results. The Weigert-Pal method was given a trial, but with negative results, owing to the special means of preservation and hardening employed.* The following regions were studied histologically :—

(*a*) Mid-lumbar, dorsal, and cervical regions of the *spinal cord.*

(*b*) *Medulla oblongata :*

i. In the region of the pyramidal decussation.
ii. At the lower level of the olivary body.
iii. At the middle of the olivary body.
iv. At the upper level of the olivary body.

(*c*) *Pons*, lower, middle, and upper regions.

(*d*) The *mesencephalon :*

i. At the level of the posterior corpora quadrigemina.
ii. At the level of the anterior corpora quadrigemina.

(*e*) The *optic thalamus.*

(*f*) The motor region of the cortex of the cerebral hemispheres (*precentral gyrus*).

(*g*) The *cerebellar vermis* (mesial region).

(*k*) The *optic chiasma.*

(*i*) The *pituitary gland.*

(*k*) The *uncinate gyrus* of the hippocampus major.

I. Histology of the Spinal Cord.

A. *Cervical Region.* (Text-fig. 1.)

A transverse section across the upper region of the *cervical cord* shows a very marked breaking up of the grey matter into four main groups in each half, viz. :—

(*a*) A posterior mass extending from the posterior grey commissure into the posterior median column of Goll ; in this mass at the base small nerve-cells are seen, and a few at the peripheral part near the surface of the cord. The latter represent the beginning of the nucleus gracilis, which soon becomes prominent even in the cervical region.

(*b*) A postero-lateral mass, into which the fibres of the posterior roots may be seen to extend. In this mass small nerve-cells may be made out, but they are very scattered and not at all conspicuous.

(*c*) An intermedio-lateral mass, at the central portion of which some large nerve-cells are to be made out, these representing the cells of Clarke's column.

(*d*) An anterior mass (anterior cornu) of wide extent, and possessing four or five groups of very large nerve-cells (motor cells of anterior cornu).

* The pituitary gland sections were stained with Delafield's hæmatoxylin, followed by eosin to differentiate.

The postero-lateral and intermedio-lateral masses of grey matter are united by strands of neuroglial tissue, which break up the lateral regions of the cord into a well-marked reticular formation. The grey matter in general is characterised by its deeply staining neuroglia fibres, which are of a somewhat coarse nature, and are apparently less in number per unit area as compared with the supporting tissue of higher types of cord.

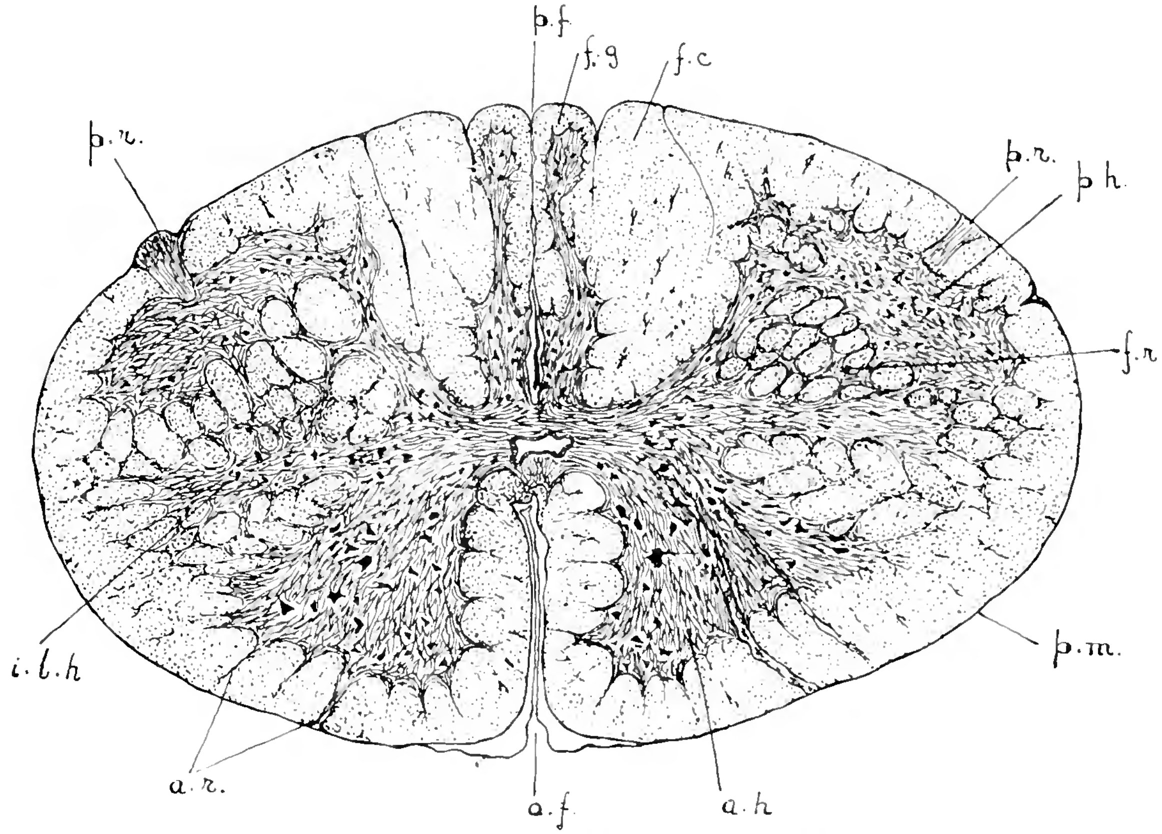


FIG. 1.—A transverse section of the spinal cord (upper cervical region).

a.f. Anterior median fissure.
p.f. Posterior median fissure.
p.r. Posterior root-bundles.
a.r. Anterior root-bundles.
f.g. Funiculus gracilis (posterior median column), showing an indication of the beginning of the nucleus gracilis.
p.h. Posterior horn of grey matter (beginning of the substantia gelatinosa of Rolando).
i.l.h. Intermedio-lateral horn.
f.r. Formatio reticularis.
a.h. Anterior horn.
p.m. Pia mater.

In the central region of the section the posterior grey commissure is of wide extent, and a small amount of neuroglia is to be seen anterior to the central canal of the cord: the latter is flattened antero-posteriorly, and is lined by a well-marked layer of columnar ciliated epithelium.

The postero-median fissure is of about the same length as the anterior median fissure, perhaps slightly longer; but the cord has apparently been subjected to a certain amount of mechanical pressure, causing flattening, and giving the whole section the appearance of abnormal transverse as compared with antero-posterior diameter. The postero-median fissure, which normally is of greater extent than the anterior, would thus be reduced in length.

The *white matter* of the cord appears to consist of very fine medullated nerve-fibres: in the posterior region, the columns of Goll (mesial) and Burdach (lateral) are very well marked, the pia mater dipping into the cord and marking off these two wedges of white matter. The pial septum, separating the postero-lateral column from the crossed pyramidal and direct cerebellar tracts, passes almost to the postero-lateral horn of grey matter.

The fibres of the anterior roots of the spinal nerves pass out through the white matter in three or four main bundles: those of the posterior roots in one thick bundle of fibres situated at the middle of the postero-lateral horn.

Comparison with higher type of mammalian cord (cervical region).

The main points in the comparative histology are the following:—

(*a*) The early appearance of the nucleus gracilis, which in the human cord does not appear before the medulla has been reached.

(*b*) The extensive spreading out of the grey matter of the posterior and intermedio-lateral horns.

(*c*) The wide disproportion between the transverse and the antero-lateral diameter of the cord, due account being of course taken of any pressure which may have arisen.

(*d*) The marked development of the formatio reticularis.

(*e*) The relatively enormous size of the motor cells in the anterior cornu: this is perhaps not sufficiently emphasised in text-fig. 1, but is nevertheless a very striking feature in the actual section. This feature is possibly related to the highly developed powers of locomotion shown by members of the seal family.

The proportion of grey to white matter is as 3 to 4 approx.

B. *Dorsal region.* (Text-fig. 2.)

The cord appears in this region to have been submitted to mechanical pressure in the transverse diameter: for this reason, the central canal appears elongated antero-posteriorly and somewhat distorted. The postero-median fissure is longer than the anterior and reaches to the grey commissure; the anterior fissure stops short of the central grey matter, leaving a well-defined anterior or white commissure. The antero-posterior diameter appears greater than the transverse. The grey matter is divided in each lateral half into three main masses, viz.:—

(*a*) A posterior horn, in which are to be seen a few medium-sized nerve-cells.

(*b*) An intermedio-lateral horn, at the tip of which a group of medium-sized nerve-cells is situated; the cells of Clarke's column are also seen, having been displaced below the base of the posterior horn by mechanical pressure.

(c) A broad anterior horn possessing several groups of large nerve-cells.

The *white matter* in the posterior region shows but slight indication of a division into postero-mesial and postero-lateral columns: the lateral columns are of relatively wide extent.

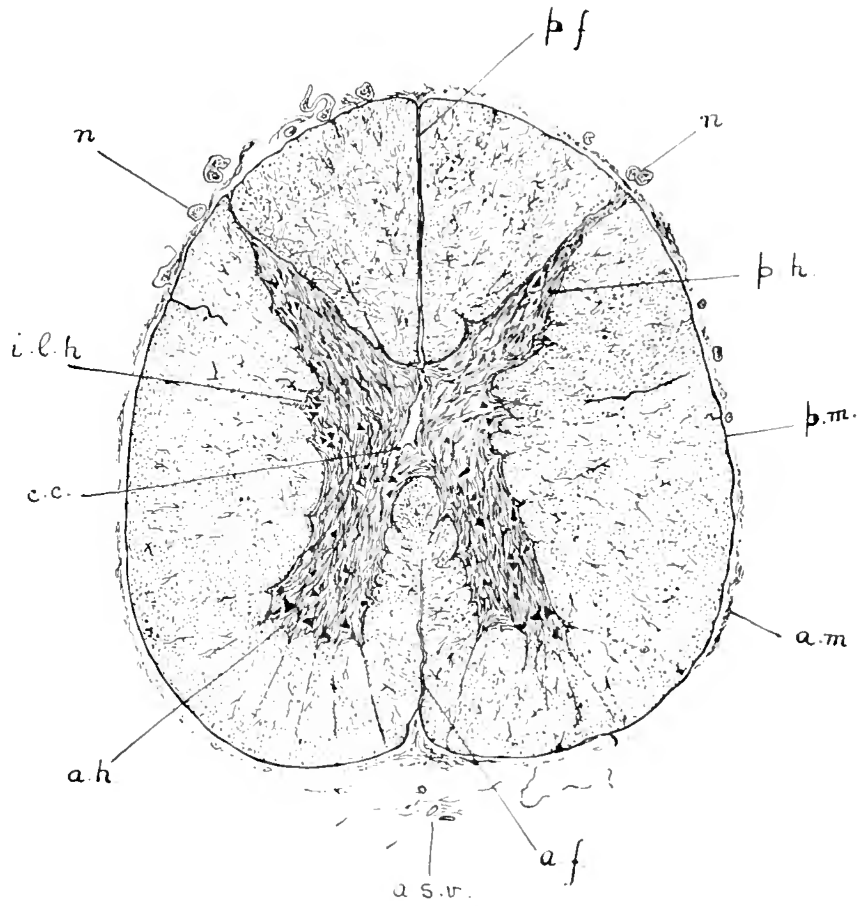


FIG. 2.—A transverse section of the spinal cord (mid-dorsal region). Lettering as in fig. 1, except:—

a.m. Arachnoid mater.
c.c. Central canal of cord.
n. Posterior roots.
a.s.v. Anterior spinal vessels.

The posterior nerve-roots are narrower than in the cervical region, but are very well defined: the root-bundles lie just outside, and are seen cut across in the section. The anterior roots pass out in three or four narrow strands.

The proportion of grey matter to white is as 9 to 20 approx.

Compared with higher types, the dorsal cord shows but few divergences: the posterior horn of grey matter is rather shorter than in the human cord, and Clarke's column of nerve-cells is but feebly developed. On the other hand, the motor cells in the anterior horn are very well defined.

C. *Lumbar region.* (Text-fig. 3.)

The three main subdivisions of each lateral crescent of grey matter can be distinguished, viz. posterior, intermedio-lateral, and anterior horns.

A few nerve-cells are present about the middle of the posterior horn, and a well-marked group is to be seen at the base of the posterior horn (Clarke's column). Groups also occur at the tip of the intermedio-lateral horn, and to the number of three in the anterior horn, these being very obvious and the component cells very large.

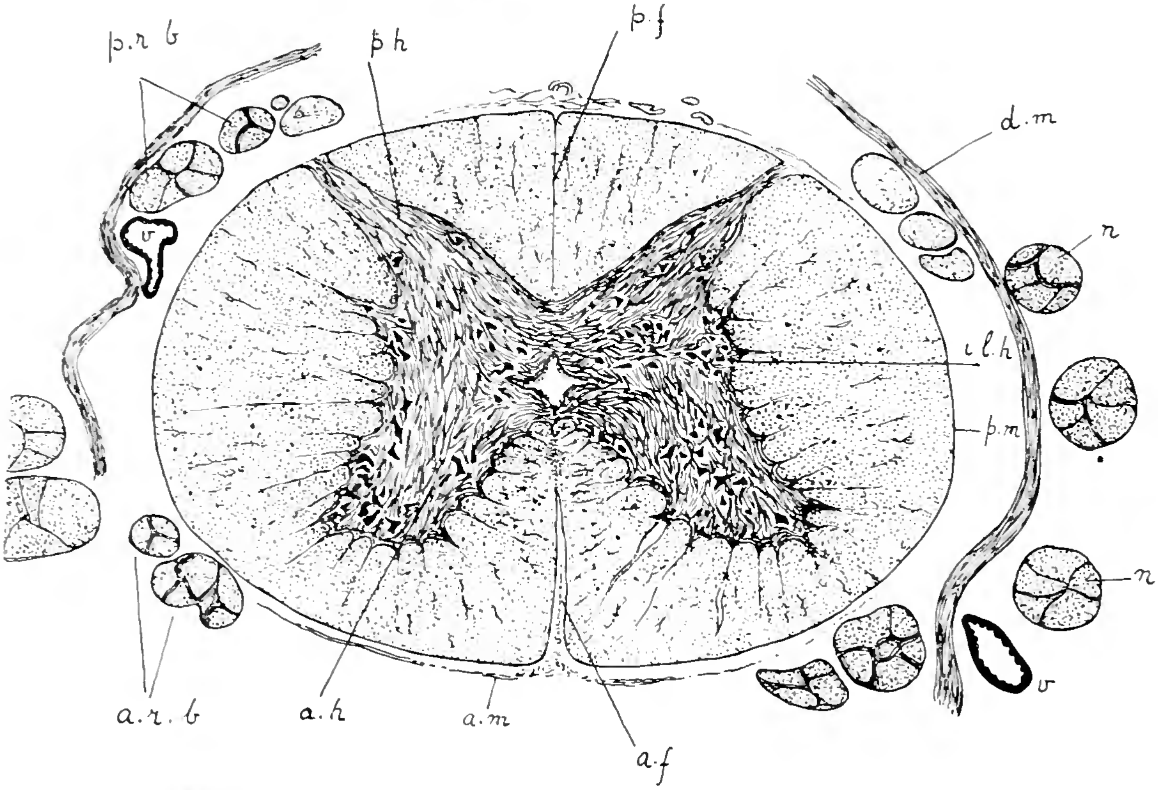


FIG. 3.—A transverse section of the spinal cord (lumbar region). Lettering as in figs. 1 and 2, except:—

d.m. Dura mater.
p.r.b. Posterior root bundles.
a.r.b. Anterior root-bundles.
n. Bundles of the cauda equina.
v. Large branches of the vertebral vessels.

The posterior or grey commissure is wide, and the anterior white commissure is relatively broad in the antero-posterior direction: the central canal appears as a four-sided space lined by an ependyma possessing an internal layer of ciliated epithelium.

The posterior root-bundles are very large and number three or four on each side posteriorly, lying between the dura mater and the pial investment of the cord; the anterior bundles are two in number on each side antero-laterally.

Of the white matter, the lateral columns are of fairly wide extent, as also are the anterior columns; there is no marked distinction between Goll's and Burdach's columns posteriorly, although a small pial septum does show the superficial division.

In the section figured the postero-median and antero-median fissures are of about the same length, but in a normal specimen the posterior would be rather longer than the anterior.

Outside the dura mater may be seen nerve-bundles representing a high origin of the cauda equina: this feature is very marked in the seal, the cord ending in a filament at a much higher level than in the human.

The proportion of grey matter to white is as 1 to 3 approx.

The chief features of comparative value are the relative shortness of the posterior horn as compared with the human, and the presence of the surrounding bundles of the cauda equina even high in the lumbar region of the cord. The motor cells of the anterior cornua are, as in the dorsal and cervical regions, larger relatively than those found in the cord of man.

II. Histology of the Medulla Oblongata.

A. *At the middle of the pyramidal decussation.* (Pl. I. fig. 1.)

Several marked points of difference are seen here as compared with the upper cervical region: firstly, the transverse diameter of the section is twice the antero-posterior diameter, and the anterior fissure is about twice the length of the posterior. The central canal is approaching the posterior surface of the cord, but there still remains a fairly wide grey commissure.

Indications of the beginning of a restiform body may be made out laterally, and the intermedio-lateral horn of grey matter now forms a well-defined mass, known as the substantia gelatinosa Rolandi (*s.g.R.*).

The grey matter generally exists in relatively large proportion: the large motor cells of the anterior horn are still very obvious, and in the postero-median and postero-lateral columns are to be seen respectively the nucleus gracilis and nucleus cuneatus (*n.g.* and *n.c.*).

The *pyramidal decussation* is a marked feature, fibres passing across from the lateral column of one side to the anterior column of the opposite half, and to a certain extent separating the grey matter of the posterior region from that of the lateral and anterior regions.*

The proportion of grey to white matter is as 3 to 4 approx.

B. *At a point just below the calamus scriptorius of the 4th ventricle.* (Pl. I. fig. 2.)

In this region the central canal is fast approaching the floor of the 4th ventricle to open out into that cavity. The pyramidal decussation is now no longer noticed, the upper level having been passed.

* The decussation of the pyramids is of greater extent longitudinally than in the human medulla, being found quite close to the calamus scriptorius at its upper level.

The substantia gelatinosa Rolandi is now quite separate from the rest of the grey matter and lies enclosed by white fibres which partly arch round it and partly form the lower limit of the restiform body. The pyramids form marked protuberances anteriorly in the middle line.

No trace of an olivary body is seen as yet, a feature which is of comparative value; the nuclei gracilis and cuneatus are well defined, the latter lying now well to the outer side of the former.

Large nerve-cells are to be made out in the grey matter of the still visible representatives of the anterior cornua.

The proportion of grey to white matter is as 3 to 5 approx.

The transverse diameter of the section markedly exceeds the antero-posterior diameter: this feature is now prominent throughout the whole extent of the medulla, until, when the pons is reached, the disproportion becomes less obvious.

C. *At the lower limit of the olivary body.* (Pl. I. fig. 3.)

A median raphe has now appeared, and the central region is occupied by intercrossing strands of fibres (*internal arcuate fibres*), and just dorsal to the pyramids the *tract of the fillet* may be seen.

The central canal has opened out on to the floor of the 4th ventricle, the latter being covered by a layer of ependyma.

The *restiform body* is now becoming a more obvious feature, and outside this fibres forming a well-marked covering, passing from the pyramid regions round the restiform body towards the dorsal region.

Two well-defined nuclei have now taken the place of the nuclei gracilis and cuneatus: these are respectively the nucleus of the 12th cranial nerve and the dorsal nucleus of the 10th cranial nerve (*n.* 12th, *n.* 10th).

The *olivary body* is peculiar in that in section it shows an internal mass of grey matter, loaded with rather large nerve-cells, having the form of a U-shaped fold, which however does not possess any folds of the second order such as are to be seen in the grey matter of the human olivary body. In some regions this olive is open centrally (hilus), but in the lower regions takes the form of a closed oval of grey matter (*o.n.*). The olive does not form a very marked external projection, and, moreover, especially in the higher regions of the medulla, appears to be further removed from the pyramids. A few of the internal arcuate fibres may be traced from the hilus olivæ across the median raphe to the opposite restiform body.

The rest of the grey matter is of a somewhat scattered aspect: the substantia gelatinosa still forms an obvious mass laterally enclosed by the curved restiform body: some of the masses of grey matter lying ventrally may possibly represent accessory olivary bodies, but some certainly belong to the category of arcuate nuclei.

Just below the floor of the 4th ventricle in the middle line is a tract of fibres representing the posterior longitudinal bundle: and ventral to this another band, not well defined, which is the anterior longitudinal bundle.

D. *At the middle of the olivary body.* (Pl. I. fig. 4.)

The main points in this region of the medulla are: the olivary nucleus, the restiform body, the nuclei of the 12th and 10th cranial nerves, and outside both of these a group of nerve cells which apparently represent the nucleus of the vestibular division of the 8th cranial nerve.

Other well-marked features are the issuing fibres of the 12th, 10th, and 9th nerves: the first of these pass down through the internal arcuate fibres to emerge from the medulla between the olive and a mass of grey matter which has become separated from the substantia gelatinosa (? nucleus ambiguus): the fibres of the 10th nerve pass through the arcuate fibres between the restiform body and the fibres of the 12th nerve to emerge at the inner edge of the restiform: the fibres of the 9th nerve are only seen for a short part of their course and emerge further forward (see next section). The pyramids are now very well defined, and the tract of the fillet and the posterior longitudinal bundle form characteristic features.

E. *At the upper level of the olivary body.* (Pl. I. fig. 5.)

In this section, a layer of grey matter appears spreading over the floor of the 4th ventricle, quite distinct from the subjacent nuclear groups; of the latter groups, two, representing nuclei of the 9th nerve, are to be seen just below and external to the very obvious posterior longitudinal bundle. The fibres of the 9th nerve are seen issuing between the olivary body and the restiform body, whilst external to the latter some fibres of the 8th cranial nerve are to be distinguished.

Several small groups of grey matter, just mesial to the olivary nucleus, may possibly represent accessory olivary nuclei.

The anterior longitudinal bundle, the fillet, and the pyramids all form marked features from above downwards; and the fibres which enclose and arch round the restiform body (? continuation of the external arcuate fibres) form also a point worthy of notice.

III. Histology of the Pons Varolii. (Pl. I. figs. 6, 7, and 8.)

A section across the *lower pontine region* of the brain shows the 4th ventricle closed over by the superior medullary velum, and the floor of the ventricle lined by a well-marked ependyma; a thick layer of grey matter lies subjacent to this, and, in the middle line, the posterior longitudinal bundle is one of the most prominent features of the section. In the middle of this region there is to be seen the formatio reticularis, and ventral to this, a fairly wide trapezium makes its appearance ventral to the trapezium, the pyramid bundles form two very distinct masses, and between them lies grey matter representing the nuclei pontis; two small masses of grey matter dorso-external to the pyramid bundles may possibly represent superior olivary nuclei. Pontine nuclei are also to be seen lying ventral and external to the pyramids.

The nucleus of the 7th cranial nerve lies at the outer and upper angle of the formatio reticularis, and the issuing fibres of the 7th nerve pass down close to and parallel to a wide bundle of fibres which arises (partly) from a nucleus close to the inner side of the restiform body; this bundle is the issuing root of the auditory or 8th cranial nerve. Outside the restiform body and the above-mentioned nerves lies part of the white matter of the cerebellar hemisphere (*c*).

Pontine fibres pass ventrally to the pyramid bundles, and form characteristic parallel strands.

The *mid-pontine region* shows a very thick layer of grey matter beneath the ependyma of the floor of the 4th ventricle, on either side of the middle line: beneath this, the posterior longitudinal bundle forms a conspicuous band, the two lying close together in the middle line. The tract of the fillet is also well defined, lying just above and to the outer side of the pyramid bundle; whilst the intercrossing fibres of the pons alternate with parallel streaks of grey matter, breaking up the majority of the central part of the section (Pl. I. fig. 7) into a reticular formation of wider extent than that in the lower pontine region.

The nuclei of the 5th cranial nerve (motor and sensory nuclei close together) appear as a large group of nerve-cells just internal to the restiform body, which latter is now known as the superior cerebellar peduncle, and the issuing fibres of the 5th nerve are seen at the lateral part of the section just ventral to the white matter of the cerebellar hemisphere.

The trapezium is represented by the dorsal portion of the reticular formation, and can hardly be distinguished histologically from that, except by appropriate methods, inapplicable in the case of the present material. The central bundle of the 5th nerve forms a rather narrow band of fibres lying just beneath the grey matter of the floor of the ventricle.

The pontine fibres which lie at the lower (ventral) aspect form very marked parallel strands curving outwards towards the 5th nerve: and the grey matter just dorsal to these fibres (nuclei pontis) are distinguished by their relatively wide extension laterally.

The *upper pontine region* appears in some respects very similar to the mid-region; the tract of the fillet is, however, becoming divided into two main portions, viz. the intermediate fillet and the lateral fillet (Pl. I. fig. 8 *f*).

The posterior longitudinal bundles are now slightly separated in the mid-line by a small amount of grey matter, and the grey matter of the floor of the 4th ventricle is not quite so thick as in the middle region of the pons.

The crossing of the 4th cranial nerves is seen as a band lying just above the ventricle, forming a kind of roof to the cavity at this point; the superior cerebellar peduncles are very distinct, and their decussation may be seen about the middle of the section, although this does not form so obvious a feature as it does in the human pons. A noteworthy feature is the absence of any sign of substantia nigra, as also is the fact that the pyramid bundles are still isolated masses lying well in the grey matter of the lateral regions. Pontine fibres are also well marked.

The anterior longitudinal bundle lies ventral to the posterior longitudinal bundle, but is not a marked feature, since a large proportion of grey matter is present in the mid-region. Below the decussation of the superior peduncles in the mid-line is some grey matter, which, although ill-defined, would represent the so-called central nucleus of the higher types.

The root-bundle of the 4th nerve appears just external to the grey matter of the floor of the ventricle, and indications of the nucleus of the 4th nerve are to be made out at the outer limit of the grey matter in the floor.

IV. Histology of the Mesencephalon. (Pl. I. figs. 9 and 10.)

A section across the mid-brain *in the region of the posterior corpora quadrigemina* shows a structure very like that seen in the human mid-brain; the aqueduct of Sylvius is, however, much nearer the dorsal surface, and moreover is rhomboidal in shape.

Each corpus quadrigeminum possesses an outer coat of white fibres and intermediate mass of grey matter, and an inner thin band of white fibres separating it from the central grey matter round the aqueduct.

The reticular formation of the tegmentum is very distinct, and the posterior longitudinal bundles show clearly just below the grey matter surrounding the aqueduct of Sylvius.

The nuclei of the 3rd and 4th cranial nerves are very well defined, lying mesially just ventral to the lower angle of the aqueduct.

The substantia nigra forms a layer, containing some very large nerve-cells, lying between the fillet tracts and the crustæ; prolongations from the substantia nigra pass into the crusta and tend to subdivide it into two or more regions on either side.

There is an ill-defined mass of grey matter between the two crustæ, representing an inter-peduncular ganglion, and above this a tract of decussating fibres which form the crossing (upper part) of the superior cerebellar peduncles. The decussating fibres of the tegmenta are well marked in the mid region above the substantia nigra.

A section across the *anterior corpora quadrigemina* shows some divergence from the human type; the Sylvian aqueduct is still rhomboidal in shape, and is some distance from the dorsal surface. The fibres of the 3rd cranial nerve are seen issuing through the posterior longitudinal bundles, and a portion of the section which in the human is occupied by the red nucleus: the latter, however, cannot be markedly distinguished as such in the section in question.

Each anterior corpus quadrigeminum possesses a very thin covering of white fibres, grey matter in the intermediate region, and a narrow layer of white fibres internally;

the grey matter surrounding the aqueduct shows mesioventrally the nuclei of the 3rd nerve, and ventral to the latter the posterior longitudinal bundles are fairly obvious. The crustæ are of less extent than those of the former section.

The posterior commissure of the brain shows dorsal to the aqueduct of Sylvius, and is of moderate antero-posterior dimensions.

Points of comparative value in connection with the medulla, pons, and mid-brain are as follows :—

(*a*) The disproportion between the transverse and antero-posterior diameters of the medulla, the former being about twice or two and a-half times the length of the latter.

(*b*) The relatively large proportion of grey matter in all these regions, much of it, however, being composed of purely neuroglial tissue.

(*c*) The aberrant shape of the olivary nucleus and the outward displacement of the whole olive.

(*d*) The marked development of the restiform body and its early distinction in a comparatively low region.

(*e*) The late formation of the crustæ, the mid-brain being reached before these are well defined. Other minor points will be made out by reference to Plate I., and comparison of the figures with sections of normal human material.

V. The Histology of the Optic Thalamus. (Text-fig. 4.)

The main features to be made out from a vertical (sagittal) section of the optic thalamus consist mainly in the relative distribution of grey and white matter; the white matter occurs in two main masses—an external, thick superiorly and thinning off towards the anterior aspect, and an internal oblique mass which divides the internal

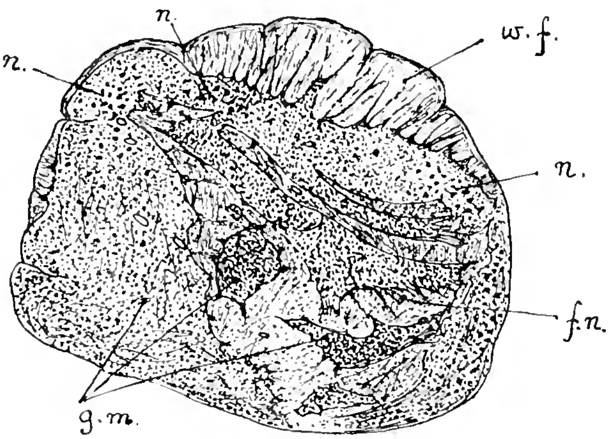


Fig. 4.—A mesial sagittal section of the optic thalamus (semidiagrammatic). × 4 times.

w.f. Superficial layer of white fibres into which septa of neuroglia pass from the deeper grey matter.
n.n.n. Groups of large nerve-cells in the grey matter.
g.m. Central grey matter. The internal mass is not sharply differentiated into grey and white matter: small nerve-cells appear scattered throughout the former.

grey matter into two main groups, an anterior and a posterior. Just beneath the superficial white matter several well-defined groups of nerve-cells may be seen (*n.*), and posteriorly a group is also to be distinguished. Many small nerve-cells are scattered throughout the masses of grey matter.

VI. The Histology of the Convolutions of the Precentral Gyrus. (Text-fig. 5.)

The *cortex of the motor area* presents a fairly typical structure, except that large multipolar nerve-cells occur at a relatively deep level, forming a deeply staining layer

Fig. 5.—Semidiagrammatic vertical section of a part of the motor cortex cerebri (precentral convolution). × 6.

1. Plexiform layer.
2. Layer of small nerve-cells (granules).
3. Layer of large flask-shaped nerve-cells, the axons passing centrally, dendrons peripherally.
4. Layer of large pyramidal cells (comp. to Bett's cells of human motor cortex).
5. Deep layer of large pyramids, lying next to the white centre: there is much dense neuroglia in this layer.

lying next the fibres of the white centre; in all, about four layers of nerve-cells may be distinguished. The following layers are quite distinct:—

(*a*) A superficial layer formed of interwoven fibres (plexiform layer).

(*b*) A second layer of small nerve cells, the axons of which are not very obvious.

(*c*) A third layer of large flask-shaped cells not unlike the Purkinje cells of the cerebellum, with axons passing centrally and dendrons peripherally.

(*d*) A fourth layer of rather large pyramidal cells, the axons passing centrally.

(*e*) A fifth layer of large multipolar cells, the axons passing in many directions: this layer contains much deeply staining neuroglia.

VII. The Histological Features of the Vermis of the Cerebellum. (Text-fig. 6.)

A section across the lamellar of the vermis (or of the hemisphere) shows the typical arrangement characteristic of higher mammals, viz. a white centre, an inner layer of "granules" (small nerve-cells, the axons of which pass peripherally), an intermediate layer of the large flask-shaped cells of Purkinje, the axons of which pass centrally, the dendrons passing peripherally, and a superficial "molecular" layer, consisting of small

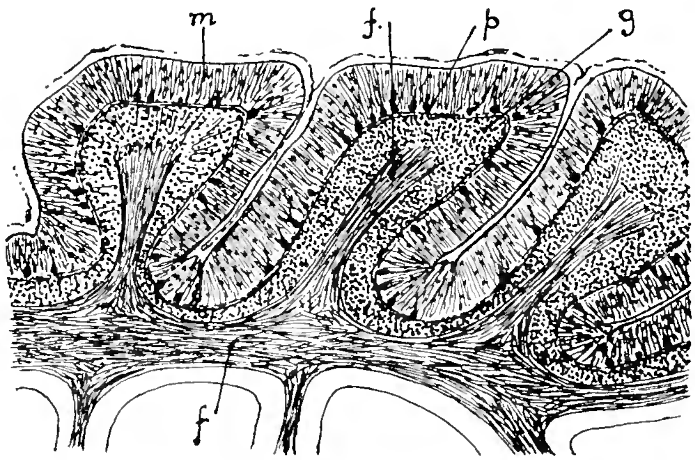


Fig. 6.—A portion of a vertical section of the vermis of the cerebellum. ×6.

f. Fibres of the white centre.
m. Molecular layer.
p. Layer of large Purkinje cells.
g. Layer of granules (small nerve-cells and axons of the Purkinje cells).

nerve-cells, the dendrons of Purkinje cells and fibres derived from neuroglia cells, and the "climbing" and "moss" fibres coming from the deeper layers.

The only point of comparative value is the relatively large size of the Purkinje cells; these are not only large, but exist also in greater numbers than are usually met with in an equivalent area of the human type.

[The uncinate gyrus and optic chiasma present much the same features as the same regions in the human type: no points of comparative value were made out in the sections.]

PART II.

The Histology of the Pituitary Gland. (Pl. II. and Text-figs. 7, 8, 9.)

The pituitary gland of the Weddell seal is a body of considerable histological interest, inasmuch as all three portions are well developed, and in addition there occurs upon its upper aspect a small portion of tissue the structure of which is not represented in the human pituitary.*

The gland (text-fig. 7) is a large one, and is made up of three main portions, viz.

* It is possible that this structure is represented in some of the lower types by the sacci vasculosi found in connection with the pituitary gland.

a large anterior lobe, a narrow but well-defined intermediate part, and a posterior lobe; the hinder portion of the intermediate mass is bent at an angle upon the rest of that part, so as to come to lie posteriorly between the lower limit of the posterior lobe and the projecting posterior part of the anterior lobe. From the surface, the upper part of the posterior lobe appears wedge-shaped and folded over the hinder part of the anterior lobe so as to cover about a third of the upper surface.

The atypical tissue on the upper surface takes the form of a small ovoid mass folded upon itself, and the upper leaf appears to be continuous with the floor of the

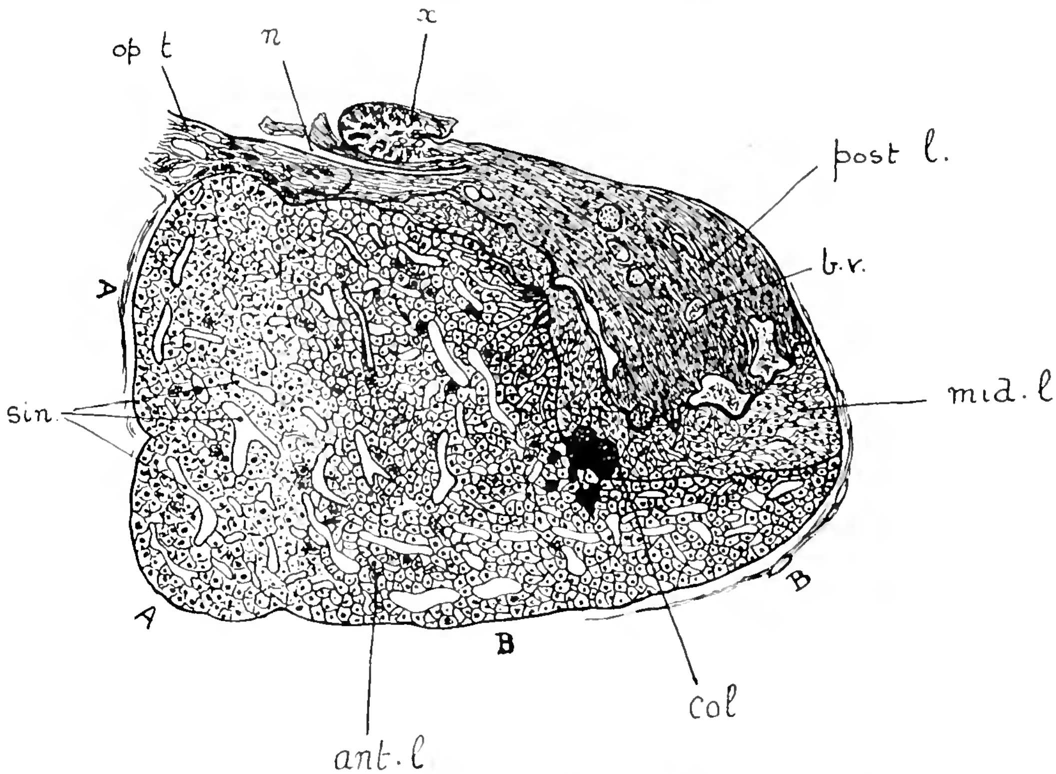


Fig. 7.—A mesial sagittal section of the pituitary gland (*Leptonychotes weddellii*). (Semidiagrammatic.)

ant.l. Anterior lobe: A A, its front part; B B, its posterior part (see Plate II.).
mid.l. Intermediate portion.
post.l. Posterior lobe.
n. Neck of the infundibulum.
op.t. Optic tract.
x. Hypothetical mass on the superior aspect of the infundibulum.
sin. Sinusoids.
col. Colloidal substance formed in the middle lobe.
b.v. Large blood-vessels in the posterior lobe (often filled with colloid).

3rd ventricle; its structure, however, in no way resembles either grey or white matter, being made up of strands of conglomerate cells (syncytium) between which is a considerable amount of connective tissue and some relatively large vessels (text-figs. 8 and 9). Below this body comes a layer continuous with the posterior lobe, then the persistent cleft continues with the third ventricle and passing some way into the "neck" of the posterior lobe, and below this again the lower part of the neck in which a small amount of the above atypical tissue also occurs, but, as will be seen, quite separate from the main mass.

The large anterior lobe appears to be made up of two distinct portions (histologically distinct), viz. a front part composed of syncytial strands of cells, with well-defined nuclei and a few intervening sinusoids, or rather capillaries, since the endothelial walls are

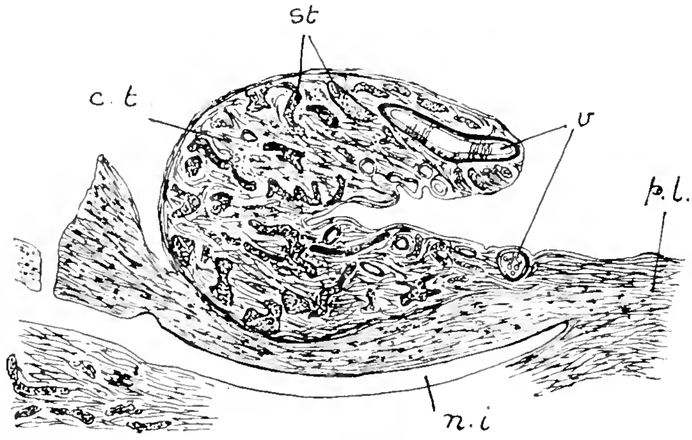


FIG. 8.—Mesial section of the portion lettered *x* in fig. 7 (moderately magnified).

n.i. Neck of infundibulum.
p.l. Posterior lobe of pituitary.
st. Strands of epithelial cells.
c.t. Connective tissue.
v. Large blood-vessels.
x[1]. Similar tissue to above seen in the tissue above anterior lobe.

present (Plate II. B). The hind part of the anterior lobe is made up of fairly large clumps of cells, the cell-outlines being quite distinct and the majority of them having deeply stained cytoplasm of a somewhat granular character; the nuclei are

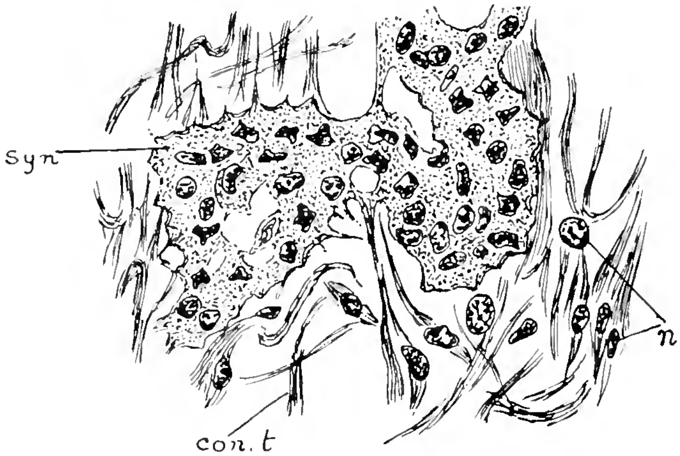


FIG. 9.—A small portion of fig. 8 more highly magnified.

syn. Syncytial strand (*st.* of fig. 8).
con.t. Connective-tissue fibres and cells.
n. Nuclei of fibroblasts (lamellar cells).

large and distinct.* In this part many large sinusoids occur, filled with erythrocytes; a few of the above-mentioned deeply-staining cells occur in the front part of the anterior lobe, but the majority in the front part are syncytial and the cytoplasm but lightly

* In these clumps, some of the cells possess much clearer cytoplasm, which is not deeply stained with eosin; in this respect the anterior lobe resembles that of the human pituitary gland.

stained with eosin and clear. The intermediate portion is a typical syncytium of clear protoplasm in which are embedded many large nuclei: colloidal substance occurs at various points bordering on the anterior lobe (Plate II. C, and text-fig. 7, *col.*).

No sinusoids are present in the intermediate portion, there being, however, cleft-like spaces between the strands of the syncytium. At the upper part of the gland the intermediate portion seems to pass insensibly into the anterior lobe—in fact, almost to blend with that lobe, and the above structure would thus lead to an inference that the middle portion is a derivative of the *front* part of the anterior lobe, since both these portions are syncytial in character. The posterior lobe (Plate II. D) is made up of a large amount of neuroglia in which large nuclei occur (nuclei of neuroglia cells), and also here and there small masses of colloid which are passing through the lobe from the intermediate portion. The large vessels of the posterior lobe (not sinusoids) are also occasionally seen to be filled with masses of colloid in which are embedded small bi- or tri-lobed masses which are either leucocytes or degenerating nuclei from the intermediate portion.

EXPLANATION OF PLATES.

Plate I.

Serial sections of the medulla oblongata, pons, and mid-brain (*Leptonychotes weddellii*).

1. At the decussation of the pyramids:
   - *S.G.R.* Substantia gelatinosa Rolandi.
   - *n.c.* Nucleus cuneatus.
   - *n.g.* Nucleus gracilis.
   - *py.d.* Pyramidal decussation.

2. Just above the pyramidal decussation:
   - *Py.* Pyramids.
   - Other lettering as in 1.

3. At the lower region of the olivary body:
   - *C.R.* Corpus restiforme.
   - *f.* Tract of the fillet.
   - *o.n.* Olivary nucleus.
   - *s.a.* Superficial arcuate fibres.
   - *p.l.b.* Posterior longitudinal bundle.
   - *n. XII.* Nucleus of 12th cranial nerve.
   - *n. X.* Dorsal nucleus of 10th cranial nerve.

4. At the mid-olivary region:
   - *i.a.* Internal arcuate fibres.
   - *n. IX.* Nucleus of the 9th cranial nerve.
   - *n.d.* Part of Deiter's nucleus.
   - *X.* and *XII.* Issuing fibres of the 10th and 12th cranial nerves.
   - Other letters as in preceding figures.

5. At the upper olivary region:
   - *IX.* and *VIII.* Issuing fibres of the 9th and 8th cranial nerves.
   - *a.n.* Arcuate nuclei.

6. Across the lower pontine region:
   - *v. 4.* Cavity of the 4th ventricle.
   - *VII.* and *VIII* Issuing fibres of 7th and 8th cranial nerves.
   - *D. VII.* Nucleus of 7th cranial nerve.
   - *p.n.* Pontine nuclei.
   - *f.p.* Pontine fibres.
   - *f.r.* Formatio reticularis.
   - *s.o.* (?) Superior olivary nuclei.
   - *tz.* Trapezium.

7. Across the middle of the pons:
   - *n. V.* Nucleus of 5th cranial nerve (motor nucleus).

V. Issuing fibres of 5th nerve.
s.c.p. Superior cerebellar peduncle.
p.l.b. Posterior longitudinal bundle.
f. Tract of the fillet.

8. Across the upper region of the pons:

IV. Intercrossing fibres of 4th cranial nerves.
n. IV. Root-bundles of 4th nerves.
s.p.d Decussation of superior peduncles of cerebellum.
f. Fillet.

9. Across the posterior corpora quadrigemina (mesencephalon):

Sy. Aqueduct of Sylvius.
f.ret. Reticular formation.
p.l.b. Posterior longitudinal bundle.
s.c.p. Superior peduncles of cerebellum.
$f_1 f_2$. Intermediate and lateral fillet.
t.d. Decussation of trapezium.
i.p.g. Interpeduncular grey matter.
n. III., *n. IV.* Nuclei of the 3rd and 4th cranial nerves.
p.p. Crusta (pes pedunculi).
s.n. Substantia nigra.
C.Q.p. Posterior corpus quadrigeminum.

10. Across the anterior corpora quadrigemina:

p.c Posterior commissure of brain.
C.Q.a. Anterior corpus quadrigeminum.
n. III. Nucleus of 3rd nerve.
f_3. Issuing fibres of 3rd nerve.
f. Fillet.

Plate II.

A. Portion of the posterior part of the anterior lobe of the pituitary gland (*Leptonychotes weddellii*). × 500:

g. Large granular cells, staining deeply with eosin.
sin. Sinusoidal blood-spaces, some of them containing erythrocytes, and occasionally showing an endothelial lining (*n.ep.*) indicative of a true capillary.

B. Portion of the anterior part of the anterior lobe of the pituitary gland. × 500:

syn. Syncytium, including here and there large isolated cells typical of the posterior part of the anterior lobe (*g*).
v. True capillaries.

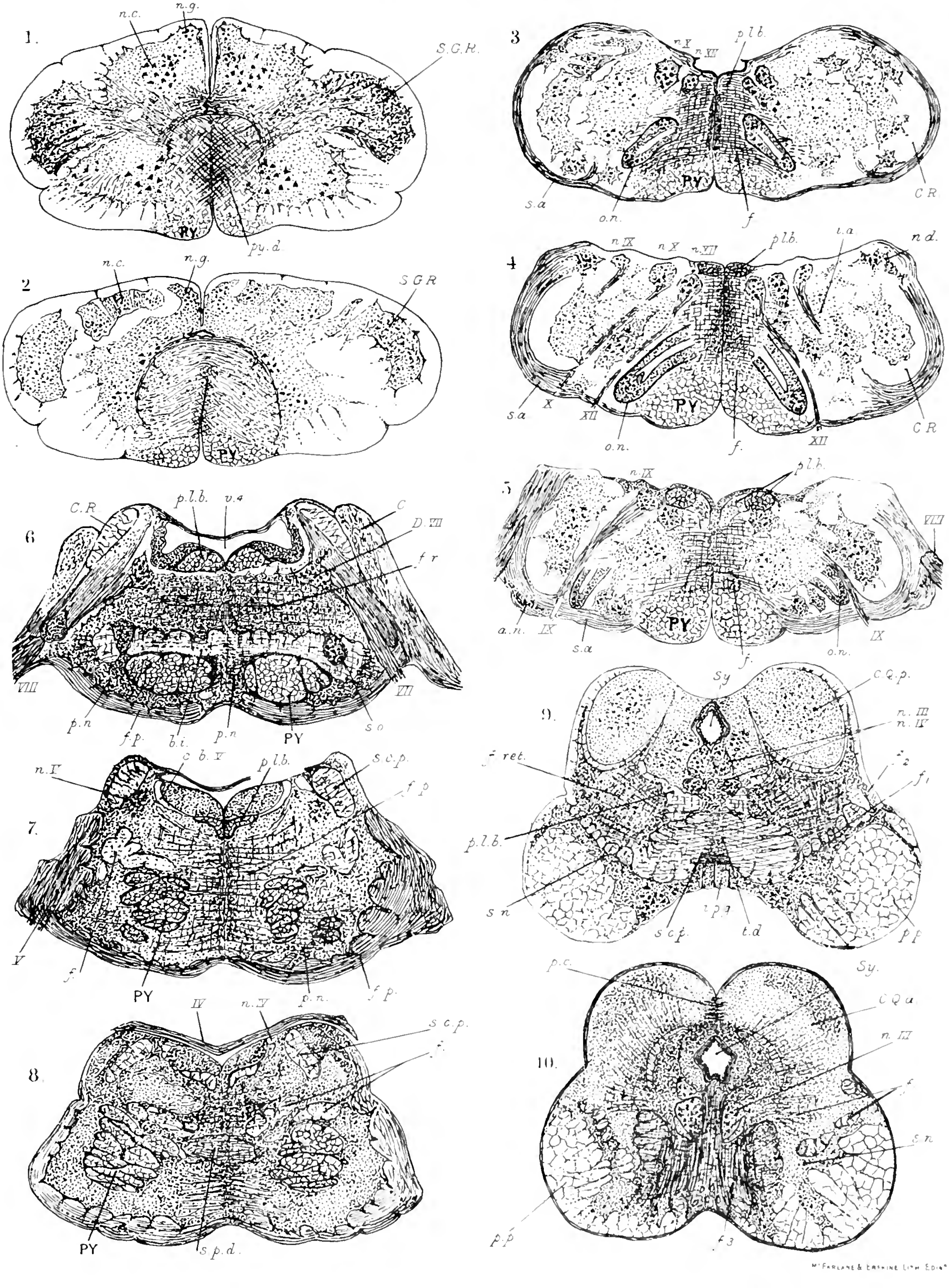
C. Part of the pars intermedia of the pituitary gland. × 500:

syn.p. Syncytium = fused spindle-shaped cells with nuclei (*n.*) embedded in the protoplasm.
col. Colloidal substance at the edge of the pars intermedia.

D. Part of the posterior lobe of the pituitary gland:

n.f. Neuroglia fibres.
n. Nuclei of neuroglia cells.
col. Isolated colloid masses.
col[1]. Large mass of colloid in a vessel (*v.*).

HAIG: CENTRAL NERVOUS SYSTEM OF THE WEDDELL SEAL—PLATE I.



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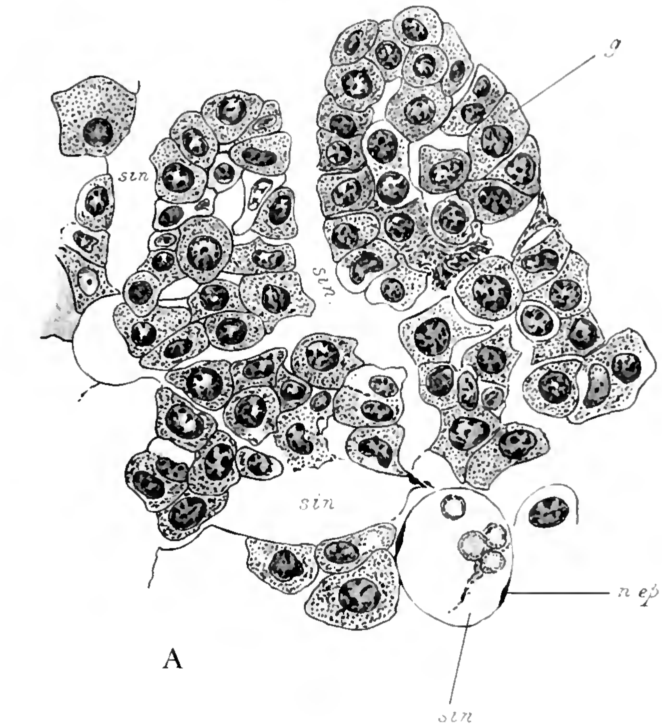
HAIG: CENTRAL NERVOUS SYSTEM OF THE WEDDELL SEAL—PLATE II.



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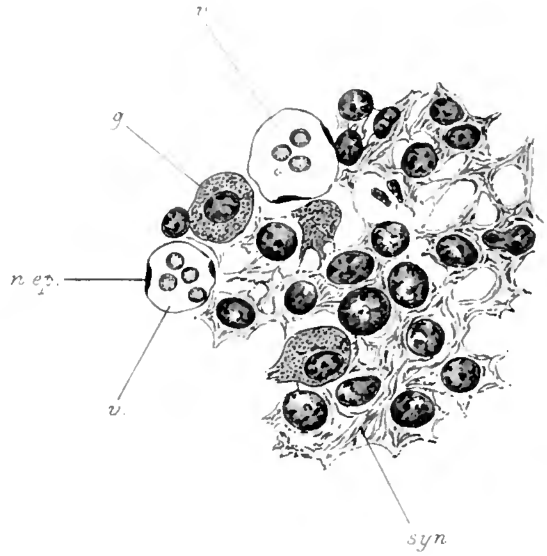

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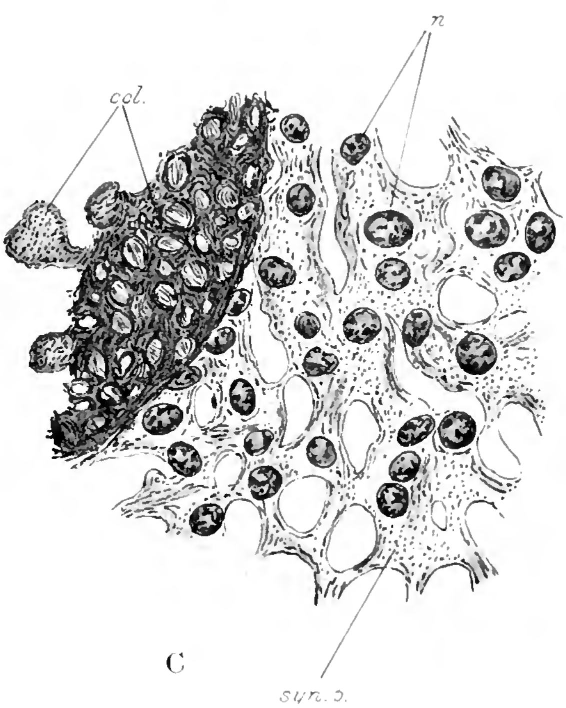

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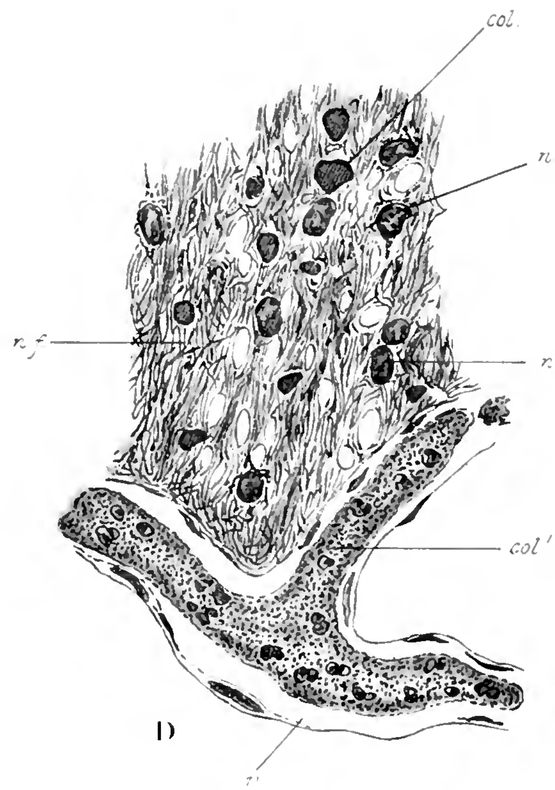

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PART XI.

S E A L S.

PART XI.—MEASUREMENTS AND WEIGHTS OF ANTARCTIC SEALS TAKEN BY THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

By WILLIAM S. BRUCE, LL.D., F.R.S.E.,
Director of Scottish Oceanographical Laboratory, Edinburgh.

(*WITH TWO PLATES AND ONE TEXT FIGURE.*)

Measurements and Weights of Antarctic Seals taken by the Scottish National Antarctic Expedition. By **William S. Bruce**, LL.D., F.R.S.E., *Director of the Scottish Oceanographical Laboratory, Edinburgh.* (With One Text-Diagram and Two Plates.)

(MS. received February 18, 1913. Read March 17, 1913. Issued separately August 4, 1913.)

During the voyage of the *Scotia* in the Weddell Sea, and during her wintering at Scotia Bay, South Orkneys, I measured as many of the seals taken as possible. I was usually assisted in this work by Mr WILTON. When a seal was killed near the ship, and it could be arranged, I also weighed them both in whole and in part, weighing the different viscera as at a human post-mortem examination. The results of these investigations are now summarised in tabular form, which makes it easy at a glance to make comparisons. In addition to the measurements and weights of the true seals of the Antarctic regions, those of a fine specimen of *Otaria jubata* (the Patagonian Sea-lion) secured at the Falkland Islands are also given.

Leptonychotes weddelli (the Weddell Seal).

Of the true seals twenty-seven of the thirty-three specimens of *Leptonychotes weddelli* taken were measured, and, except in a few cases, in great detail, and several were weighed in whole or part. The longest Weddell Seal was a female measuring $129\frac{1}{2}$ inches and weighing 908 lbs., while the heaviest, also a female, measured 124 inches and scaled 920 lbs., or about 940 lbs. counting loss of blood, etc., in cutting up. Both these were secured towards the end of September. Another female, killed on 28th August, was also of large size, but as it was killed three miles from the ship its weight could not be taken, neither was it measured. The largest male secured was 117 inches long.

Eleven adult females were taken and six adult males; six young females and ten young males. It is doubtful whether this indicates any real proportion of sexes. It may be due to the males going further afield than the females, especially just prior to and after the birth of the young. Many hundreds if not thousands of these Weddell Seals could have been obtained, but science did not demand that extensive slaughter which sealing expeditions indulge in.* I made a point of not allowing more killing than was necessary for food supply and for scientific purposes. Weddell Seals were never seen in the pack, except in the vicinity of Coats Land and the South Orkneys.

It will be noticed that about 250 lbs. of blubber may be obtained from a single seal, *i.e.* more than a quarter of the weight of the whole animal. The enormous weight

* Fully 6000 seals of the four Antarctic species were killed by the *Balæna* in 1892–93. They were mostly Crab-eaters and Sea-leopards. Upwards of 25,000 were killed by four Dundee whalers and one Norwegian whaler at that time.

Thanks are due to the Executive Committee of the Carnegie Trust of the Universities of Scotland for defraying the expenses of this paper and that entitled "Skulls of Antarctic Seals," recently published.

of 50 lbs. for the stomach and contents of one of these Weddell Seals shows the heavy meal, which usually consist of fish (mostly *Notothenia coriiceps*), that seals can digest.

Stenorhynchus leptonyx (the Sea-leopard).

Only seven Sea-leopards were secured, three males and four females, the longest of which was a female measuring 155 inches. On the *Balæna* in 1892–93 I obtained one measuring 162 inches. Two males of average size, 128 and 134 inches, sealed respectively 606 and 630 lbs. They are thus by measurement longer and lighter animals than the Weddell Seals, and they give this appearance. They are extremely lithe in their movements, jumping great distances out of the water. They catch swift penguins in the water. On the *Balæna* I frequently found stones in their stomachs, which are, I believe, derived from the stones in stomachs of the penguins they devour.

Dr PIRIE during the voyage of the *Scotia* found sand in their stomachs, which is probably derived from the same source. In four of the specimens obtained penguin feathers and remains were found, and on one occasion a Sea-leopard was seen in Scotia Bay to catch a penguin and take it under water. The penguin undoubtedly forms the staple diet of these animals, and the size and nature of the teeth is indicative of such diet. Only on one occasion did we see a young Sea-leopard, and this was early in November in Brown's Bay, off Point Thomson, when Mr WILTON, Dr PIRIE, and I tried to secure it, but failed on account of the rotten state of the ice.

Lobodon carcinophaga (the Crab-eating or White Antarctic Seal).

We only obtained five specimens of the Crab-eating Seal during the voyage of the *Scotia*, although many of these were seen on the voyage southward in 1903 at a time when we were unable to secure them. In 1892–93 the Dundee whalers secured a great number of these Lobodons, and I have seen as many as forty on a single piece of ice. This is probably the smallest of the four species of Antarctic Seals, although the Ross Seal is of very similar dimensions. One very old male that we secured weighed 494 lbs., but the other three were very much smaller and lighter than this animal. This animal is one of the specimens that I have presented to the Royal Scottish Museum. The skin of one of these animals was very badly scarred, and it is uncertain what is the cause of these scars. They may possibly be due to the attacks of a grampus, but we have no definite evidence of this. We had little evidence on the *Scotia* to tell us what was the food of these Lobodons, but on the *Balæna* I found the remains of fish and crustaceans in their stomachs.

Ommatophoca rossi (the Ross Seal).

This is the rarest seal in the world, and the *Scotia* naturalists only obtained two specimens of it, one male and one female, the skins of which have been deposited in the Royal Scottish Museum, and the skeletons in the Anatomical Museum of the University of Edinburgh. It is the very antithesis of the Sea-leopard; instead of being long and lithe, it is rather short and bulky, though of remarkably graceful form. It is characterised by a very thick neck, which it has the power of dilating at will. The weight of the female we obtained was 475 lbs., and that of the male 400 lbs., and probably this represents the average weight.

On board the *Balæna* Mr BURN MURDOCH and I obtained what was almost certainly a very young Ross Seal, which we were bringing on board alive, but which the late Captain FAIRWEATHER ordered to be killed. The skin was thrown into a heap with the rest, and the carcase was left on the ice. The illusions of ignorance consequently robbed science for the time being of an interesting discovery. The chief food of the Ross Seal is cuttle-fish, and the stomach of one of those we secured had the beaks and remnants of cuttle-fish in it. It must, therefore, be swift in the water to catch these swift invertebrates, but its teeth are of extremely small and delicate character, which is all that is necessary for such soft diet. There were apparently fish scales in the stomach of one of the animals, but these were probably the scales of small fishes.

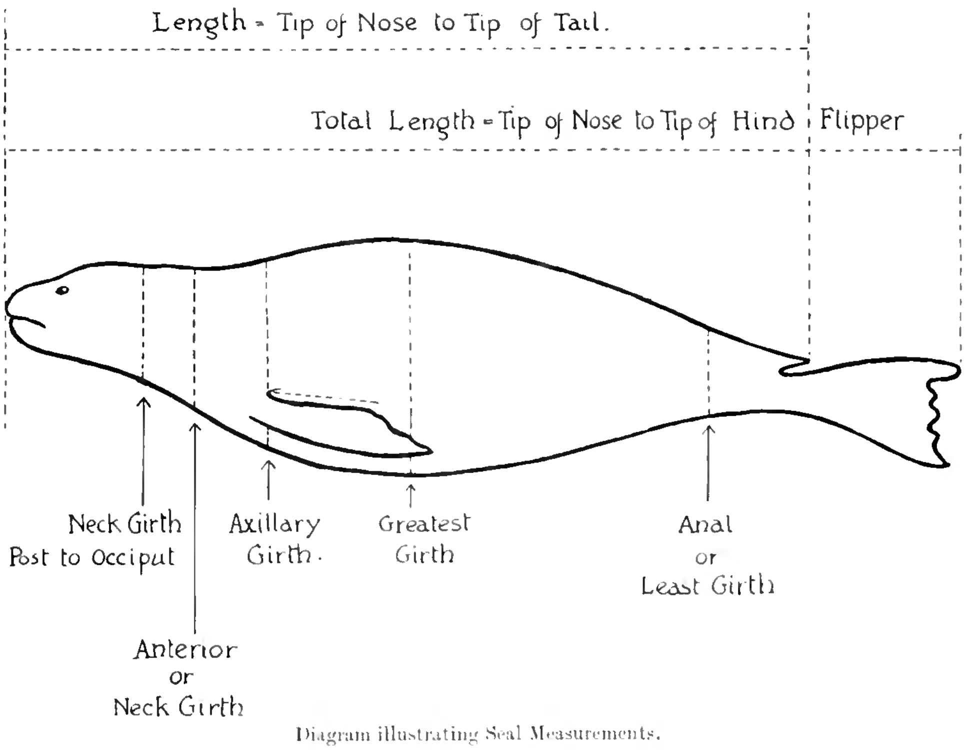


Diagram illustrating Seal Measurements.

Otaria jubata (the Patagonian Sea-lion).

Little need be said regarding this well-known species which, as already indicated, is not Antarctic in distribution, keeping clear of the ice limit. There are a considerable number of these animals round the shores of the Falkland Islands, where they live among the thick tussock grass.

Leptonychotes weddelli

No.	Date.	Sex.	Age.	Length.		Girth.				Limbs.						Eye.	
										Fore Flipper.			Hind Flipper.				
				Total = Nose to Tip of Hind Flipper.	Nose to Tip of Tail.	Anterior or Neck (6 ins. anterior to Axillary).	Axillary.	Greatest.	Least or Anal.	Outer Edge.	Inner Edge.	Stretch at Terminal Phalanges.	Outer Edge.	Inner Edge.	Stretch at Terminal Phalanges.	Vertical and Horizontal Diameter.	Interorbital Space.
	1903.			in.	in.	in.	in.	in.	in.	in.	in.	in	in.	in.	in.	in.	in.
VI.	Mar. 25	Female	Adult	$114\frac{1}{2}$	100	54	64	...	...	...	...	...	...	...	...	$1\frac{1}{4} \times 1$	$4\frac{1}{4}$
VII.		,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...
VIII.	Apr. 10	Male	Young	79	67	$40\frac{1}{2}$	47	...	$19\frac{1}{4}$	$11\frac{3}{4}$	....	...	$13\frac{3}{4}$	12	$10\frac{1}{4}$ (base)	$1\frac{1}{2} \times \frac{7}{8}$	$3\frac{3}{4}$
IX.	May 19	,,	,,	$78\frac{1}{2}$	$67\frac{1}{2}$	$37\frac{1}{2}$	48	48	...	$12\frac{1}{2}$	$9\frac{1}{2}$	...	$15\frac{1}{2}$	13	10 (base)	$\frac{3}{4} \times 1$	$3\frac{5}{8}$
X*a*.	,, 30	,,	Adult	...	..	...	...	...	...	...	...	...	...	...	...	...	
X.	July 8	Female	Young	$84\frac{1}{2}$	$74\frac{1}{2}$	$35\frac{1}{2}$	$43\frac{1}{2}$	$54\frac{1}{2}$	...	$13\frac{1}{4}$	$7\frac{3}{4}$	$7\frac{1}{2}$	15	$14\frac{1}{4}$	$20\frac{3}{4}$	Frozen	$3\frac{1}{4}$
XI.	,, 12	Male	Adult	114	100	62	$74\frac{1}{2}$	80	...	16	7	$9\frac{1}{2}$	19	16	24	$1\frac{1}{2} \times 1\frac{1}{8}$	$3\frac{3}{4}$
XII.	,, 23	,,	Young	$98\frac{1}{2}$	$88\frac{1}{2}$	49	60	$65\frac{1}{2}$	...	$13\frac{3}{4}$	$7\frac{1}{2}$	...	$14\frac{3}{4}$	$14\frac{1}{4}$	$21\frac{1}{2}$	...	$3\frac{1}{2}$
XIII.	,, 25	,,	,,	102	90	...	...	...	...	...	...	...	...	...	...	...	...
XIV.	,, 28	Female	Adult	Large		...	...	...	...	...	...	...	...	...	...	...	...
XVII.	Aug. 31	Male	Young	54	47	19	25	28	...	$10\frac{3}{4}$	4	$6\frac{3}{4}$	$11\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{4}$ $7\frac{1}{2}$ (base)	...	$2\frac{3}{4}$
XVIII.	,, 31	,,	,,	$60\frac{1}{2}$	$51\frac{1}{2}$	...	$34\frac{1}{2}$	$34\frac{1}{2}$	...	$11\frac{1}{2}$	$6\frac{1}{2}$	$7\frac{1}{2}$	$13\frac{3}{4}$	12	$13\frac{1}{4}$ $10\frac{1}{4}$ (base)	...	$3\frac{3}{4}$
XIX.	Sept. 2	...	,,	64	55	$24\frac{1}{2}$	29	34	...	$11\frac{1}{4}$	7	6	$12\frac{1}{2}$	13	...	$1\frac{1}{8}$	3

(the Weddell Seal).

Weight.							General Remarks.
Total.	Liver.	Kidneys.		Lungs.		Heart.	
		Right.	Left.	Right.	Left.		
lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	
...	...	...	...	...	...	...	Shot by D. W. Wilton in Buchan Bay, South Orkneys. Skin presented to the Natural History Museum, Marischal College, University of Aberdeen.
...	...	...	...	...	...	...	Killed by the cooks, Florence and Murray, in Scotia Bay. Pregnant. Embryo and skull preserved. Embryo presented to the University of Edinburgh.
...	...	...	...	...	...	...	Clubbed by R. Davidson in Scotia Bay. Temperature 97°·4 F. Skin poor, but preserved. Additional measurements: umbilicus to penis, $7\frac{1}{4}$ inches; penis to anus, $11\frac{1}{2}$ inches.
220	...	...	...	...	...	...	Stabbed by a seaman in Jessie Bay, South Orkneys.
...	...	...	...	...	...	...	Killed by a seaman near Ailsa Craig, South Orkneys. Skeleton preserved, but the skull and several ribs were lost while macerating in the sea.
278	...	0 $11\frac{1}{2}$	0 10	1 7	1 3	1 4	Stabbed by D. W. Wilton in Scotia Bay. Skeleton almost complete. Additional measurements: small intestine measured 60 feet, and large intestine, 3 feet.
787	16 13	2 lb. 9 oz.		3 12	3 1	3 4	Stabbed by D. W. Wilton near Point Rae, Scotia Bay. Additional weights: blubber, 250 lbs.; skin, 80 lbs.; carcase, 457 lbs. Skin presented to Royal Scottish Museum. Part skeleton at Scottish Oceanographical Laboratory.
...	...	...	...	...	...	...	Shot by J. H. Harvey Pirie in Scotia Bay. Skeleton preserved at Scottish Oceanographical Laboratory.
...	...	...	..	...	...	...	Stabbed by R. Davidson in Scotia Bay. Skeleton preserved at Scottish Oceanographical Laboratory.
...	...	...	...	...	...	...	Stabbed by D. W. Wilton near Point Rae, Scotia Bay. No dimensions taken, but of large size. No embryo in uterus. It was found that the right scapula had been fractured across the blade and had united again at an angle. Skin presented to H.S.H. the Prince of Monaco, for Musée Oceanographique de Monaco.
$54\frac{1}{2}$	...	...	...	...	...	...	Killed by chloroform on 31st August. Age one day. Born about 30th August. Carcase presented to the Anatomical Museum of the University of Edinburgh, and partly dissected for vascular system. Skin at Scottish Oceanographical Laboratory.
83	...	...	...	...	...	...	Killed with potassium cyanide on 31st August. Age two days. Born about 29th August. Injected and embalmed by Professor David Hepburn's method, by whom it has been dissected and specially reported upon. Additional measurement: tail $4\frac{1}{2}$ inches in length.
85	...	...	...	...	...	...	Killed with potassium cyanide on 2nd September. Age probably three or four days. Young of No. XX. Carcase presented to Anatomical Museum of the University of Edinburgh. Skin presented to Glasgow Corporation Art Galleries and Museum.

Leptonychotes weddelli

No.	Date.	Sex.	Age.	Length. Total = Nose to Tip of Hind Flipper.	Length. Nose to Tip of Tail.	Girth. Anterior or Neck (6 ins. anterior to Axillary).	Girth. Axillary.	Girth. Greatest.	Girth. Least or Anal.	Limbs. Fore Flipper. Outer Edge.	Limbs. Fore Flipper. Inner Edge.	Limbs. Fore Flipper. Stretch at Terminal Phalanges.	Limbs. Hind Flipper. Outer Edge.	Limbs. Hind Flipper. Inner Edge.	Limbs. Hind Flipper. Stretch at Terminal Phalanges.	Eye. Vertical and Horizontal Diameter.	Interorbital Space.
	1903.			in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
XX.	Sept. 2	Female	Adult	123	110	57	74	75	...	15½	7½	...	19	17	...	...	4¾
XXI.	,, 7	Male	Young	61½	54	23½	33	34½	...	10½	5	7¾	12	10½	14½ 9½ (base)	1⅛ × ⅝	2½
XXII.	,, 8	,,	,,	66½	58½	20¾	29½	31½	...	13	4¾	7	13	10	15 9 (base)	1¼ × ½	3
XXIII.	,, 20	Female	,,	61	53½	18½	26	28	...	13	7½	6	13	13	16 8 (base)	...	3
XXIV.	,, 21	,,	Adult	124	...	...	...	...	...	...	...	...	...	...	...	...	...
XXV.	,, 22	,,	Young	66	58	18½	26	28	...	12	5½	7½	12½	11½	13 8½ (base)	...	3
XXVI.	,, 24	,,	Adult	129½	115½	55½	72	77	...	14½	7½	7*	20	18½	19 13½ (base)	...	4½
XXVII.	Oct. 3	Male	Young	62	54	19	26	27	...	10	6	7½	14	11	5½ 10 (base)	...	3
XXVIII.	,, 3	,,	Adult	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XXIX.	,, 22	Female	,,	121¼	108	...	72	...	...	...	...	...	...	...	...	...	...
XXX.	,, 22	Male	,,	117	104½	...	65	...	...	...	...	...	...	...	...	...	4¼
XXXI.	,, 22	Female	,,	122	...	41	59		...	15½	...	18 (base)	15¼	...	23 12¼ (base)	...	4¼
XXXII.	,, 23	,,	Young	79	67	...	48	48	...	15	8¼	8½	15	12½	20¼	...	5

* Stiff when measured, probably more.

(the Weddell Seal)—*continued.*

Weight.							General Remarks.
Total.	Liver.	Kidneys.		Lungs.		Heart.	
		Right.	Left.	Right.	Left.		
lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	
838	...	...	...	...	...	...	Killed off Point Davis, Scotia Bay. Mother of No. XIX. Additional weights: blubber, 250 lbs.; skin, including skull and flippers, 228 lbs. Carcase, less head and flippers, 340 lbs.; estimated weight of blood lost, 20 lbs. Skin presented to Peterhead Museum. ?
83	...	...	...	...	...	...	Killed with potassium cyanide. About two days old. Skeleton preserved. Skin presented to Natural History Museum, Marischal College, University of Aberdeen.
84	...	...	...	...	...	...	Stabbed. Two or three days old. Carcase preserved. Additional weights: 74 lbs., and estimated blood lost, 10 lbs. The mother attempted to kill this animal, and would probably have done so had she not been prevented.
61	...	...	...	...	...	...	Captured alive in Scotia Bay. Probably twelve days old. This animal was kept on board for ten days, and was fed by bottle with condensed milk. It died of convulsions.
920	...	...	...	...	...	...	Stabbed by J. Fitchie off Point Martin, Scotia Bay. About 20 lbs. for loss of blood in cutting up and stabbing should be allowed, making the total weight nearer 940 lbs. No young with it, and no embryo within. Skin presented to the Glasgow Corporation Art Galleries and Museum. Skeleton at Scottish Oceanographical Laboratory.
71	...	...	...	...	...	...	Killed with potassium cyanide and hydrochloric acid on 22nd September. One day old. Taken from mother 21st September. Carcase preserved and skull partially severed to inject brain with formalin. Skin presented to the Royal Scottish Museum.
908	...	...	...	...	...	...	Stabbed by J. MacDougall off the Point Martin, Scotia Bay. Mother of No. XXVII. Young captured and taken on board alive at same time. Skin preserved.
57	...	...	...	...	...	...	Two to three weeks old (nine days spent on board). It died on 3rd October. The mother was No. XXVI. Presented to Coats Museum, Paisley.
...	...	...	...	...	...	...	Killed by J. H. H. Pirie while at camp off Graptolite Island, South Orkneys. Skull only preserved.
...	...	...	...	...	...	...	Killed by R. Davidson off Delta Island (near Point Rae), Scotia Bay. Skin presented to Coats Museum, Paisley.
...	...	...	...	...	...	...	Killed by R. Davidson off Delta Island (near Point Rae), Scotia Bay. Skeleton preserved. Lower jaw fractured.
...	...	...	...	...	...	...	Shot by R. Davidson. A young cub was with this seal and was brought on board alive. Skin presented to Municipal Museum of Dundee.
207	...	...	...	...	...	...	Six to eight weeks old. Shot by J. H. H. Pirie in Jessie Bay. This young seal was quite alone. The skin was handsomely marked but was spoilt by giant petrels, and the skeleton by dogs.

Leptonychotes weddelli

No.	Date.	Sex.	Age.	Length. Total = Nose to Tip of Hind Flipper.	Length. Nose to Tip of Tail.	Girth. Anterior or Neck (6 ins. anterior to Axillary).	Girth. Axillary.	Girth. Greatest.	Girth. Least or Anal.	Limbs. Fore Flipper. Outer Edge.	Limbs. Fore Flipper. Inner Edge.	Limbs. Fore Flipper. Stretch at Terminal Phalanges.	Limbs. Hind Flipper. Outer Edge.	Limbs. Hind Flipper. Inner Edge.	Limbs. Hind Flipper. Stretch at Terminal Phalanges.	Eye. Vertical and Horizontal Diameter.	Interorbital Space.
	1903.			in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
XXXIII.	Oct. 29	Male	Young	76½	67	30	49	...	...	11	6¾	7½	15	13½	15½ 11 (base)	...	3
XXXIV.	,, 29	Female	,,	79	68½	29	50	...	...	11½	7½	8	16½	15½	8 10½ (base)	..	3¾
XXXV.	,, 29	Male	,,	72	62	29	51	...	...	12½	6	8	16	14	16½ 11 (base)	...	3½
XXXVI.	Nov. 23	Female	Adult	...	...	...	...	..	...	...	...	...	...	...	...	...	...
XXXVII.	,, 23	Male	,,	...	...	...	...	...	...	..	...	...	...	...	...	...	...
XXXVIII.	,, 23	,,	,,	...	...	...	...	...	...	...	..	...	...	...	...	...	...
	1904.																
XL.	Feb. 17	,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XLI.	,, 17	Female	,,	...	...	...	...	...	...	..	...	...	...	...	...	...	...
XLIV.	Mar. 10	,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Lobodon carcinophaga

No.	Date.	Sex.	Age.	Length. Total = Nose to Tip of Hind Flipper.	Length. Nose to Tip of Tail.	Girth. Anterior or Neck (6 ins. anterior to Axillary).	Girth. Axillary.	Girth. Greatest.	Girth. Least or Anal.	Limbs. Fore Flipper. Outer Edge.	Limbs. Fore Flipper. Inner Edge.	Limbs. Fore Flipper. Stretch at Terminal Phalanges.	Limbs. Hind Flipper. Outer Edge.	Limbs. Hind Flipper. Inner Edge.	Limbs. Hind Flipper. Stretch at Terminal Phalanges.	Eye. Vertical and Horizontal Diameter.	Interorbital Space.
	1903.																
I.	Feb. 2	Male	Adult	97	88	...	51	53¼	...	15½	...	...	15¾	13½	..	...	...
IV.	,, 10	Female	,,	89	81½	25½	49	53	...	16	...	7½ (base)	16¼	13½	...	1¼ + ½	4¾
V.	Mar. 3	Male	,,	109	98	42½	55	58	...	19	20	...	17	17	22	1¼ + ½	5
XV.	Aug. 1	,,	Young	...	...	...	...	...	...	...	...	...	...	...	...	...	...
XVI.	August	,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...

(the Weddell Seal)—*continued.*

Weight. Total.	Weight. Liver.	Kidneys. Right.	Kidneys. Left.	Lungs. Right.	Lungs. Left.	Heart.	General Remarks.
lb.	lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	
...	...	...	...	...	...	..	Shot by R. Davidson in Scotia Bay. About two months old. Additional measurement, from anus to penis, 13 inches.
...	...	...	...	...	...	...	Shot by R. Davidson in Scotia Bay. About two months old. Skin presented to Glasgow Corporation Art Galleries and Museum.
...	...	...	...	...	...	...	Shot by R. Davidson in Scotia Bay. About two months old. Additional measurement, from anus to penis, 12½ inches. Skin presented to Coats Museum, Paisley.
...	...	...	...	...	...	...	Shot at Point Martin, Scotia Bay. Skeletons preserved. No dimensions taken.
...	...	...	...	...	...	...	
...	...	...	...	...	...	...	
...	...	...	...	...	...	...	Shot by R. N. R. Brown on west shore of Scotia Bay. Skeleton preserved.
...	...	...	...	...	...	...	Shot by D. W. Wilton on west shore of Scotia Bay. Skin and skeleton preserved. Skin presented to Museum of Perthshire Society of Natural Science, Perth.
830	36	2 7	2 7	5 8	4 12	4 2	Shot by W. S. Bruce, 2 miles off Coats Land, 74° 1′ S., 22° W. Additional weights and measurements: stomach and contents (fish and cuttle-fish), 50 lbs.; spleen, 5 lbs.; diaphragm, 4 lbs. 6 ozs.; gut, 43 lbs.; and measured 111 feet. Skin presented to Royal Scottish Museum.

(the Crab-eating Seal).

Total.	Liver.	Kidneys. Right.	Kidneys. Left.	Lungs. Right.	Lungs. Left.	Heart.	General Remarks.
4 to 5 cwts.	...	...	...	...	...	..	Shot by J. H. H. Pirie at Station 152, 60° 32′ S., 43° 40′ W. Skull preserved. Additional measurements: from anus to penis, 16¾ inches; from penis to umbilicus, 9 inches. Weight between 4 and 5 cwts. Skin presented to Perthshire Society of Natural Science, Perth.
300 (*circa*)	6	0 14 Length greatest	0 14 =8½ ins. width=3½	1 11	1 6	1 12	Shot by J. H. H. Pirie at Station 189, 60° 05′ S., 32° 10′ W. Skin and skull preserved. Additional weights and measurements: anus to umbilicus, 22½ inches; large intestine up to cæcum, 40 inches; cæcum, 5 × 3 inches; small intestine, 122 feet; thymus, 2 ozs.; spleen, 6¼ ozs.; pancreas, 6½ ozs.; blubber, 1 to 1¼ inches thick. Skin presented to the Royal Scottish Museum.
494	...	...	...	...	...	...	Shot by J. H. H. Pirie at Station 283, 68° 24′ S., 32° 31′ W. This was an old animal, and consequently may be regarded as being of full size. Blubber, 147 lbs.; skin, 47 lbs. Skin presented to the Royal Scottish Museum.
...	...		...	...	...	...	Killed near the ship in Scotia Bay. Skinned scarred.
325 (*circa*)	...	...	...	...	...	...	Killed by J. H. H. Pirie off Point Davis, Scotia Bay. Skin very beautifully marked, but not preserved. Skeleton secured.

No.	Date.	Sex.	Age.	Length. Total = Nose to Tip of Hind Flipper.	Length. Nose to Tip of Tail.	Girth. Anterior or Neck (6 ins. anterior to Axillary).	Girth. Axillary.	Girth. Greatest.	Girth. Least or Anal.	Limbs. Fore Flipper. Outer Edge.	Limbs. Fore Flipper. Inner Edge.	Limbs. Fore Flipper. Stretch at Terminal Phalanges.	Limbs. Hind Flipper. Outer Edge.	Limbs. Hind Flipper. Inner Edge.	Limbs. Hind Flipper. Stretch at Terminal Phalanges.	Eye. Vertical and Horizontal Diameter.	Interorbital Space.
				in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
																	Stenorhynchus leptonyx
III.	1903. Feb. 9	Female	Adult	160	138	50	68	68	...	28½	22½	13½ (base)	22	20	7½ (base)	...	8½
XLII.	1904. Feb. 26	Male	,,	132½	120	36*	60½	59	41½	25½	22½	14½	21½	21½	37 13¾ (base)	1¼ × ¾	8
XLV.	Mar. 18	,,	,,	134	...	37*	57¼	49	...	30	...	...	21½	22¼	26 14 (base)	1½ × 1	7½
XXXVIII*a*.	Jan. 7	Female	,,	138	...	...	...	...	...	...	...	...	...	...	...	...	...
XXXVIII*b*.	,, 7	,,	,,	136	...	...	...	...	...	...	...	...	...	...	...	...	...
XXXVIII*c*.	,, 30	Male	,,	107½	...	...	...	...	...	...	...	...	...	...	...	...	...
XXXVIII*d*.	Feb. 5	Female	,,	140½	...	...	...	...	...	...	...	...	...	...	...	...	...
																	Ommatophoca rossi
II.	1903. Feb. 6	Female	Adult	...	90	49 41*	52	54	...	16	...	8½ (base)	16	14½	25	1½ × 1	6
XLIII.	1904. Feb. 28	Male	,,	100½ 101 (ventral)	89½ 92 (ventral)	38½*	55½	56½	...	17¼	...	...	18½	18¾	24 11 (base)	1½ × ¾	6½
																	Otaria jubata
XXXIX.	1904. Feb. 6	Male	Adult	128½	...	62	66½	81½ (shoulders)	...	35½	11	19	25	23½	14	...	...

* Neck immediately posterior to occiput.

(the Sea-leopard).

Weight. Total.	Liver.	Kidneys. Right.	Kidneys. Left.	Lungs. Right.	Lungs. Left.	Heart.	General Remarks.
lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	
...	...	...	...	...	...	...	Shot by J. H. H. Pirie at Station 183, 59° 42′ S., 34° 13′ W. Anus to umbilicus, 35 inches: tail, 5 inches. Skin and skull preserved and presented to the Royal Scottish Museum.
606	...	1 7	1 9	...	...	2 12	Shot by J. H. H. Pirie at Station 387, 65° 59′ S., 33° 06′ W. Stomach empty: no parasites in stomach; gut not examined. Additional measurements and weights: entire gut, 54 feet; rectum, 2 feet; penis and testes weighed, 1 lb. 4 ozs.; weight of body, 317 lbs.; skin, flippers and head, 286 lbs.; blood about 3 lbs. Anus to penis, $22\frac{1}{4}$ inches; anus to tip of tail, 9 inches. Mouth, tip of chin to gape, 8·1 inches. Skeleton presented to the Anatomical Museum of the University of Edinburgh. Skin presented to the Museum of the Perthshire Society of Natural Science, Perth.
630	...	...	...	...	...	...	Shot by J. H. H. Pirie, Station 417, 71° 22′ S., 16° 34′ W. Penis to anus, 22 inches; anus to tip of tail, 10 inches; from eye to gape, $4\frac{1}{2}$ inches; from angle of lower jaw to gape, $7\frac{3}{4}$ inches; penis to umbilicus, $9\frac{1}{2}$ inches; tip of lower jaw to umbilicus, $77\frac{1}{2}$ inches. Cast of skull made. Nothing was found in stomach, but there were penguin feathers in the gut. Skin presented to the Royal Scottish Museum.
...	...	...	...	...	...	...	Shot by J. H. H. Pirie on the Beach, Jessie Bay. Uterus empty. Stomach contained much sand, many penguin feathers, and a few nematodes. Changing coat.
...	...	...	...	...	...	...	Shot by J. H. H. Pirie on the Beach, Jessie Bay. Uterus empty. Gut, 92 feet. Stomach contained large quantity of shrimp-like crustaceans, too far digested to recognise; one set of penguin tail feathers. Numerous nematodes and castodes in intestine.
...	...	..	...	...	...	...	Shot by J. H. H. Pirie on the Beach, Jessie Bay. Stomach contained large quantity of small crustaceans.
...	...	...	...	...	...	...	Shot by J. H. H. Pirie on the Beach, Jessie Bay. Uterus empty. Stomach contained penguin remains.

(the Ross Seal).

Total.	Liver.	Kidneys. Right.	Kidneys. Left.	Lungs. Right.	Lungs. Left.	Heart.	General Remarks.
475	...	...	...	...	...	...	Shot by J. H. H. Pirie at Station 165, 60° 06′ S., 43° 00′ W. Tail (webbed), 5 inches. Skull and skin preserved. Skin presented to the Royal Scottish Museum.
400	...	...	...	...	...	...	Shot by J. H. H. Pirie at Station 393, 66° 21′ S., 28° 30′ W. Entire gut measured 268 inches; from tip of lower lip to umbilicus, $57\frac{1}{2}$ inches; umbilicus to penis, $4\frac{3}{4}$ inches; penis to anus, 21 inches; anus to tip of flipper, $17\frac{1}{2}$ inches; mouth from tip of chin to gape, $3\frac{3}{4}$ inches. Cuttle-fish beaks and cuttle-fish, and apparently scales of fishes in stomach Gut full of tape-worms. Skin presented to Royal Scottish Museum.

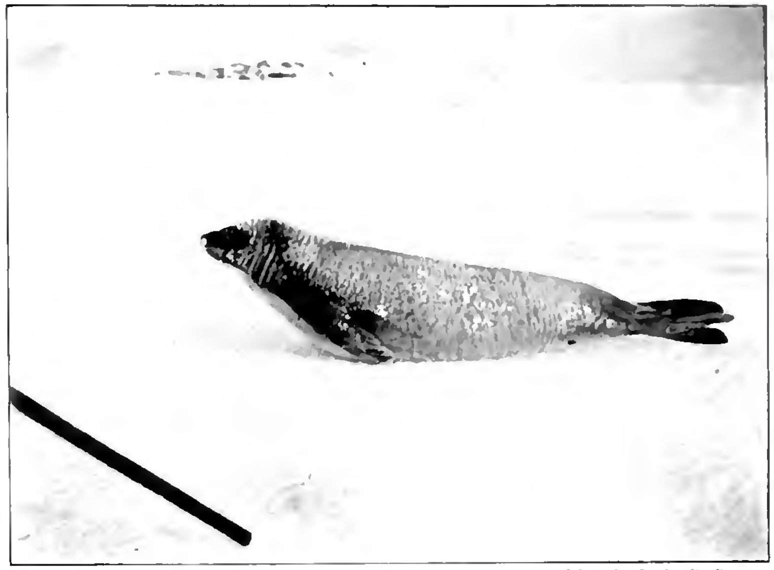
(the Patagonian Sea-lion).

Total.	Liver.	Kidneys. Right.	Kidneys. Left.	Lungs. Right.	Lungs. Left.	Heart.	General Remarks.
1150 (*circa*)	...	...	...	...	...	...	Shot on Lower Tussock Island, Port William, Falkland Islands, Station 349. Additional measurements: from anus to penis, 12 inches; from penis to umbilicus, 11 inches; chest between fore flippers, 31 inches. Skeleton in Scottish Oceanographical Laboratory. Skin presented to Royal Scottish Museum.

DR W. S. BRUCE: "Measurements and Weights of Antarctic Seals taken by the Scottish National Antarctic Expedition."—PLATE I.

[*Photo by W. S. Bruce.*

1. *Leptonychotes weddelli* (Weddell Seal).

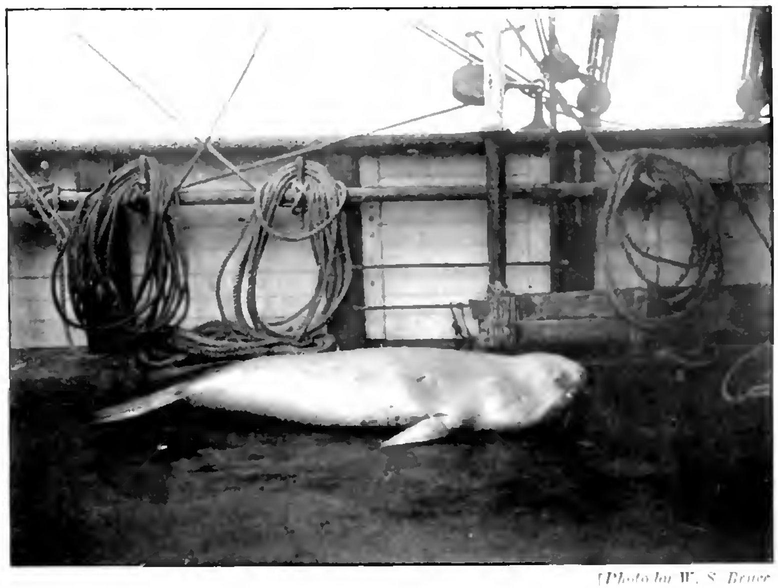


[*Photo by R. N. R. Brown*

2. *Lobodon carcinophaga* (White Antarctic Seal).

[*Photo by J. H. H. Pirie.*

3. *Stenorhynchus leptonyx* (Sea-leopard Seal).



[*Photo by W. S. Bruce*

4. *Ommatophoca rossi* (Ross Seal).

DR W. S. BRUCE: "Measurements and Weights of Antarctic Seals taken by the Scottish National Antarctic Expedition."—PLATE II.

Photo by Rowland Ward.

Otaria jubata (Patagonian Sea-lion) in Royal Scottish Museum, from Tussock Island, Port William, Falkland Islands. Weight, about 1150 pounds.

PART XII.

SEALS.

XII.—ON THE SKULLS OF ANTARCTIC SEALS: SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

By WILLIAM S. BRUCE, LL.D., F.R.S.E.,
Director of Scottish Oceanographical Laboratory.

(*WITH FIVE PLATES.*)

On the Skulls of Antarctic Seals: Scottish National Antarctic Expedition. By William S. Bruce, LL.D., Director of the Scottish Oceanographical Laboratory. (With Five Plates.)

(MS. received March 13, 1913. Read May 5, 1913. Issued separately June 27, 1913.)

Although the osteology of Antarctic seals has been very completely discussed, notably by the late Dr J. E. Gray, Sir William Turner, and Professor Robert Thomson, yet the literature regarding the subject is somewhat scattered. I have therefore considered that it might be important from the point of view, as it were, of an index to publish a complete series of photographs of a set of the skulls of seals taken by the naturalists of the *Scotia* during the Antarctic voyage of 1902–1904.

The species considered are:—

1. *Leptonychotes Weddelli* (Gill): The Weddell Seal.
2. *Stenorhynchus leptonyx* (F. Cuvier): The Sea-leopard.
3. *Lobodon carcinophaga* (Gray): The Crab Eater, or White Antarctic Seal.
4. *Ommatophoca Rossi* (Gray): The Ross Seal.
5. *Otaria jubata* (Forster): The Patagonian Sea-lion.

The type collection of the seals' skulls taken by the *Scotia* naturalists are chiefly housed in the Anatomical Museum of the University of Edinburgh, and in the Scottish Oceanographical Laboratory; those housed in the Anatomical Museum of the University of Edinburgh have been duly recorded in Sir William Turner's excellent descriptive catalogue entitled *Marine Mammals in the Anatomical Museum of the University of Edinburgh*; while Professor Robert Thomson, of Cape Town University, has contributed a paper to the *Transactions of the Royal Society of Edinburgh* entitled "Osteology of Antarctic Seals," which also appears in the *Scientific Reports of the Voyage of S.Y. "Scotia,"* volume iv.

Beyond this it is unnecessary to say more at the present time, except to refer to the plates published herewith. It will be observed that the skulls of the species of each seal are shown from every possible aspect:—

From (1) The posterior aspect.
(2) The anterior aspect.
(3) The lateral aspect.
(4) The inferior aspect without the lower jaw.
(5) The inferior aspect with the lower jaw.
(5*a*) The superior aspect of the lower jaw.
(6) The superior aspect.

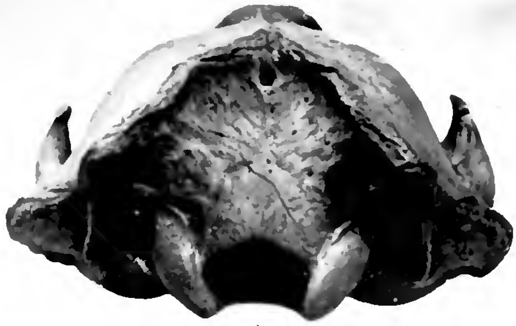
(Reprinted from the Transactions of the Royal Society of Edinburgh, Vol. XLIX., pp. 315, 316.)

The figures speak for themselves, and, as already stated, are intended to be an index for the use of museums and for the use of naturalists exploring in Antarctic and Subantarctic Regions.

I have considered the measurements and weights of Antarctic seals in the flesh in a separate paper; the anatomy of the Weddell Seals taken by the *Scotia* has been fully considered by Professor DAVID HEPBURN and Dr HAROLD AXEL HAIG; while Dr R. N. RUDMOSE BROWN has dealt with "The Habits and Distribution of the Seals of the Weddell Sea." *

* Vide *Scientific Reports of the Voyage of S.Y. "Scotia,"* vol. iv., parts ii., iii., v., vi., ix., x., xi., xii., and xiii.

Bruce: "Skulls of Antarctic Seals."—Plate I.



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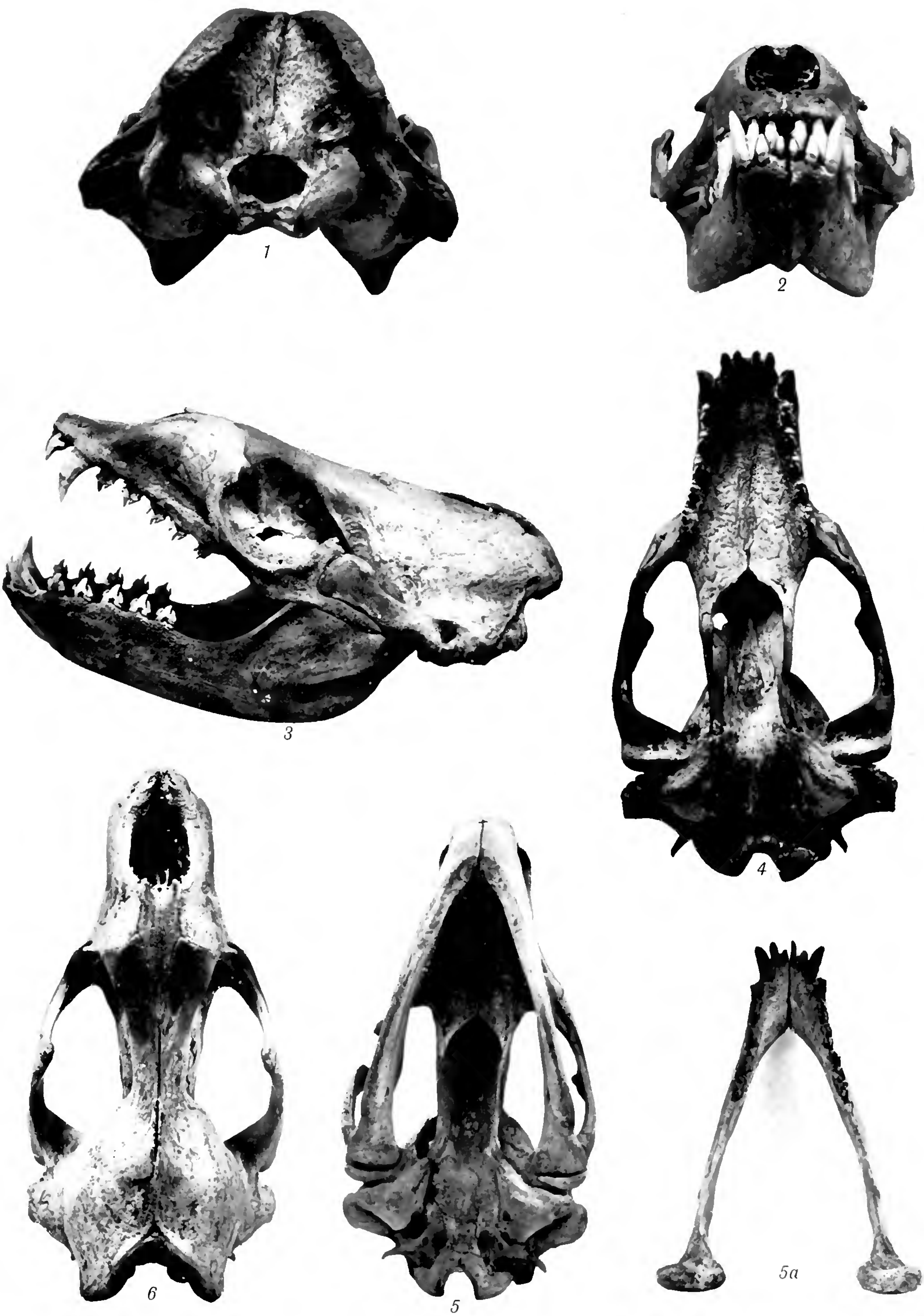
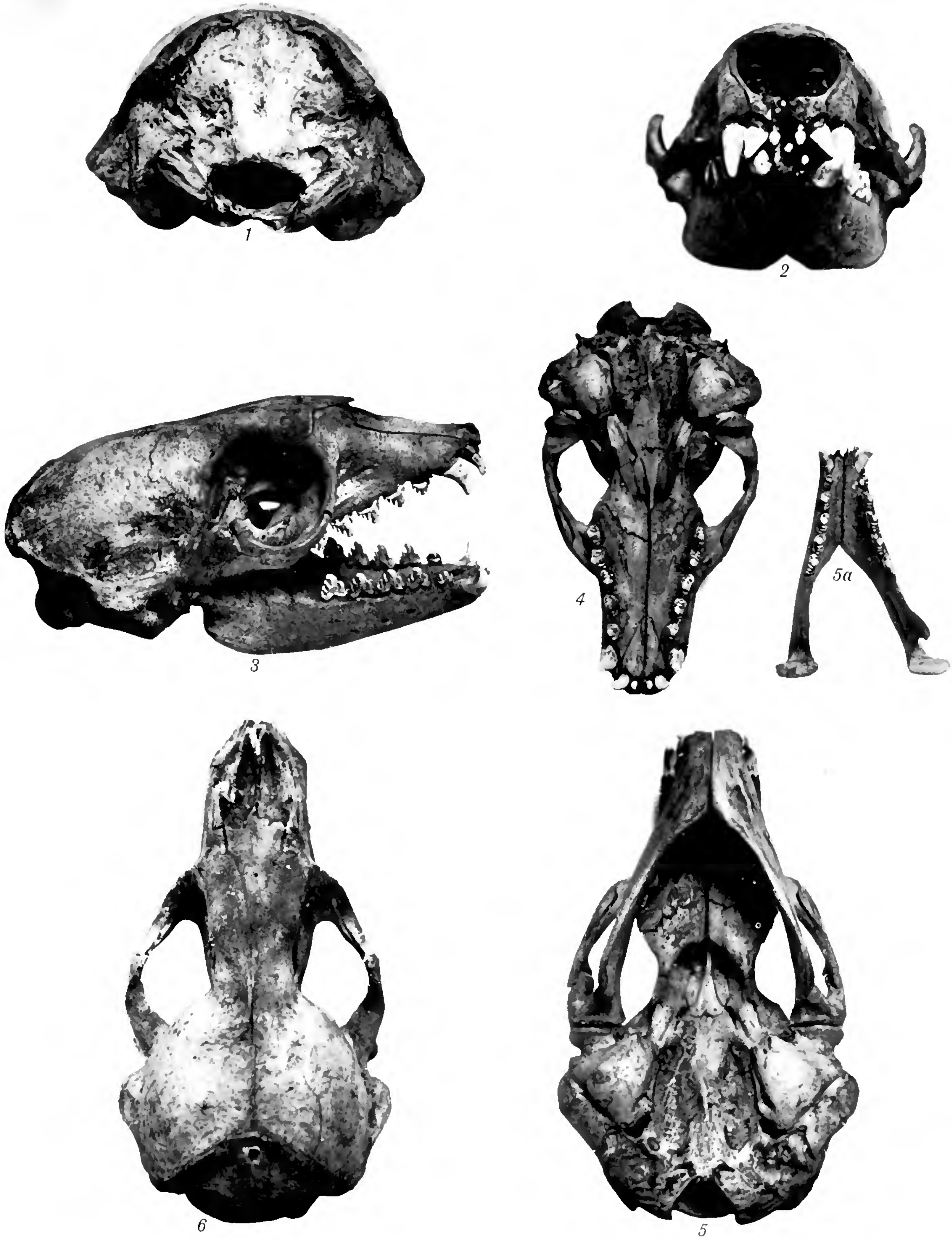
LEPTONYCHOTES WEDDELLI.

Bruce: "Skulls of Antarctic Seals."—Plate II.

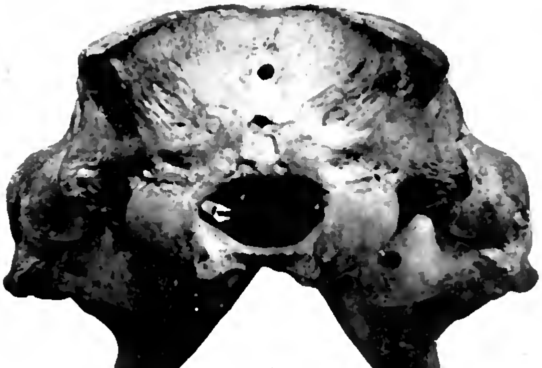


STENORHYNCHUS LEPTONYX.

Bruce: "Skulls of Antarctic Seals."—Plate III.



LOBODON CARCINOPHAGA.



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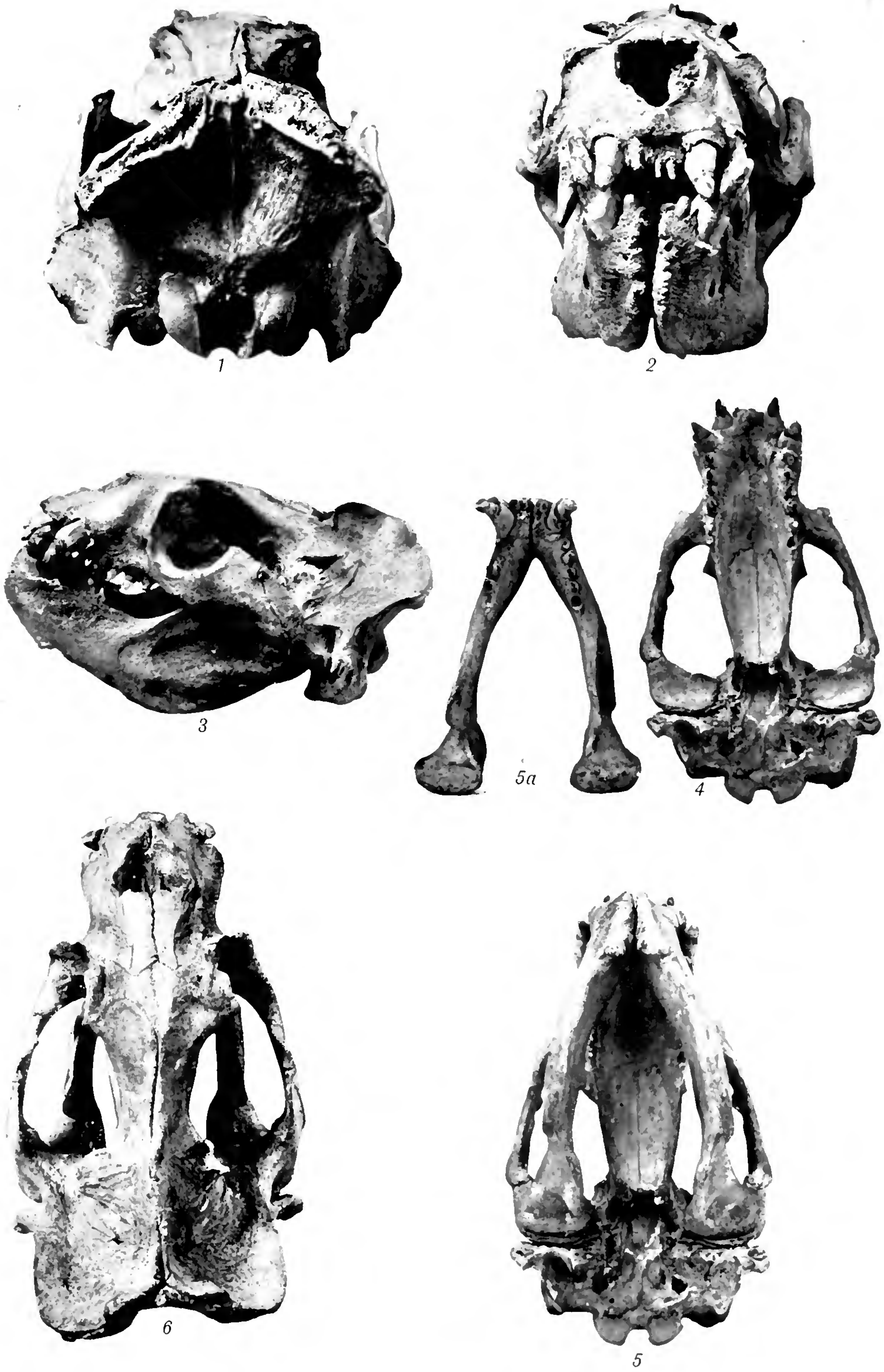
Ommatophoca rossi.



OTARIA JUBATA.

PART XIII.

SEALS.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

XIII.—THE SEALS OF THE WEDDELL SEA: NOTES ON THEIR HABITS AND DISTRIBUTION.

By R. N. RUDMOSE BROWN, D.Sc., University of Sheffield;
Naturalist, Scottish National Antarctic Expedition.

(*WITH NINE PLATES.*)

The Seals of the Weddell Sea: Notes on their Habits and Distribution. By R. N. Rudmose Brown, D.Sc., University of Sheffield; Naturalist, Scottish National Antarctic Expedition. (With Nine Plates.)

(MS. received February 15, 1913. Issued separately May 20, 1913.)

During the voyages of the *Scotia* all four species of Antarctic seals were met with, the Weddell Seal (*Leptonychotes weddelli*), the Crab-eating or White Seal (*Lobodon carcinophaga*), the Sea-leopard (*Stenorhynchus leptonyx*), and the Ross Seal (*Ommatophoca rossi*). We found, as all other Antarctic expeditions have found, that the Ross Seal was the rarest of these four species and was very infrequently seen. The Weddell Seal we found to be far the commonest, and to occur in enormous numbers around the land. It is probably this liking of the species for the vicinity of the land which has made it a familiar seal to most South Polar expeditions, since, wherever the ship may winter, these seals are sure to be seen in large numbers in spring, while many stay far from the open sea in the winter, utilising holes in the ice for access to the water. Captain Amundsen found them numerous off the Ross Barrier. On some coasts, however, the Lobodon is the commonest species. During the voyage of the Dundee whalers to the east of Graham Land and adjacent seas in 1892–93, Dr W. S. Bruce, who accompanied the *Balæna*, noticed that "the mottled Grey Seals were in greatest abundance"; "the greatest number I saw on one piece of ice at a time was forty-seven." These seals, which Dr Bruce referred at the time to the Ross Seal, were really Crab-eating Seals. The mistake was very pardonable considering the marked difference between young and adult Crab-eating Seals, and the fact that at the time no living person, except Sir Joseph Hooker, was acquainted with Antarctic seals, outside a very few museum specimens. Dr Bruce had not, it need hardly be said, a reference library of even the most modest dimensions on board the whaler in which he sailed, and indeed the first photograph of an Antarctic seal was taken by Dr Bruce during that voyage—one of a Sea-leopard, a reproduction of which is now published. Moreover, the commercial nature of the expedition afforded no facilities for collecting, and what skins were saved for the purposes of identification at home were taken by the captain and cut up for leather, while the skulls that Dr Bruce had managed to collect were thrown overboard as being an encumbrance on the ship. Under such circumstances it can readily be understood that mistakes were liable to be made in the identifications such as the cabinet zoologist at home would have no excuse for and would probably fail to understand.

Exclusive of these four species of seals, there are two which, though not truly Antarctic, yet approach the regions of pack-ice: these are the Sea-elephant (*Macrorhinus leoninus*) and the Southern Fur Seal (*Arctocephalus australis*). The

Sea-elephant, which used to frequent Kerguelen, Heard, Gough, Tristan da Cunha, and other subantarctic islands in huge numbers, is now rapidly becoming extinct. The value of its oil was too great to suffer it to live in peace. But it is not yet a vanished species: individuals are occasionally seen in various subantarctic islands, including Fuegia, South Georgia, Kerguelen, Heard, the Crozets, Tristan da Cunha, Macquarie, and Campbell Islands. During 1902 one was shot in Port William, Falkland Islands, and early in 1903 another came ashore near Cape Pembroke lighthouse, Falkland Islands, but escaped; and there are other records of its occasional occurrence in the Falkland Islands. During our visit to Saddle Island, South Orkneys, in February 1903, we sighted what was probably a Sea-elephant, but could not get to close quarters. However, in April 1904 a large male $13\frac{1}{2}$ feet long came ashore on the beach in Scotia Bay. This record is of interest since it is not generally considered that the Sea-elephant penetrates the pack. In fact, the edge of the pack-ice probably limits the southern distribution of the Sea-elephant, but variations in the distribution of the pack may mean a considerable southward extension of its range in some years. However, it must be recalled that the *Discovery* sighted one in MacMurdo Strait (77° 50′ S.), and that Ross in 1840–43 recorded it from the Palmer Archipelago and off Louis Philippe Land in 65° S.

Of the Southern Fur Seal (*Arctocephalus australis*) we saw nothing at the South Orkneys. It is almost certain that this seal has been exterminated at the South Orkneys, where even in Weddell's time it was rare. "In the evening the boats returned, having coasted these islands for fifty miles. They had found but one Fur Seal and some Sea-leopards" (*A Voyage towards the South Pole*, London, 1825, p. 23). Off Cape Dundas, South Orkneys, Weddell got two Fur Seals, but none to the westward. At the South Shetlands in 1820 and 1821 Weddell says 300,000 Fur Seals were killed. This kind of slaughter naturally led to its extermination, and recent expeditions to the South Shetlands, as well as Norwegian, Chilian, and other whalers, have looked for it in vain; though the Swedish Antarctic Expedition found one, and secured the skin, at Nelson Island, South Shetlands, in 1902. There are probably no Fur Seals now living in true Antarctic seas. In South Georgia, where it was once found in enormous numbers, it is extinct. At the South Sandwich group it may still rarely occur: it certainly was found there in comparatively recent years. On the subantarctic islands of New Zealand a few still exist.

One other seal which the *Scotia* secured may be mentioned here, although it is not, and never was, an Antarctic species: that is, the Sea-lion (*Otaria jubata*), of which a large male was shot at the Falkland Islands in February 1904. There are several herds of them to be seen at certain of the smaller islands of the Falkland group, notably at the Tussock Islands in Port William. These are low-lying islands covered with thick tufts of tussock-grass growing man-high. The Sea-lions love to lie among this grass, and in consequence it is necessary to proceed warily, for they are formidable antagonists and exhibit surprising agility in their movements on land. This seal well merits the name of Sea-lion, with its creditable mane and its habit of emitting a deep roar as it rears itself on its fore-flippers. The one secured, a male, measured 10 ft. 8 ins. over all, and scaled over 1200 lbs.

The chief importance of the *Scotia* collections lies in the large number of skins and skeletons brought home, as well as two injected specimens of young Weddell Seals. The anatomy of the Weddell Seal and the skeletons of this and other species are dealt with elsewhere in this series of volumes. The notes in this paper deal with the distribution and habits of the seals observed in the Weddell Sea. In addition to observations made by the naturalists of the *Scotia*, I have included various notes made by Dr W. S. Bruce during the cruise of the Dundee whaler *Balæna* to the western Weddell Sea in 1892–93, since these deal with the same area of Antarctic seas and supplement the observations of the Scottish National Antarctic Expedition. It may be added that a complete set of skins collected by the *Scotia* is now in the Royal Scottish Museum, Edinburgh. Others have been distributed to the museums of Glasgow, Aberdeen, Dundee, Paisley, Perth, and Monaco: a few are in the museum of the Scottish Oceanographical Laboratory. The skulls and skeletons are in the Scottish Oceanographical Museum and the museums of the universities of Scotland, the type collection being in the Anatomical Museum of the University of Edinburgh.

Leptonychotes weddelli (Lesson)—the Weddell Seal.

Both at the South Orkneys and at Coats Land this was the commonest species we encountered, and one which we had facilities for studying better than others. Fifteen years ago it was one of the rarest of known mammals, despite its extraordinary abundance in the Antarctic.

While it is very plentiful near land, it is never found in large numbers in the open pack far from the shore: in this it contrasts with the Lobodon. No recent expedition in any part of the Antarctic has found the Weddell Seal to be rare, and its previous rarity was solely due to the want of expeditions for a long period, and the little careful coastal exploration that had ever been conducted until the days of the *Belgica*. In fact, the Weddell Seal haunts the coast and adjacent pack to such an extent that its presence may almost be taken as an indication of the proximity of land.

While during the winter at the South Orkneys some of these seals undoubtedly deserted the floe for the edge of the pack, many, on the other hand, remained. In every winter month at the South Orkneys a certain number, principally males, were seen, and numerous seal-holes were noticed in the ice. Dr Nordenskjöld found them common during the winter at Snow Hill (1902–1903), and Dr Charcot likewise records them as occurring during winter around Petermann Island (1909), sometimes singly, sometimes in groups. But none of these localities are far from the edge of the pack. However, this species, of all Antarctic ones, goes furthest from the open water, and makes use of holes in the ice for breathing purposes to an extent that other species do not.

The *Discovery* in winter-quarters in 77° 50′ S. was some ten miles from the open water, and yet Weddell Seals were present all winter in such numbers that Dr E. A. Wilson did not look upon them as migratory. In that latitude blowholes are far more numerous than holes by which the seals leave and enter the water, and Dr Wilson ascribed this to the reluctance of the seal to face the low temperatures and darkness of winter: the sea is certainly much warmer. Mr James Murray, of the *Nimrod*, says the Weddell, which was the only common seal at Cape Royds, stayed in winter, though several weeks might pass without one being seen. At the South Orkneys the Weddell Seals only emerged on to the floe during calm, sunny days: in windy weather they were seldom to be seen unless under the lee of a hummock. It must be remembered that in the latitude of the South Orkneys, 60° 43′ S., there is no continuous night in mid-winter, and this may account for the appearance of this seal being more frequent in winter than it is further south.

The Weddell Seal, like the Lobodon, is a true Antarctic species, but there are records of stragglers to subantarctic lands and even beyond. The large herds of Sea-leopards which the *Challenger* heard of at Kerguelen were possibly herds of Weddell Seals.* But authentic specimens have been observed at Santa Cruz in Patagonia, Heard Island, Kerguelen, and even New Zealand.

The Weddell is the most lethargic of all the Antarctic seals. After a good meal they come up through the seal-holes on to the floe to lie asleep for hours. On sunny and calm days especially are they to be seen. They sleep on their sides or almost on their backs, every now and then giving a scratch with the uppermost fore-flipper. When disturbed, they look at the aggressor with a sleepy stare and appear to take very little interest in him, and in a few moments lazily drop to sleep again. It requires somewhat drastic treatment to awake a Weddell sufficiently to make him move away, and even then his movements are far from energetic. One can sit down on a Weddell Seal and only cause him to open his eyes and blink: then once more he falls asleep, unalarmed. Not only is the animal of a naturally slothful disposition (except at the pupping season), but he has never learned to fear man in the seclusion of his polar wastes, and he has no natural enemies on the land or ice. This fearlessness applies equally to other Antarctic seals, and birds. So tame and lethargic is the Weddell Seal that ammunition was never expended on one when it was desired to secure a specimen: they were always stabbed with a long knife.

At the end of August these seals returned to the South Orkneys, and large numbers of females then collected at the rookeries. For the previous month or two no females had been seen, only males. The females had probably been away feeding in preparation for their long period of starvation. The rookeries are on the floe near to land, and though they may be some little distance from the open sea when the young are born, the breaking up of the floes generally puts them in near proximity to the water by the time that the young are able to swim. On the other hand, the nearness of the rookeries

* *Notes of a Naturalist on the "Challenger,"* H. N. Moseley, London, 1892, p. 174.

to land would enable the mothers, in the event of the floe breaking up prematurely, to save their young at an age when they cannot swim.

In the last days of August the first young were born. Each mother has one pup, which at birth measures from $2\frac{1}{2}$ to $3\frac{1}{4}$ feet in length. They are born with their eyes open. The young have soft grey downy coats, with no suggestion of the coarse hairs of the adult skin, nor any of its mottled markings. They have the usual disproportionate head, and their flippers, especially the hind ones, are well developed and out of proportion to the rest of the body. The eyes are large, brown, and slightly bloodshot in the white. The baby moves in the same way as its parent, by drawing itself forward with the help of the fore-flippers, and then dragging onward the hinder part of the body; but naturally the movements are slow, and in following its mother any distance it has to rest every few yards. The mother lies alternately on one side or another while suckling the pup, and often seems to shelter it by lying to windward. Sometimes a mother plays with her young as well as such clumsy animals can, and at times one saw a mother presumably caressing her baby by pressing her nose against the young one's side. The cry of the pup is something like the bleating of a lamb, but strangely human at times.

The altruism of maternity awakens the mother at this season to an alert and ferocious animal who savagely resents any approach to the pup—a great change from the sleepy placidity of other seasons. It was only rarely that a cowardly or indifferent mother was met with. The capture of a young one, without the sacrifice of the mother, consequently entailed a certain amount of strategy. The mother places herself between the aggressor and her baby, and heroically endeavours to defend it. On one occasion when the young had been secured the mother made good her escape by plunging down a seal-hole, but at other times the mother remained on the floes, no doubt bewailing her lot in the peculiar hoarse roar which is heard only at the breeding-season. On another occasion a mother, on seeing our approach to close quarters, made no attempt to drive us away, but instead attacked her pup, giving it several bites about the head and neck. Finally she seized it in her mouth and shook it as a dog might worry a rat. The pup was badly mauled, and would probably have been killed had we not separated the two. The deep roar of the mother at this season replaces the hoarse rattling cuckle, and occasionally is accompanied, in anger, by foaming at the mouth. Males were not seen at the rookeries or on the floe until September 21st, that is, three weeks after the pupping commenced, when one or two began to appear, but they remained rare for some time. In no case was a mother with more than one pup noticed, and by the end of September all the young were born. The mothers who were robbed of their young sometimes remained on the rookeries for days before departing. At this season they probably do not feel hunger, as they are thickly coated with blubber when they reach the rookeries, and on this they have to subsist for about four or five weeks until the young are ready to take to the water. No instance was noticed of a mother leaving her young earlier and going into the sea to feed.

It was noticed that the umbilical cord is severed by the young seal breaking it at birth; it is not bitten through by the mother. A number of Sheathbills (*Pagodroma nivea*) haunt the rookeries and feed on blood and excrement, while Giant Petrels (*Ossifraga gigantea*) are in waiting at each birth for the delivery of the placenta. No sign was noticed, though carefully watched for, of attempts on the part of these petrels to attack the young seals.

In the first week of October the young seals began to take to the water, that is, when about four weeks old. The pup gingerly slides off the ice into a seal-hole and, keeping near the surface, stays in the immediate vicinity of the hole; in some cases the mother gently pushes it in. In a few minutes he clambers out again, when mother and young greet one another joyfully. Several days later the young seal is left to shift for himself. It is only at that period, when the young are yet a little chary of the water, though well able to maintain themselves in it, that motherless pups are to be found. The mothers may go off for a few hours' fishing and return, but very soon they finally leave their youngsters. At the end of October all the young had left their mothers. The males then begin to return, and from this time onwards were frequently seen, all in a fat and sleek condition, and with the slothfulness characteristic of the Weddell Seal. In the end of October and in November the males and females are often seen together. The period of gestation is probably eight to nine months, as far as could be judged from the size of embryos taken from females killed during the first half of the year.

During the summer individuals with bad scars were more than once seen, though far less frequently than in the case of Lobodons. One was seen (January 30th, 1904) with a bare patch over the back of the skull about five inches in width, and with one eye badly injured. Another was noticed (October 10th, 1903) in a badly scarred condition and with his jaw broken. One with a bleeding sore on its flank was noticed trying to force his way between two narrow ice-tongues, which might suggest that ice is a possible cause of the scars. However, in all probability most of these injuries are caused by fighting at the rutting season. It is quite possible that the females join in the fights; at any rate they are occasionally scarred, though less than the males. The relative immunity from scars which the Weddell Seal exhibited compared with the Lobodon agrees with the more peaceful, lazy nature of the former.

It has been suggested by more than one naturalist, writing on Antarctic seals, that these scars are due to attacks made on the seals by the Killer (*Orca gladiator*), which is common in southern seas around the edge of the pack and among loose pack. While the smaller scars which form the majority are probably due to fighting, the Killer quite likely may be responsible for some of the larger gashes and severer injuries. There is certainly no direct evidence that the Killer of the southern ocean feeds on seals, but the probability is great, and is strengthened by the fact that the southern Killer is probably identical with that of Arctic seas. The Arctic Killer or Grampus certainly feeds on porpoises and seals, and has been known to attack the largest whalebone whales.* The immunity that the Weddell Seal undoubtedly experiences from these scars Dr Wilson attributed to its frequenting coastal waters and pack-ice, where it is free from the attentions of the Killer, which stays in deeper and generally more open water. To a certain extent, no doubt, this is true, but I believe that the lazy nature of the Weddell Seal means fewer fights among themselves and so fewer injuries.

The young adopt the adult coat soon after taking to the water, and the adults change their coats in midsummer, about January. The general colour is grey or olive-green, often very silvery, mottled with dark or light spots. Dr Harvey Pirie, who had opportunities to observe many cases at the summer station at Scotia Bay, and made a study of the colouring, says: "In observing closely their coats one finds there is great variation, no two being alike, and they seem to be in all stages of changing coats; some even have a complete old coat, of which the hairs can easily be pulled out. Then again the colour varies greatly, and apart from the actual variations it differs according to your point of view, *i.e.* whether you look from for'ard with the lie of the hair, abeam, or from aft for'ard against the grain. When looking aft, and to a less extent abeam, there is a silvery sort of sheen which is quite awanting if they are viewed from aft. Some few were of an almost uniform creamy colour with a yellowish tinge, sometimes a greenish yellow, and in two cases a brownish yellow. In practically every one the dorsal aspect is darker than the ventral. Mottling is practically always visible, but where the old coat is complete it may be very indistinct. The amount and size of the mottling also varies very much, and may take the form of small spots or of large patches. Generally speaking, however, it comes to be light spots with a dark ground dorsally, and dark spots with a light ground ventrally. The mottling is best seen ventrally and about the flippers, as these are the first places to cast the old coat; a broad dorsal ridge is the last region to change. The coloration of the new coat is on an average a dark slatey-grey in the dark parts and a yellowish white in the light, but the exact shades vary very much in their intensity." (*Rep. on the Scien. Res. of Voy. of "Scotia,"* vol. iv., Zoological Log, p. 99.)

The food of the Weddell Seal consists entirely of fish, lamellibranchs, cuttlefish, crustaceans, and holothurians. They seem never to attack penguins. Many attempts which we made to induce them to do so failed. Dr Turquet, of the *Français* expedition, writes of a Weddell Seal eating a shag after playing with it half an hour. But it is probable that this was in reality a Sea-leopard. It is very doubtful if this seal is lithe and quick enough in its movements to catch penguins, and hence it has never taken to them as food.

The adult Weddell measures up to 9½ feet in length, and weighs as much as 900 lbs. or more.

This seal is sometimes referred to as Weddell's False Sea-leopard, owing to a remote resemblance between the two; but it would be wise to drop the name, since it has

* "On the History and Geographical Relations of the Cetacea of Davis Strait and Baffin's Bay," Robert Brown, *Proc. Zool. Soc.*, xxxv. pp. 533–556, and *Arctic Manual and Instructions*, 1875, pp. 69–93.

helped to cause confusion in the past. The type and only specimen was for long on exhibition in the Royal Scottish Museum, and a figure of this, taken from the stuffed specimen, appeared in Weddell's book (*A Voyage towards the South Pole performed in the years* 1822–24, James Weddell, London, 1825). That specimen was grotesquely stuffed and a caricature of the real animal. It has now been removed from the public galleries, unstuffed, and put away as a cabinet skin. A number of specimens from the *Scotia* collections replace it.

Stenorhynchus leptonyx Cuvier—the Sea-leopard.

The Sea-leopard, without being common, was frequently seen at the South Orkneys, in the pack, and about Coats Land. We secured three skins of adults, but no young. It is a solitary animal and is never found in herds: three were seen together on one occasion only, and we never saw more in company. In 1893, off Louis Philippe Land, Dr Bruce noticed large hosts of Sea-leopards, but generally met with them in twos or threes or solitary. At the South Orkneys it was absent throughout the winter 1903, with the exception of three which were seen in August. Otherwise it disappeared from March until February. In 1904 Señor Valette records Sea-leopards in Scotia Bay only in November and December. Dr Charcot notes their disappearance from Petermann Island in midwinter (1909), and records the last one in April.

It is impossible to say with certainty where the Sea-leopard breeds, but we have only slight evidence that it does so at the South Orkneys. In this connection it is of interest to note that Dr Bruce saw a young Sea-leopard on Point Thomson in Brown's Bay in November (19th). and an attempt was made by him, Mr Wilton, and Dr Pirie to secure it. Señor Valette records young Sea-leopards in Scotia Bay in the end of December (1904). Wherever the rookeries of the Sea-leopards occur, the young are probably born in September, and would be quite able to look after themselves and travel some distance even before December. However, the probability of these young ones having travelled from Graham Land is not great. It is far more likely that they were born at the South Orkneys. Unfortunately, the sex of those specimens seen in August could not be determined, as they did not emerge from the water. In any case they had not the appearance of pregnant females. The males of no species of seal appear near the breeding-places in early spring, and had these been males it would indicate that no rookery existed in the vicinity. In July and August, Mr A. E. Felton informs me, Sea-leopards are common on the beaches of the Falkland Islands, but he has seen nothing of their young or their breeding-places.

No other expedition has been any more successful than the *Scotia* in locating the breeding-places of Sea-leopards, and this may of course be accounted for by the comparative scarcity of the species, on which all expeditions have commented. On the *Balæna* expedition, however, as noted above, Dr Bruce and Mr Burn-Murdoch report seeing many. Dr Bruce estimates that the crew of the *Balæna* killed fully a thousand during December, January, and February. The expedition of the *Français* appears to have seen only one, and that is not certain, though the *Pourquoi Pas?* in the same region saw several. But I am inclined to think that the failure to discover the breeding-places is due, in reality, to there being no large Sea-leopard rookeries. This species is probably more or less solitary, even at the breeding-season, and thus would largely escape notice.*

Dr Bruce and Dr Donald brought back several fœtal Sea-leopards from the expedition of the *Balæna* and the *Active* in 1892–93, which were given to the Zoological Department of University College, Dundee.

The only other fœtal Sea-leopard known was obtained by Dr Charcot at Petermann Island in March 1909, during his expedition in the *Pourquoi Pas?*

The *Challenger* found this seal on Kerguelen in midsummer, and bones of it at Heard Island. But the large herds on Kerguelen of which Moseley speaks by report were probably Weddell Seals.† It is not uncommon at the Falkland Islands, and has been recorded from South Georgia and Fuegia as well as from such low latitudes as Tasmania, Wellington, N.Z., and the Lord Howe Islands, so that it is not confined to Antarctic waters. However, the more northerly of these must be looked on as records of mere stragglers from the habitual haunts.

The Sea-leopard is the largest of all Antarctic seals, and may reach 12 to 14 feet in length and weigh over 900 lbs. In appearance it is comparatively graceful, with its long slim body and its light grey coat generally touched with darker spots. Alone among the seals of the Antarctic does this species threaten man, even without provocation. With its formidable array of teeth, its powerful jaw, and its remarkable agility, it is not an animal to be played with. Other species never show any resentment to man except during the pupping season, and then only on provocation. When on the floe the Sea-leopard lies characteristically on its stomach, with its head resting on the ice, and rears itself on its fore-flippers and at once shows fight on the approach of a man. It is usually alert, ready, and energetic in its movements, while it has not the same love of lying on the ice which the lazy Weddell Seal exhibits, and seems to go on to the ice principally for a rest, when out in mid-sea. The food of this seal seems to consist chiefly of penguins, which it chases with great agility under the surface of the water, and even catches on the ice. In one instance, in Scotia Bay, a Sea-leopard was observed swimming noiselessly up to a piece of pack, near the edge of which was standing a Gentoo penguin: suddenly, with a quick jump, the Sea-leopard raised himself from the water, caught the penguin's leg in his jaws, and drew the bird away into the sea. In one specimen the *Discovery* found the body of an Emperor penguin; and Dr Davidson, of the *Morning*, in another found the remains of a young Weddell Seal. Dr Bruce found large quantities of stones in Sea-leopards' stomachs in 1892–93, which were evidently from the stomachs of digested penguins. Feathers from the same

* It is probable that the "Sea-leopards" which Mr Borchgrevinck describes as breeding in Robertson Bay, Victoria Land, were really Weddell Seals (*First on the Antarctic Continent*, London, 1901, p. 237).

† *Notes of a Naturalist on the "Challenger,"* H. N. Moseley, London, 1892, p. 174.

source were also found in the Sea-leopards' stomachs. However, on occasions when penguins are not available the Sea-leopard does not despise fish and crustaceans. Probably in midwinter the Sea-leopards migrate northwards to the edge of the pack, and so keep in touch with the penguins, which do the same.

Lobodon carcinophaga (Jac. et Puch.)—the White Antarctic Seal.

The White Antarctic Seal or "Crab-eater" is not uncommon at the South Orkneys, and in some parts of the Antarctic occurs in large numbers. Dr Turquet thinks it the commonest species in the regions west of Graham Land explored by the *Français*, where the *Pourquoi Pas?* also found it plentiful. Dr Bruce in 1892–93 found this species in the greatest abundance of any off Louis Philippe Land, where the *Balæna* killed some 4000 to 5000 of them. In the Bay of Whales, in the Ross Barrier, Captain Roald Amundsen found it to be a common species. No expedition has found it uncommon, although we did not see it as frequently as the Weddell Seal. This, however, may be because numerous Weddell rookeries occurred near our winter-quarters.

The Lobodon typically occurs on the pack-ice, often far from land, and it was in these conditions that most of the specimens we saw were recorded. They are seldom seen on shore. During February and March 1903, while the *Scotia* was cruising in the pack of the Weddell Sea, scarcely a day passed without several being seen. They are never found far from open water. The Lobodon is not as a rule a solitary animal: generally several are seen together. Dr Bruce in 1892 recorded as many as forty-seven lying on the same piece of pack-ice.

During the winter the Lobodons desert the fast ice. Not a single specimen was seen by us at the South Orkneys from the middle of March to the 1st of August. In the somewhat less severe regions west of Graham Land they seem to leave a little later. The *Discovery* also found that the Lobodons left when the sea froze over in winter. In the winter they apparently stay at sea among floating ice, for there seems to be no record of them visiting such lands as the Falkland Islands, Kerguelen, or Macquarie Island; but stragglers have been reported from Patagonia, and as far north as the Rio de la Plata and also the coasts of Australia.

We came on no breeding-places of the Lobodon, but found a number of young ones during the summer. An individual captured on August 1st, which Russ, one of the dogs, chivied out of a tide-crack on to the floe, was a young one, but evidently about a year old.

The pupping season, according to M. Racovitza, is September, which would agree with the apparent age of the young that we captured during the summer. There is little doubt that they lived at or near the South Orkneys, though not in the bays we visited, for numbers of them were seen towards the end of August, after which none seem to have been noticed until November. In that month two old males were seen. In the later summer they again became common, both adults, male and female, and young. Not only did we fail to find any quite young Lobodons, but we were unfortunate in not securing any pregnant females, and so cannot offer any contributions to the embryology of the species. The *Belgica* alone secured a very young specimen. However, among our collection of skins are two of young males not more than one year old. M. Racovitza maintains that they bear their young on the pack away from land; the number of young he saw during the *Belgica's* long drift in the pack would confirm this.

The Lobodon is a comparatively shapely seal, and never attains the grossness of the Weddell. It swims rapidly and gracefully, while on the ice it is generally alert and vivacious in its movements, and can travel much faster than the Weddell.

The young has a thick mouse-grey coat, often with a mottled appearance, but this changes in the adult into a coarser coat, but beautiful creamy-white in colour, though some are rather silvery-white and others remain mouse-grey. Dorsally it is darker than on the ventral surface. However, the colour varies somewhat with the position of the spectator. If looked at from behind forward, it is several shades darker than in the reverse direction; and this applies equally to the Weddell Seal. With increasing age the coat seems to become whiter.

A peculiarity of the Lobodon is the scarred appearance it presents in midsummer. In December this is most noticeable; in January their condition improves, and in February, as a rule, they are free from scars. On the other hand, the young specimen we captured in August had several half-healed scars, and badly scarred Lobodons were seen both in February and March. Yet the fact seems to be that these scars are inflicted in November and December as a rule; this coincides with the rutting season, when no doubt the males are badly wounded in fighting with one another. As far as the observations of the *Scotia* naturalists go, the scars are confined to the males; but in 1892 Dr Bruce comments on the females being as badly scarred as the males. The *Discovery* seems to have noted the same. If that is so, the females must join in the fight. But the deep abdominal gashes that the Lobodon so frequently bears can scarcely be ascribed to this cause. The idea that they are due to attacks by Sea-leopards can be dismissed as groundless and unlikely in the extreme. The likelihood of the Killer Whale being responsible I have discussed in speaking of the Weddell Seal. Dr Wilson pointed out how the pelagic habits of the Lobodon would make it more exposed to these attacks than other seals, and hence the more frequent scars. On the other hand, however, it must be noted that the Lobodon is more agile than the Weddell, not only on land, but also in the water, which should give it greater immunity than the Weddell. This agility of the Lobodon we had ample opportunities to note during the many months the *Scotia* spent cruising in the pack. Possibly, however, it is more than counterbalanced by the continual presence of the enemy, which the Weddell Seal, in its shallow-water haunts, largely escapes.

The principal food of the Lobodon is *Euphausia*, an index to its more pelagic habits, and hence presumably its name of "Crab-eater."

This seal has also been referred to as Dumont d'Urville's Seal, since it was discovered by that explorer, in analogy with the names of the Weddell and Ross Seals. The appellation, though quite justifiable on these grounds, is a clumsy one, and is unlikely to come into use.

A full-grown Lobodon attains a length of over 9 feet and a weight of 500–600 lbs. or more. A temperature of 99° F. was recorded in one by Dr Pirie.

Ommatophoca rossi Gray—the Ross Seal.

This seal was rarely seen, and, despite the frequent expeditions of recent years, still remains one of the rarest of known mammals. It is the only one of the Antarctic seals that is entirely confined to Antarctic seas, and which has never been recorded from extra-polar regions. During the voyage of the *Scotia* the Ross Seal was only seen on five occasions, and on four of these it was among the pack some distance from land. The most southerly one was seen about the latitude of the Antarctic circle, midway between the South Orkneys and Coats Land, in the month of March. In December 1903 an old male with very worn teeth was observed in Scotia Bay, and several were noted there in the course of the following and subsequent years. During the first year (1904) of the Argentine occupation of Omond House Mr R. C. Mossman captured a young female of this species, about 5½ feet in length and estimated at about six weeks, near Cape Burn-Murdoch, Scotia Bay. This is particularly interesting, since it is the first young specimen of the Ross Seal ever brought home, and the only one known up to the present time. In 1892, Dr Bruce and Mr W. G. Burn-Murdoch captured what Dr Bruce is now certain was a young Ross Seal. As soon as the boat came alongside of the *Balæna*, however, Captain Fairweather ordered the animal to be taken out on to the ice and skinned. The carcase was left on the ice, and the skin heaved aboard as one of the 6000 skins taken home to Dundee. Prof. T. W. E. David speaks of two young Ross Seals in February on the Drygalski Ice Barrier Tongue in Victoria Land, but he does not give their age. Under the circumstances neither could be preserved.* Previous records of this seal in the Weddell Sea are those of Ross and Weddell. Dr Bruce, in 1892, refers to great numbers of Ross Seals, but he admits that he was wrong in his identification in this case. Solitary individuals, as in the Weddell Sea, have been recorded by practically all recent expeditions from other parts of the Antarctic, but everywhere the Ross Seal is very rare. Dr Turquet, of the expedition of the *Français* to the west of Graham Land, is not sure that he saw any, but some of his colleagues certainly heard the characteristic cry. The collection of skins, however, of this expedition seems to contain one of the Ross Seal. In the same region the *Pourquoi Pas?* seems to have sighted but two. M. Racovitza, of the *Belgica*, comments on their rarity; and the Swedish expedition in the *Antarctic* on the east and north of Graham Land during their twenty-one months' stay saw none.

* *The Heart of the Antarctic*, vol. ii. p. 208, London, 1909.

Mr Mossman, on board the *Uruguay* (1905), saw a Ross Seal at the South Shetlands in Pendulum Cove, Deception Island.

Of the breeding-habits of this seal nothing whatever is known, but in all probability the young are born on the pack and not near land. From the rarity of the species it is almost certain that they do not collect in rookeries at that season.

Their movements in winter are equally mysterious, for they seem to leave the ice-bound region at that season. Presumably they migrate to the edge of the pack, but there is no record of a Ross Seal having been seen on any subantarctic island.

The Ross Seal feeds principally on cattle-fish, but remains of fish and *Euphausia* were found in their stomachs. A large cephalopod, over 6 feet in length, was captured in Scotia Bay in 1904 at the Argentine Meteorological Station, which from its beak appeared to be of the same species as that on which the Ross Seal feeds.

The colour of this seal is a dark grey with lighter stripes or elongated spots, chiefly on its sides, while its ventral surface is of a uniformly lighter tint, sometimes almost white. Several peculiarities distinguish it in a striking way from other Antarctic seals. It is probably the most shapeless of them all; as M. Racovitza says, "the form of the quadruped has almost disappeared." The enlarged size of the fore-flippers is very noticeable, but the most remarkable feature of all is the thick neck due to a great development of the larynx. This gives the animal an extraordinary appearance. Furthermore, this seal is generally very fat, and the head is much dwarfed by folds of fat about the neck. The distended larynx acts as a resonator, and hence the explanation of the curious loud cry, which is quite characteristic and unmistakable.

Both on ice and in the water the Ross Seal is far more agile than the Weddell, and can be alert and active when the occasion demands it; but, unconscious of danger, they allow one to approach near without showing signs of fear. The agility of this seal may account for its feeding habitually on cuttle-fish, in contrast to the slow, deliberate Weddell, which has to be content with less active prey. Moreover, its quickness in the water may be an adaptation to a pelagic mode of life which it seems to follow. Large scars are seldom seen on the coat of this seal, and Dr Trouessart attributes this to the greater agility of the Ross Seal, which enables it to escape the attacks of the *Orca*, to which he ascribes such wounds. Certainly the Ross Seal is a very powerful swimmer, but in view of the small number seen it is difficult to generalise regarding the scars. In any case, the small scars which this seal occasionally bears are quite in keeping with its feeble dentition, and would point to battles over females being the real cause.

The Ross Seal attains a maximum length of about 8 feet 6 inches; we measured none larger than this, and found most of them somewhat shorter. But Mr Bernacchi, on the *Southern Cross* expedition, speaks of one nearly 11 feet. The *Scotia* secured two skins and one complete skeleton. The temperature in one case was 96°·2 F.; in another case Señor Valette recorded 98°·6.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. Sea-leopard (*Stenorhynchus leptonyx*) (length = 13 ft. 6 in.), on board the s.s. *Balæna*, off Graham Land, 1892. Mr W. G. Burn Murdoch seated. (This is the first photograph ever taken of a Sea-leopard.) Photo by W. S. Bruce.

Fig. 2. Sea-leopard on The Beach, Jessie Bay, South Orkneys. Photo by J. H. H. Pirie.

Plate II.

Fig. 1. The Lobodon or Crab-eater Seal (*Lobodon carcinophaga*). Adult with unmottled coat in foreground. Young behind, showing mottled coat. W. Smith del. and photo.

Fig. 2. The Lobodon or Crab-eater Seal. Young, showing mottled coat. W. Smith del. and photo.

Plate III.

Fig. 1. Ross Seal (*Ommatophoca rossi*) and Dr Pirie on board the *Scotia*. Photo by W. S. Bruce.

Fig. 2. Weddell Seal (*Leptonychotes weddelli*), male, off Coats Land, Antarctica. Photo by W. S. Bruce.

Plate IV.

Fig. 1. Weddell Seal on ice in Ellessen Harbour, Lewthwaite Strait, or Spencer's Straits. Photo by W. S. Bruce.

Fig. 2. Weddell Seal (male) on beach of Mossman Peninsula, Scotia Bay. A usual attitude during sleep. Photo by W. S. Bruce.

Plate V.

Fig. 1. Weddell Seals on beach of Mossman Peninsula, Scotia Bay. Photo by W. S. Bruce.

Fig. 2. Weddell Seal (waking up) on beach of Mossman Peninsula, Scotia Bay. Photo by W. S. Bruce.

Plate VI.

Fig. 1. Weddell Seal off Coats Land. Photo by W. S. Bruce.

Fig. 2. Sea elephant Seal (*Macrorhinus leoninus*) at South Georgia. Photo lent by T. E. Salvesen.

Fig. 3. Weddell Seals on beach of Mossman Peninsula, Scotia Bay. Photo by W. S. Bruce.

Fig. 4. Weddell Seal and young, about three days old, Scotia Bay, South Orkneys. Photo by W. S. Bruce.

Plate VII.

Fig. 1. Weddell Seal (*Leptonychotes weddelli*) and newly-born young, Scotia Bay, South Orkneys. Photo by W. S. Bruce.

Fig. 2. Weddell Seal, with young two or three weeks old, Scotia Bay, South Orkneys. Photo by R. N. R. Brown.

Fig. 3. Young Weddell Seal, one day old. Photo by W. S. Bruce.

Fig. 4. Young Weddell Seal, two days old. Photo by R. N. R. Brown.

PLATE VIII.

Weddell Seals in Scotia Bay, South Orkneys.

Figs. 1–4. Adults.
Figs. 5–6. Mothers with young a few days old.
Fig. 7. Young, several weeks old, landing on beach.
Fig. 8. Young about one week old.

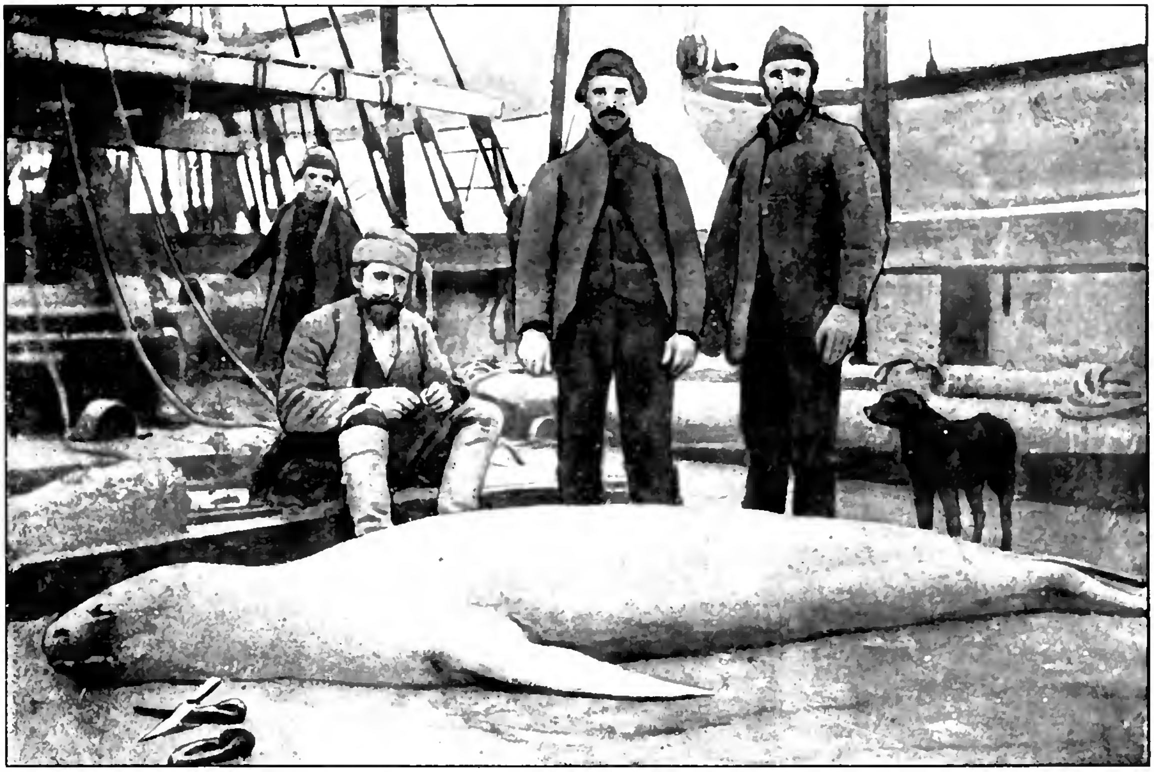
Photos by W. S. Bruce.

PLATE IX.

Weddell Seal (mothers and young). The young are only a few days old. Photos by W. S. Bruce.

Nos. 7 and 8 show the mother and young playing with each other. The white spots in eyes of the young of No. 8 are frozen tears.

Brown : Seals of the Weddell Sea. Plate I



[Photo by W. S. Bruce.

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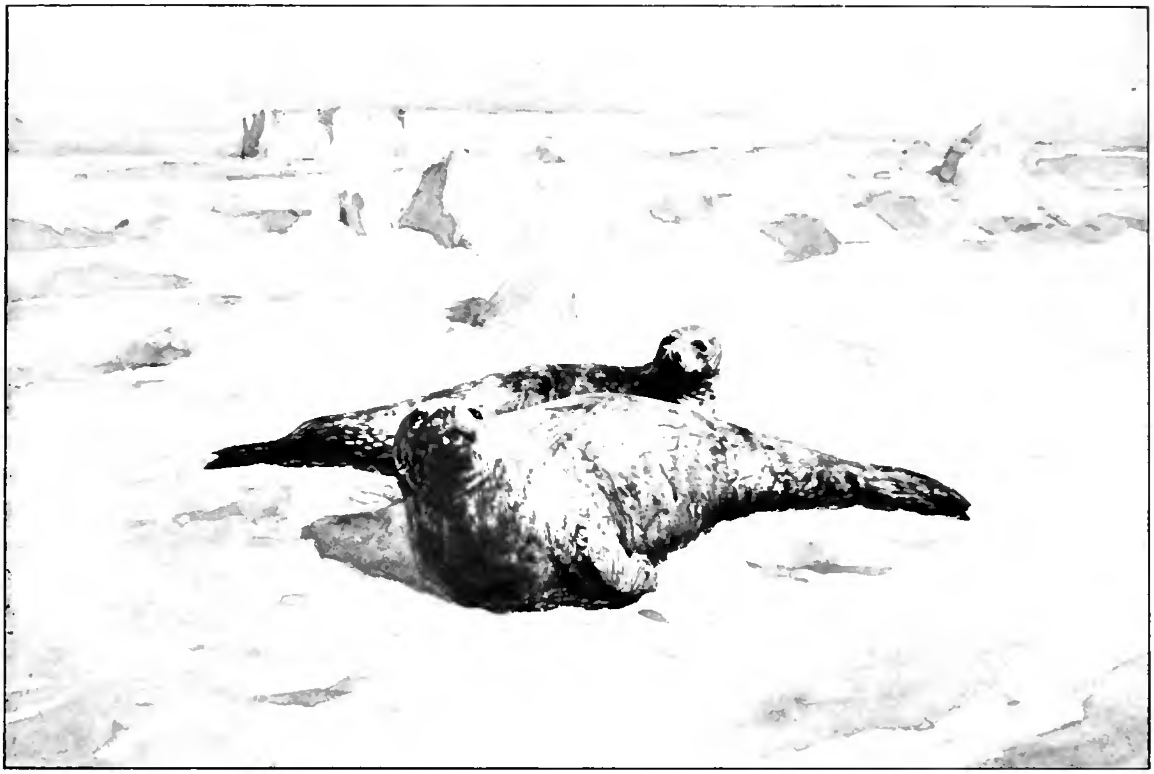
2. Sea-leopard on the beach, Jessie Bay, South Orkneys.

Brown : Seals of the Weddell Sea. Plate II.



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1. The Lobodon or Crab-eater Seal (*Lobodon carcinophaga*). Adult, with unmottled coat, in foreground. Young behind, showing mottled coat.

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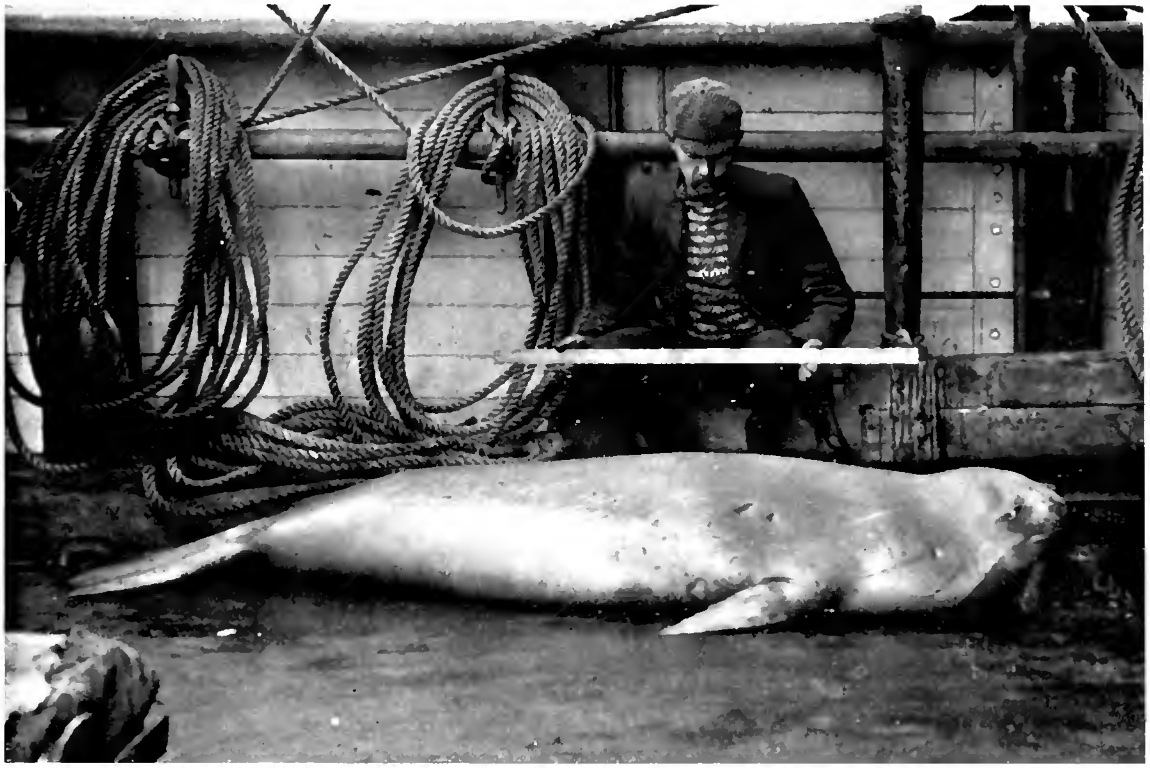
2. The Lobodon or Crab-eater Seal (young, showing mottled coat).

Brown: Seals of the Weddell Sea. Plate III.



[Photo by W. S. Bruce.

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2. Weddell Seal (*Leptonychotes weddelli*), male, off Coats Land, Antarctica.

Brown : Seals of the Weddell Sea. Plate IV.

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2. Sea Elephant Seal (*Macrorhinus leoninus*) at South Georgia.

[Photo by W. S. Bruce.

3. Weddell Seals on beach of Mossman Peninsula, Scotia Bay.

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4. Weddell Seal and young, about three days old, Scotia Bay, South Orkneys.

Brown : Seals of the Weddell Sea. Plate VII.

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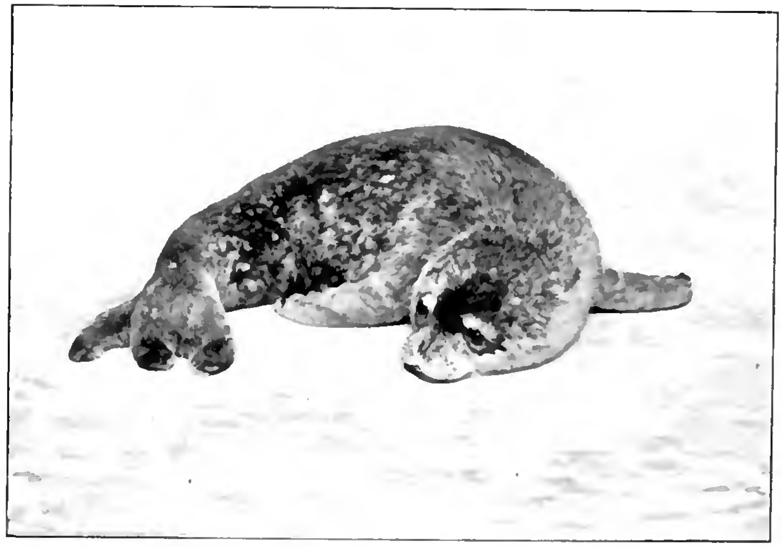

[Photo by R. N. R. Brown.

4. Young Weddell Seal, two days old.

Brown: Seals of the Weddell Sea. Plate VIII.

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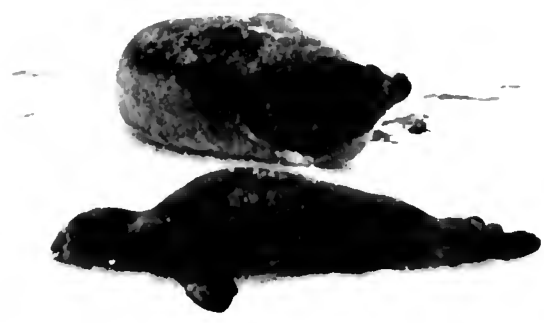

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[Photos by W. S. Bruce.]

Weddell Seals in Scotia Bay, South Orkneys.
(1-4, Adults; 5-6, Mothers, with young a few days old; 7, Young, several weeks old, landing on beach; 8, Young about one week old.)

Brown : Seals of the Weddell Sea. Plate IX.

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Weddell Seal (mothers and young). The young are only a few days old. Nos. 7 and 8 show the mother and young playing with each other. The white spots in eyes of the young of No. 8 are frozen tears.

PART XIV.

BIRDS.

PART XIV.—ORNITHOLOGY OF THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

SECTIONS I. TO XIII.

By W. EAGLE CLARKE, F.R.S.E., F.L.S., Keeper of Natural History in the Royal Scottish Museum; L. N. G. RAMSAY, M.A., B.Sc., Universities of Aberdeen and Cambridge; R. N. RUDMOSE BROWN, D.Sc., University of Sheffield; Naturalist, Scottish National Antarctic Expedition; and WILLIAM S. BRUCE, LL.D., F.R.S.E., Director of the Scottish Oceanographical Laboratory, Edinburgh.

(WITH SEVEN PLATES AND TWO MAPS.)

ORNITHOLOGY OF THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

Section I.—Introduction.

By William S. Bruce, LL.D., F.R.S.E.,
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That the ornithological results of the Scottish National Antarctic Expedition have proved to be of considerable importance is because they were attained by the united efforts of the officers and crew as well as the scientific staff of the *Scotia*. The keenest observer on board, the one who would first detect a bird, not seen before, at a great distance and be able to give a very exact description of its form and plumage, was our second mate, the late Mr Robert Davidson. To him are due many of the excellent records of the voyage. I spent many an hour on deck with Mr Davidson making notes of birds that we observed together, and also notes of other birds he had seen during his watch. Very often he would pass the word below that there was a new bird about that we had not seen before, which brought the naturalists out on deck. To Mr D. W. Wilton also great praise is due for his energy and pluck in being ever ready to be lowered away in a boat in any sea a boat could live in. He was even ready, had he been encouraged, to undertake many more risky boat expeditions than he did. Wilton was usually accompanied by two seamen, and most often by the young Shetlander Johnnie Smith. While the *Scotia* was lying during sounding, trawling, and vertical tow-netting, and other operations, Wilton was almost always in the dinghy or gig securing birds for the *Scotia* collections, and was responsible for many of the best *Scotia* records. On one occasion, when the *Scotia* was trawling in one hundred fathoms under the lee of Gough Island, Wilton got too far off the land and was blown far out to sea in very rough weather, out of sight from the ship—a venture which, but for the seaworthiness and the skilful handling of the boat, and level-headedness of Wilton and his companions, might have ended in disaster. He was quite unconcerned, however, when we picked him up after the trawl came on board, and with his gun had secured a large part of the fine collection of birds that we collected at Gough Island. In winter quarters there were more chances for everybody, and during the absence of the *Scotia* refitting at Port Stanley and Buenos Aires, Dr J. H. Harvey Pirie specially distinguished himself by plucky rock-climbing, making many valuable additions of eggs and young to the *Scotia* collections. Dr R. N. Rudmose Brown was also assiduous in his observations at various penguin rookeries, and he and Pirie secured the most complete series of penguin embryos in unbroken sequence from the day of laying to hatching. These excellent embryological preparations form the basis of the valuable investigations of Dr Waterston and Dr Geddes.*

On many occasions we "fished" for birds with baited hooks and triangles, but, contrary to my previous experience on board the *Balæna* in 1892–3, we did not secure many birds by this method. On the *Balæna* I have seen as many as thirteen albatroses taken by the seamen in a day. On the same voyage I caught many birds in this way myself, but, during the voyage of the *Scotia*, although we would sometimes hook a bird and bring in to within an arm's length, it invariably got clear before being hauled aboard.

The consideration of the ornithology of the voyage has been based primarily on geographical distribution; the birds of every region passed over by the *Scotia* having been considered separately. The first place that any special collection of birds was made was St Paul's Rocks, where, in spite of a heavy swell running, the *Scotia* naturalists secured two out of the three species that are known to breed there. Here Dr Pirie had a narrow escape, when he was washed off the rocks, on to which he jumped from the boat, into a sea swarming with sharks. So numerous were the sharks that we caught several at the ship with ease, although our attention was taken up at the time with testing our sounding gear and with kite-flying. At the rocks fishing was tried from the boat, but each time a fish was hooked it was swallowed by one of the sharks that were swarming round the boat. Little was then secured till the Falkland Islands were reached, on account of our forcing as quick a passage south as possible to the region we were specially fitted out to explore. At the Falkland Islands my attention and the attention of the officers and crew had to be given almost entirely to ship's business, but the naturalists managed to make several excursions in the vicinity of Stanley Harbour. On two occasions I accompanied excursions to Cape Pembroke, where I had to set up and subsequently inspect the meteorological equipment at the lighthouse; this made an opportunity for field naturalist's work in that region. I also conducted a special excursion to the Tussock Islands, while the *Scotia* was coaling, when we secured a Sea-lion and quite a number of interesting birds. To Mr Thomson and Mr Coulson, of the lighthouse, is chiefly due our collection of Falkland Island birds' eggs.

Very detailed and important work was done in ornithology at the South Orkneys, in the Weddell Sea, and at Gough Island, and these collections have been examined and described in three excellent reports by Mr W. Eagle Clarke in *The Ibis*,† which are now reprinted. The type collection of the birds from these regions, including males and females, types of every stage of plumage obtained, and a large and complete series of eggs, I have presented to the Royal Scottish Museum; while a further typical

* *Idem*, pp. 32–58.

† *The Ibis*, Eighth Series, vol. v., April 1905, pp. 247–268; Eighth Series, vol. vi., January 1906, pp. 145–187; and Ninth Series, vol. i., April 1907, pp. 325–349.

series of the whole collection has been housed in the Scottish Oceanographical Laboratory. I have presented several of the new and rarest species to the British Museum, while the museums in Scotland have also benefited.

I have to thank Mr Eagle Clarke for his important contributions. I have also to acknowledge the valuable work Mr L. N. G. Ramsay has done in putting in excellent order the ornithological collections as a whole, and in giving such a complete account of the birds seen and captured during the whole voyage. Dr R. N. Rudmose Brown gives an important contribution on the "Life and Habits of Penguins," a brief summary of the results of his own excellent observations and those of the other naturalists of the *Scotia*. Free use has been made by the various authors of the bird notes in the *Zoological Log of the "Scotia"* (*Rep. on the Sci. Res. of the Voyage of the S.Y. "Scotia,"* IV. i.), and also of the journals kept by the other naturalists and myself during the voyage. The ornithological report, therefore, is a very complete one, and the sum of the united efforts of all on board the *Scotia*.

Section II.—St Paul's Rocks, and the Voyages to the Falkland Islands, and to Buenos Aires and Back.

By L. N. G. Ramsay, M.A., B.Sc.

The *Scotia* reached St Paul's Rocks on December 10th, 1902. "These isolated rocks rise up in mid-Atlantic just a few miles north of the equator. They are only about a half-mile in circumference and some sixty feet above sea-level. They have been visited and described by Darwin, Sir James Ross, and the naturalists of the *Challenger*; but, geologically speaking, they are still a puzzle and of great interest. . . . We were very anxious to secure some rock-specimens, but our hopes of effecting a landing were frustrated by a heavy swell which intensified the strong westerly equatorial current; there was a rise and fall of about ten feet, and every now and again waves breaking in spray almost right over the summit of the rocks." * Dr Pirie, who actually set foot on them, was washed off into the sea, swarming with sharks, and was rescued with difficulty. The rocks form the breeding-place of multitudes of boobies (*Sula sula*), and noddies of two species (*Anous stolidus* and *Micranous leucocapillus*), which appear to nest all the year round. Although the *Scotia* naturalists found landing was impossible, plenty of birds were seen on the rocks, and some of the boobies were found to be nesting, the young ones being nearly white in colour. Three boobies (an adult and two immature birds) were obtained, and three adult noddies (*Anous stolidus*). The smaller tern, *Micranous*, was not obtained.

From St Paul's Rocks the *Scotia* continued her voyage in a south-westerly direction, passing within 50 miles (roughly) of Fernando Noronha, in the neighbourhood of which a gannet (a white species—probably *Sula cyanops* or *S. piscator*) was seen.

On December 14th the Brazilian coast was sighted in 6° S. lat., and thenceforward the ship made a direct passage for the Falkland Islands, her course gradually diverging from the receding coast-line of the South American continent.

"Boobies" are logged as having been seen on various dates up to December 26th, in 30° S. These, with a few unidentified petrels and others, were the only bird-life met with till 30° S. was approached, after which petrels began to be more numerous.

The area of ocean between the River Plate and the Falklands was thrice traversed, the two subsequent occasions being when the *Scotia* visited Buenos Aires to refit in December 1903, returning to Port Stanley in January 1904.

* J. H. Harvey Pirie, *The Voyage of the "Scotia,"* p. 40.

The bird-notes of these three trips may be summarised together.

The Wandering Albatros (*Diomedea exulans*) on the first voyage was met with for the first time in 35° S. On all three trips it was logged at intervals from this latitude southward to near the Falklands.

The smaller species of albatros (*Diomedea* and *Thalassogeron*) were simply recorded as "Molliemauks"; none were logged on the first trip; on the second (December 1903) some were seen daily from 48° S. to about 34° S., while on the third they were only encountered once, in 50° S., when six were seen.

Few Sooty Albatroses (*Phœbetria* spp) were seen north of the Falklands, these birds being logged from about 47° and 50° S. lat. on two of the three trips.

Wilson's Petrel (*Oceanites oceanicus*) was first encountered in 30° S., and thence to the Falklands was noticed frequently, except on the last voyage, when it was only once logged, and that was doubtful. On the first voyage they became more numerous as the Falklands were approached, being noted as "very plentiful" on January 4th (47° S.). On January 26th, 1904, "Stormy Petrels, like Wilson's, only more white on their breasts and wings," were observed (43° S.). These may have been the white-bellied *Cymodroma grallaria*, which was obtained later on, in the South Atlantic. This species has lighter wings than Wilson's, and the inner under-wing coverts are white.

"Blue Petrels" (*Prion* spp.) and Nellies (*Ossifraga gigantea* Gm.) were logged on the first two days after the *Scotia* left Port Stanley in December 1903, and there is also a doubtful record of the latter for 43° S. (January 26th).

On December 28th, 1902, three petrels were shot, the skins of two of which are now in existence, in 33° S. lat. They prove to be *Œstrelata incerta* (Schl.), a little-known species, which has a wide distribution in the southern oceans:—*

(*a*) ♀, December 28th, 1902. 33° 5′ S., 48° 48′ W. Length (in skin) about 18 ins.; wing 12·75 ins.; bill (gape to tip) 2·0 ins.; tarsus 1·75 ins.; middle toe 2·4 ins.; inner toe 2·1 ins.

(*b*) ♀, December 28th, 1902. Same lat. and long. Length about 17 ins.; wing 11·9 ins.; bill 1·75 ins.; tarsus 1·7 ins.; middle toe 2·2 ins.; inner toe 1·85 ins.

Notes made on the spot describe the beak as black, the pupil blue, the iris sepia-brown, the legs yellowish white, the lower parts of the toes and webs black.

In the dried skin the beak is black, with a greyish-white mark near the tip on both upper and lower halves. Tarsi and toes yellow; outer side of outer toe, and distal portions of toes and webs, blackish.

The wings, mantle, lower back, rump, and tail are blackish brown, shading into lighter brown on upper back, neck, sides of breast, and head; a dark brown patch in front of and above the eye; middle of throat and of foreneck whitish; middle of breast and belly white. Flanks greyish brown, under wing- and under tail-coverts dark brown. Faint lighter margins to scapulars and upper tail-coverts.

* Godman, *Monograph of the Petrels*, 1910, p. 195.

The description of several petrels seen on the first voyage (December 24th to 26th) corresponds with the above specimens, except that they are described as having "a small white marking on the under and upper surface of the wing." This apparently refers to another species, perhaps one of those species of *Œstrelata* with white on the bases of the primaries.

Another species of petrel was seen in similar small numbers from December 29th to January 5th. This was about the same size, but the under parts were entirely white, the wings almost black, "verging into grey on the rest of the body, with a white ring round beak and tail."

Several petrels of one or other of the two darker kinds were seen daily from December 24th to January 3rd on this first voyage (26° to 45° S.), after which the species with under parts wholly white was the only one observed.

Section III.—The Falkland Islands.

By L. N. G. Ramsay, M.A., B.Sc.

The Falkland Islands were visited on three occasions by the *Scotia*, namely: January 6th–January 26th, 1903; December 2nd–December 9th, 1903; January 31st–February 9th, 1904. Dr Bruce had also previously visited these interesting islands in December 1892 and February 1893.

As the *Scotia* neared them for the first time, "in the cold grey dawn the low, bleak, treeless, but grassy land looked very like some parts of the north of Scotland."

"Vast stretches of undulating moorland, interspersed with peat-bogs and swamps, constitute the general type of country, unless where the land rises into rocky ridges, or higher into jagged hills. In place of heather, the 'diddle-dee' (*Empetrum rubrum*), a close ally of our blaeberry, grows in prolific abundance, clothing the moorland for miles and miles, and each in its own particular haunt various kinds of sedges flourish. The absence of trees on the islands is very noticeable." *

Although there was much to keep the staff occupied during these visits, apart from scientific pursuits, a number of excursions were made, and a considerable number of birds were collected.

The *Scotia's* collection of birds' skins includes twenty species, represented by sixty-five skins, from the Falklands. Several other species were also observed. All have been recorded as occurring in the Falklands by previous writers.

Tachyeres cinereus (Gm.).—Two specimens of the flightless "Steamer-duck" or "Loggerhead" were brought home. They were seen in numbers on all three visits. In December 1903 some of the birds had families of ducklings with them.

A number of the eggs of this bird are included in a collection of birds' eggs which Mr Thomson and Mr Coulson, jun., of Cape Pembroke lighthouse, kindly presented to the naturalists of the Expedition. These eggs measure 3·25 by 2·25 inches, and are pale creamy buff in colour.

Chloëphaga hybrida (Mol.).—These birds were also seen on all three visits, and seven skins are in the collection (three adult males, one immature male, and three females).

The eggs, if the specimens are correctly named, are hardly distinguishable in size and colour from those of the Loggerhead.

Nycticorax tayazu-guira (Vieil.).—Two specimens of the "King-quawk," as it is

* R. N. Rudmose Brown, *The Voyage of the "Scotia,"* p. 196.

locally called, were obtained, an adult on January 12th, 1903, and a young bird of the year on February 1st, 1904. A description of the latter is appended :—

Measurements: Length (skin) about 24 ins.; wing 11·75 ins.; culmen 2·7 ins.; tarsus 3·2 ins.

Back, scapulars, and wing-coverts nearly uniform brown with a rusty tinge. Some reddish-yellow and white tips among the lesser wing-coverts. Bastard wing and primary coverts tipped with white. Quills and tail dark grey with a rusty tinge. Feathers of head, neck, and under parts dusky brown with broad white and yellowish-white shaft-streaks, crown blackish-brown. Bill blackish at tip and along culmen, remainder yellow-brown. Feet dark brown (in dried skin). The adult is a male. The bill and interior of mouth were noted as black, the iris red; its stomach was full of fish.

This bird was rather rare in the islands, according to the accounts of the islanders, though Dr Bruce previously obtained it when he visited the Falklands in 1892.

Phalacrocorax magellanicus (Gm.).—Twelve skins are in the collection.

Five of these are adults. These were shot on January 7th, 1903 (one), and February 1st, 1904 (four). There is no trace of a crest, and black of the throat and foreneck is being replaced with the white of the winter plumage to a varying degree.

(*a*) 7.1.03. Has a small white spot on the chin, but the feathers between the rami of the mandible are black.

(*b*) 1.2.04. Ditto, but a small white cheek-spot also.

(*c*) 1.2.04. As (*b*).

(*d*) 1.2.04. Indistinct white patch on throat, white cheek-spot.

(*e*) 1.2.04. Feathers between mandibular rami and chin pure white, throat mottled white, white cheek-spot.

Six full-grown young birds with brown down still adhering to the feathers of head and neck were obtained at Tussock Islands in Port William on February 1st, 1904, where numbers of them were seen. Three of these are glossy brownish black on head, neck, upper parts, and thighs, with the belly greyish brown. The rest are similar except as to the belly. One has this blackish brown; one has it nearly white, only the tips of some of the feathers being blackish; and the last shows white, but to a much less marked extent.

Phalacrocorax albiventer (Lesson).—One adult was obtained at Cape Pembroke in January 1903.

Buteo erythronotus King.—An immature bird was obtained on January 21st, 1903.

Milvago australis (Gem.).—"The hawk known as the Johnny Rook" is logged as having been seen during the *Scotia's* first visit to the Falklands. It is quite a familiar bird in the vicinity of Port Stanley.

"Turkey-buzzards" (*Cathartes* sp.) were seen during the third visit.

Larus glaucodes Meyen. — One adult skin is in the collection, obtained on February 1st, 1904, at Tussock Islands, where many were seen. In life, this gull has a "beautiful rosy blush" on its breast plumage, which has disappeared, however, in the skin.

Larus dominicanus Licht.—These birds were observed on all three visits, and were found breeding in numbers on the Tussock Islands in February 1904, a number of eggs, and two young birds, being obtained there on the 1st. One of the young is a chick in the down, the other older, with quills half-grown.

Sterna hirundinacea Less.—This species was also found breeding on the Tussock Islands on February 1st, 1904, a half-fledged chick being obtained on that occasion. An adult bird was also secured on February 8th, at the same place.

Megalestris antarctica (Less.).—Skuas were seen during the *Scotia's* second and third visits.

Hæmatopus ater (Less.).—One adult was obtained at Cape Pembroke, during the *Scotia's* first visit.

Hæmatopus leucopus (Garn.).—Four skins, all adults, are in the collection, obtained on the *Scotia's* first and third visits.

Eudromias modesta (Licht.).—One skin is in the collection.

Gallinago paraguayiæ (Vieil.).—Of this species also there is one specimen.

Tringa fuscicollis Vieil.—Five skins of this winter migrant from the far north are in the collection. Four of these were obtained in January 1903, the remaining one on February 2nd, 1904.

Ægialitis falklandica (Lath.).—Four specimens, two adult, two immature, were obtained, in January 1903 (label of one immature bird lost).

Anthus correndera Vieil.—Two specimens were obtained on February 5th, 1904. They both show the long wedge of white on the penultimate pair of tail-feathers, characteristic of old birds of this species. The plumage of one is very much abraded, the pale margins of the feathers on the back being worn away so as to leave it nearly uniform dark brown. The tail especially has suffered, some of the feathers being reduced to less than half their original breadth. There is an almost complete absence of the sandy tint in the plumage of this specimen, as compared with the other.

The latter has apparently just moulted, the feathers being very fresh and new, and the broad margins to those of the upper parts are of a very warm sandy buff colour, while the whole of the lower parts are tinged with the same hue.

Muscisaxicola macloviana (Garn.).—Six specimens of this species were brought home, two of which were obtained in January 1903, and four in February 1904. The average wing measurement is almost 4·4 ins.

[*Turdus falklandicus* (ex Quoy et Gaim.).—A thrush logged as having been seen during the *Scotia's* first visit to the Falklands was presumed to belong to this species, which is confined to these islands.]

Trupialis militaris (L.).—An adult accompanied by a full-grown young bird were seen by Messrs Wilton and Brown one evening during the *Scotia's* second visit (December 1903), and one or two also on the third.

The collection of eggs referred to above includes three of this species. They measure 1·5 × 1·1 ins., and are white, irregularly spotted and blotched with pale vinaceous grey and chocolate-brown.

Phrygilus melanoderus (Q. et G.).—Many of these bright-coloured little birds were seen flitting about the shore. Three specimens were obtained, two adult males and a female, on January 12th, 1903.

Ossifraga gigantea (Gm.).—Giant Petrels or "Nellies" were seen during the *Scotia's* second visit to the Falklands, and one also during the last visit.

Catarrhactes chrysocome (Forst.).—One example of this penguin was obtained at Cape Pembroke on January 5th, 1903. It is an adult female.

Spheniscus magellanicus (Forst.).—Seven specimens (six adults and one young bird) are included in the collection. All are from the Tussock Islands, February 1904.

The young bird measures (in the skin) about 19–20 ins. in length; flipper 6·5 ins., culmen 1·7 ins. It is therefore only about half-grown, as the adult measures 28 ins. A quantity of brown down still adheres to the feathers of the median line of the crown and the whole of the hind neck.

The plumage of the whole of the upper parts is of a uniform blue-grey appearance, like that of *Pygoscelis* in fresh plumage, the feathers being tipped with blue and with black shaft-streaks. The under parts are entirely white, with the exception of an ill-defined dark grey band $1\frac{1}{2}$–2 inches wide, corresponding in position to the neck-band of the adult; sides of head white mixed with grey. Underside of flipper much as in the adult. The ridges on the base of the bill are already quite marked; the groove between culminicorn and latericorn is much more conspicuous than in the adult.

The haunts of the Jackass Penguin, on William Islands, were visited during the *Scotia's* third stay at Port Stanley. This penguin was found to inhabit burrows varying from a foot to a couple of yards in length among the roots of the tussock-grass (*Dactylis cæspitosa*), and, "with caution, one could see it sitting at the mouth taking the air, but at the least alarm away it rushes into the safety of this underground dwelling. It has a curious habit of sitting far back in its burrow eyeing the intruder, with its head turned sideways, now on one side now on another. This penguin derives its popular name from the very close similarity between its cry and an ass's bray." *

During the *Scotia's* voyage from Buenos Aires to Port Stanley, penguins were encountered on January 28th, in 45° 31′ S., or about 350 miles from the Falklands. Others were seen the next two days, before Port Stanley was reached. To the south, penguins were met with in about 57° S., 55° 30′ W., on November 30th, 1903, and again on the next two days as the ship approached the Falklands.

* R. N. Rudmose Brown, *The Voyage of the "Scotia,"* p. 200.

Section IV.—Voyages between the Falkland Islands and the South Orkneys.

By L. N. G. Ramsay, M.A., B.Sc.

Across the tract of sea lying between the Falkland and the South Orkney Islands, about 600 nautical miles apart, the *Scotia* made three voyages: southwards in January–February 1903, northwards in November–December of the same year, recrossing southwards again in February 1904.

The voyages averaged about seven days' duration; the weather conditions were sometimes clear and calm, sometimes stormy, with violent winds and snow showers; no ice was sighted north of the immediate neighbourhood of the South Orkneys, except on the first voyage, when bergs were met with in some numbers during the southern half of the journey, and the pack was encountered about 60° S. lat., unusually far north.

Bird life was fairly plentiful on all three trips, chiefly albatroses and petrels.

Diomedea exulans was noted on all three trips, chiefly towards the Falklands (seven were seen on one day about 53° 20′ S.), but they were also seen daily up to 58° S. on the first voyage.

"Molliemauks" (a general name for the smaller albatroses, except *Phæbetria*) were seen in some numbers throughout the greater part of the area. Two specimens were obtained on December 1st, 1903, at the Burdwood Bank, which lies some 90 miles south of the Falklands. These prove to be *Thalassogeron culminatus* (Gould), both adult.

The following notes were logged on December 1st, referring to these two albatroses and a third which was probably not preserved:—

> "They differ in colour especially about the head, some being much lighter than others. The bills also differ in colour, the three we secured yesterday showing this. Two of them have a yellow culmen and yellow under the mandible, while the third is almost entirely grey. The inside of the mouth is yellow. The legs are of a pale grey, almost white in parts, mottled with darker grey towards the outer end of the webs. The grey has a distinct lavender tinge, much the same as the feathers. Eyelid is black as well as the cere. At lower angle posteriorly is a patch of white feathers, which in flight looks like a white eyelid. The eye has a dark olive-green iris, while the pupil is greenish-black." In the dried skin the feet are yellowish grey (*Zoological Log of the "Scotia,"* p. 61).

Several "Grey-headed Molliemauks," recorded on February 12th and 13th, 1904 (58°–60° S.), may be of this species, or *Thalassogeron chlororhynchus*. Several of the "Real Molliemauk (Yellow-billed Albatros)" seen on February 12th of the same year were probably *Diomedea melanophrys* Temm. Sooty Albatroses were also observed in fair numbers over the greater part of this tract of sea. The notes made by Dr Bruce and the other naturalists at the time make it probable that *Phœbetria cornicoides* was present as well as *P. fuliginosa*. On November 30th, 1903, a "Sooty" having "the characteristic head and eye, but white underneath like a Mollie," may have been the light-bodied *P. cornicoides*. Also on February 1st, 1903, Sooties and "Molliemauks grey and greyish black with no white at all" were logged. The latter would seem to have been *Phœbetria cornicoides*.

Wilson's Petrels (*Oceanites oceanicus*) were seen every day on the first voyage, and one was shot on February 2nd. On the two later voyages they were more irregular, being logged as "plentiful" on two days, while on some days none were seen.

"Blue Petrels" were found in plenty throughout the area, except in the neighbourhood of the Falklands. Owing to the difficulty of distinguishing between the true "Blue Petrel" (*Halobæna cœrulea*) and the "Whale-birds" (*Prion* spp.) on the wing,* there are no records for these voyages in which the species is certain. However, it may be supposed that the "Blue Petrels" logged were Banks' Whale-bird (*Prion banksi*, Gould).†

A dead Blue Petrel was picked up on November 28th, 1903, which is stated to be *P. banksi* in a footnote in the *Zoological Log of the "Scotia"* (published 1908), on Mr Eagle Clarke's authority.

Cape Pigeons (*Daption capensis*) were plentiful, on the whole, numbers being seen near the South Orkneys; sometimes several were caught with landing-nets. On some days, however, none were logged, on others few. On the return voyage to the Falklands they were present up to the day on which Port Stanley was reached.

In the *Zoological Log* for November 29th and 30th, 1903 (58° and 57° S.), "Cape Hens" are mentioned as being seen (one on the 29th and a few on the 30th) "for the first time since we were in these latitudes last." On February 11th and 12th, 1904 (55°–58° S.) a petrel "about the size of *Larus dominicanus* or a little larger, and completely dark," was logged. These records may refer to *Majaqueus æquinoctialis*, commonly known as the "Cape Hen," and answering to the above description pretty well. There is no record in the log of the first voyage which could refer to this species.

The above, with a few other unidentified petrels, were all the birds which were apparently roaming at large on these seas when traversed by the *Scotia*. In the neighbourhood of the South Orkneys a number of other species which were nesting on those islands were encountered, viz. :—

Ossifraga gigantea, *Priocella glacialoides*, *Pagodroma nivea* (these were met with when the ship entered the pack on February 2nd, 1903) *Chionis alba*, *Sterna hirundinacea*, *Megalestris antarctica*, and *Pygoscelis antarctica* and *P. adeliæ*.

* The white tip to the tail of *Halobæna* is a sure mark of distinction : Wilson, (*British*) *Nat. Ant. Exped.*, vol. ii. *Zoology*, p. 104.

† See Mr Eagle Clarke's papers on South Orkneys and Weddell Sea under these species.

Penguins were seen on November 30th, and December 1st and 2nd, 1903, in 57°–52° S., as noted in a former section.

NOTE.—I take this opportunity of placing on record some observations of the bird-life of the seas between the Falkland Islands and Graham Land, taken from the log kept by Dr Bruce when naturalist on the whaler *Balæna* on her voyage of 1892–3, in the months of December and January.

A remarkable incident of the voyage occurred on December 16th, 1892, when birds, especially Cape Pigeons (*Daption capensis*), but also Blue Petrels (? *Halobæna*) and "Molliemauks," thronged literally in myriads over the sea, throughout the day, forming a spectacle never to be forgotten, as Dr Bruce informs me. The previous and following days these species were not observed in any large numbers. "Blue Petrels" were seen in small numbers until the *Balæna* was approaching Graham Land, but were not seen in the vicinity of this land or the adjacent islands. *Daption capensis* continued to be present throughout the voyage.

Pagodroma nivea was observed from December 20th onward, after ice had been encountered.

Ossifraga gigantea was also recorded (including several white examples) in the neighbourhood of Graham Land, also *Chionis alba* and terns of some species. Several large albatroses (*Diomedea exulans*) were seen two days after the *Balæna* left Port Stanley for the south.

Stormy Petrels (? *Oceanites oceanicus*) were present in small numbers throughout the voyage.

An account of the Penguins observed in the vicinity of Erebus and Terror Gulf, on the voyage of the *Balæna*, is given in an article by Dr W. S. Bruce entitled "Antarctic Birds, I.," in *Knowledge*, xvii. pp. 208–210; and of the sister ship *Active*, by C. W. Donald, M.B., in the *Proc. Roy. Soc. Edin.*, 1895, pp. 170–176.

Section V.—On the Birds of the South Orkney Islands.*

By Wm. Eagle Clarke, F.R.S.E., F.L.S., Keeper of the Department of Natural History of the Royal Scottish Museum.

The South Orkneys are a group of over a dozen islands situated between 60° and 61° S. lat., and 43° 3′ and 47° W. long. They lie some 600 miles S.E. by E. of the Falkland Islands, about 500 S.W. of South Georgia, and 200 E. of the South Shetlands. They were discovered by Powell in 1821, and were visited by Weddell in 1823, by Dumont D'Urville in 1838, and by Larsen in 1893. The descriptions furnished by these explorers were, however, meagre in the extreme, and until the visit of the Scottish expedition the South Orkneys remained among the least-known lands lying on the fringe of the South Polar Sea.†

So far as their ornis is concerned, only two species of birds, and one of these problematical, have hitherto been alluded to—namely, the Ringed Penguin (*Pygoscelis antarctica*), of which a specimen was obtained on Weddell Island by D'Urville, and a Crested Penguin (*Catarrhactes*) described by Larsen.

The *Scotia* visited the islands on her voyage south in February 1903; subsequently, having completed her first Antarctic cruise, she returned to the archipelago towards the end of March and went into winter-quarters, remaining there for eight months, during which period much valuable geographical and zoological work was accomplished.

Only two of the islands are of considerable size—namely, Coronation Island, which is the most westerly, and Laurie Island, the most easterly.

Laurie Island, where the *Scotia* wintered, was the main scene of the labours of the expedition, and it is almost entirely upon observations and collections made during eleven months' residence there that the following contribution is based. The length of this island is about 12 miles, its maximum breadth 6 miles, and its area fully 30 square miles. The interior is lofty, and several of the summits reach to an altitude of from 2000 to 3000 feet. A number of deep bays run inland from north to south, separated by narrow rocky peninsulas or steep lofty mountain-ranges, and cause the island to have a very remarkable outline. All the valleys are choked by glaciers, and what little exposed rock is visible is precipitous in the extreme. Here and there on the lower slopes and at sea-level are a few acres of more or less level ground. In winter the whole island and even the faces of the precipitous cliffs are covered with snow, which does not commence to disappear till October and November (the late spring and early summer months); but then many patches of moss-covered ground are laid bare, some of them bearing soil

* Reprinted, with slight verbal alterations, from *The Ibis*, Series VIII., vi., 1906, pp. 145-187.

† See *The Voyage of the "Scotia,"* 1908.

from six to ten inches deep. Except this vegetable mould, there is little soil anywhere. The rocks, various kinds of graywacke, are mostly covered with lichens, especially *Usnea*, which, with various species of moss, form the entire terrestrial flora of the island.

Concerning climatic conditions, Mr Mossman informs me that, in spite of their low latitude, the climate of the South Orkneys is essentially polar. One of the most powerful factors in determining the temperature of the air over this region is the cold Antarctic current which carries streams of ice and numerous icebergs to a latitude corresponding with that of the northern part of England. The mean annual temperature, based on nearly two years' observations, was found to be 22°·7 F., the means of the seasons being: summer 31°·4, autumn 22°·7, winter 13°·7, and spring 23°·3. The most remarkable feature was the low and equable summer temperature, which rarely rises above 37° or falls below 25°.* In winter, owing to the freezing up of the sea to the south, the islands are virtually on the edge of a continent, and the temperature at that season is thus characterised by great variability, the range of the thermometer frequently exceeding 60° in twenty-four hours. If the wind is in the south, very low temperatures, as low as 40° below zero F., are recorded; but with a change of wind to the north the thermometer may rise, even in the depth of winter, above the freezing-point. Summer is characterised by almost continuously overcast skies, and the finest and clearest weather occurs in winter. Owing to the large amount of cloud which hangs over the islands in summer, the temperature is much the same as at places ten degrees further south. The snowfall is excessive, the sunshine is very deficient, and strong gales are frequent.

The first landing on the archipelago was effected at Saddle Island, which was fortunately clear of ice, on February 4th, 1903. Here the explorers were met by a host of Ringed Penguins (*Pygoscelis antarctica*), which had a large "rookery," where many young and some eggs were found. Cape Petrels or "Pigeons" (*Daption capensis*), Sheathbills (*Chionis alba*), and Skuas (*Megalestris antarctica*) were also nesting, and specimens of both young and old were obtained. Gulls (*Larus dominicanus*), Giant Petrels (*Ossifraga gigantea*), and Shags (*Phalacrocorax atriceps*) were observed on the adjacent islets and rocks, and were apparently nesting there.

From Saddle Island the *Scotia* sailed for the far south, and, having made a successful voyage in the southern waters of the Weddell Sea, the Expedition returned to the South Orkneys on March 21st. This was followed by a quest for suitable winter-quarters, during which Leathwaite Strait and the east side of Coronation Island were explored, and, finally, on March 25th, a bay, afterwards named "Scotia Bay," on the south coast of Laurie Island, was selected.

It was now autumn, and the birds were beginning to emigrate in search of more genial winter-quarters to more northern latitudes, or, in the case of some species, the nearest open water to the archipelago, wherever that may have been. Even in mid-winter (June and July) Laurie Island was not devoid of feathered inhabitants, for the

* Subsequent data slightly alter these values, but not as much as a degree —EDITOR.

following birds were observed more or less frequently, though not abundantly :—Snowy Petrels (*Pagodroma nivea*), Giant Petrels (*Ossifraga gigantea*), Gulls (*Larus dominicanus*), and Sheathbills (*Chionis alba*). The Skuas (*Megalestris antarctica*) and the Ringed Penguins (*Pygoscelis antarctica*) departed during the last days of April, and were followed by the Cape Petrel (*Daption capensis*) and the Adélie and Gentoo Penguins (*Pygoscelis adeliæ* and *P. papua*).

The first spring immigratory movements took place in October, when Cape Petrels, Adélie and Gentoo Penguins, Skuas, and Terns (*Sterna hirundinacea*) arrived in the order indicated, the last-named at the very end of the month. These were followed in November by Wilson's Petrel (*Oceanites oceanicus*), the Ringed Penguin, and the Silver Petrel (*Priocella glacialoides*).

With the return of spring the explorers were busy and journeys were undertaken in various directions, while a camp was established on the northern shore of the island, which was productive of excellent ornithological results, but had unfortunately to be abandoned at an interesting period on account of the break-up of the ice.

After having been icebound for eight long months, the *Scotia* was liberated on November 23rd, 1903, and immediately departed for the Falklands and Buenos Aires to refit; but a party under the charge of Mr Mossman, the meteorologist, and Dr Harvey Pirie, the medical officer and geologist, was left to carry on the various observations and investigations and to make collections throughout the summer months. It is to the assiduous labours of Dr Pirie that we owe most of our knowledge of the bird-life of the island during this most interesting part of the year, and he has earned the best thanks of ornithologists for the vast amount of valuable work which he accomplished.

During the summer bird-life was extremely abundant. Rookeries of the three species of penguin (*Pygoscelis*) were numerous on the low rocky shores and less steep cliffs on various parts of the coast. Some of these bird-cities contained several millions of inhabitants, and their daily life presented scenes so remarkable as to be almost beyond description. The cliffs and their screes were the home of several species of petrels, which resorted in great numbers to the ledges and crannies for nesting-sites, and the shores were the abode of the gull, the skua, and the tern.

The Ringed Penguin, hitherto regarded as being nowhere an abundant species, was found to have its metropolis at the South Orkneys, where the summer population on Laurie Island alone was estimated at not less than one million birds.

The finding of the eggs of the familiar Cape Petrel (hitherto unknown to science) and of the chicks and young of the Ringed Penguin and the Snowy Petrel, the remarkable extension of the known range of the Macaroni Penguin (*Catarrhactes chrysolophus*) and of *Fregetta melanogaster* (which was undoubtedly breeding), were also among the results of the summer's work. Eggs of Wilson's Petrel, the Sheathbill, the Blue-eyed Shag (*Phalacrocorax atriceps*), and other well-known Antarctic species were also obtained, some of them in great abundance. The collection of bird-skins, too, was largely augmented.

The series of bird-skins is one of the most important ever made in the Antarctic Seas. It comprises one hundred and forty-three specimens, representing sixteen out of the eighteen species now known to frequent the islands and their immediate vicinity; while the eggs number several thousands. Many of the skins afford additional information concerning little-known phases in the plumage of several species, and enable me to describe for the first time the young or immature stages of others, such as the Ringed Penguin, Shag, Snowy Petrel, and so forth.

Add to the above slight summary of the bird-work accomplished the innumerable notes on and accounts of the nidification and other habits of not a few little-known species, and the investigations of their periods of incubation and the dates of their arrival at and departure from their summer haunts, and we have an outline of the ornithological results obtained by the Scottish National Antarctic Expedition at the South Orkneys—results of the first importance, and meriting the full recognition, the sincere thanks, and the most hearty congratulations of all interested in our favourite science.

On the return of the *Scotia* from the Falklands, the members of the Expedition, save Mr Mossman and another, embarked, and the South Orkneys were finally quitted on February 22nd, 1903, for the southern shores of the Weddell Sea—the Antarctic Continent, the then-discovered Coats Land.

In the preparation of this contribution I feel conscious that I have laboured under one very great disadvantage, namely, that of not having been a member of the Expedition, a circumstance which must naturally result in unavoidable shortcomings. Much valuable information, both written and verbal, has, however, been placed at my disposal, including the official Zoological Log and full and interesting notes from the private diaries of Dr Bruce, Dr Pirie, Dr Rudmose Brown, Mr Wilton, and Mr Mossman. Mr Mossman, at the request of the Argentine Government, spent a second winter and summer at Laurie Island, engaged in meteorological and magnetic work, and he has most kindly supplied me with some additional information on bird-life made after the departure of the Scottish Expedition. To all these friends I desire to express my deep indebtedness and my sincere thanks. My friend Mr Norman B. Kinnear has also earned my acknowledgments for his assistance in classifying records.

I propose to conclude this section of my contribution by instituting a comparison between the avifauna of the South Orkneys, that of the nearest regions lying to the south and north of them, and that of the Antarctic Continent.

Before proceeding to do this it will be well to remark that the avifauna of the South Orkneys, as at present known, comprises 19 species; of these 13, perhaps 15, are natives, *i.e.* breeding birds.

Turning our attention first to the south, and comparing the avifauna of the Orkneys with that of the South Shetlands, which lie to the south and west, we find a remarkable similarity between the ornis of the two archipelagoes. This similitude is no doubt due to analogous climatic and other conditions influencing both animal and vegetable life. As regards their bird-life, the two groups are practically identical, the Orkneys only claiming one nesting species which does not occur in the Shetlands, namely, the petrel *Fregetta melanogaster*; while I am not aware that the latter group possesses a single native species not found in the Orkneys.

When, however, we come to extend our ornithic survey to the nearest northern land, South Georgia Island, the result is entirely different. Here we find that while there are 9 * native birds common to both, South Georgia has at least 12 † which do not breed in the Orkneys, while the latter isles can only claim 3 which do not summer in Georgia, namely *Pygoscelis adeliæ*, *Phalacrocorax atriceps*, and *Sterna hirundinacea*. When we examine and compare the climatic conditions prevailing at these two stations we have the key to these marked differences. In South Georgia, though only six degrees north of the South Orkneys, the mean summer temperature, Mr Mossman informs me, is 8°·8 higher, while autumn, winter, and spring are respectively 11°·6, 15°·9, and 10°·7 warmer. At South Georgia the lowest temperature recorded was 9°·9 above zero, while at the South Orkneys 40° below zero has been registered. In South Georgia no less than 15 species of flowering plants (phanerogams) are known: in the South Orkneys not one.

Extending our survey in like manner to the far south, and comparing the avifauna of the South Orkneys with that of the Antarctic Continent, we find that the latter has only 3 native birds not summering in the Orkneys, namely, the stately *Aptenodytes forsteri*, *Megalestris maccormicki*, and *Sterna macrura antistropha* Reichenow. The birds common to both are also 3—*Pygoscelis adeliæ*, *Oceanites oceanicus*, and *Thalassœca antarctica*.

The final instalment of the ornithological results of the Scottish National Antarctic Expedition will be devoted to the birds of the Weddell Sea, southwards of the South Orkneys, and Coats Land.

Pygoscelis antarctica (Forst.).

Pygoscelis antarctica Cat. B., xxvi. p. 634.

The Ringed Penguin is an uncommon bird in collections, and has hitherto been regarded as not an abundant species anywhere within the somewhat limited area in which it occurs; while its phases of plumage were little known except in the adult state.

Now, thanks to the work of the Scottish Expedition, we know that the species is extremely abundant at the South Orkneys; while the collections brought home

* These are *Pygoscelis antarctica* and *P. papua*, *Fregretta melanogaster*, *Pagodroma nivea*, *Ossifraga gigantea*, *Daption capensis*, *Larus dominicanus*, *Megalestris antarctica*, and *Chionis alba*.

† *Aptenodytes patagonica*, *Catarrhactes chrysolophus* (possibly a breeder at the South Orkneys), *Pelecanoides exsul*, *Garrodia nereis*, *Majaqueus æquinoctialis*, *Prion desolatus*, *Diomedea exulans*, *Phœbetria fuliginosa*, *Sterna vittata georgiæ*, "*Phalacrocorax carunculatus* Gm. (*P. albiventer* Less.)," *Querquedula catoni*, and *Anthus antarcticus*.

enable me to describe all the stages of plumage from the newly hatched chick to the mature bird.

Although not nearly so numerous as its congener *P. adeliæ*, yet next to that species it was the most abundant of all the birds found at the South Orkneys, where the total number resorting to Laurie and Saddle Islands for the summer is estimated at over one million.

This species was first seen by the Expedition on February 2nd, 1903, in lat. 60° S., to the north-east of the archipelago. Here a party was observed, some of which were sitting on an iceberg, others on the water. Two days later the first landing on the islands was effected at Saddle Island, where the explorers met with a vast concourse of these birds, and a number of specimens, young and old, and some eggs were secured. The rookery at this island is believed to be tenanted by not less than 50,000 birds.

On her return to the South Orkneys in the autumn after the first voyage to the Weddell Sea, the *Scotia* encountered Ringed Penguins off the east coast of Coronation Island on March 23rd. On March 26th she went into winter-quarters in Scotia Bay, Laurie Island, and there these birds were observed until April 28th, on which date the last of the autumn emigrants were seen. They were entirely absent during the whole of the winter; and the earliest of the spring immigrants were noticed on November 2nd. On the following day a few more arrived, and the first bird to land walked straight up to a small moraine, picked up a stone, and laid the foundation of its new nest. After this date the immigrants were observed in varying numbers, many arriving on November 9th.

When walking over hard surfaces to reach their nesting-grounds, it was noticed that the birds maintained an erect position, marching in column of route; but when they came to soft snow they assumed a prone attitude and propelled themselves by means of their legs; when ascending a slope, or being chased, they brought their flipper-like wings into play, using them either alternately or synchronously; and when descending from any height they tobogganed.

Eight rookeries were found on Laurie Island. The largest of these were at Cape Robertson and Ailsa Craig, each of which contained many thousands of nests. There were two other rookeries almost equal in size, but the rest were smaller, each tenanted by a few hundred birds, and situated at different places on the coast. On some of the off-lying Rudmose and Murray Islands there were jumbled rookeries of Ringed Penguins and Shags (*Phalacrocorax atriceps*). Dr Pirie tells me that at Cape Robertson and Ailsa Craig the inhabitants of the great bird-cities were solely composed of the ringed species. At Cape Robertson, the birds occupied a strip of the coast about half a mile long extending over the low rocky foreshore and up the gently rising cliffs behind, until the farthest-inland birds must have been a couple of hundred yards from the sea, and at a height of two or three hundred feet above it. He reckoned that on an average there would be about a nest to each square yard, and there could not have been much less than a quarter of a million birds. Here Dr Pirie and two companions took 1000 eggs in a very short time on December 12th. Dr Pirie had under more continuous observation a small congeries which had taken up its abode amidst the Adélie rookery at Point Martin, Scotia Bay. Here they constituted a small foreign element on fairly high ground, with their congeners higher up as well as all over the ground between them and the sea. Although massed together, they apparently get on with their neighbours as well (or as ill) as with each other. The nests were poor affairs composed of a few pebbles, varied occasionally by the bones of deceased ancestors. Woe betide the inhabitant of these cities and villages that strays beyond the boundaries of his or her domain; then the beaks of all the penguins around dart out at the intruder and soon drive it back to its own territory. There was one point where the path up the cliff was very narrow, and here a constant stream of penguins of both species used to go up and down on their way to the water. Right on the track were some nests of the ringed species, and how these birds managed to hatch their eggs is a mystery, for all day long they were incessantly engaged in pecking at the passers-by, who, though often in a hurry, frequently stopped and retaliated. The cry of this bird is harsher than that of the other species, and during the breeding-season it is active and always on the move, though at other times it is solemn and phlegmatic in temperament. Its pugnacious disposition made a visit to the rookery a painful adventure, for the protection of long sea-boots did not always suffice. This bird is a good strategist, and believes in getting in the first blow. Dr Pirie has seen one take a run of several yards, jump, and fasten on to an intruder above his boots, at the same time lashing out vigorously with its flippers. When on the beach or ice-foot mingled with other species, the Ringed Penguins seemed always to take the lead in entering the water. They took the lead, too, in repelling the attacks of the Samoyede dog "Russ." He could outmanœuvre any Adélie or Gentoo Penguin, but he had frequently to retire before the onslaughts of the present species, which would face up to him and sometimes deliberately attack him. It was decidedly the "boss," and jockeyed both the Adélies and the Gentoos.

Occasionally three eggs are laid, usually two, and sometimes only one. A considerable number of eggs were obtained, and these vary in size from 7·70 cm. × 5·40 cm. to 6·95 cm. × 5·50 cm. A small egg, one of a clutch of three, measured 4·43 cm. × 3·92 cm. The average weight of fresh eggs was 3·56 oz. The eggs seem to be little known. They vary in shape, some being almost perfectly oval, others more elongate in form and narrower at one end. In colour the majority of those in the collection are of a uniform very pale greenish white, with a thin coating of a chalky nature, such as is found on the eggs of cormorants (*Phalacrocorax*) and other birds.

The first chicks were found on January 7th, 1904, and appeared to be about two days old; but this was not at the rookery where the first eggs were laid. The young, though hatched considerably later than those of their congeners, seemed to develop more quickly, and by February 11th some of them were beginning to show the characteristic black ring.

In the autumn of 1904 Mr Mossman saw this species for the last time on April 26th.

The first bird seen in spring was noted on November 14th, and the first eggs of the season were found on November 27th.

The collection of skins contains only thirteen specimens of the Ringed Penguin, but these represent the species in all stages of its plumage, and include a magnificent albino example.

The following is an account of the various stages of plumage, most of them hitherto unknown, passed through by this species :—

Chick (Laurie Island, January 7th, 1904).—The newly-hatched chick differs somewhat remarkably from that of its congeners, since it lacks the dark or black head characteristic of *P. adeliæ* and *P. papua* and is entirely clad in silky-white down, except in the lower part of the abdomen, where it is partially naked. Bill black. Feet yellowish. (It would have been more correct to figure this little bird in a nest rather than erect, but such a mode of treatment would not have shown it to advantage.)

Young in Down (Saddle Island, February 4th, 1903).—There is a great change from the plumage of the chick to the full-grown young in down. The latter is densely clothed in short down resembling fur, the upper parts of which are mouse-grey, passing into pale whitish grey on the head and cheeks; the hind-neck is tipped with white and the lores are blackish. The under surface is drab-grey, paler in the centre of the abdomen; the chin and throat are blackish. Bill black. Feet yellowish. Wing 4·9 inches. Culmen 1·4 inches. Tail-feathers 1·5 inches.

Young in Down and Feathers (Eillium Island, February 22nd, 1904).—Has blue-grey feathers on the lower back, tail, sides of the back, and on the edge and tip of the wing; a band of blackish feathers on the crown and hind-neck; lores feathered black, and the rest of the upper surface covered with mouse-grey down. Under parts with pure white feathers on the abdomen, lower breast, and chin; upper breast and neck in whitish down with a dusky band across the throat, under which the characteristic black ring or bridle is in evidence. Wing 6·3 inches. Culmen 1·35 inches.

Immature Birds in First Plumage resemble the adults, from which they only differ in having the back almost entirely blue, *i.e.* showing little black. Here, again, this species differs from its congeners, which have more or less pronounced colour-characters associated with their first plumage.

Adults.—The old birds on their arrival in spring (November) have the blue and black of the upper surface very bright in tint, but as summer advances (February) the blue fades and the black assumes a brownish hue. In February, too, some are in deep moult, the under down shows through the scanty covering of contour-feathers, the feathers on the wings are ready to drop off in patches, and the birds are quite tailless. In March and April the new plumage has been assumed, with the exception of the tail-feathers, which are still quite short, and yet these are the first to be assumed by the otherwise downy young. The wing in the adult males measures from 7·1 to 7·5 inches, and in females from 6·75 to 7·2 inches.

The average weight of seven adult males taken on the 4th of February 1903 was

9·1 lbs., the smallest scaling 7 lbs. and the largest 11·75 lbs. Eight females averaged 8·65 lbs., the smallest being 6·75 lbs. and the largest 10 lbs. On February 9th, 1904, Dr Pirie got specimens weighing as much as 17 lbs.

The albino is an adult female, and the plumage is *entirely* pure white with a silky gloss. The bill is black and the feet are orange. It was obtained on the south beach of Scotia Bay on the 2nd of February 1904.

Pygoscelis adeliæ (Hombr. et Jacq.).

Pygoscelis adeliæ Cat. B., xxvi. p. 632.

Thanks to the researches of the Expedition, the northern range of this truly Antarctic species has been considerably extended, and the South Orkneys and their neighbourhood now mark the extreme limits of its ascertained distribution at all seasons of the year.

The Adélie or Black-throated Penguin is no doubt a resident bird in the archipelago, for it was observed there all the year round, though only occasionally during the winter months, which were probably spent on the open sea in the vicinity of the islands.

This bird was first noticed in lat. 60° 30′ S. and long. 43° 40′ W. on February 3rd, 1903, when the *Scotia* was nearing the South Orkneys. A number were then observed swimming after the ship in company with *P. antarctica*, while others were seen on the ice, either lying down or squatting. Those walking on the floes presented a comical appearance, their gait resembling that of an "old salt" just ashore after a long voyage. In jumping from the water on to the ice they made remarkable leaps of several feet, but were not always successful, and fell back into the sea. The species does not appear to have been observed at Saddle Island, but at Laurie Island it was the most abundant of all the penguins, and its numbers during the summer were estimated at not less than five millions.

Though a few were noticed throughout the winter of 1903, it was not until October 7th (October 8th in 1904) that the birds commenced to return to their summer haunts. Over forty were then observed in Scotia Bay, most of them engaged in climbing up the rocks into the old rookeries as if they had come to stay. They were all in plump condition and travelled quickly, most of them moving on their bellies at full speed. On the 10th large bodies were making their way from the open water, and on arriving at the shore clambered up the rocks at once and made for the rookery. A party of these birds, accompanied by some Gentoos, was met *en route*, and as soon as the Adélies observed the intruders they hurried ahead, moving quickly on their bellies, to meet the strangers, and on arriving moderately near they stood up, threw back their heads, and loudly screeched defiance; but they retreated on being approached, scuttling off in the prone position at full speed, followed by the more timid Gentoos.

Mr Mossman noted that in the springs of 1903 and 1904 the first great arrivals of penguins took place immediately after the last cold snap of the season.

At Laurie Island and its off-lying islets no less than fourteen rookeries of Adélie Penguins were discovered. The largest of these was located on the Ferrier Peninsula, which for several miles was simply alive with these birds and some Gentoos, the former being not less than two millions in number. Another vast colony was on Graptolite Island, and there were smaller though still extensive rookeries on the west side of Scotia Bay, on Delta Island, Point Rae, and on Watson and Pirie Peninsulas, with numerous lesser settlements on other parts of the coast and on various small islands.

The favourite sites for these communities were on plateaux where small stones abounded, and these were sometimes occupied up to 500 feet above sea-level. As the season advanced these rookeries became indescribably dirty, being masses of mud with pools of filth, and the birds themselves became correspondingly defiled.

At the rookery in Scotia Bay the first signs of nest-building were noted on October 10th. By the 20th nearly all were paired, and the appearance of an unpaired bird gave rise to a fearful commotion, every bird trying to get a billful of feathers from the unhappy one, while all the penguins in the vicinity raised their voices and screeched their loudest. The appearance of such wanderers, too, generally resulted in a free fight among those around.

The nests were heaps of stones deliberately collected one by one from far and near, even from under the snow. They were hollowed in the centre, and lined with some bones of their departed brethren, or with dropped tail-feathers when procurable. Some of the birds sat on the snow until it was thawed down to the stones beneath, and then set to work to form an irregular hollow in which to lay their eggs. A number of the nests became covered with snow, in some cases a foot deep, and several were deserted in consequence. The birds are accomplished thieves, and start their knavish tricks as soon as nest-building commences, but do not entirely desist when the young are hatched, though they then practise them to a lesser extent.

Three eggs are sometimes laid, but two is the usual number, and not infrequently one only. The first egg of the season was found on October 29th, 1903. On the 31st, 739 were gathered on Delta Island, which was covered with these birds. Between November 2nd and 10th, 2075 eggs were taken for domestic use, and as late as the 21st a number were obtained from a small rookery in Scotia Bay. The sitting bird incubates in a procumbent position, the mate standing erect by her side. The period of incubation was ascertained to vary from 31 to 33 days.

This species is very bold as compared with the Gentoo, and attacks fiercely anyone who enters the rookery. The birds had always to be forcibly evicted from their nests if the eggs were wanted. It was quite a business to go through a rookery unless attired in long sea-boots, and even then the birds sometimes got at the intruder unawares, taking a running jump and fixing on his legs above the boot, whence they were not easily shaken off. Other penguins passing the nests came in for violent assault, and some were seen bleeding, while others were literally pecked to death. An angry bird ruffles the feathers on the back of its head and neck, draws back its head, and glares viciously with eyes and bill wide open. When the old birds leave the nest to go down to the water to bathe, it takes them a long time to make up their minds to enter the sea, and a whole crowd collects and walks up and down the ice-foot. They lean over the edge, as if about to dive, and then retire again and run off to another point to go through the same performance. When one makes a plunge a number of others immediately follow. After they dive they roll over and over in the water, and wash themselves thoroughly with the aid of their feet, gradually getting rid of the red dirt with which they are bespattered and smeared. On leaving the water they have to jump about four feet to reach the rock or ice. They often attempt to do this in places which are too high, and fall back into the water.

The first young were found on December 6th, but probably some of these were hatched on the 4th. Many were seen on the 11th. On the 18th a mother penguin was observed feeding her chicks. She bent her head until her bill was inclined about 45°, *with the lower mandible uppermost*, and the chicks sucked in the semi-digested food brought up, taking it from the hollow between the rami of the upper mandible. When the young were older they were fed from the beak. Some young under a fortnight old were found to have already a small geological museum of pebbles in their stomachs. By January 7th, 1904, the young were beginning to lose their down. The rookeries at that date were in a greater state of filth than ever, and the stench was almost unbearable. On February 11th not a single old bird was in the rookery or in the bay, and only a very few young were seen. They had evidently all gone out to sea.

In 1904, Mr Mossman informs me, the first spring immigrants were noted on October 8th, followed by several hundreds on the 14th, after which they were continually arriving at the rookeries. On November 2nd the first egg was found, and the first chick emerged on December 12th.

The collections contain forty-five specimens, in all stages of plumage, from the South Orkneys; also a large number of eggs.

As the various stages of plumage of this species have been carefully worked out from the material collected by the *Southern Cross* Expedition, very little remains to be said on the subject. I would remark, however, that of the thirty-four adult specimens before me, obtained at all seasons, not one resembles the figure of the adult bird on plate vii. of the *Southern Cross* collections. In all the South Orkney specimens of this handsome species there is much less blue on the back, where black is the predominant colour, and the head and throat are almost entirely black, the feathers of the head being merely tipped with blue.

Immature birds show more blue and less black on the upper surface than adults. Some obtained in February, and presumably about a year old, have the chin entirely black, and the throat a mixture of black and white. And these same birds vary in the extent of the black apical spot on the under surface of the wing: in some it is developed, in others it is practically absent. This black apical spot cannot be regarded as a sign of maturity, as some young birds have it more developed than certain adults—indeed, one white-chinned example has this spot more pronounced than any other specimen in the collection.

A fine albinistic male was captured on the south beach at Laurie Island on January 11th, 1904. The plumage of its upper surface is cream-coloured, washed with pale brown on the hind-neck and crown; the tail, wings, and under parts are white, except the chin and throat, which are brown and indicate that the example is an adult; the bill and eyes were normal in colour; and the feet pale on both surfaces.

A series of measurements taken in the flesh, and of the weights, revealed the fact that there was great diversity in the size of the adults. The males varied in total length from 28 to 33·1 inches, and their wings from 7·1 to 7·7 inches; the females from 27 to 30·8 inches, and their wings from 7 to 7·4 inches.

As regards weight, it would seem that by the end of the nesting-season the weight of birds of both sexes had run down to a low ebb, indicating, perhaps, that they had been drawing on the stores of fat laid up since the previous autumn. In April males ranged from 7·25 to 10 lbs., while in October the lightest bird scaled 11·5 lbs. and the heaviest 14·1 lbs. Females in April ranged from 6 to 8 lbs., and in October from 9 to 13 lbs. These results were based upon a large number of specimens.

The temperature of this species was found to be as high as 106° F.

Pygoscelis papua (Forst.).

Pygoscelis papua Cat. B., xxvi. p. 631.

The Gentoo Penguin, which nears the southern limits of its range at the South Orkneys, was only found in small numbers as compared with its congeners, the total number at Laurie Island being estimated at 100,000 birds. It was confined to four or five rookeries, in which it nested in company with *P. adeliæ*.

This species was first met with by the Expedition at Saddle Island early in February, though no mention is made of its nesting there, and later in the season it was observed off Coronation Island on March 23rd. At the winter-quarters in Scotia Bay many were observed departing late in March and early in April, and the last of the autumn emigrants went north on April 25th. Not all of them departed, however, for a few were occasionally seen during the winter months of May, June, and July. They increased in numbers during the third week of August, and the spring return movements set fairly in by September, on the 25th of which month they appeared at the rookery on Cape Dundas, while numbers arrived from the north as late as November 5th.

On October 18th many were observed on their way from the open water to a big rookery, in company with *P. adeliæ*. On reaching the shore they at once clambered up on to the rocks forming the breeding-ground. Here the Gentoos occupied the lower and less favourable sites, and formed a ring, as it were, round the Adélies. This was, no doubt, due to the fact that many of them wandered about aimlessly for some time ere commencing nesting, and thus allowed all the more desirable sites to be occupied by the other species.

The nest was a much better and larger structure of stones than that of its congeners, *P. adeliæ* and *P. antarctica*, being from seven to eight inches high, and containing some old tail-feathers and a few bones. The birds, too, were cleaner than the rest all through the season. They were, however, great thieves, so far as pilfering nesting-materials was concerned.

On November 14th many of the nests became snowed up, and some of the birds sat in more or less deep holes in the snow; many, too, were completely covered.

The first eggs were laid on November 6th. They were usually two in number, frequently only one, never three. In shape they were very uniform, and rounder than those of *P. adeliæ*. The period of incubation was found to vary from thirty-one to thirty-five days.

The birds are somewhat timid; a few of those incubating were bold enough to peck at human intruders, but the majority ran off their nests when approached. They were a little more courageous after the young were hatched, but even then some of them deserted their chicks without making any pretence at protection. They, however, fought fiercely among themselves, using both wings and bills, giving some hard smacks and sharp bites.

The young birds did not commence to lose their down until February 11th; but on one or two the white band across the crown had already begun to show itself, and the neck to darken in colour.

The collection of skins from the South Orkneys contains specimens in all stages of plumage, and many eggs were also obtained.

The newly hatched chick is clad in silky down, and is of an olive-grey tint on the upper surface (darker, nearly black, on the head), but lighter beneath, and the bill is bluish grey. This stage soon gives place to a darker coat of down, to the tips of which the paler down of the first coat is attached for a time. In this second coat of down, the upper parts, including the head, are slate-grey, the plumes of the back having pale tips, and the under surface is white. When only a few days old, the bill begins to assume the orange tint characteristic of the adult birds.

The adults obtained in February are in faded plumage, and late in that month and during March and April had either moulted their tails or had that appendage only in an incipient stage of growth.

Eighty specimens of mixed sexes, weighed on April 28th, 1903, varied from 8·5 to 13·75 lbs. Of these, the heaviest male scaled 13·75 lbs., the heaviest female 12·5 lbs.

Catarrhactes chrysolophus Brandt.

Catarrhactes chrysolophus Cat. B., xxvi. p. 641.

The presence of this species at the South Orkneys is an interesting discovery, since it indicates a considerable extension in its hitherto-known range, for there was no reliable evidence before that the Macaroni Penguin had occurred south of the Falklands and South Georgia in the western Antarctic seas, or of Heard Island in their eastern waters.

Whether this species is an annual visitor, having breeding-grounds in the South Orkneys, must remain an open question; but it would seem not unlikely that such is the case, perhaps on some of the unexplored islands of the archipelago.*

Five specimens were obtained in 1904 in the penguin rookeries on Laurie Island. These were mostly captured singly towards the end of summer, and are regarded as being more or less immature birds. Two of them, namely those last obtained, are decidedly younger than the rest, and have the merest indications of yellow feathers on the sides of the crown, and also small bills. The remaining three are considered to be not fully adult, and have well-developed tufts of golden-yellow (not orange) plumes, but are otherwise mature in plumage and in the dimensions of their bills.

The two younger birds are, there can be little doubt, birds of the year, and their presence seems to point to the South Orkneys being their native land, for it is difficult to believe that birds only a few weeks old could have accomplished the rough sea-passage of 600 miles from their nearest known breeding-station at South Georgia.

The three older specimens, though not fully adult, are probably about a year old, though whether this species breeds at such an age is uncertain.

None of these birds were observed in the autumn of 1903, when the Expedition arrived, and their appearance in the summer of 1904 was a surprise to the explorers.

The first specimen, a male, was captured on January 7th in a big penguin rookery at Scotia Bay, where it was found amongst a crowd of *P. adeliæ*. Ten days later a female was secured in exactly the same place; and on the 29th of January another male, just below where the previous captures had been made. These three were the not fully adult birds alluded to, and the place where they were taken was so frequently visited that it is thought to be most unlikely that they could have been bred there without being detected.

One of the younger birds was taken higher up in the same rookery on December 29th, and the other was captured on the beach on February 6th. Both were males.

Regarding the age of these specimens I was somewhat uncertain, and sought the assistance of my friend Dr A. E. Wilson, of the National Antarctic Expedition, who had had considerable personal experience with the allied *Catarrhactes schlegeli*, and whose aid it is a pleasure to acknowledge.

In connection with the occurrence of this species at the South Orkneys, it is well to recall the fact that Capt. C. A. Larsen, of the Norwegian sealer *Jason*, informed Dr Donald,† of the whaler *Active*, that he saw a rookery of Crested Penguins on the South Orkneys. These birds he described as being intermediate in size between the

* A Crested Penguin, supposed to be of this species, was found by Mr Paulsen on November 29th, 1907, "occupying the same nest with one of the 'Ringed' species."—Mossman, *Scottish Geographical Magazine*, xxiv., 1908, p. 354.

† Cf. *Proc. Roy. Phys. Soc. Edin.*, xii., 1894, p. 335.

Emperor and Adélie Penguins, and as having a yellow patch under each eye [? the yellow angle of the gape] and a red superciliary crest three or four inches long. This might well be regarded as a glorified description of fully adult examples of the present species.

It is probable, too, that this is the species of *Catarrhactes* observed and obtained by the Swedish Expedition on Nelson Island, one of the South Shetlands, which was thought to belong to *C. chrysocome*. Most unfortunately the specimens were lost with the wreck of the Expedition (*cf.* Lönnberg, *Wissen. Erg. Schwed. Südpolar-Exped.*, Bd. v. Lfg. 5, p. 3).

Aptenodytes forsteri G. R. Gray.

Aptenodytes forsteri Cat. B., xxvi. p. 626.

The Emperor Penguin claims mention for the South Orkneys on the strength of the following incident:—

On November 21st, 1903, two sailors reported having seen, by some open water at the mouth of Scotia Bay, a large penguin, which was "three times the size of an Adélie," but having black feet and a bill like a Gentoo, though with no mark on the head like the latter species.

The bird unfortunately escaped into the water when the men attempted to capture it. There can be no doubt about the size of the bird having been correctly described, as the Adélies were close at hand for comparison. The two men who reported these facts were among the most careful and trustworthy of the crew, and the conclusion come to at the time was that the bird seen by them was an immature Emperor Penguin.

Note.—As reported by Mr Mossman,* two Emperor Penguins were captured by Mr Paulsen, of the Argentine Government Meteorological Station at Scotia Bay, South Orkneys, on May 4th and 31st, 1907, respectively, and individuals visited the islands also in the years 1905 and 1906, usually during the autumn and winter.—Editor.

Oceanites oceanicus (Kuhl).

Oceanites oceanicus Cat. B., xxv. p. 358.

Wilson's Petrel is a common summer visitor to the archipelago, and though not nearly so abundant as either the Cape or Snowy Petrels, yet resorts in thousands to Laurie Island to nest on the cliffs of its remarkably extensive coast-line. It was also observed at Saddle Island during the short visit of the Expedition on February 4th, 1903, and was probably breeding there.

In the autumn of 1903 it was last seen on March 23rd, as the *Scotia* was approaching the islands from the south, on her first voyage from the Weddell Sea. It was never observed during the winter months, and did not appear until late in the spring, namely

* *Scottish Geographical Magazine*, xxiv., 1908, p. 354.

on November 11th,* being the last of the summer visitors to arrive. On the 23rd the ice broke up and many birds arrived, including numbers of this species. After this date it was constantly under observation, for several dozens took up their abode in the cliff above the observatory, where, on December 11th, the first egg was obtained.

There was no attempt at nest-making; the egg was simply laid in a hollow in the earth in narrow clefts and fissures in the face of the cliffs, under boulders, and sometimes under stones on the screes sloping from the foot of the precipice, at heights varying from 20 to 300 feet above sea-level. It was often placed far in, and this and the fact that the hole was so narrow made the egg difficult to procure. Some of the eggs were laid at such a distance from the entrance that a spoon had to be lashed to a long bamboo in order to reach them. The searchers could hear the low whistle uttered every few seconds by the sitting bird, but on reaching the spot whence it seemed to proceed the sound would appear to come from an entirely different direction. The dog "Russ" proved to be a great aid in work of this kind, for he easily detected the bird's presence by his keen sense of smell. When caught on the egg the birds brought up a reddish fluid, which issued both from the mouth and nostrils. In addition to the low whistle, these petrels had a harsh screaming chuckle. These noises they kept up almost continuously after dark, especially on still nights.

They appear to return year after year to the same nesting-places, for both eggs and dead young birds of previous seasons were numerous in the tenanted holes containing the fresh eggs. This fact indicates that a very serious waste of life takes place in some seasons, if not annually. It may be accounted for by the late arrival of the bird at its breeding-stations, which, coupled with the lengthened period of incubation characteristic of all petrels, results in winter setting in ere the eggs are hatched, or the young, which develop slowly, are old enough to leave the nesting-holes. Another, and perhaps more probable, explanation is that the disasters noticed were due to a succession of cold summers, which are actually known to have occurred. None of the eggs in the summer of 1903–4 had been hatched when the Expedition left the islands on February 21st. These facts would seem to indicate that the South Orkneys lie at the extreme limits of possible breeding for Wilson's Petrel. Indeed, for many individuals of this species, perhaps all, during some seasons the climatic conditions place the islands distinctly beyond that range; though it breeds further south, most likely with similarly disastrous results.

From 7 to 11 p.m. these birds flitted about the cliffs and over the head of Scotia Bay in great abundance, and in striking contrast to their habit in the daytime, when only occasionally was one to be seen on the water, though there were probably many at sea off the islands.

The nest figured was situated at the bottom of a crack in the rock, about four

* This and other species appear to be remarkably constant as to the times of their appearance and departure at the South Orkneys. As an instance of this, it is interesting to note that Mr Mossman observed the first Wilson's Petrel in the spring of 1904 on November 12th.

inches wide and two feet deep. It was the only one found which was open enough to permit of a photograph being taken, and then only under particular circumstances as to time. At about 7 a.m. the sun shone for a few minutes directly into the crack, and it was during those moments that this unique picture was secured.

Eight eggs average 33·7 × 24 mm. The largest is 36 × 24 mm., and the smallest is 32 × 23 mm.

Fregetta melanogaster (Gould).

Cymodroma melanogaster Cat. B., xxv. p. 364.

On December 5th Dr Pirie discovered a pair of unknown petrels. He heard a low whistling sound proceeding from a crevice in a rock on the east side of Uruguay Cove, Laurie Island. and about fifteen feet above the sea, and on climbing up found what he at first thought to be a pair of Wilson's Petrels, and managed to secure the female. Two eggs, badly broken in the endeavour to capture the birds, were found near the mouth of the crack—one of them obviously of a previous season, the other deeply incubated.

On examining the captured bird it was at once evident that it was not a specimen of *Oceanites oceanicus*, for it had entirely black feet, had white on the under surface, the feathers of the back slightly edged with white, a longer and more hooked mandible, and strongly upturned nasal tubes. On the return of the Expedition, I found this bird to be an example of *Fregetta melanogaster*—the Black-bellied Storm-Petrel.

The dimensions of the egg secured were 3·60 × 2·55 cm., and correspond with those of *F. melanogaster*, from the Falklands and Kerguelen, in the British Museum collection. The locality was again visited in the hope that the escaped bird might be found. It was not there, however, nor were other individuals of this species observed elsewhere in the islands.

The occurrence of this species is one of the most interesting ornithological discoveries made by the Expedition. It implies a remarkable extension in its known range, and removes the doubt which has hitherto overshadowed (cf. *Antarctic Manual*, p. 228) the record of its having bred at South Georgia, as mentioned by Pagenstecher (*Die Vögel Süd-Georgiens*, p. 18, 1885), in the southern summer of 1882–1883.

Thalassœca antarctica (Gm.).

Thalassœca antarctica Cat. B., xxv. p. 392.

A few examples only of the Antarctic Fulmar were seen at the South Orkneys; but it is thought by the members of the Expedition that it may possibly have bred on the east side of the Ferguslie Peninsula, along with the Cape and Snowy Petrels, in the summer of 1903.

A number of these birds were seen in the previous autumn when the *Scotia* was between Saddle Island and Cape Bennet, the northern limit of Powell Island, on March 23rd, 1903. Several were again observed on the following day in Leathwaite Strait, between Coronation Island and Powell Island.

On June 1st, when winter was well advanced, Dr Bruce noticed one flying round the *Scotia*; and another is believed to have been seen at the open water in Scotia Bay on August 17th.

There are no South Orkney specimens in the collection, but a number had been obtained in the Weddell Sea before the Expedition arrived at Laurie Island and went into winter-quarters there.

Priocella glacialoides (Smith).

Priocella glacialoides Cat. B., xxv. p. 393.

The Slender-billed Fulmar, or Silver Petrel, was observed in the summer of 1903, in MacDougall Bay, on the north coast of Laurie Island, on November 4th. After this date examples were occasionally seen about the cliffs on the north side of the island during November and December, and it is considered highly probable that a few pairs were nesting there. The breeding-places of this bird, however, still remain to be discovered.

This species was first observed during the previous autumn, when a number came under notice between Saddle Island and Cape Bennet, the north end of Powell Island, on March 22nd, 1903; and again on the following day when the *Scotia* was in Leathwaite Strait, between Coronation Island and Powell Island, in search of winter-quarters. It was also seen in numbers off the north-west end of Coronation Island on February 14th, 1904.

It had been seen commonly, and specimens obtained, in the Weddell Sea just prior to the date of the above observations.

Pagodroma nivea (Gm.).

Pagodroma nivea Cat. B., xxv. p. 419.

The Snowy Petrel of Cook was not only an abundant summer bird, but was by far the most numerous of the few species which remained for the entire winter at the South Orkneys.

In summer it frequented the high precipitous sea-cliffs which formed its breeding-haunts, and where, during the nesting-season, some 20,000 birds were estimated to be present on Laurie Island alone. It was never seen on the hills at the head of the ice-sheets.

It was also found at Saddle Island and was nesting there. The single eggs were laid under rocks, in caves, and in holes and crevices on the steep cliffs facing the sea, at heights ranging from a few to several hundred feet above the water. The nests were rough primitive structures, and consisted of a few stones or a little earth. They were less accessible than those of the Cape Petrel, and mostly isolated; but in one cave under Mount Ramsay a dozen or more eggs were taken. This bird does not fly off when its nest is approached, but retreats a little, and ejects an oily fluid at the intruder, uttering all the while shrill cries.

The first eggs were obtained on December 2nd, but were not quite fresh. By the 4th all the birds seemed to have laid, and eighteen eggs were found, most of them in a cave from twenty to twenty-five feet above sea-level. The cave was thickly carpeted with the dung, and the nests, unlike the rough examples outside, were all well formed in the dung and had a few feathers in them. Some were placed as much as forty feet from the entrance, where it was almost dark. In 1904 the first eggs were observed on November 25th (*Mossman*).

Young birds were found on January 28th, 1904, but the parents were not present with their chicks—not an unusual circumstance during the daytime with certain birds of this order. When discovered, these chicks uttered the same harsh notes as are characteristic of the old birds. Their stomachs were found to be crammed with crustaceans.

The young bird does not seem to have been described. One about one-third grown, and captured on January 28th, 1904, is clad in long fluffy down which almost conceals the feathers appearing on the wings and tail. The down is of a lavender-grey tint on the back and chest, darker on the head, and dull ivory-white on the abdomen.

Ossifraga gigantea (Gm.).

Ossifraga gigantea Cat. B. xxv. p. 422.

The Giant Petrel was present at the Station all the year round, but was very much less numerous during the winter months. There was a decided falling off in May, but the lowest ebb was reached in June and continued until September, when the summer birds of this species commenced to arrive. During the nesting-season it was estimated that about 5000 were on Laurie Island alone, and when one remembers the savage nature and almost insatiable appetite of these giants, it is easy to realise what a terrible scourge they must have been to the penguins, upon which and their eggs and young it was their one aim to gorge themselves to repletion.

They were to be seen everywhere in the summer-time, but their rookeries were confined to the north and east coasts. Three of these rookeries were visited, two of which, namely those on the Watson Peninsula, contained two hundred nests each, while the third at Cape Geddes comprised only about one hundred. One of the larger colonies was situated on bare rocky ground from 300 to 400 feet above sea-level, and the other on a moraine at an elevation of from 250 to 300 feet. The nests consisted of great piles of small angular stones, and were about two feet in diameter. The third and smaller rookery was on a low strip of ground between a cliff and the shore, and was close to the sea; the nests were similar to the others. Although these contained no eggs on November 3rd, yet the birds allowed a close approach, one of the parents sitting on the nest, the other usually standing close alongside.

The first eggs were laid on November 4, but four only were found on that date. On the 19th, however, eighty were obtained, all single specimens, except in two instances where two were found, probably laid by as many females. The birds had to be pushed off the nests ere the eggs could be taken, for very few flew away of their own accord. They showed no fight when evicted, and usually sat down a yard or two away; nor did they shoot oil from their nostrils, but they vomited the contents of their stomachs, not as a mode of defence, but to get rid of ballast in order to take wing. They resorted to the same lightening process when chased. Unfortunately, the weather conditions and those of the ice did not permit of these rookeries being again visited, so that the period of incubation could not be ascertained nor the capture of young be effected.

The average length of 80 eggs was 10·38 cm. and the breadth 6·57 cm.

This species was observed on Saddle Island, and was thought to be breeding on the adjacent rocks.

The heavy toll ruthlessly demanded from the penguins was very manifest on visiting their rookeries. Here abundant remains of recently killed young penguins, in the shape of clean-picked skins and bones, were lying all around, while the gorged feathered giants were either waddling about or sleeping off the effects of their orgies on the neighbouring snow-slopes. They were observed to feed on dead seals, and during the winter resorted to the ship's refuse-heap in search of scraps of meat. They were very bold when in want of food, and one swooped down close to the cook and tore a piece of flesh off a dead penguin.

The proportion of birds in pure white plumage in the rookeries was not more, perhaps less, than two per cent. The colour of the birds ranged from very dark brown through all shades of chocolate, and from grey through light grey and mottled white to white. Some of these facts indicate interbreeding between the two forms and, perhaps, between their offspring and typically coloured birds and others. Dr Pirie thinks that they interbreed, because he has no recollection of seeing two white birds together on the nesting-grounds.

Four specimens in the collection are from the South Orkneys, and two of these are of the white form. The weight of these birds varied from 7·25 to 10 lbs.

Daption capensis (Linn.).

Daption capensis Cat. B., xxv. p. 428.

Although the Cape Petrel or "Cape Pigeon" is one of the most familiar birds to voyagers in the southern oceans, and one, too, that has been known since the days of Dampier (that is to say, since the closing years of the seventeenth century), yet the eggs remained entirely unknown until December 2nd, 1903, when Dr Pirie took the first specimens at the South Orkneys.

The three nests from which eggs were then obtained were placed on open exposed ledges of cliffs on the west side of Uruguay Cove, Laurie Island, at heights of from twenty to a hundred feet above sea-level. The nests were composed of a few small angular fragments of rock and a little earth, and contained single eggs, which were quite fresh. When approached, the sitting birds ejected an evil-smelling reddish fluid composed of the semi-digested remains of crustaceans of the genus *Euphausia*. It was extremely disagreeable to the collector to receive it in his face when peering over a ledge, and the odour of it was found to cling to clothes for a very long time. The birds can squirt this fluid with great precision for a distance of six or eight feet. They did not leave their nests readily, and even allowed themselves to be captured while sitting. The pure white eggs seemed very large for the size of the bird.

On December 3rd three more eggs were obtained. There were six nests on the ledge where they were found, but three of them were empty. On the following day about two dozen eggs were taken on the cliffs under Mount Ramsay, and on the 5th some fifty eggs were found on the cliffs on the east side of Jessie Bay. The birds seemed to be of a sociable nature, for several were frequently found nesting near to each other on the same ledge, but isolated nests were not uncommon.

The work of collecting the eggs of this species proved to be such an unpleasant business, owing to its nasty methods of defence already alluded to, that a long ski-pole was used. With this the birds were pushed off their nests, and the eggs secured without the captor being defiled. When thus removed they took short flights, and then alighted near the nest. Both birds were often found sitting side by side (one on the nest and the mate close alongside) and cooing and clucking to each other, though not to the same extent as during the month previous, when courtship was in full swing.

On December 12th more eggs were procured from the locality in which they were obtained on the 5th, and the nests robbed on that day, though still empty, were covered by sitting birds. On January 13th, 1904, a fresh egg marked on December 2nd was found chipped, so that the period of incubation was not less than forty-two days. On January 18th a chick five days old was taken for a skin, and young birds were still in down on February 5th, after which date the state of the ice did not permit of further observations being made ere the Expedition left for the far south.

It was noted that before laying its eggs this petrel sits close on the nest for about a month, and it was also observed that it entirely disappeared from its nesting-haunts for some ten days before the first eggs were laid.

The eggs vary from oval to elongate-ovate in form. Taking two extreme forms, I find their dimensions to work out as follows:—Oval type, $56{\cdot}5 \times 43$ mm.; elongate-ovate type, $67{\cdot}2 \times 43{\cdot}3$ mm. The average of a large number of specimens is $62{\cdot}35 \times 43{\cdot}11$ mm. The length varies from $56{\cdot}5$ to $67{\cdot}2$ mm., and the breadth from $46{\cdot}5$ to $40{\cdot}5$ mm.

In 1904 the first eggs were laid on December 3rd, or one day later than in the previous year (*Mossman*).

The numerous nests found were placed either on ledges of cliffs, or, though these were few, in hollows in the earth and among small stones on steep scree-slopes, and all were quite open. These are noteworthy facts, for the nests (containing young) found previous to the discoveries of the Scottish Expedition were obtained *in burrows and grottoes* on the island of Kerguelen. There is little doubt that the Cape Petrel breeds at South Georgia, and Mr Mossman tells me that he saw it in numbers off Deception Island, one of the South Shetlands, in the height of the nesting-season.

This species is a summer visitor to the South Orkneys. In the autumn of 1903 it was only once seen after April 21st, on which date a flock was observed flying north, and was entirely absent during May, June, July, August, and September. The first of the spring immigrants was seen on October 1st, but the bird was not noted again until the 23rd, after which date it became frequent.

About 20,000 resort to Laurie Island for nesting purposes, and they are found in hundreds all round the coast. In Uruguay Cove alone there were over one hundred accessible nests, and many others were out of reach. They also nest on Saddle Island, where both young and old were obtained on February 4th, 1903, and are doubtless abundant throughout the other islands of the archipelago, which may be regarded as a metropolis of the species.

They were never observed flying over the land, but were to be seen on the wing in front of the cliffs (not wheeling high over them, like *Pagodroma nivea*) or sailing over the sea.

The chick in down, five days old, taken on January 18th, 1904, is slate-grey above, and paler and sooty on the under surface.

A young bird obtained at Saddle Island on February 4th, 1903, has the head and body clad in down, with feathers developing on the wings and scapulars. The down on the upper surface is sooty (darker on the head and cheeks) and paler and greyish on the under parts. The wing-quills, the largest of which are 2 inches in length, are black, some of them with the inner webs white towards the base. The feathers of the scapulars are black and white. There are no signs of tail-feathers. Wing 8 inches.

The mature birds from the South Orkneys and the Weddell Sea present two types of plumage. The first of these, which perhaps represents old birds in weathered dress, were captured towards the end of summer (in February); and in them the dark portions of the plumage are blackish with a brown cast, the head alone being black; the feathers of the mantle have whitish bases; and the marginal and lesser coverts show less white than in the next form. In the second type the dark portion of the plumage is slate-black, and the bases of the feathers of the mantle are dusky. Specimens in this phase were obtained early in the autumn (late in March), and are either in new or first plumage. A male captured on the nesting-ledges on December 3rd, 1903, is intermediate in plumage between these two forms.

Prion banksi Gould.

Prion banksi Cat. B., xxv. p. 434.

This "Whale-bird" fairly claims a place in the avifauna of the South Orkneys on the strength of specimens seen off Coronation Island, within the territorial waters of the archipelago, on November 27th, 1903, the day on which the *Scotia* left her winter-quarters to proceed to the Falklands to refit.

It had been frequently observed on the outward voyage of the previous year, but fell off rapidly in numbers as the pack-ice was entered, and ceased to be noted some sixty miles ere the South Orkneys were reached. It was also seen, and specimens were obtained at sea, to the eastward of the group during the early days of the first voyage in the Weddell Sea.

Sterna hirundinacea Less.

Sterna hirundinacea Cat. B., xxv. p. 52.

The White-rumped Tern was first observed by the Expedition at Saddle Island, on February 4th, 1903. It was not found to be an abundant species at Laurie Island, where only some two or three hundred spent the summer, nesting in small scattered colonies of about a dozen pairs, and also in isolated pairs.

In the spring of 1903 the first terns of the season were observed on October 21st, but it was thought that some had been heard two or three days before. The bird had been absent from the island since the 25th of March of the previous autumn.

The nests were mere hollows, lined with a few small fragments of stone, on the tops of small rocks, or on raised beaches and small screes, and were always quite close to the shore. The nests in the colonies were placed fairly close together, and often in proximity to those of *Larus dominicanus*. When not surprised on their nests, these birds usually betrayed the whereabouts of their treasures by hovering over them and screeching loudly.

The eggs were one or two in number. The first were found on November 14th, and from that date onwards they were observed until January 15th. In 1904 Mr Mossman records the first eggs observed on November 27th.

The earliest chicks were obtained on December 25th, and by February 7th young were noted as having lost all their down.

A few adult specimens and a chick are included in the collections; also a number of eggs, averaging 4·73 cm. × 3·34 cm.

This species is also a summer visitor to the South Shetlands. But according to Reichenow the South Georgian bird is a subspecies of *Sterna vittata*, which he has named *Sterna vittata georgiæ* (*Orn. Monatsber.*, xii. p. 47); while the same authority has described (*l.c.*) the tern of the Antarctic Continent as a race of the Arctic Tern, *Sterna macrura antistropha*.

Larus dominicanus Licht.

Larus dominicanus Cat. B., xxv. p. 245.

This Black-backed Gull has a remarkably wide latitudinal distribution, ranging as it does from 10° S. in the South Atlantic to within a few degrees of the Antarctic Circle.

It was not a very abundant species at the South Orkneys, and the numbers visiting

Laurie Island as a summer resort did not exceed some three hundred birds. It was also observed at Saddle Island in the late summer, and had apparently been breeding there.

The chief nesting-haunts on Laurie Island were at Point Davis on the south coast and Uruguay Cove on the north. At each of these places about a dozen nests were found. Elsewhere it was found less abundantly, mostly in isolated pairs, all round the coast.

The Southern Black-backed Gull was one of the few species that was observed all the year round, for some of them braved the severities of the winter, and were seen more or less frequently in the neighbourhood of the Expedition's winter-quarters at Scotia Bay.

The return of the spring immigrants commenced in mid-October. The birds were seen pairing on November 3rd, and the first eggs were laid on November 15th (on the 23rd in 1904 (*Mossman*)). The first young are mentioned under the date of December 26th, and are described as being then about a week old. Fresh eggs marked on December 3rd were found chipped on the 28th, indicating an incubation-period of about twenty-five days. Young still in down were observed as late as January 30th, 1904.

The nests were placed on raised beaches, small screes, and rocks within a few yards of the shore. The nest was a well-built structure of seaweeds, mosses, lichens, and feathers; and was usually surrounded by great quantities of limpet-shells, this mollusc being evidently a favourite food of the bird. The eggs were usually two in number, but sometimes three were found, and occasionally only one.

On April 15th Messrs Bruce, Pirie, and Wilton saw an entirely white gull, resembling in all other respects this species, of which it may have been an albino specimen; and on September 21st an almost white example of this gull was seen, in which the wings and upper surface were much lighter than usual.

The collection contains skins of this species in various stages of plumage, and a number of eggs.

Megalestris antarctica (Less.).

Megalestris antarctica Cat. B., xxv. p. 319.

About five hundred Antarctic Great Skuas spend the summer on Laurie Island, taking up their quarters in the vicinity of the penguin-rookeries, where they revel among the eggs and young of their neighbours. They were also observed nesting in similar situations on Saddle Island.

During the southern autumn of 1903 they were seen daily until the 28th of April, on which date the last bird of the season was met with. They were entirely absent during the winter months, and the first spring immigrants were noted on October 16th. These were followed by a few others on the 26th, after which they gradually became abundant.

On November 22nd two skuas, presumably males, were observed fighting fiercely, while a third was looking on, evidently an interested spectator. The birds fought with bills and claws for nearly an hour, when one of them became quite exhausted; and then the victor flew off with his bride, and the vanquished was ruthlessly torn to pieces and devoured by a Giant Petrel, which had been an interested spectator of the fight.

The first eggs were laid on December 2nd, and young birds a week old were found on January 29th. By February 11th, dark feathers were appearing on the wings and sides of the breast of these youngsters.

The period of incubation was not precisely ascertained, but was believed to be about six weeks.

In the spring of 1904 the skuas returned on October 21st; and the first eggs were found on November 27th (*Mossman*).

The nests were usually placed on the tops of mossy rocks, or on plateaux from 100 to 400 feet above the sea, and consisted of well-made hollows in the moss, while teased-out fragments of moss formed the lining. Occasionally nests were found on the tops of moraines, and were then hollows in the earth lined with lichens.

The eggs were two in number, and on these the bird sat very close, her mate usually remaining near at hand. When the nest was approached the owners screamed defiance, and if the eggs were wanted the sitting bird had to be forcibly ejected from the nest—not a very pleasant proceeding, as the sentinel bird wheeled above and dashed at the head of the intruder, though never actually striking him. When a dog, however, appeared upon the scene both birds swooped down on it, and sometimes struck it with their wings. The nests were surrounded by many shells of eggs and remains of young penguins. The young—pretty little masses of light brown down—soon wander away from the nest, and are most difficult to detect among the moss, which they closely resemble.

These birds were to be seen incessantly hovering over the penguin-rookeries, and swooping down ever and anon at the sitting birds to snatch their eggs or young. On such occasions the penguins combined in screeching at the harpies, but to little purpose.

Many were about the house all the summer, being attracted by the remains of penguins thrown out by the cook. Nearly one hundred were observed around a seal's carcase; while dead Giant Petrels, and even deceased members of their own species, did not seem to come amiss as food.

Numerous specimens were obtained at the South Orkneys. These vary in colour, though mature and obtained at identical periods. Specimens captured in November, soon after their arrival on the nesting-grounds, were of two types. One had the ground-colour of both upper and under surfaces dark, being of a deep blackish brown, rather paler below, and showing comparatively few light markings on the mantle and scapulars; indeed in some specimens the back is practically uniform. The other type is less numerously represented in the collections, and is much paler (drab) generally, except on the head; while the feathers of the interscapulary region and under surface have grey-buff margins. In these light-coloured birds the yellow streaks on the neck are much more numerous and pronounced than in the darker birds; and they agree with the form described by Saunders (*Brit. Mus. Cat. Birds*, xxv. p. 320) as inhabiting the Falklands, except that they are not smaller in size than the ordinary dark form, their wings measuring 16·65 inches, as against 16 to 17 inches in the last-mentioned. The Falkland Islands bird has recently been described by Lönnberg (*Wissen. Erg. schwed. Südpolar-Exped.*, Bd. v. Lfg. 5, p. 8, 1905) as a sub-species under the name of *M. antarctica falklandica*.

It is of interest to remark that one of these light birds was observed to be mated with one of the dark examples.

Megalestris maccormicki (Saund.).

Megalestris maccormicki Cat. B., xxv. p. 321.

Mr Mossman informs me that a specimen of McCormick's Skua was procured by the Argentine naturalists at Laurie Island on November 11th, 1904, and is in their collection of birds. Mr Mossman saw this bird in the flesh and examined it, and he tells me that it was quite different from the skuas, light or dark, which bred at the South Orkneys. This South-Polar bird has not hitherto been obtained so far north as the South Orkneys, indeed I believe not outside the Antarctic Circle.

Chionis alba (Gm.).

Chionis alba Cat. B., xxiv. p. 710.

This Sheathbill, the "Paddy" of the explorers, was an abundant species, and though chiefly a summer visitor to the islands, yet wintered in small numbers at Scotia Bay, being attracted by the refuse cast out from the ship. Some wintered away from the ship at the seal-haunts on the north side of the island.

In the summer it was present in all the penguin and shag rookeries, as many as two hundred haunting some of the larger colonies. Altogether it is believed that from 2000 to 3000 of these birds passed the Antarctic summer of 1903 on Laurie Island alone. Adults and young birds were present in considerable numbers at Saddle Island on the occasion of the Expedition's visit early in the previous autumn, namely on February 4th, 1903.

It was also fairly abundant around Scotia Bay in March, but towards the end of April, when the temperature approached zero, the numbers fell off considerably, and when winter conditions became fairly established only some twenty or thirty remained, and for many days during that drear season were the only living creatures observed. These pensioners eked out an existence on the refuse odds and ends which were daily thrown out from the *Scotia*. One of the birds became very tame, and for a number of days in succession visited the ship, remaining all day either in the fo'c'sle or in the galley.

Late in September and during the first half of October many returned to their summer-quarters, and their numbers greatly increased when the ice broke up on November 23rd.

The first eggs were found on December 11th, when eleven (two clutches of three, two of two, and a single egg) were taken, but some of these proved to be considerably incubated.

A nest found on December 3rd was on a ledge under an overhanging rock, and was composed of small stones and penguins' tail-feathers. Five nests were found on the 11th in the large penguin-rookery in Scotia Bay: four of these were on the fringe of the colony and quite low down, being only from ten to twenty feet above sea-level, and placed in crevices of rocks or underneath boulders on the moraine; while the other nest was under a large boulder about one hundred feet up the moraine, and right in the midst of the penguins. These nests were mainly composed of the shells of penguins' eggs, bones, and feathers, and a number of limpet-shells. The position of the nest is not difficult to detect, for one of the birds generally sits on a rock close by. The eggs are usually three in number.

Fresh eggs marked on December 11th hatched on January 7th, an incubation period of twenty-eight days. The newly-hatched young are clad in brown down and show conspicuous bare patches; they are not by any means pretty objects like the young penguins and skuas. On January 29th white feathers were beginning to develop under the down of these chicks; and by February 11th the down had nearly all disappeared.

These birds were found to be very tame and unwilling to fly; indeed, some of them would not take wing when pushed with a stick, and most allowed an approach to within striking distance ere they walked leisurely away.

In the penguin-rookeries they were to be seen perched in prominent places, on the look out for dead birds or broken eggs. They are very bold, and one was observed to abstract an egg from under a sitting shag, which was somewhat disconcerted at having its photograph taken for the first time. Sheathbills were seen to revel in garbage of every description, including the excrement and placentæ of seals. Crustaceans were found in the stomachs of some of those dissected.

The young bird figured is about one-third grown. The wings, scapulars, and flanks have white feathers with a little down. The head, sides and back of the neck, lower part of the back, and abdomen are clad in grey down mottled with brown.

The temperature of an adult bird, taken on March 26th, 1903, was found to be 107°·3 F.

The collection contains a few skins of adults and the young bird described, also a small number of eggs. The latter are elongate-ovate in shape, and in colour white boldly blotched with greyish black or dark brown and liberally freckled with the same tints. They do not vary much in size, and measure from 54 to 58 mm. in length by 37 to 39 mm. in breadth.

Phalacrocorax atriceps King.

Phalacrocorax atriceps Cat. B., xxvi. p. 390.

It had long been known that a species of *Phalacrocorax* nested in the icy regions of the Antarctic, for Ross found a "Cormorant" breeding at Louis Philippe Land, and saw innumerable examples at Cockburn Island on January 6th, 1844. The specific identity of these Antarctic Shags remained somewhat uncertain until the Scottish Expedition finally settled the matter at the South Orkneys in 1903.

The Blue-eyed Shag, as the explorers termed this species, was present all the year round in the archipelago.

In summer it was numerous, but avoided the main islands and sought nesting-places on small islets or rocks off the coast of Laurie and Saddle Islands, where it was estimated that about two thousand five hundred pairs were breeding, and where some of the rookeries contained as many as two hundred nests. In winter it was much less numerous, but the species never escaped observation for many days in succession.

On August 2nd a flock containing several thousands, probably early immigrants, was seen from the *Scotia* as she lay in her winter-quarters.

The first eggs were obtained on November 8th, on a small islet some forty feet high situated off the north coast of Laurie Island, where a few Ringed Penguins were also nesting. The nests were well-built structures composed of seaweed, moss, lichens, and feathers. Some of the birds were still engaged in nest-building, and were diving and bringing up masses of seaweed in their bills, while others were busily engaged in picking mosses and lichens off the rocks. They were great thieves, even worse than the penguins, for when the more timid of the nest-builders retreated on the approach of the explorers, the bolder birds immediately carried off the momentarily deserted materials for their own use. A few only of the nests contained eggs, mostly one apiece, though some had two; and the conclusion was arrived at that the birds had only just commenced laying. Many of the nests were on rocks, some of them in the sites of previous years; while others were on pinnacles of ice, having been built on snow which had gradually thawed away all round the nest, but not at its base. The sitting birds were very confiding, and allowed themselves to be stroked on their nests. On the following day, November 9th, another nesting colony was found on a small bare islet. Here many of the nests contained three eggs, and the rock between them was in a terribly unsavoury condition. The usual number of eggs was two, but three were not unfrequent. The eggs varied in size from 51 to 67 mm. in length, and were 41 mm. in breadth.

It was unfortunately impossible to visit these rookeries later in the season; and there were none within reach of Scotia Bay, though some birds rested every night on the rocky islets in the bay in December, where no signs of their nesting were apparent.

There are a number of skins in the collection in both adult and immature plumage, and a considerable number of eggs.

Adult males shot in September have the crest well developed, the feathers being from 1·5 to 1·75 inches long. A male shot in December has a much shorter crest, and others of the same sex obtained in February are devoid of these ornamental plumes. The September specimens are much more brilliant in plumage than the rest of the adults, and also have the nasal caruncles more developed. The white dorsal patch varies much in size, even in adult males obtained at the same season; and in one captured in December it is represented by a narrow band of white blotched with black across the middle of the back. The culmen of adult males varies from 2·2 to 2·5 inches, and the wing from 11·8 to 12·1 inches. Weight 6·5 lbs.

The bird in first plumage has not, I think, been described. One obtained in December has the upper surface hair-brown, tinged with green on the back, where the feathers have narrow margins of lighter brown; the head and hind-neck show a few darker feathers; outer scapulars and tail whitish, the shafts of the latter dull light green; primaries and secondaries dusky with a faint greenish tinge; wing-coverts edged with dull white, with a narrow buff-white alar band below the marginals; under wing-coverts brown; under surface white; thighs brown. These young birds show no signs of a white dorsal patch. Slightly older birds obtained in February have their upper plumage a mixture of brown and metallic feathers, and one specimen shows slight indications of a white dorsal patch; the central tail-feathers are blackish with white shafts, and the rest of the plumage is as in the younger bird.

Section VI.—The Life and Habits of Penguins.

By R. N. Rudmose Brown, D.Sc., University of Sheffield; Naturalist, Scottish National Antarctic Expedition.

Early in the spring the penguins begin to return to their rookeries from the open sea or the edge of the pack to the north, where they have spent the winter. They are sea-birds, although they spend a considerable time at the rookeries every spring. By the second week in October the flood tide of returning birds had set in at the South Orkneys, but previous to this there had been many stragglers. From year to year the time of return has proved to be much the same, whether the season is open or not. Even if great stretches of land ice have to be crossed the penguins are not deterred. They hurry onwards through water and over ice, perhaps even crossing necks of land, to reach their favourite rookeries. On some days a steady stream of them passed the *Scotia* from the north over the Beach across the fast ice in Scotia Bay to the large rookeries on its western side, especially round about Cape Martin. Generally they marched erect, but some in their hurry adopted the prone attitude and scurried ahead of the others. Seldom did a penguin deviate from the line of march; everyone knew its goal and made straight for it. There can be little doubt that the same birds return year after year to the same rookeries. Possibly the one-year birds return to their birth-places, or may be they simply follow older birds. The erect mode of progression is slow and ungainly, but the prone attitude is the reverse; propelling themselves forward on their bellies by aid of feet and flippers, they can move over the floe considerably faster than a man on ski can travel, certainly over five, probably more than six miles an hour.

By the third week of October the rookeries around Scotia Bay were filled with a noisy, excited crowd of birds, preparing for mating and nesting. As a rule, the rookeries prove to be places that are clear of snow relatively early in the spring. Sometimes they are at sea-level, but more generally several feet above, even as much as 100 feet in places. At some rookeries we found birds as high as 300 feet. There are few suitable sites that are not occupied during the breeding season, and often enough the late-comers or less fortunate ones are crowded out from the bare ground on to the snow, where they are forced to build their nests. Sometimes it happens that, on the arrival of the birds, parts or all of the rookery are still covered with snow. That makes no difference to the activities of the penguins, unless, perhaps, they voice their dissatisfaction and so add to the noisy clatter that always reigns on the rookeries. However, by the time the eggs are laid the nest is clear of snow, through the sun's action, unless a particularly heavy snowstorm leaves the rookery several inches deep for a day or more.

The Adelia or Black-throated Penguins (*P. adeliæ*) arrived first in Scotia Bay. About a fortnight after them arrived the slower, less energetic gentoos (*P. papua*), and a few Ringed Penguins (*P. antarctica*) straggled southward to their haunts around Saddle Island about the same time (see "Zoological Log of the Scotia," *Rep. Sci. Res. Voyage S.Y. Scotia*, IV., and "Birds of the South Orkneys," *ibid.*, Section V.).

As soon as the birds arrive at the rookeries the mates are chosen, and this involves much display and showing off on the part of the male. He stands erect, drawing himself up to his full height, with head thrown back and neck craned forward, and slowly and impressively waves his flippers several times, emitting a long, loud cackle. This over, he resumes his normal, somewhat squat appearance, and looks round to see what impression his charms and powers have had on the onlooking females. This process repeated a few times generally results in a couple being paired off, and nest-building then begins.

One often sees what is clearly a demonstration of affection on the part of a couple. The two stand facing one another, and stretching forward cross their beaks, and proceed to sway from side to side in unison, uttering the while a shrill, harsh cry. At other times the two sit facing one another with a look of the smuggest complacency on their faces.

Within a week of the arrival of the penguins nest-building is in full swing in the rookeries. The first-comers get the best positions, already clear of snow, while the later arrivals have to be content with less favourable sites. Nest material is not plentiful, and the Black-throated Penguin almost entirely confines itself to the use of stones; the gentoo generally adds to his stones any stray feathers and bones which he can find. Male and female take an equal share in the nest-building. The bird walks to and fro collecting pebbles in its beak, and carries them to the chosen spot one by one, there depositing them in a little heap. He is quite energetic over the work and, though a penguin can walk but slowly on his feet, he often travels ten yards or more for a stone. It is most amusing to watch their cunning in acquiring stones, for a penguin never walks far for a stone if he can steal one near by. Since the nests are seldom more than a couple of feet apart, theft is a relatively simple matter. A penguin sets out to fetch a stone and notices a nest near by unwatched for the moment. He approaches with the obvious intention of stealing a stone, when at that moment the rightful owner, himself probably coming from a raid, returns. The intending culprit, walking on with a most innocent air and with a look as if the thought of theft had never entered his head, passes on to pick up an unclaimed pebble farther away. But given a better opportunity he will not fail next time.

Often, of course, the culprit is caught in the act, and then an angry fight with beaks ensues, and blood flows and feathers fly before peace is restored. In fact, the penguin is a most pugnacious bird, and on every rookery there are always several fights in progress, while neighbours continually snarl threateningly at one another. Not infrequently one sees an unpaired male—very probably a one-year bird whose powers had been unavailing to encharm a mate—running about the rookery in a forlorn and battered state, pecked at by every bird it passes, and only too glad to escape to safety beyond the rookery. Penguins fight almost solely with their beaks, dealing an occasional blow with their flippers. But such blows in the case of an Emperor Penguin are most powerful. A harsh cry accompanies every peck the penguin gives his enemy, so that it is easy to imagine that with courtship and fighting a rookery is anything but quiet. Wherever penguins nest, except in the very bad weather, there is an incessant cackle that requires only a few hundred birds to become deafening at times. The nest does not take long to complete, for it is merely a small heap of stones a few inches high, scooped out in the middle into a slight hollow.

Towards the end of October, at the South Orkneys, the eggs of the Adelia Penguins were laid. As a rule there are two in each nest, but occasionally three. The pugnaciousness of the birds then increases, and they show much courage in defending their eggs, and later their chicks, from the attacks of enemies. The skua (*Megalestris antarctica*) is the bird for which the penguins must always be on their guard. As soon as the eggs are laid skuas hover continually over the rookeries, and if one spies an unguarded egg it swoops down immediately, seizes the egg, and carries it off to a distance in order to suck the contents. On a skua flying low over the rookery all the penguins in the vicinity combine in a shrill uproar in the hope of scaring it away, but seldom with much success, and scores of eggs are thus destroyed during incubation. So great, in fact, is the harvest of the skuas, that for a few weeks these birds congregate near the rookeries and live on little else than eggs of penguins.

The presence of the Expedition introduced the penguins to a new and more persistent enemy. Thousands of eggs were collected for food. This presented no difficulty: the birds were simply pushed off the nests and the eggs picked up. But the Adelia Penguin did not submit to this robbery without a protest. It would rush at the intruder and bite him savagely, sometimes even jumping up and trying to bite his arm. The bite of an angry penguin is not soon forgotten, so it was well to be protected with long leather sea-boots. Occasionally a robbed bird would follow a man several yards, attacking him courageously all the time, but generally they stayed near the plundered nest and bewailed their lot. In most cases another couple of eggs were laid very soon.

Two weeks after the Adelias had begun to lay, the first Gentoo Penguin's egg was obtained. The Gentoos, who had been a fortnight later in arriving, inhabited the same rookeries as the Adelias, but owing to their coming later had to be content with the more outlying or otherwise less favourable sites. They had a small rookery of their own on the west side of Scotia Bay, less than a mile from the ship. This afforded excellent opportunities for the collection of dated eggs for embryological study. The Gentoos are much more timid than the Adelias, and seldom made a stand when we approached their nests, but bolted in a body, leaving their eggs at our mercy. This certainly facilitated our work, if it lessened the interest and excitement. Scarcely ever did a molested Gentoo stand firm and show fight. Later on it was noticeable, however, that an occasional Gentoo would defend its chick, fighting with flippers rather than beak. In fact, their timidity and peacefulness seem to result in their being unable to hold their own in competition with the Adelias for the rookeries. They build fairly large nests, and use, in addition to pebbles, bones and tail-feathers. Some of the latest arrivals, however, laid their eggs in mere holes in the snow. Their eggs frequently fall a prey to the rapaciousness of the skuas. In all their movements the Gentoos show less activity and alertness than the Adelias, and are altogether less interesting birds. The cry of the Gentoo is strangely like the bray of an ass—so much so, in fact, that the closely allied Falkland Island species (*Spheniscus magellanicus*) gets the name of the Jackass Penguin.

The Bridled or Ringed Penguin (*P. antarctica*) occurs in large numbers at Saddle Island, Nigg Rock, and Eillium Island, but around Scotia Bay and the shores of Laurie Island in general no rookeries were discovered. This is more pugnacious than either of the two common species, and a Ringed Penguin has been known more than once deliberately to attack a man on the floe and only to retreat after receiving several hard blows. The *quagh* of the Ringed Penguins is harsher than that of the other species.

For the first few weeks after their arrival the penguins live on their thick coats of blubber and abstain altogether from fishing. After the eggs are laid, however, the male and female take turns at making excursions to the nearest open water in search of food. The one that remains behind looks after the eggs. In fine weather the penguin sits upright against the eggs, partially enveloping them in a ventral groove in its coat of feathers. In windy weather or a blizzard the bird lies prone and completely covers the eggs. Sometimes in a blizzard the birds are almost snowed up, but the eggs rarely suffer.

A large rookery of penguins, such as the one at Graptolite Island, may contain several million birds. At Route Point Dr Pirie estimated there were at least 200,000 Ringed Penguins in one rookery. As rookeries fringe all Antarctica and its bounding islands, wherever a site offers, it can be realised how enormous is the wealth of penguin life. The nests occur at intervals of a few feet, and this gives a strangely regular appearance to a rookery. If viewed from the right point of view, the birds seem to be arranged in long streets. Some of the photographs reproduced in this volume illustrate that symmetry.

About the middle of December the Adelia and Gentoo chicks were hatched, those of the Ringed Penguin some weeks later. For a study of the rookeries and the habits of the penguins at this season I am largely indebted to Dr Harvey Pirie, who was one of the party left at the South Orkneys while the *Scotia* went to Buenos Aires to refit. The young Adelias are covered with a dark, almost black down, the Gentoos and Ringed Penguins of a light grey, the former becoming darker before the down is cast, the latter always darker on the dorsal surface. The chick is fed by the adult bird. Dr Pirie, describing the mother feeding her youngster, says: "She bends her head down till her bill is inclined at about 45°, with *upper* mandible *lowermost*. Then the chick sucks up the semi-digested food, brought up from her stomach out of the hollow between the rami of the upper mandible." The young have voracious appetites, and grow rapidly. It was a funny sight to see a poor emaciated parent being chased by two fat chicks as big as herself, demanding loudly to be fed, with cries of *Māā*, *Māā*, like a young lamb. The young birds have several enemies, and the death-rate must be high. While skuas do not neglect the chicks, most of their depredations are on the eggs. Giant Petrels (*Ossifraga gigantea*), on the other hand, are greedy for young penguins. On the outskirts of a rookery there are always a number of these birds lying asleep after a gorge, or waddling to and fro in a state of repletion, unable to fly.

When about a month old the chicks begin to lose their down, and at this time present a very bedraggled appearance, for the rookeries by then are like quagmires. The birds are caked all over with mud and dirt, and the stench is abominable. When the wind was in the right quarter a rookery at that season could be smelt more than a mile away.

The casting of the down commences on the breast and under parts of the body, neck, and flippers, and then on the dorsal aspects, the last parts to cast being generally above the root of the tail and at the base of the flippers, and finally the crown of the head. When the moulting is complete the young birds rapidly take to the water, and then the parents leave them to shift for themselves. They are about six weeks old when this happens, and the parents show no reluctance to abandon their young; in fact, they occasionally do so rather prematurely. Clumps of ten or twenty very forlorn-looking youngsters may often be seen on the rookeries, left by the adults, but a little timid of trusting to their own resources. In their defenceless state the young birds pay a heavy toll to the giant petrels, skuas, and gulls.

The Sheathbill probably never attacks the chicks nor does it seize eggs, but haunts the rookeries on the look out for offal.

Once their parental duties are over the old birds quickly fatten. Early in February they had altogether lost their emaciated look, and were stout and prosperous again, scaling some sixteen or seventeen pounds. By the middle of that month they had deserted the rookeries and put to sea—their normal habitat. In the water the penguin has only one enemy, the sea-leopard, which has been seen to come up alongside a floe, seize a penguin in its huge jaws, and sweep down with its prey. At other times the Sea-leopard chases the penguin in the water as the bird darts torpedo-like through the sea before its enemy.

Further notes on the habits of penguins, more especially with regard to nesting, will be found in the previous paper by Mr Eagle Clarke (pp. 223–233). Mr Clarke's notes were compiled from observations supplied by the leader and other naturalists of the *Scotia*.

Section VII.—On the Birds of the Weddell and Adjacent Seas, Antarctic Ocean.*

By Wm. Eagle Clarke, F.R.S.E., F.L.S., Keeper of the Department of Natural History of the Royal Scottish Museum.

This instalment of the ornithological results of the voyage of the *Scotia* deals with the bird-life observed in the Antarctic Ocean southwards of the 60th parallel of south latitude, and between the meridians of 12° and 45° of west longitude; in other words, the Weddell Sea and the waters fringing it on the north. Previous to the voyages of the *Scotia*, the Weddell Sea had only been visited by Captain Weddell, during his marvellously successful cruise in 1823; by Morrell later in the same year; by Sir J. C. Ross, who traversed its waters in 1843; and lastly, by Dr Otto Nordenskjöld, who penetrated to its western portion in 1902.

Dr Bruce made two voyages into the Weddell Sea; the first in the late southern summer of 1903, and a second and more extended cruise in the same season of 1904. On both these occasions a high southern latitude was attained, and on the latter the Antarctic Continent within this area was discovered and named "Coats Land," after Mr James Coats and Major Andrew Coats, in recognition of their public-spirited liberality towards the Expedition. During these voyages birds received much attention, and specimens were collected whenever opportunity afforded, chiefly while the *Scotia* was engaged in taking soundings, or while trawling operations were in progress for the capture of deep-sea organisms. As no landing was effected on *terra firma*, the birds were observed or obtained either amid the ice-fields or on the open sea. The collection thus formed comprises seventy-four specimens, and is one of great value and interest, for it is not only the first ever made in the region, but adds greatly to our knowledge of the geographical distribution of bird-life in the Antarctic Seas.

The first of the above-mentioned voyages commenced on the 4th of February 1903, on which date the *Scotia* sailed from Saddle Island, one of the South Orkneys. It was the intention of the explorers to follow a south-easterly course, as Weddell had done in 1823, but the pack-ice, in places from fifteen to twenty feet thick, compelled them to proceed in an easterly direction, hugging, as it were, the 60th degree of south latitude. On February 14th, when some distance off Southern Thule Island, the southernmost of the South Sandwich group, the edge of the pack was fortunately found to trend towards the much-desired south.

During the run from the South Orkneys towards the South Sandwich Islands the following birds were either obtained or came under notice:—Banks's Whale-bird

* Reprinted, with slight verbal alterations, from *The Ibis*, Series IX., i., 1907, pp. 325–349.

(*Prion banksi*), Wilson's Petrel (*Oceanites oceanicus*), Cape Petrel (*Daption capensis*), Giant Petrel (*Ossifraga gigantea*), Silver Petrel (*Priocella glacialoides*), Snowy Petrel (*Pagodroma nivea*), Hutton's Sooty Albatros (*Phæbetria cornicoides*), Ringed Penguin (*Pygoscelis antarctica*), Sheathbill (*Chionis alba*), and several "Molliemauks."

From noon on the 15th of February until the 18th, when the Antarctic Circle was crossed, the *Scotia* had a fine run southwards in a sea clear of pack-ice. On the 19th, however, the edge of the pack was again encountered, and an E.S.E. course was steered until the 22nd, when, in 70° 25′ S. lat. and 17° 12′ W. long., or a little short of Ross's furthest south in this region, the ship became firmly beset. Later in the day, however, the *Scotia* managed to free herself, but, the temperature having fallen to 13° F., it was resolved to retreat to the South Orkneys in search of winter-quarters.

The birds observed between the Sandwich group and the Antarctic Circle were Wilson's Petrels, "Blue Petrels" (? *Prion* or *Halobæna* *), Giant Petrels, Hutton's Sooty Albatroses, Cape Petrels, Snowy Petrels, Silver Petrels, Antarctic Skuas (*Megalestris antarctica*), Antarctic Petrels (*Thalassœca antarctica*), and Terns (*Sterna* sp.).

Between the Antarctic Circle and the furthest south (lat. 70° 25′ S., long. 17° 12′ W.), the same species came under notice, with the addition of Emperor and Adélie Penguins (*Aptenodytes forsteri* and *Pygoscelis adeliæ*).

On the return voyage a north-easterly course was steered, the Antarctic Circle was recrossed on March the 11th, and the first southern voyage of the *Scotia* was completed on the 21st, on which day she reached the South Orkneys.

The only bird worthy of note obtained during the final stages of this cruise was a McCormick's Skua (*Megalestris maccormicki*).

Having spent the winter of 1903 at Laurie Island, the *Scotia* proceeded to the Falklands and Buenos Aires to refit, and returned to the South Orkneys on February 14th, 1904. On the 22nd, the Expedition bade adieu to the Orkneys, and the *Scotia* commenced her second and most important voyage to the Weddell Sea. In contrast to the preceding season, the sea was almost free from pack-ice and a south-easterly course was possible. At the beginning of March the old track of the previous year was crossed, and a few days afterwards the *Scotia* broke her southern record of 1903, and that of Ross in 1843. Skirting, more or less, the open pack for 300 miles, the ship met with no obstacle to her progress southward, whereas in 1903 all had been impenetrable ice. On reaching 72° 18′ S., 17° 59′ W., however, a lofty ice-barrier effectually barred further progress towards the south, and here Coats Land was discovered. This barrier was traced for a distance of 150 miles to the south-west, when, on the 7th of March, the ship was caught in a north-easterly blizzard and became locked in heavy pack-ice. On the gale abating two days later, it was found that the *Scotia* had been driven into a bight in the ice-barrier off Coats Land in 74° 1′ S., 22° 0′ W. No open water was in sight, and with the temperature down to zero the pack

* Both *Prion banksi* and *Halobæna cærulea* appear under the name of "Blue Petrels" in the Zoological Log, and when specimens were not obtained it is impossible to say which species is intended.

soon froze up. For several days there was no change, and the lateness of the season, and the possibility of not being liberated, made it imperative that preparations should be made for wintering. On the 13th, however, under the influence of a south-west wind, the pack began to break up and the ship was once more afloat. Off this newly discovered land Emperor Penguins were abundant, and twenty were captured; while Adélie Penguins, Giant Petrels, McCormick's Skuas, Arctic Terns (*Sterna macrura*), and Snowy and Silver Petrels were swarming all around. The birds previously observed during the voyage, in addition to the species named, were Cape Petrels, Wilson's Petrels, Blue Petrels (*Halobæna cærulea*), Hutton's Sooty Albatroses, and Banks's Whale-birds, the last-mentioned being only observed north of the Antarctic Circle.

The Antarctic summer was now fast drawing to a close, and the *Scotia* having narrowly escaped the miseries of wintering in the pack, turned her prow towards the north on the 17th of March, her immediate goal being the remote Gough Island in the middle waters of the South Atlantic Ocean. In the run northwards to the Antarctic Circle, the birds logged were Emperor and Adélie Penguins, Antarctic, Silver, Snowy, Cape, Blue, and Wilson's Petrels, Hutton's Sooty Albatroses, Arctic Terns, and a new petrel to the fauna of the South Polar Ocean, namely *Œstrelata brevirostris*. The species noted between the Circle and 60° S. lat., which was crossed in about 12° W. long., and between March 27th and April 2nd, included most of the species named, the absentees being the two penguins, the Snowy and Antarctic Petrels, and the Arctic Tern. On the other hand, an additional petrel, from the description probably *Majaqueus æquinoctialis*, was encountered.

It may be interesting here to notice that the Expedition added no less than four birds—namely, *Sterna macrura*, *Phœbetria cornicoides*, *Halobæna cærulea*, and *Œstrelata brevirostris*—to the short list of nine species previously known, according to Mr Howard Saunders in the *Antarctic Manual*, to have occurred south of the Antarctic Circle.

A specially important ornithological feature of these voyages of the *Scotia* was the presence in the Polar Sea of a number of species of petrels far beyond the southern limits of their breeding-areas. This seems to indicate that at the close of the southern summer numbers of Hutton's Sooty Albatroses (*P. cornicoides*), Cape Petrels (*D. capensis*), Giant Petrels (*O. gigantea*), Antarctic Petrels (*T. antarctica*), Silver Petrels (*P. glacialoides*), Blue Petrels (*H. cærulea*), and *Œstrelata brevirostris* cross the Antarctic Circle and sojourn among the polar ice ere they retreat northwards to pass the winter in more genial oceanic resorts. It is possible, however, that some of these visitors to the far south are non-breeding birds, and, if so, they may have spent the entire summer there. The Tubinares are, as is well known, great wanderers, but these very remarkable southern incursions are, perhaps, to be explained by the extraordinary abundance of food to be found in the waters of the far south in the summer and autumn, which allures some of the birds further and further towards the Pole, until the great ice-barrier, which almost girdles the Antarctic Continent, arrests their further progress, since at its base the food-supply entirely ceases. This, too, explains why our familiar Arctic Tern (*Sterna macrura*) passes the southern summer (our northern winter) amid these ever-icy seas.

Full particulars of the distribution of all the species collected or observed by the Expedition south of 60° 0′ S. during the voyages that I have thus briefly described will be found in the systematic portion of this contribution, which is chiefly based upon the information afforded by the *Zoological Log of the "Scotia,"* kept by Mr Wilton, though I am also indebted to Dr Bruce for extracts from his private diary relating to this portion of the expedition under his leadership.

Mr Kinnear has again earned my acknowledgments for the aid which he has rendered me in classifying the numerous records.

I shall have occasion to refer to the following works:—

WEDDELL.—*A Voyage towards the South Pole, performed in the Years* 1822–1824. By JAMES WEDDELL, Master in the Royal Navy. (1825.)

ROSS.—*A Voyage of Discovery and Research in the Southern and Antarctic Regions during the Years* 1839-43. By Capt. Sir JAMES CLARK ROSS, R.N. Vol. ii. (1874.)

SAUNDERS (1).—*Catalogue of Birds in the British Museum.* Vol. xxv. Gaviæ. By HOWARD SAUNDERS. (1896.)

SALVIN.—*Catalogue of Birds in the British Museum.* Vol. xxv. Tubinares. By OSBERT SALVIN. (1896.)

CHUN.—*Aus den Tiefen des Weltmeers.* Von CARL CHUN. (1900.)

RACOVITZA.—*La vie des Animaux et des Plantes dans l'Antarctique.* Par EMILE G. RACOVITZA. (1900.)

SAUNDERS (2).—*Antarctic Manual for the use of the Expedition of* 1901. By HOWARD SAUNDERS. (1901.)

SHARPE.—*Report on the Collections of Natural History made in the Antarctic Regions during the Voyage of the "Southern Cross": Aves.* By R. BOWDLER SHARPE, LL.D. (1902.)

ANDERSON.—"Das höhere Tierleben im antarktischen Gebiete." Von K. A. ANDERSON. *Wiss. Ergebn. d. schwedischen Sudpolar-Exp.* 1901–1903. Bd. v. Lfg. 2. (1905.)

NORDENSKJÖLD.—*Antarctica, or Two Years amongst the Ice of the South Pole.* By Dr N. OTTO NORDENSKJÖLD and Dr JOH. GUNNAR ANDERSON. (1905.)

LÖNNBERG.—"Die Vögel der schwedischen Südpolar-Expedition." Von EINER LÖNNBERG. *Wiss. Ergebn. d. schwed. Südpolar-Exp.* Bd. v. Lfg. 5. (1905.)

VANHOFFEN.—"Bericht über die bei der deutschen Südpolarexpedition beobachteten Vögel." Von Prof. Dr E. VANHOFFEN. *Journ. für Orn.*, 1905, pp. 500–515.

BROWN, MOSSMAN, and PIRIE.—*The Voyage of the "Scotia."* By Three of the Staff (1906). An excellent and graphic account of the work of the Scottish National Antarctic Expedition.

Aptenodytes forsteri G. R. Gray.

Aptenodytes forsteri Cat. B., xxvi. p. 626.

The occurrence of this bird as a visitor to the South Orkneys was considered probable in 1903 (*Ibis*, 1906, p. 166), and the fact has since been fully confirmed by the Argentine naturalists, who, Mr Mossman informs me, captured two specimens on Laurie Island in March 1905. This establishes a record for the northern range, namely 60° 44′ S., of this species.

On the first Antarctic voyage, in the early southern autumn of 1903, this species was not observed until latitude 69° 46′ S. (20° 58′ W.) was reached. Here a male, weighing 64 lbs., was shot on February 21st, whose stomach contained cuttle-beaks, fishes, and three small gneiss pebbles. On the following day an individual was captured on the ice in 70° 25′ S., and was brought on board alive. This bird soon became reconciled to its strange surroundings, and with remarkable equanimity paced up and down the deck of the *Scotia*, every now and then giving utterance to a musical cry. On the return passage to the South Orkneys for winter-quarters, another male was obtained in 67° 10′ S. (39° W.), but none were seen further north.

On the second voyage, in 1904, this species was not encountered till 72° 18′ S. (17° 59′ W.) was attained on March 3rd, on which day three examples were seen and secured. In 73° 30′ S. (21° 28′ W.) Emperor Penguins were in abundance on the water, but only one was observed on the ice, which was captured. In 74° 1′ S. (22° W.), while the *Scotia* was for several days fast in the pack off Coats Land, until March 14th, an extraordinary number of these penguins were seen on the ice around the ship, and many were captured with a view to providing food for the Expedition should it be compelled to winter in the pack. While the ship was thus incarcerated, Piper Kerr played on his pipes to one of the captive penguins which was tethered on the ice, but it is said that neither rousing marches, lively reels, nor melancholy laments seemed to have any effect on this lethargic and phlegmatic bird: it was absolutely indifferent to them all!

Some of the individuals captured weighed close on 80 lbs., and it was all that a man could do to lead one of them up to the ship. With their beaks they bit fairly hard, while with their long flipper-like wings they dealt severe blows.

None were seen after the *Scotia* escaped from the ice and proceeded northwards.

Pygoscelis antarctica (Forster).

Pygoscelis antarctica Cat. B., xxvi. p. 634.

Ringed Penguins were abundant in the South Oreadian waters, and were seen at sea during the easterly run towards the South Sandwich group in February 1903. Afterwards, when the *Scotia* was proceeding southwards, these birds were met with at intervals until latitude 69° 39′ S. (22° 58′ W.) was reached on February 20th. On the return passage to the Orkneys they were met with in 67° 39′ S.

For the second voyage there were but few records, but it is said that several individuals were seen by one of the sailors on March 18th (1904), when the *Scotia* was in latitude 71° 22′ S. (16° 34′ W.). The only other observation is for April 1st, on which date some were noticed on the water in 60° 33′ S. (12° W.)—the last the *Scotia* naturalists were to see of a bird to our knowledge of which they have added so much.

Pygoscelis adeliæ (Hombr. et Jacq.).

Pygoscelis adeliæ Cat. B., xxvi. p. 632.

The Adélie Penguin—another native of the Antarctic Continent—was not observed during the first voyage into the Weddell Sea until the latitude of 69° 46′ S. (20° 58′ W.) was attained on February 21st, 1903, the day on which the Expedition made the acquaintance of the Emperor Penguin, which shares with this species the distinction of being the most southerly representative of its order. On the following day, when the *Scotia* reached her furthest south (71° 25′) for the season, the birds were very abundant; and on the return passage to the Orkneys were seen almost daily in considerable numbers. On one occasion some twenty to thirty were observed seated on an iceberg from forty to fifty feet high, to obtain a footing on which others were seen jumping out of the water on to the berg's precipitous, slippery sides, and holding on where Dr Bruce believes no other bird or mammal could. They took advantage of the wash of the sea, but often had to try again and again ere they succeeded in landing on the lowest ledges of the berg.

During the 1904 voyage this bird was not logged until March 6th, when a few examples were noted in 73° 30′ S. (21° 38′ W.). A few more were observed on the northward passage, but not beyond 61° 25′ S. (12° 47′ W.).

Three adults captured on February 23rd, 1903, were still in moult, having only partially assumed their new coats of blue-black tipped with steely blue. The temperature of these specimens was found to be 102°–103° F.

Oceanites oceanicus (Kuhl).

Oceanites oceanicus Cat. B., xxv. p. 353.

After the nesting-season this little petrel becomes a great wanderer on the face of the ocean. As such it was almost daily to be seen in numbers, both at sea and among the ice, throughout the voyages of the *Scotia*—being observed as far south as 72° 22′ S., while northwards it was present in abundance off Gough Island (40° 19′ S.).

It was one of those birds which followed in the wake of the ship, probably on the look out for scraps cast overboard from the galley. On February 7th, 1903, in lat. 60° 35′ S. and long. 39° 44′ W., a great number were observed around a dead whale, picking up morsels of fat that fell from the bills of a host of Giant and Cape Petrels, which were regaling themselves to repletion on the blubber of the defunct leviathan. On one occasion "a flock" was observed resting on the water in 61° 22′ (42° W.).

The *Belgica* obtained it in the pack in 70° S. (87° W.); the *Southern Cross* found it breeding on Victoria Land; and Dr Wilson saw it off the Great Ice Barrier in 78° S., some seventy miles from the nearest open water (*Voy. of the "Discovery,"* ii. pp. 482–3).

Thalassœca antarctica (Gm.).

Thalassœca antarctica Cat. B., xxv. p. 392.

The Antarctic Petrel was first encountered by the Expedition on February 17th, 1903, in latitude 64° 18′ S. (23° 09′ W.). Afterwards it was much in evidence in the vicinity of and amidst the great polar ice-fields. During the first voyage this bird was seen almost daily, sometime in flocks, its latitudinal range varying from 62° to 70° S., and its longitudinal from 16° to 44° W.

It was equally frequent during the second voyage, in 1904, and often followed the ship all day. When off Coats Land in 74° 1′ S. no less than twenty were shot on March 14th, while the *Scotia* was locked in the pack. Just previously to this, namely on March 5th, when in 72° 31′ S., thousands of this species were seen in company with McCormick's Skuas, Giant and Snowy Petrels, and Arctic Terns. On the northward voyage it was not observed beyond 68° 26′ S. (10° 11′ W.).

As already recorded (*The Ibis*, 1906, p. 169), a few came under notice at Laurie Island in the summer of 1903–4, and it was thought not unlikely that the bird was nesting there. A number were also seen near Saddle Island, another of the South Orkney group, on March 22nd, 1903, in about 60° S., the most northerly point at which this species was observed during the voyages of the Expedition. A number of specimens were obtained in the month of March during the Antarctic voyages of 1903 and 1904, and these vary in their plumage. Some are more or less faded (drab) in colour and abraded in feather, and are, no doubt, unmoulted birds; others are evidently freshly moulted adults or young of the year; in these the head, back, scapulars, lesser wing-coverts, quills and tip of the tail are slaty black, and the under parts purer white. Specimens in moult are intermediate between these two forms, and make clear the relationships of these phases in plumage as regards adult birds. Some of these moulting birds lack rectrices, their tails being represented by the long under tail-coverts only. The feet in life have the tarsus and outer toe greyish, the other toes and the webs paler and washed with yellow.

Priocella glacialoides (Smith).

Priocella glacialoides Cat. B., xxv. p. 393.

The Silver or Silver-grey Petrel was observed during the voyages to and from the Weddell Sea, between the latitudes 44° 30′ and 71° 22′ S., and the meridians of 9° 43′ and 42° 30′ W. The extreme southerly range here indicated has only been exceeded, I believe, in the case of the observations made by Dr Wilson during the National Expedition under Captain Scott, when the bird was seen in the Ross Sea (*Voy. of the "Discovery*," ii. p. 481).

This petrel was first met with on the 9th of February, when the *Scotia* was skirting the pack-ice in 58° 57′ S. and 33° 34′ W., or about midway between the South Orkney and South Sandwich groups; but it was not observed beyond 63° 54′ S. on the 1903 voyage. On the second voyage it was noted as high as 71° 22′ S., on March 18th, 1904, when one was seen in company with several other species of petrel and Arctic Terns.

It does not appear to be an abundant species in the Weddell Sea; but it was observed in numbers during the northward voyage, when latitude 60° S. was reached, and was last seen when the *Scotia* was nearing Gough Island.

As stated on page 236 of this volume, it was occasionally seen in the summer of 1903 about the cliffs at Laurie Island, where it was considered probable that a few were nesting. I mentioned (*l.c.*) that its breeding-haunts remained unknown. Since then, however, I have learned that the Swedish Expedition under Nordenskjöld found it nesting at Cape Roquemaurel, on the west coast of Louis Philippe Land (Anderson, *t.c.*, p. 43).

A coloured drawing made by the artist to the Expedition shows the maxilla and mandible tipped with black, the middle portion of the bill pale flesh-coloured, and the base and nares pale cobalt-blue. The feet are pale flesh-coloured, the webs washed with yellow, and the claws black. The iris is dark brown, and the pupil blue-black.

Pagodroma nivea (Gm.).

Pagodroma nivea Cat. B., xxv. p. 419.

The Snowy Petrel being a native of the Antarctic Continent, it is not surprising to find that it was one of the most abundant and most frequently observed species which came under the notice of the Expedition in the Weddell Sea. During both the southern voyages of the *Scotia*, there was hardly a day on which this beautiful bird was not met with—often in great numbers. It was most abundant in the neighbourhood of the pack, and became less numerous as soon as open water clear of ice was entered.

The extremes of latitude between which this bird was met with during the voyages of the *Scotia* were from 59° 44′ to 74° 1′ S. (off Coats Land, the *Ultima Thule* of the Expedition). Longitudinally it occurred from 12° 49′ to 43° 40′ W. On the voyage from Coats Land northwards to Gough Island it was not observed beyond 68° 32′ S. (12° 49′ W.).

The Snowy Petrel was sometimes seen in flocks around the ship, and often followed it all the day long. It was seen to capture fish at or near the surface of the water.

Œstrelata brevirostris (Lesson).

Œstrelata brevirostris Cat. B., xxv. p. 409.

This species is new to the avifauna of the Antarctic Ocean, where it was discovered by the Scottish Expedition on March 20th, 1904, in 69° 33′ S. and 15° 19′ W., during the northward voyage from Coats Land towards Gough Island. On that day, while the *Scotia* was engaged in trawling for the capture of various forms of marine life, Dr Pirie left the ship in a boat for the purpose of obtaining specimens of birds, a quantity of which, including terns and various species of petrels, were in the vicinity. While thus employed he came across numbers of a petrel that he had not seen before, and succeeded in shooting a male, which on examination I found to belong to this species. Afterwards this "New Petrel," as it was logged, was observed on five different days down to March 25, when it was seen in 65° 58′ S. and 11° 24′ W.*

The habitat of this interesting addition to the fauna of the South Polar seas has hitherto been supposed to be confined, according to Salvin (*op. cit.*, p. 410), to the South Atlantic and South Indian Oceans, and he mentions specimens as being in the British Museum Collection from Kerguelen (where it breeds) and Tristan da Cunha.

* See also *infra*, Section VIII., p. 276.

Vanhoffen (*l.c.*, pp. 506 and 508) records it as seen so far south as 59° during the voyage of the *Gauss* from Kerguelen towards Wilhelm Land; and on the return voyage northwards from that part of the Antarctic Continent it was again met with 200 nautical miles south of Heard Island, or in about 57° S.

The feet of the specimen obtained by Dr Pirie are, according to a coloured drawing made at the time of its capture, purplish grey and the claws black; while the iris is dark brown and the pupil blue-black.

Ossifraga gigantea (Gm.).

Ossifraga gigantea Cat. B., xxv. p. 422.

The Giant Petrel was seen everywhere and almost daily during the Antarctic voyages of the *Scotia*, even in the highest latitudes reached during each year's cruise, namely 70° and 74° S.; and yet its breeding-grounds are all, so far as we know them, to be found north of the Antarctic Circle.

Perhaps some of these petrels which frequent the far south in late summer and autumn may be either non-breeding or immature birds which have spent the summer there; while others may proceed south at the close of the nesting-season, as may also young birds. These are points which at present do not admit of satisfactory solution.

Off Coats Land, in 74° 1′ S. and 22° W., from the 9th to the 13th of March 1904, when the *Scotia* was fast in the grip of the pack, a number of these birds were seen, as were also many of McCormick's Skuas, Antarctic and Snowy Petrels, and Arctic Terns. White examples are only alluded to in the *Zoological Log* during these voyages as being seen on four occasions, all north of 61° S.

As regards the food of this bird as a marine species, a great host of individuals, including white examples, were feeding on the carcass of a dead whale in 60° 03′ S. (39° 44′ W.) on February 7th, 1903, and the stomach of one shot contained crustaceans.

Daption capensis (Linn.).

Daption capensis Cat. B., xxv. p. 428.

The Cape Pigeon was one of the most abundant species observed by the Expedition during its two Antarctic voyages. It was seen almost everywhere, both at sea and amid the ice, as far south as 71° 50′, though it was only found in small numbers in the high latitude mentioned.

The presence of this (with other petrels) in great numbers in the Weddell Sea, far to the south of its breeding-haunts, in the late summer and in autumn, has already been alluded to (p. 257), and a possible explanation of its remarkable incursions amid the South Polar ice, ere it moves northward to reach its accustomed oceanic winter-quarters, has been offered.

All the specimens obtained in the Antarctic Ocean during these voyages in the autumns of 1903 and 1904 have the dark portions of their plumage of a fresh slate-black tint, instead of the faded brown presented by the examples obtained at the South Orkneys during the breeding-season. This is, with little doubt, attributable to the fact that the birds were either adults recently moulted, or young in their first plumage, or both.

Whenever the *Scotia* stopped for the purpose of taking soundings, these petrels settled on the water on the look out for scraps of food, and so tame were they that specimens were often captured by simply scooping them out of the water by means of a large landing-net. Birds thus taken were sometimes liberated on the ship's deck, where they showed their entire inability to escape, the *Scotia* not being long enough to afford them a sufficiently extended run to enable them to rise on the wing: it was the same with the Giant Petrels.

When in pursuit of food at or near the surface, the Cape Petrels were observed to plunge downwards into the water after the manner of terns.

On February 7th, 1903, in 60° 35′ S., 39° 44′ W., a vast number, along with Giant and Wilson's Petrels, were observed feeding on the floating carcass of a dead whale.

Ross (*l.c.*, ii. p. 191) saw this bird off Victoria Land, on January 14th, 1841, in 71° 50′ S., or in precisely the same latitude in which Dr Bruce made his southernmost observation.

During the voyage of the *Southern Cross* it does not appear to have been noted beyond 65° 3′ S. (Sharpe, *t.c.*, p. 157); but Vanhoffen (*t.c.*, p. 507) observed it right down to the winter-quarters of the *Gauss*, namely to the Antarctic Continent (Wilhelm Land) in 66° 2′ S., 89° 38′ E. The Swedish Expedition (Anderson, *l.c.*, p. 46) also observed it near their southern limit, namely in the pack-ice east of Graham Land in 64° 30′ S.

Halobæna cærulea (Gmelin).

Halobæna cærulea Cat. B., xxv. p. 431.

Under the collective name of "Blue Petrels," both this species and at least one of the Whale-birds (*Prion*) were confounded by the Scottish explorers—a pardonable error also made long years ago during Cook's voyage in the Antarctic Seas, and, no doubt, often since repeated. Fortunately, however, a number of specimens of these "Blue Petrels" were secured, and afford authentic information regarding both this species and *Prion banksi* in the seas visited by the Expedition.

The data accompanying the skins of *H. cærulea*, the Blue Petrel proper, enable me to extend the distribution of this species far to the south of all previous records of a reliable nature. Salvin (*t.c.*, p. 431), the monographer of the petrels, gives its range as being between 40° and 60° S., or practically where Cook left it in the latter half of the eighteenth century; and it has no place in the bird section of the *Antarctic Manual*. From the *Scotia*, specimens were captured as far south in the Weddell Sea as 69° 33′ S., and others, believed to be of this species, were observed as high as 71° 28′ S. It probably occurs even beyond the limits indicated, for I think there can be little doubt that this was the bird which Weddell met with on February 18th, 1823, a little further to the west, in 73° S., where he tells us (*op. cit.*, pp. 35–6), "the sea was literally covered with birds of the Blue Petrel kind." Ross (*t.c.*, p. 359) also mentions a "Blue Petrel" as seen in the Weddell Sea in 67° 06′ S. and 8° 35′ W. Banks's Whale-bird (*Prion banksi*), the other "Blue Petrel" of the Expedition, was not obtained beyond 66° S., and I am not aware of any reliable record of its occurrence within the Antarctic Circle.

"Blue Petrels" appear very frequently in the Log of the *Scotia* during the two southern voyages, but *H. cærulea* was not obtained north of 64° 29′ S., and the ten specimens in the collection were secured between that latitude and 69° 33′ S., and longitudes 12° 49′ W. and 35° 29′ W. All but two were obtained south of 68°, and in the month of March (1903 and 1904). On February 25th, 1904, two specimens of this species, and one of *Prion banksi*, were captured in 64° 29′ S. and 35° 29′ W.

Weddell (*op. cit.*, p. 144) mentions the Blue Petrel as occurring at the South Shetlands, but later explorers do not mention *Halobæna cærulea* for that group or for the Antarctic regions proper. It would seem that this species is local in its far southern range, and is a specially characteristic bird of the Weddell Sea. It was not seen at the South Orkneys during the summer, nor was it encountered at sea in the vicinity of that archipelago.

In some of the specimens in the collection the white feathers of the forehead show their dark bases, and thus the front presents a mottled appearance. The bill in freshly killed examples was cobalt-blue, except the nares and culmen, which were black. The feet were cobalt-blue, the webs pale flesh-coloured, the claws black.

Prion banksi Gould.

Prion banksi Cat. B., xxv. p. 434.

Banks's Whale-bird (and perhaps others of its genus *), as has already been stated, when treating of *Halobæna cærulea*, was logged during the Antarctic voyages of the *Scotia* as a "Blue Petrel." Here, however, the specimens collected with such praiseworthy diligence again come to our aid, and enable us not only to distinguish between the two species on important occasions, but also to extend the southern range of this bird from 60° S. (*fide* Salvin, *t.c.*, p. 434, and the *Antarctic Manual*) to 66° S.†

The first specimens, a male and female, were procured on February 9th, 1903, when the *Scotia* was off the edge of the pack-ice in 59° 42′ S. and 34° 13′ W., or about midway between the South Orkneys and Southern Thule, the most southerly of the Sandwich Group. These were the only examples obtained during the Antarctic voyage of 1903.

* *Prion desolatus* appears (*Antarctic Manual*, p. 231) to reach the edge of the Antarctic Circle, having been obtained by the *Challenger* at the ice-barrier. It breeds at Kerguelen. This bird was not obtained by the Scottish Expedition.

† In the Liverpool Museum, however, there is a specimen which is believed to have been obtained by Dr J. Hooker off Victoria Land in 70° S. This example is recorded, along with *Ægialitis falklandica*, *Nettion flavirostre*, and *Podicipes calipareus*, as new to Antarctica in the *Bulletin* of the Museum (ii. p. 48). None of these species have come under the notice of later observers within the Antarctic Circle.

On the second voyage four (two males and two females) were captured in the Weddell Sea, or its confines, on February 25th and 26th, 1904, in 64° 29′ (35° 29′ W.) and 65° 59′ S. (33° 06′ W.).

This species does not appear to have come under the notice of other recent Antarctic explorers, but a species of *Prion* is recorded by Vanhoffen (*t.c.*) as having occurred off Wilhelm Land, or just without the Antarctic Circle, on March 18th, 1903, and one was also noticed between that part of the Antarctic Continent and Kerguelen Island where *P. desolatus* is known to breed.

The bill and feet of the specimens secured by the Scottish Expedition are described as being bluish grey, and the iris as brown.

Phœbetria cornicoides Hutton.

Phœbetria fuliginosa Cat. B., xxv. p. 453; Chun, *t.c.*, pp. 167, 220; *Voy. of "Scotia,"* pp. 181, 232.

It is a matter for surprise that two such genuinely distinct species as *P. cornicoides* and *P. fuliginosa* should have collectively passed for a considerable number of years under the name of the Sooty Albatros. The *Scotia* collection of birds has been the means of calling attention to the claims of Captain Hutton's so-called variety, described in 1867, to full specific rank. Now there remains the important but at present almost impossible task of unravelling the tangled skein involved in defining the geographical distribution of the two species. Here the *Scotia* collections again lend a helping hand, for they enable me to say that all the birds obtained and seen in the far south belonged to Hutton's species, and that it was only when the waters of the South Atlantic were approached that Gmelin's *fuliginosa* appeared upon the scene.

Specimens of both birds were collected, and the species under consideration was the only one obtained in the Antarctic Ocean, where it was observed as far south as 69° 46′ S.

During the first Antarctic voyage, in 1903, this bird was noticed on eight occasions between February 14th and March 21st, in latitudes varying from 59° 33′ to 69° 46′ S., and in longitudes from 20° 58′ to 27° 32′ W.; and on the second voyage, in 1904, it was logged for south of 60° on ten days between February 23rd and April 1st, in latitudes ranging from 60° 30′ to 67° S., and longitudes between 10° 42′ and 41° 55′ W. On February 25th, when in 64° 29′ S. and 35° 29′ W., six individuals were sailing around the *Scotia* at the same time. North of 60° it was encountered as far as Gough Island (40° 19′ S.), as related below (Section IX., p. 289).

Previously to the researches of the *Scotia* Expedition, this albatros had not been recorded within the Antarctic Circle, though Ross (*t.c.*, p. 359) observed a "Sooty Albatros" in the Weddell Sea in 67° 06′ S. and 8° 35′ W. on March 1st, 1843, which most probably was of this species.

No specimen of *P. fuliginosa* was obtained or observed by the Expedition beyond 58° S., though it is certain that this albatros does attain to a higher degree of southern latitude. "Sooty Albatroses" were frequently logged during the voyages of the *Scotia* between the Falklands and the South Orkneys, and are believed to have been *P. cornicoides*, but no specimens were captured.

Having made some incursions into the literature of Antarctic ornithology in the preparation of these papers, perhaps it may be well to allude to these researches so far as they concern *P. cornicoides*.

Captain Hutton told me, in 1905, that this species is the common form in New Zealand, and that it breeds at the Auckland and Antipodes Islands at the end of October; and Lönnberg in his *Contributions to the Fauna of South Georgia*, i. p. 71 (1906), mentions it as breeding on cliffs at that island.

Chun (*t.c.*, p. 167) informs us that during the voyage of the *Valdivia*, "*Diomedea fuliginosa*, die aschgrauen Albatrosse mit schwarzlichen Kopfe," was met with about midway between the Cape of Good Hope and Bouvet Island on November 20th, 1898, and (p. 220) that the Smoke-grey ("rauchgraue") Albatros was seen almost daily from Bouvet Island onwards. There is no mistake as to the bird meant, for reference is made to an excellent figure of *P. cornicoides*.

Bernacchi (*To the South Polar Regions*, pp. 316, 317) says that during the month of January 1900 an albatros, which he describes as "generally sooty, paler on the shoulders and under surface," was occasionally seen in the pack-ice.

Vanhoffen (*t.c.*) has a number of references to *Phœbetria* during the voyage of the *Gauss*, as seen between Kerguelen and the Antarctic Circle, but he evidently did not realise or recognise that there were two species of the genus.

Anderson (*op. cit.*) makes no allusion to *Phœbetria* under "Sturmvögel" in his records of the "Höhere Tierleben" of the Swedish Expedition; but Lönnberg (*t.c.*, p. 6), in his account of the birds seen during the relief expedition, mentions that several examples of *P. cornicoides* were seen between Cape Horn and South Georgia, and that it was last seen in 61° 42′ S. and 57° 35′ W.

No Sooty Albatros was obtained by the *Southern Cross* Expedition, though, as I have said, Bernacchi saw this bird; nor does Dr Racovitza (*t.c.*) mention either species in his account of the animal life observed during the voyage of the *Belgica*.

Note.—For further discussion of these species in the light of more recent knowledge, see Section VIII. of this volume, "'Scotia Rise' Region."—EDITOR.

Diomedea exulans Linn.

Diomedea exulans Cat. B., xxv. p. 441.

Single examples of this species were seen on four occasions, namely:—March 20th, 1903, when the *Scotia* was in 61° S. and 43° 20′ W.; February 24th, 1904, in 63° S. 38° W., and on March 27th and 30th, in 67° S. 11° W. and 61° S. 13° W. respectively.

"Molliemauks" were logged on February 5th and 6th, 1903, when the ship was proceeding eastwards from the South Orkneys and was a good way off the edge of the pack-ice. This was from 60° to 61° S., and about 43° W. (Vol. IV. Part I. pp. 8 and 9.)

Sterna macrura Naum.

Sterna macrura Cat. B., xxv. p. 62.
Sterna hirundinacea Bruce and Wilton, *Scot. Geogr. Mag.*, 1904, p. 128 ; Pirie and Brown, *op. cit.*, 1905, p. 26.

In the *Antarctic Manual* (p. 223) Mr Saunders tells us that there is ample evidence that terns are found in large numbers in the South Polar regions, and even within the Antarctic Circle, and that Webster found terns at the South Shetlands, whence the Dundee whalers brought back specimens which were referable to the well-known South American species *Sterna hirundinacea.* Mr Saunders then expresses the opinion that it may be reasonably assumed that all the terns found southwards of America are of this form, and this is quite correct so far as the breeding species are concerned. No tern is, however, known to breed within the Antarctic Circle, nor have, I believe, any specimens hitherto been *obtained* to the south of 66°.

When the *Scotia* sailed from the South Orkneys she left *Sterna hirundinacea* behind her. Other terns were met with, often in considerable numbers, and specimens were fortunately obtained in widely scattered portions of the Weddell Sea. These, strange to say, I found to belong to the most northern representative of their genus, namely, to *Sterna macrura*, the Arctic Tern ! Thus this familiar bird to British ornithologists would seem to have the most extensive latitudinal range to be found among vertebrate animals, since it is now known to occur from 82° N. to 74° 1′ S. It was doubtless the species seen by McCormick in 76° 52′ S. in Ross Sea, off Victoria Land, in the 'forties of the last century, and also the bird noted by him in the ice between 65° and 66° S. and 158° W.

During the Antarctic voyages of the *Scotia* terns frequently came under notice, and specimens of *Sterna macrura* were obtained between 64° 29′ and 72° 18′ S. latitude and from 12° 49′ to 35° 29′ W. longitude. They were often observed in considerable numbers, and are logged for March 5th, 1904, as being seen in thousands in 72° 31′ S. ; while from the 9th to the 13th of the same month, when off Coats Land, in 74° 1′ S., 22° 0′ W., many were seen along with McCormick's Skuas, Giant, Antarctic, and Snowy Petrels, when the *Scotia* was locked in the pack.

It seems very remarkable that the far-off ice-fields of the South Polar Ocean should be visited during the northern winter season by this boreal species. That it is only a winter visitor does not admit of doubt, for the bird certainly does not breed there ; nor is any other tern, so far as we know, a native of the Antarctic Continent. During the southern summer (the northern winter) there is an extraordinary abundance of marine life, especially of surface-swimming crustaceans, and so this elegant bird is tempted to seek retreats which can otherwise only be regarded, even in summer, as inhospitable in the extreme.

The finding of this tern in the seas off the South Polar Continent must be regarded as one of the most important ornithological discoveries made by the Expedition, for.

as has already been stated, no terns appear to have been previously captured within seas girdled by the Antarctic Circle.

The *Scotia* collections include some interesting specimens. An adult female obtained on March 23rd, 1904, in 68° 32′ S. and 12° 49′ W., has already assumed full breeding-plumage, and shows no signs of moulting. Another (a male) is assuming its summer hood, leaving the head a mixture of black-and-white feathers; this specimen still retains the dusky upper wing-coverts of youth. In addition to gaining the black head for the first time, it exhibits further evidence of moulting, inasmuch as neither the primaries nor the rectrices are quite fully grown, the first primary being still shorter than the second by about half an inch. I am inclined to think that we have here a bird about twenty-one months old.

The series also includes two immature examples in the plumage known as the *S. portlandica* stage. These have the forehead and crown nearly white, the rest of the head blackish, the lesser wing-coverts conspicuously dark, and the bill and feet black. They are in deep moult so far as their primary-quills and tail-feathers are concerned, but apparently not otherwise. Some of their primaries are only three inches long.

The *Gauss* obtained a tern off Wilhelm Land, in 66° S., 89° 38′ E., on February 18th, 1903, which Reichenow (*Orn. Monatsber.*, xii. p. 47) described as a new subspecies of the Arctic Tern under the name of *Sterna macrura antistropha*. This is said to be "very like *S. macrura*, but with the bill darker, not cinnabar or poppy-red, but carmine at the base and blackish towards the tip; lower edge of mandible longer, 21–22 mm., in *macrura* only 16–19 mm. Feet not yellowish red to cinnabar-red, but dusky carmine red, webs blackish. Tarsus somewhat longer, 15–17 mm." If described from skins, that fact might account for the subtle differences in colour, or if such differences really exist they might be due to the season (the winter for *S. macrura*). The *Scotia* specimens do not exhibit the peculiarities attributed to this subspecific form, except that one of them agrees with it so far as the dimensions of the mandible and tarsus are concerned.

[*Gulls.*

No gulls were observed during the Antarctic voyages of the *Scotia* except *Larus dominicanus* in the vicinity of the South Orkneys. In the *Antarctic Manual* (p. 232) it is stated that this gull was obtained in 64° 18′ S., and that a specimen of *Larus scoresbyi*, also in the British Museum, was obtained in the vicinity of the South Shetlands in 64° 55′ S. Dr Bruce, who was naturalist on the *Balæna*, from which vessel the birds in question were obtained, tells me that these examples were undoubtedly captured at the Falkland Islands, and that they were skinned by him.]

Megalestris maccormicki Saunders.

Megalestris maccormicki Cat. B., xxv. p. 321.
Megalestris antarctica Pirie and Brown, *Scot. Geogr. Mag.*, 1905, p. 26.

This species was not distinguished from the Antarctic Skua (*M. antarctica*) during the active work of the Expedition, and hence it is only possible to discriminate with certainty between the two species by reference to the specimens obtained. No doubt, however, all the skuas seen south of the Antarctic Circle belonged to the species named after Dr McCormick.

There are only two skins of this skua in the collection brought home by the *Scotia*. The first of these, an adult, was procured on March 10th, 1903, in 66° 40′ S. and 40° 35′ W., or the lowest latitude in which this species has, I believe, been obtained, except the example alluded to by me above as captured at the South Orkneys by the Argentine observers in 1904.

The second example, an adult male, was shot alongside the ship on March 9th, 1904, in 74° S. and 22° W. The *Scotia* was then fast in the pack and about two miles off the Ice Barrier at Coats Land. Many of these birds were then present, as were also numerous Giant and Snowy Petrels and Arctic Terns (*Sterna macrura*).

The Antarctic Skua (*M. antarctica*) did not occur with certainty beyond 62° 49′ S. (38° 12′ W.).

Chionis alba (Gmelin).

Chionis alba Cat. B., xxiv. p. 710.

This bird, the only one found in the regions treated of that may be regarded as a terrestrial or, to speak more correctly, a semiterrestrial species, was several times observed at sea during the first voyage of the *Scotia*. It does not, however, penetrate into the Weddell Sea, but was met with when the ship was running eastwards from the South Orkneys towards the South Sandwich group in the late summer of 1903.

During this voyage the White Sheathbill was observed on three occasions:—First, on February 6th, in lat. 60° 10′ S. (42° 35′ W.), when the *Scotia* was a good way off the edge of the ice. Here this species, along with Banks's Whale-bird, Cape, Wilson's, and Snowy Petrels, followed in the wake of the ship during the day. Again, on February 8th, in 59° 44′ S. (36° 40′ W.), or about midway between the Orkney and Sandwich groups and 300 miles from land, Sheathbills were observed along with the birds already mentioned. Finally, it was noted at sea to the southward of the Orkneys on March 21st in about 61° S.—its furthest south.

In the Liverpool Museum (*Bull. Liverpool Mus.*, ii. p. 48) there is a specimen of this bird which is said to have been shot on the Antarctic Continent in 78° S. by Dr Gunn, who, strange to say, was afterwards proved never to have been there! (see *The Ibis*, 1895, p. 165, and *Antarctic Manual*, p. 234, footnote).

Section VIII.—"Scotia Rise" Region: the Voyage from the Weddell Sea northward to Gough Island.

By L. N. G. Ramsay, M.A., B.Sc.

This section deals with the observations made by the *Scotia* naturalists and the specimens obtained during the period between April 1st, 1904, and the ship's arrival at Gough Island. An irregular northerly course was followed, chiefly between the 8th and 13th meridians of west longitude.

The voyage lasted twenty days, and some 1200 or more nautical miles of ocean were traversed. Very rough weather was experienced for most of the way. A cluster of a dozen bergs seen on April 5th was almost the last ice encountered.

Bird-life was rather plentiful throughout the voyage, in the form of numerous albatroses and petrels—of which eighteen to twenty species were seen—and a few penguins and terns and (towards Gough Island) skuas.

Hutton's Sooty Albatroses (*Phœbetria cornicoides*) were about the ship in some numbers the whole way (the *Scotia* had first met them, after leaving the Antarctic Seas, in 67° S. lat.).

P. fuliginosa was not met with till 55° S. was reached. These two species, as stated by Mr Eagle Clarke in the preceding section, had not been recognised as distinct previous to the voyage of the *Scotia*, although the form *cornicoides* had been described long before as a variety of *P. fuliginosa*. The difference between the two was sufficiently striking, even when seen only on the wing, to make Dr Bruce believe that they must be specifically distinct. His diary for April 4th records that another species of "Sooty," different from the "blue-billed" form (*cornicoides*), by which they had been accompanied for a week past, was seen, thus: "A Sooty Albatros with a yellow instead of a blue stripe on its beak, and the streak is broader, the plumage altogether more uniform and darker in colour than that of the blue-billed form, whose head alone is very dark."

After this date, *fuliginosa* was seen in about equal numbers with *cornicoides* until Gough Island was approached, but for 70 miles or so south of the island the "yellow-billed" species was the more numerous.

The *Scotia's* collection includes ten specimens of *Phœbetria*, three of which are *P. cornicoides*, the remaining seven *P. fuliginosa*. The labels of one of the former and of two of the latter have unfortunately been lost, but all the others were obtained on the part of the *Scotia's* voyage at present under consideration, except one of the specimens of *P. fuliginosa*, which was obtained at Gough Island. The dimensions of these specimens do not indicate any very marked difference in size between the two species. They may be tabulated thus :—

	P. fuliginosa (7 examples).		*P. cornicoides* (3 examples).	
	Average.	Extremes.	Average.	Extremes.
Culmen . .	4·45	4·8 – 4·1	4·05	4·2 – 3·9
Tarsus	3·2	3·0 – 3·4	3·1	3·15 – 3·1
Midtoe	4·8	5·0 – 4·5	4·75	4·8 – 4·6

It will be seen that there is a distinct difference in the length of the culmen, which is shorter in *P. cornicoides*. This may, or may not, be characteristic of the species. The sexes were not determined. The primaries are damaged or being moulted in most cases, so that it is impossible to compare the length of wing. In plumage, all the specimens of *P. cornicoides* can be picked out at a glance by the very distinctly lighter grey colour of the neck, back, breast, and belly (the two species in this respect may be compared to the Hooded and Carrion Crows, although the contrast is not quite so marked) ; the scapulars and wing coverts of *P. cornicoides* also have a slightly greyer tinge than those of *P. fuliginosa*. In other respects the plumage is quite identical in the two species. The bills in the dried specimens are similar in size and form, but the groove on the mandible is dull yellow in *fuliginosa*, greyish black in *cornicoides*.

Diomedea melanophrys was first logged on April 8th, in 52° 30′ S., and again the next day, and later, on the 12th, 15th to 17th, 19th, and around Gough Island on April 21st and 23rd.

The *Scotia's* collection includes four skins of *D. melanophrys* :—

(*a*) No. 275 (obtained in April on the voyage north to Gough Island). Bill entirely orange-yellow. Phase 1.

(*b*) No. 292, April 30th, 1904 (probably killed April 29th, 40° S., 2° 30′ E.). Bill orange-yellow, tip dusky brown ; head white. Phase 3.

(*c*), (*d*) The labels have been detached ; on April 27th, 1904, "two Mollies with horn-coloured bills" shot, may refer to these. (*c*) Bill pale yellow, tip greyish yellow ; head white. Phase 2 or 3. (*d*) Bill pale yellow, ridge of hook brownish ; head white. Phase 2 or 3.

Dr E. A. Wilson * gives the following table of what he came to the conclusion were various plumage-stages of *D. melanophrys* :—

Phase 1. White head and neck, orange-yellow bill, deep orange tip.
2. ,, ,, lemon-yellow ,, ,, ,,
3. ,, ,, ,, ,, dusky-brownish tip.
4. ,, ,, dull yellow bill, blackish tip.
5. Grey head and neck, dusky brownish bill, darker tip.

* (*British*) *National Antarctic Expedition : Natural History*, vol. ii., 1907, pp. 111–113.

Of these birds he says:—

"Some were pale grey all over the head and neck, others had merely a broad or narrow collar of grey incomplete below. The size also varied considerably, but all had the bill of *D. melanophrys*, dusky yellow and always with a darker tip. We considered these grey-headed and grey-necked individuals, if the bill was broad, to be the young of *D. melanophrys*. There was no difficulty in distinguishing the grey-headed *D. melanophrys* from the grey-headed *Th. chlororhynchus* and *Th. culminatus*, since the colour of the bill in the two latter is much more clean-cut and distinctly black and yellow than the dusky-brownish or yellowish bill of the immature *D. melanophrys*.

"Until October 19th we saw only immature birds, but on that day the white-headed adult, with lemon-yellow bill and orange tip, appeared. After this we saw each day for a while only adult birds, but on October 28th we had the following together: white-headed adults with lemon-yellow bill and bright orange tip; white-headed birds with bright yellow bill and dusky tip, or with dull yellow bill and blackish tip; and grey-headed birds with dusky brownish bill and darker tip.

"Throughout the first half of November we saw one or other of these forms almost daily, and came to the conclusion that they were simply age-changes, and that the grey-headed were the immature."

The *Scotia's* specimens belong to phases 1 to 3 according to the above arrangement. It does not appear that the *Scotia* encountered any birds in the grey-headed immature stages of this species, although this cannot be definitely affirmed. It is significant, however, in view of the curious way in which the *Discovery* sometimes for long periods encountered only white-headed adults, at other times only grey-headed young birds, and at others, again, all the phases together. The different varieties of "Molliemauks" seen on the present section of the *Scotia's* voyage were described fairly clearly in the *Zoological Log*, but it is possible that grey-headed stages of *D. melanophrys* were not distinguished from the grey-headed or grey-collared birds which will now be described.

From April 9th onwards a distinct form of Albatros was noticed, which was logged as the "Black-billed Albatros." It is thus described on the above-mentioned day in the *Zoological Log*:—"Mr Bruce saw a new albatros of the size and shape of *D. melanophrys*, and of the same colour except the back of its neck, which was dark with a dark ring complete or almost complete round about it, and a black beak." This form, after being observed on April 9th in 51° S., was not again met with until the 16th, on which day and on the ensuing days up to the 20th April it was again encountered. It was, however, not observed in the immediate vicinity of Gough Island, nor subsequently.

In his account of the *Discovery's* birds, Dr Wilson (*loc. cit.*, p. 113) says:—"In the Atlantic between Punta Arenas and the Falkland Islands we occasionally saw one or two of the typical adults, the last on July 27th, when *D. melanophrys* disappeared entirely, and its place was taken by a form which we had before this hardly seen at all, a bird in every respect the same in shape and size as *D. melanophrys*, but with a grey ring always round the neck and the bill always quite black"; and again in a footnote to the foregoing quotation: "This bird appears to agree with the 'Mollymauk' (*Thalassogeron* sp. inc.) mentioned by Mr Eagle Clarke amongst the birds of Gough Island (see p. 287 of this volume, 'The Birds of Gough Island'). Those that we saw were evidently adult. They had the bill entirely black and the head white, shading on the occiput, or sometimes on the hind-neck, into grey, which deepened on the sides of the neck to form a well-marked grey collar incomplete on the fore-neck. The feet were rosy pink. In other respects, as in size, the bird closely resembled *D. melanophrys*. We saw it several times in March from 55° S. lat. northwards as we came up to the Auckland Islands from Wilkes Land. We saw nothing of it in the South Pacific; but in July we found it again in the South Atlantic between 30° and 40° S. lat. as we came north from the Falklands in 1904."

It appears highly probable that the "Black-billed Albatros" of the *Scotia* was the same bird as that described by Dr Wilson in the extracts just quoted. Also, as he suggests, it is possible that the Gough Island specimen (see Section IX., p. 287) is likewise of this species. This specimen has, in the meantime, been submitted to Mr Godman and other eminent authorities, and in his great work on the petrels the former says:—*

"Mr Eagle Clarke, in his paper on the 'Birds of Gough Island,' procured by the Scottish National Antarctic Expedition, mentions (*The Ibis*, 1905, p. 265) a bird which he was unable to identify with any known species. . . . Mr Rothschild, to whom he referred it for examination, recognised its resemblance to *Thalassogeron carteri*, but noticed that it differed in having the toes nearly ·75 in. shorter, and also the hind-neck washed with grey like the back, instead of being white (*Bull. Brit. Orn. Club*, xiv. p. 6). Mr Eagle Clarke has now kindly lent me this specimen for examination, and I find that the short foot is occasioned by the absence of a phalanx in two of the outer toes on both feet, but in other respects it agrees very well with *Thalassogeron carteri*. There are, however, some minor points worthy of notice, viz.:—the extension of the dark colour of the back to the hind-neck as mentioned above, and a slight difference at the base of the culminicorn; there is also a grey tinge on the face and crown; these characters, however, appear to me of trivial importance. I ascribe the absence of a joint in the toes to a malformation, or an individual peculiarity, and I am the more inclined to do so as the feet look out of proportion to the size of the bird. Moreover, I am not aware that any other member of the order Tubinares is without the full complement of toe-bones; consequently I place this bird, for the present at all events, under *Thalassogeron carteri*."

Accordingly, we may say that it seems probable that the "Black-billed Albatros" of the *Scotia's* log, as well as the similar birds mentioned by Dr Wilson, may belong to the species *Thalassogeron carteri*.

From April 10th to 19th inclusive (49° 30′ to 43° S.) a grey-headed species of albatros with dark bill and yellow culmen, and otherwise resembling *Diomedea*

* *A Monograph of the Petrels*, 1907–1910, p 361.

melanophrys, was seen daily (except on one day). They were recognised as belonging to the same species as the two albatroses secured at Burdwood Bank in December 1903 (*Thalassogeron culminatus*, see Section IV., p. 215), and were logged as "Burdwood Bank Albatroses." None were seen in the neighbourhood of Gough Island or subsequently on the voyage to the Cape of Good Hope. It is, however, equally if not more probable that these birds may have been *Thalassogeron chlororhynchus*.

Diomedea exulans appeared irregularly on this voyage. Several were met with on April 3rd, when one was shot, and again on the 7th, the 10th, 11th, and 18th; on the 19th very many were seen (nearing Gough Island, about 43° S.), but next day only some young birds are logged. On the 21st, when the *Scotia* was lying to off Gough Island, many were flying about her all day long.

Priocella glacialoides, after having been unusually numerous on March 31st, was seen in decreasing numbers for the next three days (up to about 57° S.), and not again, except a single example on April 17th (44° 30′ S.).

"Blue Petrels" were logged nearly every day during this part of the *Scotia's* voyage, chiefly up to 55° S., after which none were seen for several days. From 51° to 46° S. one or two were seen daily, and then they began to appear in larger numbers. Many were seen about 43° S., and also in the neighbourhood of Gough Island.

As no specimens of these "Blue Petrels" were obtained in this region, it is not possible to say with certainty whether they were *Halobæna cærulea*, or species of *Prion*, but it may be regarded as probable that most were of the latter genus (see Section VII., under *Halobæna*). The only "Blue Petrel" obtained at Gough Island was a *Prion*, *P. vittatus* (Gm.) (see Section IX. of this volume, p. 286).

A fair number of Cape Pigeons (*Daption capensis*) were seen up to 55° S., thereafter one or two per day occasionally up to 43° S.

Giant Petrels (*Ossifraga gigantea*) were seen in small numbers up to 56°, after which none were observed for a week. About 49° they again appeared, and a few were seen almost daily up to the date of arrival at Gough Island.

Dr Bruce tells me that the Giant Petrels observed near Gough Island were distinctly darker in plumage than those seen in the far south.

A white example was seen on April 1st.

Wilson's Petrel (*Oceanites oceanicus*) was seen almost daily all the way, but not in large numbers.*

On the 4th April a "Storm Petrel differing from Wilson's in having a white abdomen, and this white extending on to the lower surface of the secondaries, except at their tips," was seen. This very probably refers to *Cymodroma grallaria*, specimens of which were obtained further north at Gough Island. It was observed almost daily thereafter till Gough Island was reached.

* In general, it may be said that Wilson's Petrel, so far as plumage is concerned, could only have been confused with *Oceanodroma leucorrhoa* (or allied forms), or with *Procellaria pelagica*; the latter, however, has white under the wings—a character which was at once "spotted" in *Cymodroma grallaria*.

Several Diving Petrels (*Pelecanoides* sp.) were observed on April 8th and 9th (52° 30′ S. to 51° S.).

Priofinus cinereus, logged as the "light brownish-grey petrel," was first noticed on April 10th, in 49° 25′ S. On the 13th several were again seen, and thereafter the species was observed daily till Gough Island was reached (where several examples were obtained—Section IX.).

Œstrelata brevirostris, a specimen of which had been shot when these birds were first met with on March 21st, continued to be logged at intervals (to be more exact, on eight different dates) up to April 11th (49° S.), but only in small numbers.

A larger species, otherwise similar to the last, was seen along with it on March 28th, and again, though alone, on the next three days. Again on April 14th, 16th, and 17th similar but larger birds were seen. These may have been *Majaqueus æquinoctialis*. Captain Robertson named them "Cape Hens" on seeing them.

Œstrelata mollis was first met with on April 4th in 55° S., and on several other dates up to the 15th, after which it was seen daily (except on the 19th) till Gough Island was reached. Off Gough Island it was found in large numbers, and specimens were obtained.

Dr Bruce's description on the 5th April (as well as the Gough Island specimens) leaves no doubt as to the species, viz.: "About the size of a Cape Pigeon, more slender in build, general colour pale grey, darker on the upper surface of the wings and top of the head, white muzzle, dark eye, blackish beak, brownish ring round the neck, most of the under surface white." It was usually logged as "Black-backed Petrel."

Several other forms of petrel were logged during the voyage to Gough Island, which it is not possible to identify, as no specimens were obtained. One in particular, logged as the "Grey-bodied Petrel," was seen almost every day from 5th to 19th April, and on the 7th and 12th in large numbers. The following description in Dr Bruce's log for April 5th apparently refers to the "Grey-bodied Petrel": "One about the size of a Blue Petrel, but brown instead of bluish grey, and paler brown on the under surface, with one diffused white patch on its breast."

Skuas (*Megalestris antarctica*) were met with on the 18th April (two), when the *Scotia* was still about 180 nautical miles south of Gough Island. Two were again seen next day, and one on the 20th (around the island they were numerous).

Terns were logged on the 7th (three), 9th and 20th (one), which were probably *Sterna vittata*.

Of penguins, some were observed on April 8th, 9th, and 11th, in mid-ocean. On the two latter dates they were identified as *Spheniscus magellanicus* and *Catarrhactes* sp.

Section IX.—On the Birds of Gough Island, South Atlantic Ocean.*

By Wm. Eagle Clarke, F.R.S.E., F.L.S., Keeper of the Department of Natural History of the Royal Scottish Museum.

When homeward bound from the farthest southern point reached—the newly discovered Coats Land—the Scottish National Antarctic Expedition paid a flying visit to Gough Island, and made the collection of birds here described. This contains forty-five specimens, and, with the Antarctic birds, has been placed in my hands for identification and record.

Gough Island, or, to speak more correctly, Diego Alvarez (for such it was named by its Portuguese discoverers), is situated in lat. 40° 19′ S. and long. 9° 44′ W. It lies far out in the South Atlantic Ocean, being some 1500 miles W. by S. of the Cape of Good Hope and about 2000 miles N. by E. of Cape Horn; and, with the Tristan da Cunha group, which lie over 200 miles to the northwards, is among the most remote of all oceanic islands. It is small and uninhabited; of volcanic origin; from seven to eight miles long, and from three to four wide; and is lofty, rising to a height of 4380 feet.

The island has been but little visited, except by sealers, who, in days gone by, found it worthy of their attention; and the *Scotia's* party were the first naturalists who have ever set foot upon its fastnesses.

Dr Harvey Pirie and Dr R. N. Rudmose Brown give the following description of the island, and Mr D. W. Wilton gives me other valuable information:—

"Gough Island rises on every side abruptly from the ocean in sheer precipices several hundred feet high. The general aspect of the island, as seen from ship-board, is very beautiful, with its green slopes and moss- and lichen-covered cliffs, over which numbers of rushing waterfalls shoot out into the sea with a drop of several hundred feet. The only apparent landing-place is on the eastern side, where the party from the *Scotia* landed. Here a ravine runs down from the interior to the coast, and along it flows a small stream. Near the seaward end of this ravine are a few acres of level ground covered with grass or, in the moister parts, with ferns and rankly growing celery and docks. Here, too, is a narrow beach, perhaps a hundred yards long, strewn with many large boulders and numerous fern-rhizomes of considerable size. At the S.W. end of the island there appears to be a plateau of about half a square mile in extent at an elevation of some 300 feet, but everywhere else the island rises into steep ridges separated by narrow valleys, which must render its exploration a matter of extreme difficulty. On the lower ground and up to a height of over 1000 feet the island is thickly covered with tussock-grass (*Spartina arundinacea*) and buckthorn-trees

* Reprinted, with slight verbal alterations, from *The Ibis*, Series VIII., v., 1905, pp. 247–268.

(*Phylica nitida*): the former spread profusely over the steeper slopes, and the latter gnarled and stunted, yet growing vigorously even on the most exposed ridges. These trees appear hardly to rise beyond twenty feet in height, and generally bear a thick growth of lichens on their stems. Under the waterfalls and the sheltered banks of the streams ferns and mosses grow in luxuriance. More than the general aspect of the vegetation on the higher ground could not be determined, but the very summit of the island seemed by its green appearance to be clothed with mosses and lichens."

To this description may be added a few items culled from Mr Comer's notes, to which reference will be made more particularly anon. He tells us that there are two kinds of trees on the island, one of which is quite plentiful, but the other is scarce. These, though stunted, are dense in some places, and retain their leaves all the year round. The thick bushes, he says, extend up to an elevation of about 2000 feet, while the grass and brakes grow very rankly and make walking extremely difficult.

According to the *Report on the Fisheries and Fishing Industries of the United States*, vol. ii. p. 415 (1817), Gough "Island at one time abounded in fur-seals and sea-elephants, but is now almost deserted by those animals. About 1825 a party of American sealers lived there, but met with such indifferent success that the station was abandoned."

The few accounts agree that, owing to the weather conditions usually prevailing, landing on Gough Island is a matter of great difficulty. In the case of the *Scotia*, three days were spent off the island, during which her staff, after landing under the most trying conditions, were only able to remain ashore about four hours. This was on the 22nd of April 1904.*

Previous to this visit only twelve species of birds had been identified as forming the avifauna of the island. The naturalists of the *Scotia* observed or secured examples of nineteen species, and added no less than twelve to the ornis of the island, of which two, or possibly three, are new to science. The total avifauna now stands at twenty-three species.

Only three terrestrial forms are known, all of which are peculiar species—namely, two buntings of the genus *Nesospiza* and a flightless Gallinule, *Porphyriornis comeri*.

The two species of *Nesospiza* are the most interesting, not, however, because they are novelties, nor because we owe our knowledge of them to the researches of the Scottish Expedition, but because they differ very considerably from their single congener, *N. acunhæ*, peculiar to Tristan da Cunha, where it is now confined to Inaccessible Island, though it was formerly also found on the main island of the group.

The Gough Island birds of this genus differ remarkably among themselves, and whether they represent two species or only one in various stages of plumage is a matter on which opinions differ. At first I was under the impression that they were representatives, sexual or otherwise, of a single species; but an examination of the material revealed characters which it was difficult to reconcile with such an opinion, and which led me to describe them as two species. My reasons for doing so will be explained in the systematic portion of this contribution.

* For a fuller account of Gough Island, see *Scot. Geog. Mag.*, xxi., 1905, pp. 430–440.

The Gallinule or "Island Hen" (*Porphyriornis comeri*) appears to differ only slightly from the species (*P. nesiotis*) found on Tristan Island; though, on the other hand, both of them would seem, if report is to be relied upon, to be widely different from the representative of the family found on Inaccessible Island (see Moseley, *Naturalist on the Challenger*, p. 122).

These three terrestrial endemic birds are, moreover, representatives of genera entirely unknown elsewhere except in Tristan da Cunha; and thus Gough Island, though lying over 200 miles to the south, must be looked upon ornithologically as an outlier of the Tristan group. The relationship is, however, somewhat remote, for the buntings found on Inaccessible and Gough Islands are specifically very distinct; the Tristan possesses a peculiar genus of thrush, *Nesocichla*, with a single species (*N. eremita*), which is not at present known to have any representative on Gough Island.

The other birds forming the ornis of Gough Island are mostly Tubinares. The number of species of this order observed during the short visit of the *Scotia* is quite remarkable, and it would seem probable that a thorough investigation of the island—as yet almost untrodden by the foot of man—in the summer season would reveal the fact that it is a perfect paradise as a breeding-station for "petrels." Indeed, one species of albatros (*Thalassogeron eximius*) has not been obtained elsewhere.

The only previous contribution to our knowledge of the avifauna of the island is, I believe, contained in a communication by Mr G. E. Verrill to the *Transactions of the Connecticut Academy*, based upon the collections and experiences of Mr George Comer. Mr Comer resided on Gough Island from the 22nd of August 1888 until the 23rd of January 1889, and was engaged, along with others, in the capture of seals. During the period he got together a very creditable ornithological collection, and among his specimens were two birds which proved to be new to science, namely, the flightless Gallinule (*Porphyriornis comeri*) and an albatros (*Thalassogeron eximius*). Mr Comer's notes are of considerable interest, and I have not hesitated to make use of them where desirable. I have also included the names of the very few species observed by him of which examples were not obtained or noted by Dr Bruce and his colleagues, in order to render my account of the avifauna of this most interesting and little-known isle as complete as possible: these are given within square brackets.

The date of the visit of the *Scotia* to the island was not the best for ornithological work, April being mid-autumn in the southern hemisphere. Unfortunately, too, the state of the weather did not permit of more than a few hours being spent ashore, and even then the party could not proceed far inland, owing to the uncertainty of the prevailing meteorological conditions. Under these circumstances the members of the Expedition are to be congratulated upon having accomplished so much good work.

The colours of the bills and feet, when given, are taken from a series of carefully prepared drawings made at the time of capture of the various birds by Mr Cuthbertson, the artist to the Expedition.

The few species in the following list the identification of which I consider doubtful are not numbered.

I have to thank Mr W. P. Pycraft for having most obligingly examined certain material submitted to him, and for giving me his valuable opinion thereon.

I shall have occasion to make several references to the following works, in addition to other literature :—

CARMICHAEL.—"Some Account of the Island of Tristan da Cunha and of its Natural Productions." By Captain DUGALD CARMICHAEL, F.L.S. *Trans. Linn. Soc.*, xii. pp. 483–513 (1817).

THOMSON.—*Voyage of the "Challenger": The Atlantic.* By Sir C. WYVILLE THOMSON. Vol. ii. (1877).

VERRILL.—"On some Birds and Eggs collected by Mr George Comer at Gough Island, Kerguelen Island, and the Island of South Georgia, with Extracts from his Notes, etc." By G. E. VERRILL. *Trans. Connecticut Acad.*, ix. pp. 430–478 (1895).

SALVIN.—*Catalogue of Birds in the British Museum.* Vol. xxv. (Tubinares) (1896).

1. *Nesospiza goughensis.*

Nesospiza goughensis Eagle Clarke, *Bull. Brit. Orn. Club*, xv. p. 18.

This species possesses the essential characters of the genus *Nesospiza* as propounded by Cabanis (*Journ. für Orn.*, 1873, p. 154). It is a larger bird than the type (*N. acunhæ*) ; it has a longer and more slender bill, in which the culmen is more arched and the keel of the mandible straighter ; and the third primary is slightly the longest.

Adult Male.—General colour bright olive-green, slightly washed with silvery grey ; centre of abdomen, under tail-coverts, a stripe from the forehead over and behind the eye, and a malar stripe olive-yellow ; chin, throat, and lores black ; primaries and secondaries slate-grey, with silvery-grey tips and bright olive-green margins, and their under surfaces broadly margined with silvery grey on the inner webs ; under wing-coverts grey washed with yellowish green ; central pair of rectrices olive-green, the rest grey edged and slightly washed with green. Bill and feet, in life, clove-brown. Wing 4·15 inches, tail 3·68, tarsus 1·18, culmen ·71.

This is probably the summer plumage.

Adult Female.—Resembles the male, but is not so brightly coloured, being dull green. Chin, throat, and lores dusky, and, with the buff stripes over the eye and on the malar region, inconspicuous ; feathers of the back and outer margins of secondaries slightly fringed with reddish brown ; secondaries and tertials tipped with greyish buff ; flanks faintly washed with brown ; middle of abdomen and under tail-coverts buff ; central rectrices dull green, the next edged with buff and the outermost with green. Wing 4·0 inches, tail 3·5, tarsus 1·15, culmen ·68.

? Adult in Winter Plumage.—Pileum and hind-neck olive-grey ; back tawny olive, broadly striped with black on the interscapulary region ; upper surface, wing-coverts, and tail washed with sage-green ; primaries narrowly edged outwardly with brown ; secondaries broadly margined with sage-green and tawny olive ; under parts greyish green, washed with tawny olive on the breast and flanks and passing into buff on the lower abdomen and tail-coverts.

This specimen is unfortunately unsexed, but, since the yellow stripes on the head and the black on the throat and lores are brighter than in the female, it is probably a male.

I have ventured to suggest that this bird is an adult in winter plumage, taking my cue from the fact that a somewhat analogous seasonal change is to be found in the male of *Phrygilus melanoderus* of the Falklands. I may mention that the adult male of *N. goughensis* bears a strong resemblance* in colour and markings to the adult male of *P. xanthogrammus* of the Falklands, in which apparently the various stages of plumage are as yet incompletely known, as are also, unfortunately, those of *Nesospiza acunhæ*.

These buntings, with those next to be described, were captured on the low ground bordering the landing-place, where they were mostly observed hopping about on the boulders, stranded wood, and seaweed, a little above high-water mark. They were not so tame as to permit themselves to be caught, but readily allowed an approach to within two or three yards, and then flitted off to a short distance. They were not observed in the ravine running inland, nor on its steep sides.

Mr Comer (Verrill, *l. c.*, p. 463), alluding to these birds, says that small birds, like sparrows, are very common at Gough Island, and are of two kinds—one slatish above, yellowish beneath, and with a round black spot on the breast: the other much like the first, but lacking the black spot; possibly it is the female. Of the habits he merely remarks that they are very tame and sing.

2. *Nesospiza jessiæ.*

Nesospiza jessiæ Eagle Clarke, *Bull. Brit. Orn. Club*, xv. p. 18.

Male and Female.—General colour orange-buff (brighter on the lower back), streaked with black on the head, back, scapulars, lesser wing-coverts, breast and flanks; primaries blackish, narrowly edged with dull yellow; secondaries and wing-coverts blackish, broadly edged externally with buff; rectrices with dusky centres and broad buff margins. Bill and feet blackish. Wing 4·05 inches, tail 3·45, tarsus 1·2, culmen 0·65.

In this form the culmen is nearly straight, the gonys is ascending, the first primary is equal to the sixth, and the tail-feathers are lanceolate. In all these respects it differs from *N. goughensis*.

I at first thought that we had in these buff specimens the female and young of the green *N. goughensis*, but on dissecting specimens it was found that the green birds were of both sexes. There then remained the possibility of the buff birds being the young of *N. goughensis*, though differing remarkably in plumage from either parent. An examination of the material, however, disclosed the fact that, although identical in plumage, some specimens were unmistakably immature, while others possessed characters which I interpreted as indications of maturity. In these examples the tendons of the feet were ossified or partially ossified, the fibula was fused to the tibia,

* See Gould's figure in Darwin's *Voyage of the Beagle: Birds*, plate 33.

and the claws were well-worn. In this connection it is important to remember that, if all young, these birds could only vary a few weeks in their respective ages, for they were obtained in the autumn, and hence must be "birds of the year." This evidence, and the other peculiarities alluded to wherein *N. jessiæ* differs from *N. goughensis*, led me to depart from my first impressions regarding the relationship of these forms to each other and to consider them distinct species. I may have been mistaken in so doing, but I think it best to leave it an open question—one to be decided by further investigations based upon a more complete set of specimens.

Judging from Mr Comer's rough descriptions of the Passerines, he does not seem to have observed this form, and yet he remained on the island down to the very end of summer, when young birds must have been in evidence. We must remember, however, that his observations were not published till some six years after he had left Gough Island, and therefore much that he has told us may have probably been from memory.

3. *Porphyriornis comeri* Allen.

The flightless Gallinule peculiar to this island was abundant in the dense undergrowth along the sides of the stream. Among this it endeavoured to hide, but its brilliantly coloured bill and feet easily betrayed it. The specimens captured were secured whilst running amongst this thick mass of vegetation. One ran into a burrow in its endeavours to escape, and it is probable that others resorted to similar tactics.

Five specimens were secured, one of which is an immature bird, though full-grown so far as size is concerned. In this undescribed phase the bill and the frontal shield, which is small, are dull olive-green, and the tarsus and toes dull oil-green. It also varies in plumage from the adult, having the upper surface a warm vandyke-brown, a little darker on the head and primaries; the under surface strongly washed with sepia-brown; the flanks brown, two or three of the feathers on each side having short inconspicuous cinnamon stripes; the outer margin of the first primary cinnamon-buff; the edge of the wing streaked with greyish white; the feathers of the lower part of the abdomen edged with greyish white.

In the adult specimens the frontal shield and the basal two-thirds of the bill are deep coral-red, the distal third of the bill bright yellow. The exposed portion of the tibia is deep coral-red. Tarsus and toes bright yellow, the former irregularly blotched with coral-red, while a narrow line of the same colour runs along the sides of the latter. The amount of yellow and red varies much in different specimens, and in some the red predominates. The iris is crimson. The wing-measurement of the adults varies from 5·3 to 5·95 inches; in the young specimens it is 5·5 inches.

In form and in the colour of its plumage this bird very closely resembles our familiar waterhen (*Gallinula chloropus*). The bill and frontal shield are larger and the feet more robust.

Regarding the habits of this bird, which he calls the "Mountain Cock," Mr Comer

(Verrill, *t.c.*, pp. 434–435) states that they "cannot fly and only use their wings to help them in running. . . . They are quite plentiful and can be caught by hand. . . . The bushes grow on the island up to about 2000 feet, and these birds are found as far as the bushes grow. I do not know how many eggs they lay. . . . When alarmed, their note is a shrill whistle. They eat the eggs of other birds and also follow the tide down to feed on small animals left by the receding waves, but are careful never to go into salt water . . . but are very fond of getting into fresh water and splashing it over them. . . . They run swiftly when pursued, helping themselves with their wings, and endeavour to get under a tussock, or some such place, to hide. . . . They have a very peculiar habit of always hopping *over* every obstacle, such as a branch or dead stick, instead of going under it as might be expected."

This species differs from *P. nesiotis*, of Tristan da Cunha, in having scarcely any white on the outer edge of the first primary, and in the narrower and smaller streaks of white on the flanks.

4. *Sterna vittata* Gmelin.

There are five specimens of this tern in the collection. One of these is an adult, and the rest are in the pretty first plumage, in which the back is strongly barred with buff and black, and the buff fore-neck finely dusted with grey. In the young birds in life the bill is brownish black and the feet pinkish brown. Many of these terns were seen in the vicinity of the island.

Mr Comer describes this bird as not uncommon at Gough Island, but makes no mention of its breeding there. It has been recorded from Tristan da Cunha.

5. [*Anous stolidus* (Linn.).

This noddy was apparently not observed by the members of the Expedition. Mr Comer's collection contained a specimen from Gough Island, and he remarks: "Quite a number here" (Verrill, *t.c.*, p. 452). It occurs and nests at Tristan da Cunha.]

[*Larus dominicanus* Licht.

This gull is included in Verrill's lists (*t.c.* pp. 450 and 464) for Gough Island, but no specimens appear to have been obtained there. Mr Comer remarks that there were "a very few sea-gulls; do not think there were more than six around the island." These remarks are supposed by Verrill to refer to this species. It did not come under the notice of the Scottish naturalists, nor does it seem to have been observed at Tristan da Cunha.]

6. *Megalestris antarctica* (Lesson).

Many skuas were observed off the island, and two specimens were added to the collection—probably birds of the year, since they show rufous markings on the mantle, neck, and lesser wing-coverts.

Under the name of "sea-hen," Mr Comer (Verrill, *t.c.*, pp. 450 and 464) describes them as being "quite plentiful," and commencing to lay in the middle of September. "When the penguins lay, the sea-hens come ashore in large numbers, and get their living by robbing the nests and catching the young penguins. They also kill the young albatroses, and all the small birds they can catch." Mr Comer killed about 300 of these birds at Gough Island for the sake of their feathers.

This is also a common bird at Tristan da Cunha.

7. *Oceanites oceanicus* (Kuhl).

Wilson's Petrel, together with *Cymodroma grallaria*, was observed in some numbers in the vicinity of the island. One specimen was obtained, but another which had been shot was carried off by a skua ere it could be retrieved. Although this species has a remarkably wide range and occurs in the Atlantic as far north as the European and North American coasts, it has not yet been recorded for Tristan da Cunha, and did not come under the notice of, or was not identified by, Mr Comer at Gough Island.

8. *Cymodroma grallaria* (Vieillot).

This species was observed off the island along with Wilson's Petrel, and was the more numerous of the two. Several examples were obtained and are in the collection.

Though widely distributed in the southern oceans, it does not seem to have been hitherto observed at the Tristan da Cunha group or at Gough Island.

9. *Puffinus assimilis* Gould.

The collection contains a pair of these birds which Dr Pirie captured in a deep nesting-hole on the steep grass-covered bank flanking the side of the ravine, his attention being drawn to them by their loud croakings. Similar burrows were extremely numerous, in fact the bank was honeycombed with them; and numbers of the birds were seen off the island. Basal half of the bill pale blue, distal part and nasal tubes black. Front of tarsus and toes greyish blue, posterior portion of tarsus and sides of toes black, webs yellowish.

This species does not appear to have been previously recorded from Gough Island, or from any of the islands of the Tristan group or their neighbourhood.

10. *Priofinus cinereus* (Gmelin).

There are three specimens of this bird in the collection, all of which have the feathers of the back, upper tail-coverts, and wing-coverts edged with paler grey than the rest of their exposed portions. In life the maxilla is dull pea-green, the nostrils, culmen, and unguis are black; the mandible with apical plate and cutting-edge is black, the lower plate is pea-green. The tarsus and toes are pinkish grey, darker or blackish at the joints, the webs yellowish. In two of the skins the feet are yellow.

A considerable number of these "light brownish-grey petrels, skin No. 9," were seen in the immediate vicinity of the island.

This species has not a place in Verrill's list for Gough Island, nor did it come under the notice of the *Challenger* naturalists at Tristan da Cunha, but Carmichael (*t.c.*, p. 497) records it under the name of *Procellaria cinerea* for the group.

11. *Majaqueus æquinoctialis* (Linn.).

One specimen was obtained, skin "No. 20, Gough Island," and similar "Black Petrels" are recorded as having been observed. In the example obtained the bill was yellowish, with the basal part of the culminicorn, its margins contiguous to the latericorn, and its tip black; the distal plate and the narrow median plate of the mandible black.

This species does not appear to have been recorded hitherto from any of the islands of the Tristan group.

12. *Œstrelata mollis* (Gould).

A great number of "Black-backed Petrels (skin No. 14)" were observed off the island, and three examples which were secured are in the collection. In these specimens the bill was black, the tarsus and basal half of the inner toe and of both webs were pinkish white, the rest of the foot was deep brown.

This species was not represented among the birds collected at Gough Island by Mr Comer, and is not included in Verrill's list; but I think that it is probably the unknown species there alluded to under the name of "Paddy nuker," a "dark bird with white breast and white feet," of which there is one egg, measuring 2·37 × 1·64 inches, in Mr Comer's collection (Verrill, *t.c.*, p. 449).

Œ. mollis has been recorded from Nightingale Island of the Tristan da Cunha group (Salvin, *Voy. "Challenger": Zool.*, ii. pt. viii. p. 144).

13. [*Œstrelata lessoni* (Garnot).

Mr Comer's collection contained an example from Kerguelen, and he states (Verrill, *t.c.*, pp. 448–464) that this "Mutton-bird" was also common at Gough Island. No specimens were, however, obtained there, nor has the bird been recorded from Tristan da Cunha.]

14. *Ossifraga gigantea* (Gmelin).

Many "Nellies" were observed off the island, and one example, a female, was obtained—a remarkably dark specimen, without a trace of brown, its plumage being throughout deep slaty grey, each feather (except the remiges, the greater wing-coverts, and the tail) terminally or subterminally margined with a slightly paler tint.

The Giant Petrel breeds at Gough Island, where Mr Comer (Verrill, *t.c.*, pp. 447–8 and 464) says that it is not numerous, and commences to lay at the middle of September. He tells us that it enters the penguin "rookeries" and carries off the young to eat, and also pulls birds [petrels] out of holes in the ground. This destructive species also breeds at Tristan da Cunha.

15. *Prion vittatus* (Gmelin).

There is only one specimen in the collection, and this is seemingly a large example, for the wing measures 8·7 inches. The lower plate of the mandible was pale blue, and the remainder of the bill black. Tarsus and toes cobalt-blue, webs black.

Great numbers of "Blue Petrels or Whale-birds" were also seen, and other specimens which were shot were carried off by skuas ere they could be picked up from the water.

This *Prion* has not a place in Verrill's list for Gough Island; but as "*Procellaria vittata*" it is included in the ornis of Tristan by Carmichael (*t.c.*, p. 497), and Wyville Thomson (*t.c.*, p. 177) mentions it as a breeding species on Inaccessible Island.

16. [*Prion desolatus* (Gmelin).

Mr Comer obtained skins of this bird at Kerguelen, and remarks (Verrill, *t.c.*, p. 449) that it is also found at Gough Island, but he does not appear to have brought back specimens procured there. Salvin (*Cat. B.*, xxv. p. 435) says that it is found between 35° and 60° S.; but it has not, so far as I am aware, been recorded from Tristan da Cunha.]

17. *Pelecanoides urinatrix* (Gm.).

The collection contains a single example which was captured from the *Scotia* while her party of explorers was ashore on the 22nd of April 1904. According to a coloured drawing, made at the time of capture, the tarsus and toes in life are cobalt-blue and the webs and claws black.

No *Pelecanoides* has hitherto been recorded, I believe, for any of the islands of the Tristan group; and if we follow Salvin and regard *P. urinatrix* and *P. exsul* as distinct, then a very considerable extension eastwards of the range of this species is indicated by its occurrence at Gough Island, for it does not appear to have been previously obtained in the South Atlantic elsewhere than at the Falkland Islands. It is even possible that it breeds at Gough Island, for Verrill (*t.c.*, p. 449) mentions under this species that there is an egg obtained there in Mr Comer's collection which is "supposed" to be that of a "Diver." This egg measures 1·57 × 1·6 inch as against 1·54 × 1·26 and 1·52 × 1·23 for eggs of *Pelecanoides* obtained by Mr Comer, together with skins, at Kerguelen, and hence the *P. exsul* of Salvin (*t.c.*, p. 438).

18. *Diomedea exulans* Linn.

Many albatroses of this species were observed around the *Scotia* as she lay off the island from the 21st to 23rd of April, but no specimens were obtained.

Mr Comer (Verrill, *t.c.*, p. 437) says that this species is common at Gough Island and breeds there. It commenced to lay at the end of December; he obtained the first eggs on the 26th of that month, and found them quite plentiful by the third of January. The young, he says, must be ten months old before they can fly, and not more than five per cent. live to leave their nests; they are killed by the skuas and Giant Petrels. Mr Comer considers that the Gough Island race is smaller than those from the other islands (South Georgia and Kerguelen), and his statements are borne out, according to Verrill, by both specimens and eggs.*

[*Diomedea melanophrys* Temm.†

The occurrence of this species must be regarded as doubtful. Mr Wilton records it in his Log as being abundant off the island on the 21st of April. No specimens of this albatros are, however, in the collection, nor are they mentioned as having been obtained. The species is not included in Verrill's list, based upon Mr Comer's material and observations; nor does it appear to have been recorded from Tristan da Cunha.]

19. [*Thalassogeron eximius* Verrill.

This was described as a new species by Verrill (*t.c.*, pp. 440–445), being founded on a skin and skeleton which were obtained, together with seventy-five eggs, at Gough Island by Mr Comer.

It is described as similar in plumage to *T. chlororhynchus*, but the mandible lacks the transverse yellow bar at its base and is entirely black (except at the extreme outer end, where it is tipped with light horn-colour). The bright yellow of the culmen deepens and brightens into orange in the middle, and finally into dull red on the margins, growing paler towards the tip.

Mr Comer says there is but one kind of "Molly-Mawk" on Gough Island, which is known as the Blue-head. The birds lay their eggs separately, keeping well apart, and are scattered about the island among the tussocks and brakes. They commence to lay on the 20th of September, and their nests are like those of *D. exulans*, only smaller.

It is possible that some of the birds recorded by Mr Wilton as *Diomedea melanophrys* (but of which no specimens appear to have been obtained), and as being numerous off the island during the stay of the *Scotia*, were of this species.]

20. *Thalassogeron* sp. inc.‡

There is in the collection a single specimen of a "Molliemauk" of great interest, since it does not entirely agree with the description of any known species.

I was inclined to think that it might be an immature example of *T. chlororhynchus* in a phase of plumage which, if known, is not described by Salvin (*t.c.*, pp. 451–2). It differs, however, from the mature bird of that species in having the bill shorter and entirely black, and the toes much shorter. Its dimensions are: wing 18·2 inches, tarsus 3·0, middle toe 3·5, outer toe 3·2, inner toe 2·3, and culmen 4·75.

* See this volume, p. 292. † *Ibid.*, p. 272. ‡ *Ibid.*, p. 271.

This bird was captured under somewhat singular circumstances. Dr Harvey Pirie was proceeding up the ravine when he came upon it on the top of a mass of tussock-grass on which it had alighted, but from which it could not rise on the wing again. It was apparently quite uninjured, and could only have been there a few minutes, for other members of the party had passed the spot only a little in advance, and could not have failed to see the bird had it been there, as the ravine is particularly narrow at the point where it was found. This curious incident might be explained on the supposition that it was a young bird essaying to reach the sea from its inland nursery which had halted by the way. Mr Comer tells us that the young of *Diomedea exulans* do not fly until they are ten months old; and if this holds good even for a lesser period in other species it would help to explain the date and the peculiar circumstances under which this specimen was found away from the sea.

Mr Rothschild and Dr Hartert, who have examined the specimen, tell me that it resembles *T. carteri*, recently described by Mr Rothschild (*Bull. Brit. Orn. Club*, xiv. p. 6) from a single example which came ashore with an injured wing at Point Cloates, N.W. Australia, and that the Gough Island bird only differs in having the toes nearly ·75 inch shorter, and in having the hind-neck washed with grey instead of being white. As regards my suggestion that the specimen under consideration may possibly be immature, Dr Hartert remarks that he finds nothing to show that other albatroses have the bill black in the young, and, moreover, that such an example would hardly have a face with pure white sides.

21. *Phæbetria fuliginosa* (Gmelin).

A typical specimen of the Sooty Albatros is in the collection, and many others were seen, with lesser numbers of Hutton's Albatros (*P. cornicoides*), around the *Scotia* as she lay off the island.

Mr Comer (Verrill, *t.c.*, pp. 445 and 464) describes the species breeding at Gough Island as having the beak dark with "a yellow stripe on each side." It is common but does not breed in "rookeries"; it places its nests separately on cliffs or projecting rocks, where it is most difficult to get at them. The bird commences to lay by the middle of September, and, while sitting, keeps up a continual cry similar to that of a young goat.

This is probably the form which also nests at Tristan da Cunha, for Captain Carmichael (*t.c.*, p. 489) alludes to the bird as the "Black" Albatros (*Diomedea fuliginosa*) and describes its breeding-habits.

22. *Phæbetria cornicoides* Hutton.

I think that there can be little doubt of this being a distinct species. It was only imperfectly described by Captain Hutton (*The Ibis*, 1867, p. 192), from specimens observed at sea, and as a variety of *P. fuliginosa*.

In a letter dated January 4th, 1905, Captain Hutton tells me that this form has the "back and breast grey, head and neck sooty brown," and that his statement about the mark on the mandible being white was an error. As we now know, this mandibular stripe is pale blue and much smaller than in *P. fuliginosa*.

Salvin (*t.c.*, p. 454) says, "If these birds can be traced to a definite breeding-place where they alone are found, it would be well to assign them specific rank." This Captain Hutton has done, for he tells me that it is the common form in New Zealand, and "breeds at the Auckland Islands and Antipodes at the end of October," but that he does not recollect ever having seen the sooty form in New Zealand. That *P. fuliginosa* alone, so far as our present information goes, breeds at Gough Island and Tristan da Cunha has already been mentioned under that species, and this affords additional evidence in favour of the specific difference of the two forms.

This species was, however, observed off Gough Island by the Scottish Expedition in somewhat less numbers than the last, but no specimens were obtained there.

23. *Catarrhactes chrysocome* (Forster).

Several Rock-hopper Penguins were seen ashore, but at places where they could not be reached. Two skeletons, with some feathers still adhering to them, were found on the beach where the landing was effected, and were secured.

At Gough Island, Mr Comer says (Verrill, *t.c.*, p. 462), there is no other kind of penguin. They "number millions" and commence to lay by the 15th of September. This is the only species of penguin found at Tristan da Cunha, where it breeds on all three islands.

In addition to the three endemic land-birds, to which special allusion has already been made, the following marine species have been recorded for the Tristan da Cunha Isles which have not been observed or obtained at Gough Island, namely: *Anous melanogenys*, *Pelagodroma marina*, and *Daption capensis*, which Moseley (*op. cit.*, p. 134) says breeds there!

Section X.—South Atlantic—Voyage from Gough Island to Cape Town, thence to St Helena.

By L. N. G. Ramsay, M.A., B.Sc.

In this section the oceanic observations of the voyages from Gough Island to the Cape of Good Hope (April 24th to May 5th, 1904), and from Saldanha Bay to St Helena (May 21st to 29th), will be dealt with.

The rich petrel-fauna of the southern ocean was gradually left behind on the voyage to St Helena, and as the tropical seas were entered, the almost complete absence of bird-life recorded in the log forms a striking change.

Leaving Gough Island, the *Scotia* followed an irregular course towards the Cape, keeping about 38°–40° S. till within a couple of hundred miles or so of the latter.

Sooty Albatroses of both species (*Phæbetria fuliginosa* and *P. cornicoides*) were met with up to the day of arrival at Table Bay. Only the yellow-billed species (*P. fuliginosa*) was seen till the second day after leaving the island; for the next few days both were common, but after the 27th their numbers decreased greatly. None were seen after Cape Town was left.

Diomedea melanophrys was plentiful nearly every day up to the arrival at the Cape, but was not subsequently seen.

Besides the above three species, the Wandering Albatros, *D. exulans*, was the only albatros met with; it was numerous up to the day of arrival at Table Bay, also on the 22nd and 25th May many were about; next day (24° S.) a few were seen, and those were the last albatroses that the *Scotia* encountered.

It is here necessary to add a note as to the identity of the large albatroses observed by the *Scotia* naturalists, which have all been recorded in these pages as *D. exulans*. Two other closely allied species are at present recognised, inhabiting the southern oceans, to wit, *D. regia* and *D. chionoptera*. Of these, Godman * says:—

"The geographical distribution of *D. regia* and *D. chionoptera* appears to be restricted to certain districts of the southern oceans, whereas *D. exulans*, the Wandering Albatros, seems to be dispersed over the whole of the seas inhabited by *D. regia* and *D. chionoptera*. Thus, while *D. regia* is an inhabitant of New Zealand and the adjacent islands, *D. chionoptera* is found only in the South Atlantic."

It further appears that immature stages of *D. chionoptera* are practically indistinguishable from stages up to the adult of *D. exulans*, and in fact the identity of

* *Monograph of the Petrels*, p. 322.

the various species remains in a somewhat hazy condition until more material is available.

All this must be borne in mind in connection with the records of *D. exulans* throughout the voyage of the *Scotia*. Godman adds on p. 323 that he thinks it highly probable that the albatros of Gough Island (this in reference to Mr Eagle Clarke's paper, Section IX.) will be found to be *D. chionoptera* rather than *D. exulans*.

It seems improbable that the fully adult white-winged examples of *D. chionoptera*, if present in numbers, could have been overlooked by such competent observers as several of the staff of the *Scotia*.

The day must be looked forward to when the numerous problems connected with the albatroses and petrels of the southern oceans may be solved by the despatch of an expedition having this as one of its main objects.

Three skins of *D. exulans* were brought back by the *Scotia*. Data of two of these are unfortunately lacking at the present time (1912). The description and dimensions of all three may be given :—

(*a*) Immature skin. "No. 100." Wing 23 ins. ; culmen 5·6 ins. ; tarsus 4·2 ins. ; mid-toe 6·25 ins. Bill pale yellow ; forehead, sides of head, and throat white ; wings above, and scapulars, entirely blackish brown ; crown and rest of upper parts, fore-neck and breast, and flanks, lighter brown ; axillaries and whole of under wing-coverts white ; middle of abdomen nearly white, fine brownish vermiculations on the thighs.

(*b*) Adult, "7th May 1904." * Wing 24 ins. ; culmen 6·5 ins. ; tarsus 4·6 ins. ; mid-toe 6·5 ins. Bill pale yellow. Longer scapulars, and all upper surface of wing, blackish brown, except for some white mottlings on the coverts forming an irregular patch near the elbow-joint. Under wing-coverts and axillaries white ; head, fore-neck, and belly white, but a mottled brown and white patch on the crown ; back of the head, and all the rest of the upper parts, chest, flanks, thighs, and under tail-coverts white, closely vermiculated with fine transverse brown lines ; tail grey-brown.

(*c*) Adult. Unlabelled. Wing 23·75 ins. ; culmen 5·9 ins. ; tarsus 4·7 ins. ; mid-toe 6·7 ins. Colouring as in the last, except that the vermiculated parts are much whiter in appearance, owing to the brown lines being much further apart.

After Gough Island was left behind, a few examples of *Priofinus cinereus* were seen daily up to May 1st (39° 30′ S., 10° 30′ E.). These were probably the last met with, although two of the specimens of this species collected by the *Scotia*, at present in the Royal Scottish Museum, are labelled "near Ascension." The original labels of these skins are lost, and it is highly probable that this locality is due to a mistake, as the *Zoological Log* makes it clear that no petrels of any sort (except a few Storm-Petrels) were obtained

* At this date the *Scotia* was lying at Cape Town. This is probably one of three examples which were shot on April 29th.

or seen anywhere near Ascension. This record has unfortunately been quoted by Mr Godman in his monograph.

Majaqueus æquinoctialis was seen in small numbers on May 1st to 5th. It was again observed between Cape Town and Saldanha Bay, and also in numbers on May 22nd and 25th (about 26° S.), and a single one (the last seen) by one of the sailors on the 27th (about 22° 30′ S.).

Œstrelata mollis continued to be met with all the way to South Africa, except on the last day, and was also met with on the voyage to St Helena (but only at a long distance from land) in numbers on the 25th and 26th, and a single bird, the last seen, on the 28th, in about 20° S.

On April 29th a petrel of a species not hitherto met with was shot, and several others seen. The specimen proves to be *Œstrelata macroptera*, A.Sm. Others of the same were seen on the next three days, and also on May 4th and 5th, when the *Scotia* was approaching land. The description and measurements of the specimen obtained are appended :—

No. 291, killed April 29th, 1904. Wing 11·4 ins.; bill (gape to tip) 2·1 ins.: tarsus 1·75 ins.; mid-toe 2·4 ins.; inner toe 2·1 ins. Bill black, with a whitish mark on the hook and near the tip of the mandible. Legs and feet black. Plumage of the upper parts entirely dark blackish brown, with faint paler margins to the feathers of mantle and hind-neck; on scapulars and some of lesser wing-coverts a more reddish-brown tinge. The feathers have light greyish bases. Forehead and lores greyer than crown. Throat cinereous. Fore-neck and chest like the back, rest of under parts rather paler, and with a more brownish tinge. Under tail-coverts dark like the upper ones; longest ones almost as long as central tail feathers. Under wing-coverts and axillaries dark like the back.

Whale-birds (*Prion* sp.) were seen in small numbers (many on April 26th) up to May 2nd (38° S., 14° 30′ E.). The only subsequent record is a doubtful one, of a single bird on May 22nd in 22° 30′ S.

Single examples of *Daption capensis* were logged on May 22nd, 25th, and 26th, (24° S.).

Wilson's Petrel (*Oceanites oceanicus*) and White-bellied Storm-Petrels (*Cymodroma grallaria*) were seen daily on the voyage to the Cape, but not in large numbers. Very few Storm-Petrels were observed between the Cape and St Helena, only one or two being noted on three different days.

On the last two days before reaching St Helena only a single bird (an *Œstrelata mollis*) was seen.

Section XI.—South Africa.

By L. N. G. Ramsay, M.A., B.Sc.

After spending twelve days at Cape Town, the *Scotia* left Table Bay on May 17th. Her course lay northward along the coast, and next forenoon she lay to off Dassen Island, one of the islands where the Jackass Penguins (*Spheniscus demersus*) nest under protection. A permit had been obtained for collecting here, but the heavy surf prevented a landing being made. Saldanha Bay was reached the same evening, and here the vessel anchored for two or three days. A small collection of birds, comprising eight species, was made here, and about midday on the 21st the anchor was weighed and the *Scotia* left for St Helena.

The Saldanha Bay collection includes the following:—

Phalacrocorax capensis (Sparrm.).—Two immature skins, shot off Marcus Island, May 21st, 1904.

This is one of four species of *Phalacrocorax* which frequent the coasts of South Africa. It is said to be extraordinarily abundant along the west coast.*

Numerous other shags or cormorants were seen off the coast at Saldanha Bay, and on Meeuw Island, a tiny islet in the bay, their nesting-places were found. Dr Rudmose Brown describes these as follows†:—"On low acacia-bushes the shags one year build a platform of twigs and grass with perhaps a dozen nests on the same level, next year a second platform with some new nests is built above the former one, and so on year by year, each successive series of nests covering the previous one, until one finds a stack higher than a man, of ten to fifteen years' growth. Often, on pulling such a stack to pieces, deserted eggs of years ago may be discovered."

Larus dominicanus Licht.—Two skins are in the collection, an adult and an immature (probably second year's bird), shot on May 19th on the shore at Saldanha Bay, where these gulls were numerous. This species is very common all round the coasts of South Africa, breeding on islands off the north-west and south coasts.

Larus hartlaubi (Bruch.).—Two adults and a young bird are in the Saldanha Bay collection. This gull is very common along the west coast of the colony.

The young bird mentioned above has the quills and tail-feathers about half-grown (the wing measures 6·8 ins., as against 10·75 for the adult). It is remarkable for the absence of any trace of a terminal dark band on the tail, which is pure white. A dark

* *Fauna of S. Africa: Birds*, by A. C. Stark and W. L. Sclater, vol. iv. p 7 (the information regarding the status in South Africa of the following species from Saldanha Bay is also taken from this source).

† *The Voyage of the "Scotia,"* p. 277.

tail-band is, I believe, almost universal in the young and immature stages of other members of this genus. No mention of this peculiarity is to be found in the descriptions of the species in the *British Museum Catalogue of Birds*, nor in the *Fauna of South Africa* referred to above. The plumage of this specimen differs from that of the adult in the presence of brown marks on the tips of the scapulars, median wing-coverts, crown and ear-coverts, lead-coloured centres to the secondaries, and the smaller amount of white on the three outer primaries (no white mirrors on Nos. 2 and 3, and just a trace on No. 1).

Hæmatopus moquini Bp. One specimen is in the collection, shot at Saldanha Bay on May 19th. It is an adult. The bill was noted as bright crimson, the legs darker crimson.

The Black Oyster-catcher is common and resident along the shores of Cape Colony.

Ægialitis marginata (Vieil.).—Two specimens of the White-fronted Sand-plover were shot on the shore at Saldanha Bay. This species is common and resident around the South African coasts. It is stated to breed at Walvisch Bay in April or May. These specimens (obtained on May 19th) have the sandy tint on the breast which characterises the summer plumage.

Although a shore-bird, and apparently similar in habits to its black-and-white banded congeners, this species has a plumage of a general fawn coloration, with black reduced to a minimum on the head, so that from its appearance it might be taken for an isabelline desert-form. (Sclater mentions that it has been stated by Layard to occur on inland waters as well, but that he has never heard of its occurrence except near the sea.)

Erythropygia coryphæus (Less.).—A single example of this species, known as the Cape Ground-robin, was obtained on the 19th. It is a common bird in many parts of western Cape Colony.

Passer arcuatus Gray.—A male example of the Cape Sparrow was shot on the 19th. This sparrow has assumed similar habits to those of our European House-sparrow in the towns, but is also found remote from human habitation in the Karroo and elsewhere.

Serinus imberbis Cab.—A single specimen of this finch was also obtained.

Fringillaria impetuani (Smith).—This bunting, common locally throughout the colony, is represented likewise by one specimen.

Alæmon nivosa (Swains.).—One specimen was obtained. This lark is found in South Africa up to the Orange River, and is abundant in the Karroo.

In addition to the above, the following species were observed in South Africa:—

Ibis æthiopica (Lath.).—Numbers of which were seen at Reits Bay, Saldanha Bay.

Megalestris antarctica (Less.).—Skuas seen at sea on the day of arrival at Cape Town, and also many on the 22nd May after leaving Saldanha Bay, were probably of this species, which visits South Africa during the southern winter. The Arctic Skua (*Stercorarius crepidatus*) is only found on the South African coasts from October to March.

Sula capensis Layard.—These gannets were seen in plenty along the west coast, and some on the 23rd May, after the *Scotia* had left for St Helena.

A single specimen of the Lesser Double-collared Sunbird, *Cinnyris chalybeus* (L.), is also in the collection, labelled "Cape Town." It is a species which is common over the greater part of Cape Colony.

Two papers on Saldanha Bay and its Bird-Islands, by W. L. Sclater, have appeared in *The Ibis* (1896, p. 519, and 1904, p. 79).

Section XII.—St Helena, Ascension, and between.

By L. N. G. Ramsay, M.A., B.Sc.

There is not much of importance to be recorded of this section of the *Scotia's* voyage.

A few days were spent at each of these two oceanic islands, and a few specimens of their scanty avifaunas were obtained. During the voyage between, the tropical seas were devoid of bird-life, except for a few gannets seen as Ascension was neared (the first were observed between one and two hundred miles from the island).

St Helena (lat. 16° S., long. 6° W.).—The *Scotia* touched here from May 30th to June 2nd (1904). Specimens of three species of birds were obtained, viz.: *Anous stolidus* (L.) (several adults), *Gygis candida* (Gm.) (three), and *Caccabis saxatilis*, subsp. *chukar* (Gray) (one). The last is a species of Red-legged Partridge introduced into the island.

Ascension (lat. 8° S., long. 14° W.).—At this island the *Scotia* lay from 7th to 10th June.

One of the sights of the island is the "Wideawake Fair," or breeding-ground of the "Wideawakes" (*Sterna fuliginosa*), millions of which are said to nest there. The birds were absent at this time (although some were seen during the first day's sail after the *Scotia* left the island), but great numbers of their corpses strewed the ground. A dozen eggs of these terns were kindly presented by Mr Chalmers of the Eastern Telegraph Co.

On June 10th, while the *Scotia* was trawling off Pyramid Point before leaving, Mr Wilton landed from a small boat on a rock near the shore and found gannets and noddies busy in bringing up their young. The eggs were laid on the bare rock, no nests being built. Some of the gannets had fresh-laid eggs, others had chicks, some of which were big birds almost ready for flight. No eggs of the noddy were seen, but some young birds unable to fly were caught. They were much infested with lice.

The specimens from Ascension include:—

Sula sula (L.).—Three skins, immature.

S. cyanops (Sund.).—Three skins (two adults and an immature bird in dark brown plumage).

S. piscator (L.).—Two skins (one adult, one nearly so but with traces of brown in the mantle).

Anous stolidus (L.).—Five specimens, including a half-grown youngster.

Fregata aquila (L.).—Two skins (adults).

Sterna fuliginosa Gm.—Two carcases in spirit, much damaged.

Section XIII.—The North Atlantic.

By L. N. G. Ramsay, M.A., B.Sc.

This, the final section, includes the observations of the voyage from Scotland southward to St Paul's Rocks in November-December 1902, and the return journey from Ascension *via* the Cape Verde Islands and Azores in June and July 1904.

On the southward trip, very few birds were seen till Madeira was reached on November 20th. A lark flew aboard about noon on the second day out, in 50° 45′ N., 7° 35′ W. (about half-way between Land's End and the Irish coast), in an exhausted state, and succumbed the same night.

Gulls were logged on the 16th, about 200 miles off the coast of Spain, and two again on the 18th, still further from land.

After Madeira, petrels were logged almost every day till St Paul's Rocks were reached, lying near the equator, but none were identified. Porto Grande, in the Cape Verde Islands, was touched at on December 1st.

On the northward voyage in 1904, the *Scotia*, after passing through the Cape Verde Islands on June 21st, steered much further to the westward, and was beyond the 34th meridian of west longitude for two days.

At this point the floating gulf-weed of the Sargasso Sea was passed through from June 28th to July 2nd (chiefly in lat. 29°–34° N.).

Between Ascension and Cape Verde Islands few birds except some Stormy Petrels were seen. Two Sooty Terns (*Sterna fuliginosa*) were seen on June 12th, some 300 miles W.N.W. from Ascension. In the neighbourhood of the Cape Verde Islands gannets were seen, and also several examples of what was probably the Tropic-bird (*Phaëthon lepturus*), and some boobies (?).

Between the 19th and 35th parallels of latitude only one bird (a small petrel) was seen. After this the Azores were drawing near, and Stormy Petrels were seen daily till the English Channel was reached. On 4th July the *Scotia* stopped to trawl on the Princesse Alice bank, south of the Azores, and here nine Stormy Petrels (eight of these which are now in existence are all *Oceanites oceanicus*) and five large shearwaters were shot.

Four of the shearwaters I have examined. One of these is a *Puffinus gravis*, O'Reil., the other three are *P. kuhli* (Boie). They are the Atlantic dark-winged form of this species, in which the white on the inner webs of the primaries does not extend beyond the under wing-coverts (separated by Dr Hartert as *P. kuhli flavirostris*). The dimensions of two of the latter are as follows:—

(*a*) Wing 13·4 ins.; culmen 2·1 ins.; tarsus 2·2 ins.; mid-toe 2·7 ins.

(*b*) Wing 14·0 ins.; culmen 2·1 ins.; tarsus 2·2 ins.; mid-toe 2·7 ins.

Shearwaters similar to these species were seen on July 7th to 10th, from the Azores north-westwards to 43° N., 19° 30′ W. A Black-backed Gull resembling *Larus marinus* was seen on July 3rd and 4th.

Section XIV.—Bibliography of Antarctic Birds.

Only the main works dealing with the birds of the Antarctic regions, properly speaking, are included. Preliminary notices are omitted in most cases.

(1) ANDERSSON, K. A., "Das höhere Tierleben im antarktischen Gebiete," *Wissen. Erg. Schwed. Südpolar-Exped. (1901–03)*, Bd. v., 2, Stockholm, 1905.

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EXPLANATION OF PLATES.

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The young of the Ringed Penguin (*Pygoscelis antarctica*), showing the two stages in down. Painted by H. Goodchild.

Plate II.

Fig. 1. The young of the Snowy Petrel (*Pagodroma nivea*).

Fig. 2. The young of the Sheathbill (*Chionis alba*).

Painted by H. Goodchild.

Plate III.

Fig. 1. Wilson Petrel (*Oceanites oceanicus*) on nest, with egg.

Fig. 2. Cape Pigeons (*Daption capensis*) preparing to nest.

Fig. 3. Young of the Antarctic Skua (*Megalestris antarctica*).

Fig. 4. Nest and eggs of the Southern Black-backed Gull (*Larus dominicanus*).

Photographs by J. H. H. Pirie.

Plate IV.

Fig. 1. Tracks of Black-throated Penguin (*Pygoscelis adeliæ*). Photo by J. H. H. Pirie.

Fig. 2. Black-throated Penguin building its nest (*P. adeliæ*).

Fig. 3. Gentoo Penguin (*P. papua*) sitting tight on its eggs after a blizzard.

Fig. 4. Ringed Penguins (*P. antarctica*) at their rookery on Saddle Island.

Photographs by R. N. R. Brown.

Plate V.

Two new species of Buntings taken at Gough Island.

Fig. 1. *Nesospiza jessiæ.*

Fig. 2. *N. goughensis.*

Painted by H. Goodchild.

Plate VI.

Eggs of Antarctic birds in natural colour, and reduced to four-fifths their natural size.

Fig. 1. *Megalestris antarctica*, Antarctic Skua, taken at the South Orkneys on 11th December 1903; *Scotia* collections. Egg number 4: length = 76 mm., weight = 1720 grains. *Vide* original Log, p. 35.

Fig. 2. *M. antarctica*, taken at the South Orkneys on 2nd December 1903; *Scotia* collections. Egg number 1*a*: length = 74 mm., weight = 1524·7 grains.

Fig. 3. *M. maccormicki*, McCormick's Skua, taken in Victoria Land by Shackleton Expedition, 1907–09, per Dr Forbes Mackay. Length = 78 mm.

Fig. 4. *Larus dominicanus*, Dominican Gull or Southern Black-backed Gull, taken at South Orkneys; *Scotia* collections. Length = 70 mm., average weight = 1519·3 grains.

Fig. 5. *L. dominicanus*, taken at the South Orkneys; *Scotia* collections. Actual length = 71 mm., average weight = 1519·3 grains.

Fig. 6. *M. maccormicki*, taken in Victoria Land by Shackleton Expedition, 1907–09; per Dr A. Forbes Mackay.

Fig. 7. *Chionis alba*, the Sheathbill or Paddy, taken at the South Orkneys; *Scotia* collections. Length = 56 mm.

Fig. 8. *C. alba*, taken at South Orkneys on 18th December 1903; *Scotia* collections. Length = 55 mm., weight = 615 grains. *Vide* Log, p. 36.

Fig. 9. *Sterna hirundinacea*, the White-rumped Tern, taken at South Orkneys on 12th December 1903; *Scotia* collections.

The numbers 1 to 9 read from left to right in each row.

PLATE VII.

Eggs of Antarctic birds which are either white, pale blue, or, as in the case of Wilson's Petrel, only faintly spotted. The plate shows the relative size or shape of these eggs, reduced to four-fifths their natural size.

Fig. 1. *Pygoscelis antarctica*, the Ringed Penguin, or Antarctic Penguin, taken at South Orkneys, 1903; *Scotia* collections. Egg number M. 2: length = 68 mm., weight = 1880 grains. *Vide* original Log, p. 53.

Fig. 2. *P. antarctica*, taken at South Orkneys, 1903; *Scotia* collections. Egg number 11: length = 68 mm., weight = 1530 grains.

Fig. 3. *P. adeliæ*, Black-throated Penguins, taken at South Orkneys, 1903; *Scotia* collections. Length = 67·8 mm., weight = 1530 grains.

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Fig. 8. *Oceanites oceanicus*, Wilson's Petrel, taken at Churchill, Jessie Bay, South Orkneys, on 4th January 1904; *Scotia* collections. Egg number 3: length = 33 mm., weight = 155 grains. *Vide* original Log, p. 47.

Fig. 9. *Pagodroma nivea*, the Snowy Petrel, taken on west side of Jessie Bay, South Orkneys, on 5th December 1903. Egg number 26: length = 55 mm., weight = 685 grains. *Vide* original Log, p. 29.

The numbers 1 to 9 read from left to right in each row.

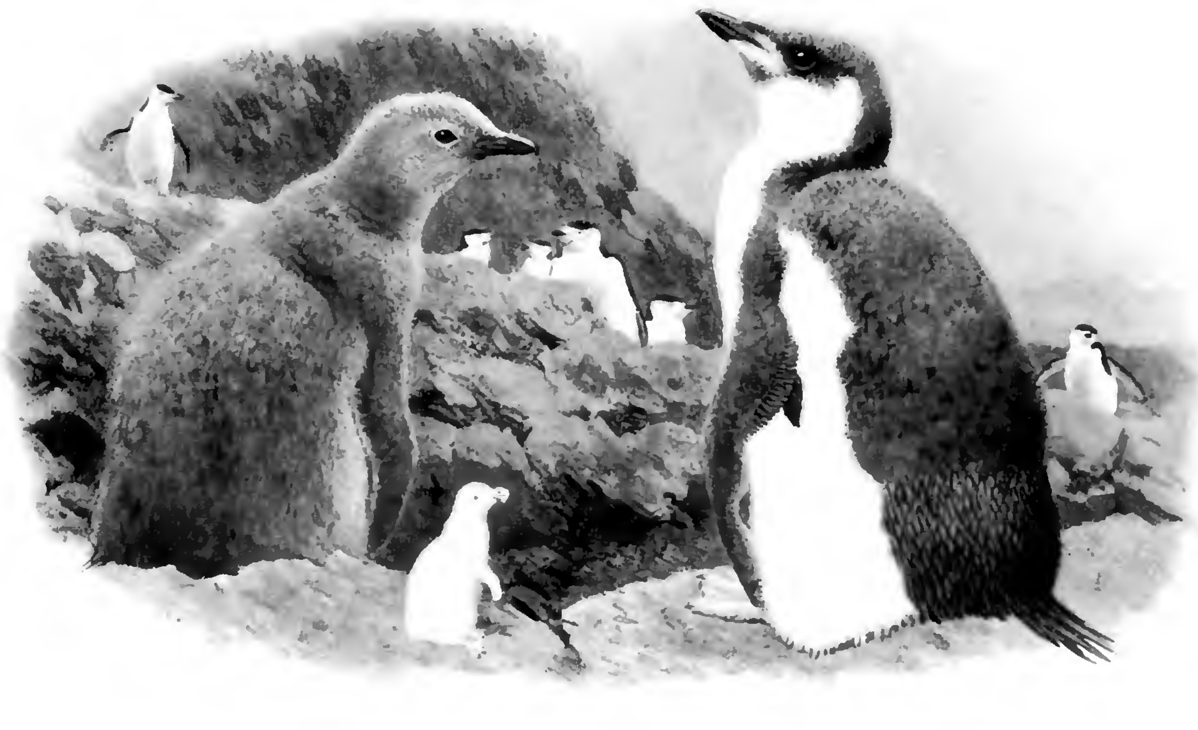
MAP I.

Scotland to Coats Land: Track Chart of the *Scotia*, 1902–04, by William S. Bruce, LL.D.

MAP II.

Weddell Sea: Track Chart, including the trawling stations of the *Scotia*, 1902–04, by William S. Bruce, LL.D.

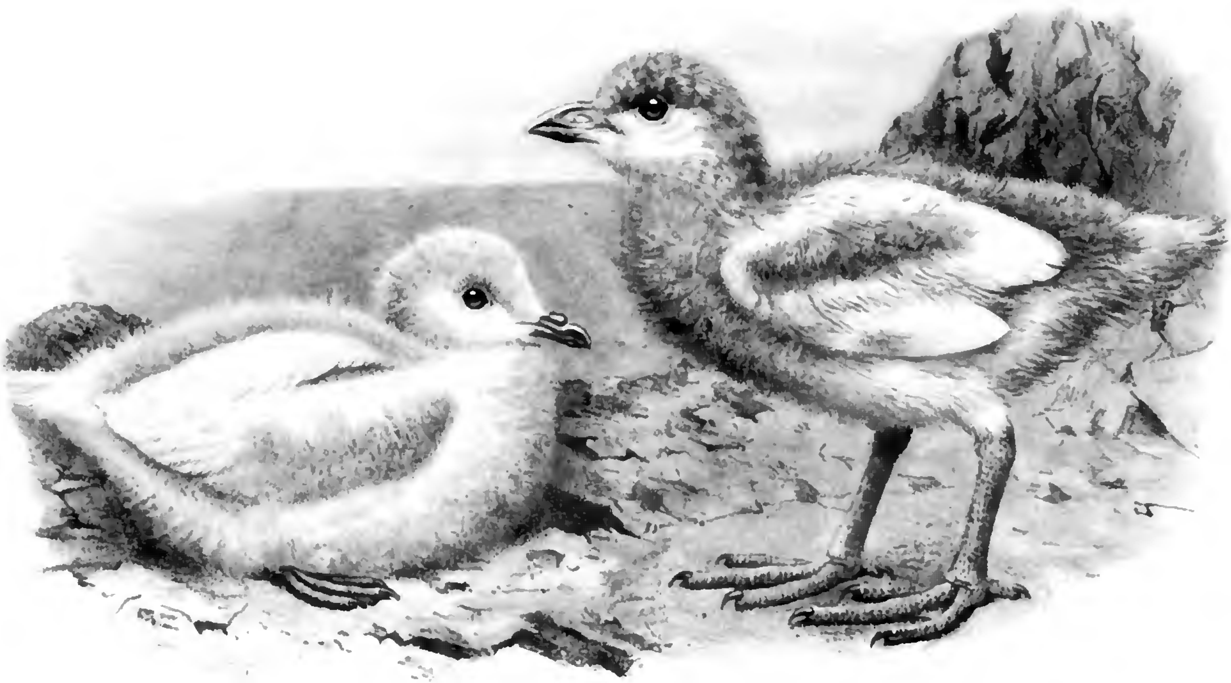
Ornithology of the "Scotia." Plate I.



H. Goodchild, del.

The young of the Ringed Penguin (*Pygoscelis antarctica*) showing the two stages in down.

Ornithology of the "Scotia." Plate II.

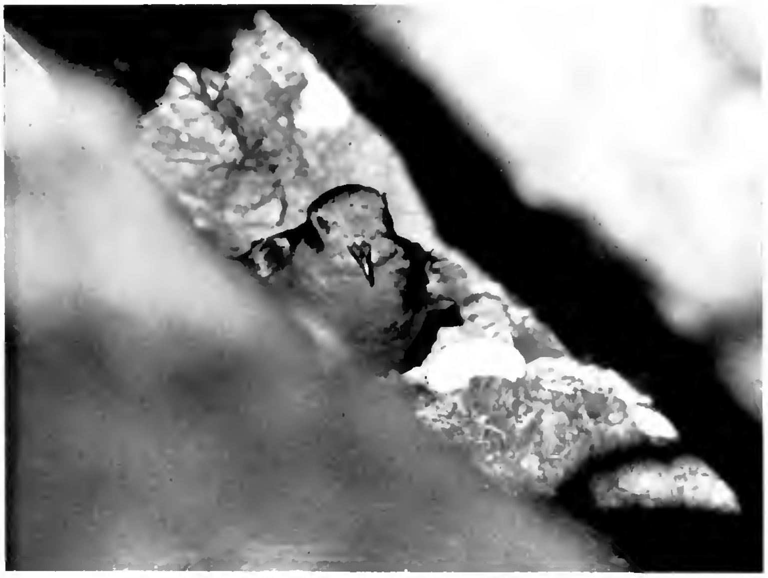


1. 2.

H. Goodchild, del. Oliver & Boyd, Edin., Imp.

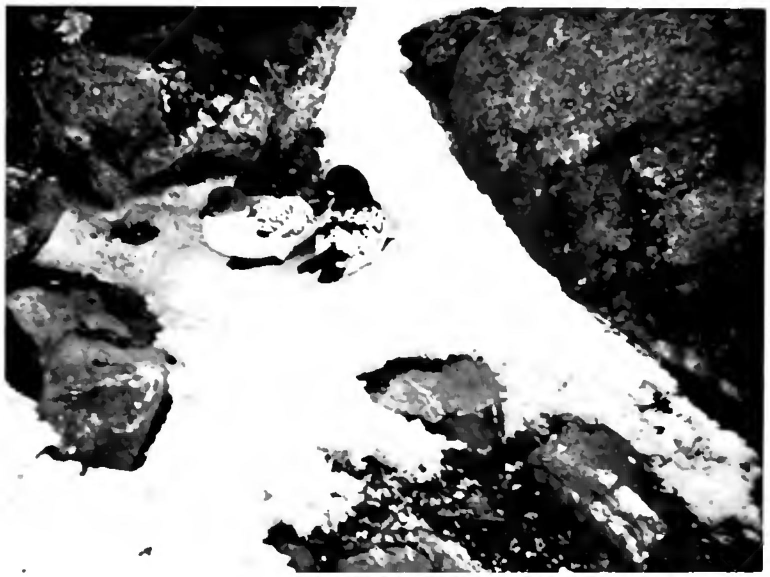
1. The young of the Snowy Petrel (*Pagodroma nivea*). 2. The young of the Sheathbill (*Chionis alba*).

Ornithology of the "Scotia." Plate III.



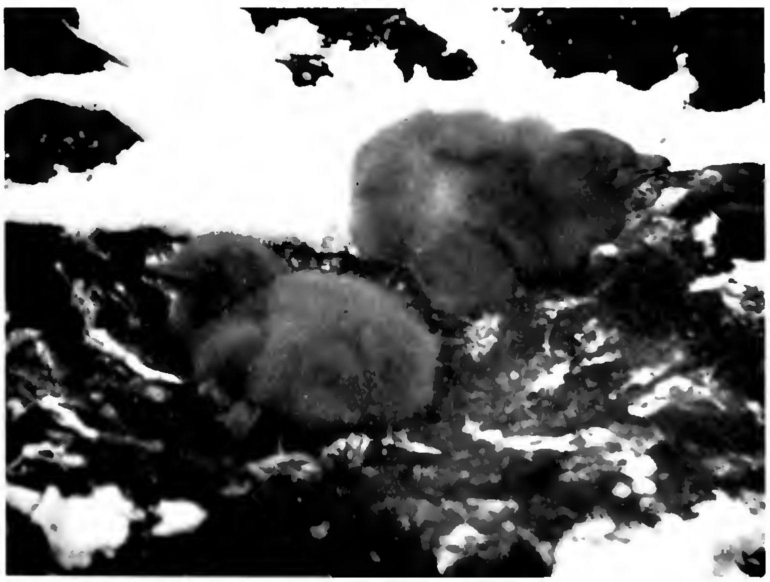
[Photo by J. H. H. Pirie.

1. Wilson Petrel (*Oceanites oceanicus*) on Nest with Egg.



[Photo by J. H. H. Pirie.

2. Cape Pigeons (*Daption capensis*) preparing to nest.



[Photo by J. H. H. Pirie.

3. Young of Antarctic Skua (*Megalestris antarctica*).

[Photo by J. H. H. Pirie.

4. Nest and Eggs of Southern Black-backed Gull (*Larus dominicanus*).

Ornithology of the "Scotia." Plate IV.

[Photo by J. H. H. Pirie.

1. Tracks of Black-throated Penguin (*Pygoscelis adeliæ*).

[Photo by R. N. R. Brown.

2. Black-throated Penguin building its nest.

[Photo by R. N. R. Brown.

3. Gentoo Penguin (*Pygoscelis papua*) sitting tight on its eggs after a blizzard.

4. Ringed Penguins (*Pygoscelis antarctica*) at their rookery (on Saddle Island).

Ornithology of the "Scotia." Plate V.

1

2.

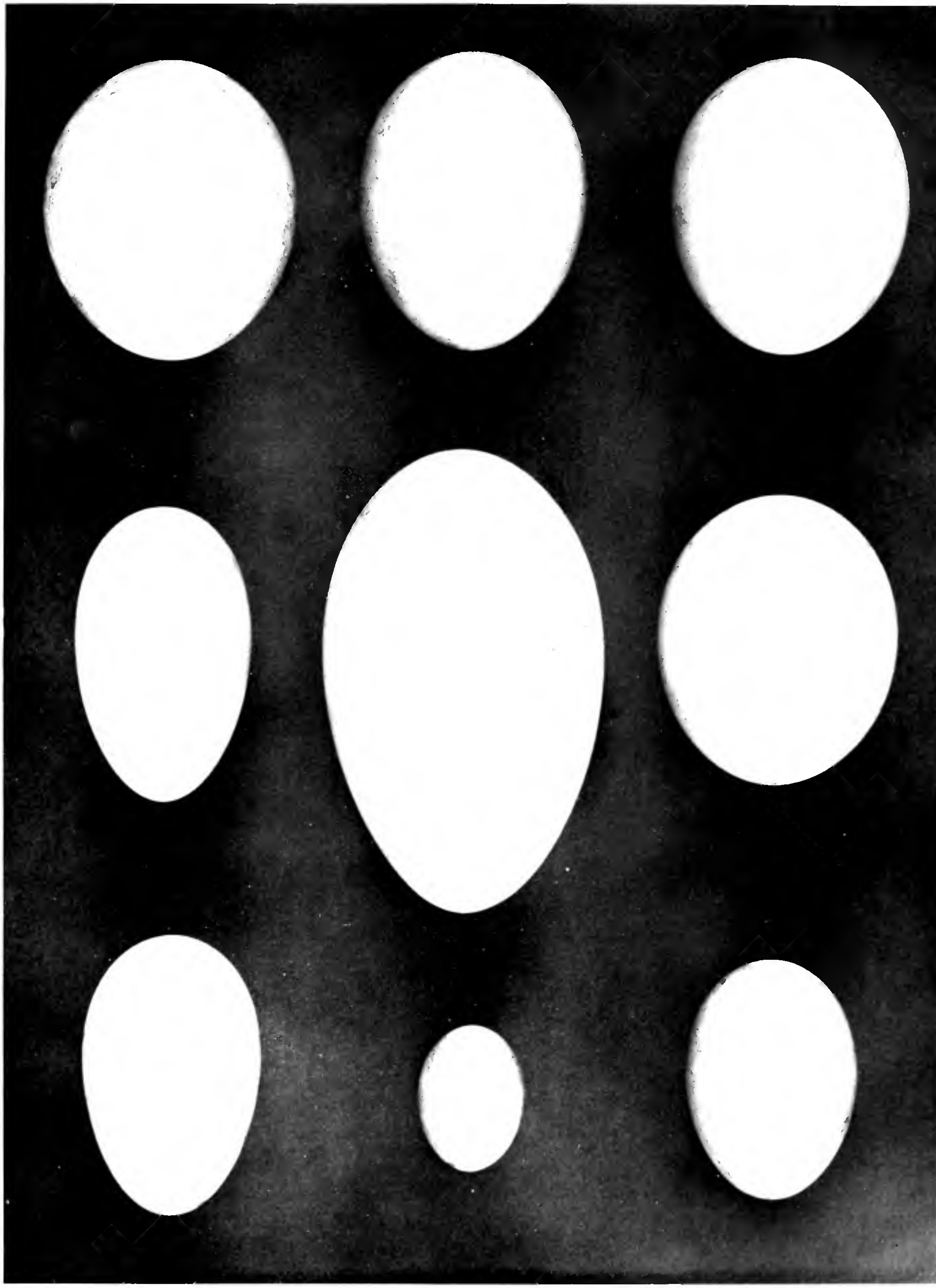
H. Goodchild, del.] *[Oliver & Boyd, imp.*

Two new species of Buntings, taken at Gough Island.

1. *Nesospiza jessiæ.* 2. *N. goughensis.*

Reduced natural size.

1. *Megalestris antarctica.*
2. *M. antarctica.*
3. *M. maccormicki.*
4. *Larus dominicanus.*
5. *Larus dominicanus.*
6. *M. maccormicki.*
7. *Chionis alba.*
8. *Chionis alba.*
9. *Sterna hirundinacea.*

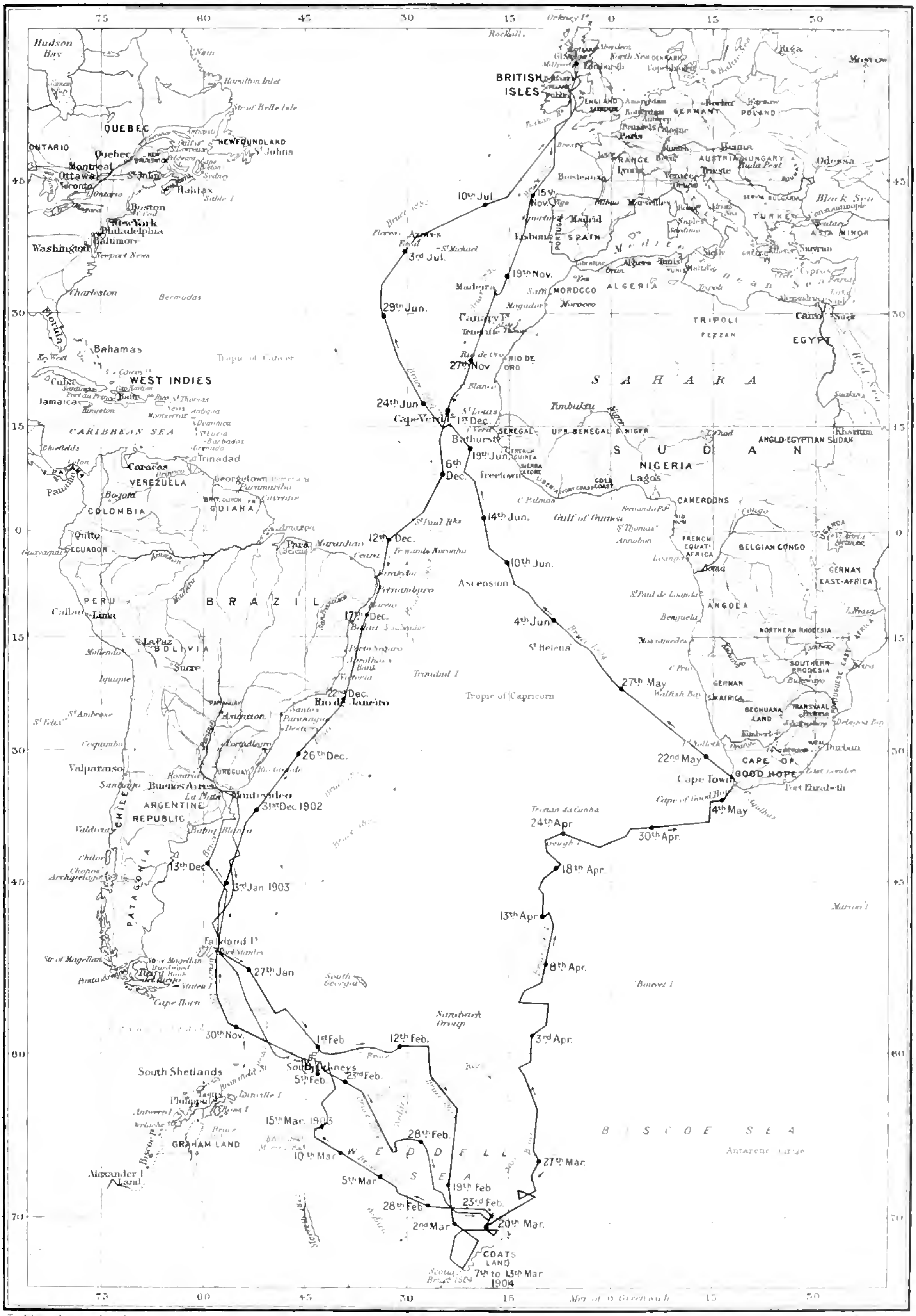


Reduced natural size.

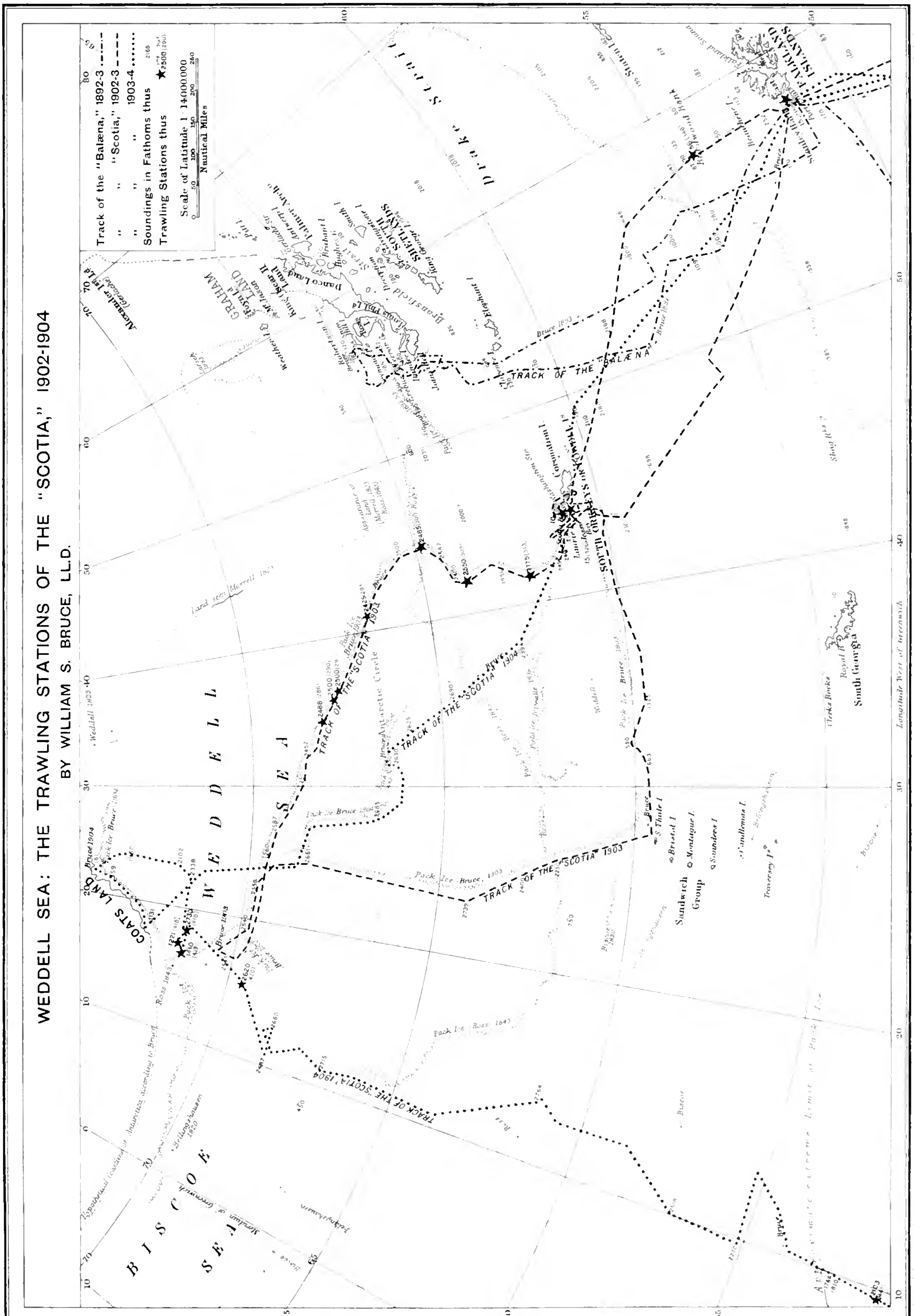
1. *Pygoscelis antarctica.* 2. *P. antarctica.* 3. *P. adeliae.*
4. *Phalacrocorax atriceps.* 5. *Ossifraga gigantea.* 6. *P. papua.*
7. *Daption capensis.* 8. *Oceanites oceanicus.* 9. *Pagodroma nivea.*

Scotland to Coats Land

TRACK CHART OF THE "SCOTIA," 1902-1904, BY WILLIAM S. BRUCE, LL.D.



The Edinburgh Geographical Institute


WEDDELL SEA: THE TRAWLING STATIONS OF THE "SCOTIA," 1902-1904
BY WILLIAM S. BRUCE, LL.D.
Track of the "Balæna," 1892-3
" " "Scotia," 1902-3
" " " 1903-4
Soundings in Fathoms thus
Trawling Stations thus
Scale of Latitude 1: 14000000
Nautical Miles
WEDDELL SEA
BISCOE SEA
COATS LAND
GRAHAM LAND
SOUTH SHETLANDS
SOUTH ORKNEYS
FALKLAND ISLANDS
South Georgia
Sandwich Group
TRACK OF THE "SCOTIA" 1903
TRACK OF THE "SCOTIA" 1904
TRACK OF THE BALÆNA
Antarctic Circle
Longitude West of Greenwich
Alexander Ist Ld
Elephant I
Coronation I
Laurie I
Clerke Rocks
Shag Rks
Traversey Is
S. Thule I
Bristol I
Montague I
Saunders I
Leskov I
Meridian of Greenwich
NOTE.—"Pack Ice (Bruce) 1904," etc., means heavy and tightly packed ice difficult or impossible to penetrate, but not the outmost limits of the Pack.
J. G. Bartholomew
The Edinburgh Geographical Institute

PART XV.

FISHES.

XV.—ANTARCTIC FISHES OF SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

By C. TATE REGAN, M.A.,
Assistant Keeper in Zoology in the British Museum.

(*WITH ELEVEN PLATES.*)

The Antarctic Fishes of the Scottish National Antarctic Expedition. By C. Tate Regan, M.A., Assistant in the British Museum (Natural History). *Communicated by* Dr W. S. Bruce. (With Eleven Plates and Six Text-figs.)

(MS. received June 18, 1912. Read December 16, 1912. Issued separately May 23, 1913.)

Our knowledge of the Antarctic fish-fauna has greatly increased during the last ten years. The Belgian expedition to Graham Land (1897–1899) was followed by that of the *Southern Cross* to Victoria Land (1898–1900), fitted out by Sir George Newnes. Next were the British expedition of the *Discovery* to Victoria Land and Edward Land (1901–1904), the German voyage of the *Gauss* to Kerguelen and Wilhelm Land (1901–1903), and Nordenskjöld's Swedish expedition to South Georgia, the South Shetlands, and Graham Land. Then came the voyage of the *Scotia* to the South Orkneys and Coats Land (1902–1904), and Charcot's expeditions to the Palmer Archipelago and Graham Land in the *Français* (1904–1905) and the *Pourquoi Pas?* (1908–1910), and finally Shackleton's expedition (1908–1909).

The fishes collected during these expeditions have been described in a series of reports, which may be enumerated in chronological order:—

1902. Boulenger, *Pisces* in "*Southern Cross*" *Collections*, pp. 174–189, pls. xi.–xviii.

1904. Dollo, *Rés. Voy.* "*Belgica*": *Poissons*, 240 pp., 12 pls.

1905. Lönnberg, "The Fishes of the Swedish South Polar Expedition," *Wissensch. Ergebn. Schwedisch. Südpolar-Exped.*, v. 6, 69 pp., 5 pls.

1906. Vaillant, *Expéd. Antarct. Française: Poissons*, 51 pp.

1907. Boulenger, *National Antarctic Expedition, Nat. Hist.*: II., Fishes, 5 pp., 2 pls.

1911. Waite, "Antarctic Fishes," in *British Antarctic Expedition*, 1907–9: *Biology*, pp. 11–16, pl. ii.

1912. Pappenheim, "Die Fische der Antarktis und Subantarktis," in *Deutsche Südpolar-Exped.*, 1901–1903: XIII., *Zool.*, v. pp. 163–182, pls. ix.–x.

Dr Dollo presented several preliminary notes in the *Proceedings of the Royal Society of Edinburgh* * on the fishes of the Scottish National Antarctic Expedition.

The fishes of the second Charcot expedition have been worked out by Professor Roule, who has published two preliminary notes (*C.R. Acad. Sci. Paris*, cliii., 1911, pp. 80–81, and *Bull. Mus. Paris*, 1911, pp. 276–281), but the final report has not yet appeared.

The important collection of fishes here reported on was made at the Falkland Islands, the South Orkneys, Coats Land, and Gough Island, and in the Weddell Sea and South Atlantic Ocean between these localities. As will be seen from the systematic list that follows, it includes examples of forty-eight species, ten of which are now described as new to science, whilst three others, known before but wrongly identified, are diagnosed and given new specific names; in addition, four species have already been described by

* *Proc. Roy. Soc. Edin.*, xxvi., 1906, p. 172; xxviii., 1908, p. 58; xxix., 1909, p. 316.

Dr. DOLLO, in whose hands the greater part of the collection has been from 1905 until March 1912.

The identification of the Notothenioids and Zoarcids has proved a difficult matter in the present state of our knowledge of these groups, and I have supplemented my report by a monograph of the former and a revision of the southern genera of the latter; further, I have added some notes on the Galaxiidæ and Haplochitonidæ, as their distribution has given rise to some discussion.

My work on the Notothenioids and Zoarcids is mainly based on the specimens in the British Museum, including the *Erebus* and *Terror*, *Challenger*, *Southern Cross* and *Discovery* collections, but I have been greatly helped by the loan of specimens from the Museums at Paris, Berlin, and Stockholm. Thus I have been able to examine all the species of *Notothenia* recorded by VAILLANT from Graham Land, two of the three species of Zoarcids recently described by PAPPENHEIM from Wilhelm Land, and co-types of some of the Notothenioids described by LÖNNBERG. For their kindness in sending me these fishes, and in giving me information about others that could not be sent, I heartily thank Dr PELLEGRIN, Dr PAPPENHEIM, and Dr LÖNNBERG.

It need hardly be said that the fishes lend no support to the theory of bipolarity. Most of the littoral fishes belong to the Nototheniidæ and related families, which are characteristic of and peculiar to the Antarctic seas and the region immediately to the north of them; there are also several species of Zoarcidæ, generically distinct from the northern members of the family. Some of the pelagic and abyssal fishes are Notothenioids peculiar to the Antarctic region; others also, such as *Notolepis*, *Cynomacrurus*, and *Eugnathosaurus*, may not be found elsewhere; but the rest belong to widely distributed genera (*Synaphobranchus*, *Bathylagus*, *Myctophum*, etc.) or even species (e.g. *Cyclothone microdon*).

In the whole paper the following seven new genera and twenty-one new species are described:—

NEW GENERA.

Eugnathosaurus, p. 316.
Ophthalmolycus, p. 325.
Austrolycichthys, p. 326.
Austrolycus, p. 327.
Crossolycus, p. 329.
Pagetopsis, p. 368.
Chænocephalus, p. 369.

NEW SPECIES.

Bathylagus glacialis, p. 313.
Eugnathosaurus vorax, p. 316.
Synaphobranchus australis, p. 317.
Chalinura ferrieri, p. 318.
,, *whitsoni*, p. 318.
Cassioperca coatsii, p. 319.
Neophrynichthys marmoratus, p. 323.
Lycenchelys antarcticus, p. 324.
Austrolycus depressiceps, p. 327.
Crossolycus chilensis, p. 329.
Cottoperca macrophthalma, p. 335.
Borichthys angustifrons, p. 337.
,, *chilensis*, p. 338.
,, *decipiens*, p. 339.
Trematomus loennbergii, p. 345.
Notothenia trigramma, p. 348.
,, *ramsayi*, p. 349.
,, *wiltoni*, p. 350.
,, *vaillanti*, p. 354.
Chænichthys rugosus, p. 369.
Cryodraco pappenheimi, p. 370.

I. Antarctic and Subantarctic Fishes collected by the "Scotia."*

SELACHII.

Raiidæ.

1. *Raia magellanica*, Steind. (Pl. I.)

Zool. Jahrb. Suppl., vi., 1905, p. 212.

One specimen from Station 346, Burdwood Bank, depth 56 fathoms; taken on 1st December 1905. Lat. 54° 25′ S., long. 57° 32′ W.; temperature 41·8° F.

This is a female of exactly the same size as Steindachner's type, and apparently in every way similar, except that there is only a single scapulary spine, instead of a series of three on each side.

This species is related to *R. murrayi*, Günth., from Kerguelen, but has a blunter snout, a shorter tail, and somewhat different spination.

ISOSPONDYLI.

Clupeidæ.

2. *Clupea fuegensis*, Jenyns.

Zool. "Beagle," Fish., p. 133 (1842); Smitt, *Bihang. Svensk. Vet.-Akad.*, xxiv., 1898, iv., No. 5, p. 59, pl. v. fig. 41

Depth of body 4 to 5 in the length. Lower jaw very prominent; minute teeth in a single series on the palatines and in an elongate patch on the tongue. Dorsal 17–18; origin equidistant from anterior edge of eye and base of caudal fin. Anal 17–20. Origin of pelvics vertically below that of dorsal. About 50 scales in a longitudinal series; ventral scutes not prominent.

Several specimens, up to 170 mm. in total length, taken at Station 118, Port Stanley, Falkland Islands, in February 1904, when extraordinary shoals of this herring visited Port Stanley Harbour.

Argentinidæ.

3. *Bathylagus glacialis*, sp. n. (Pl. IX. fig. 2.)

Depth of body 6 to $6\frac{1}{2}$ in the length, length of head $4\frac{1}{3}$ to $4\frac{1}{2}$. Diameter of eye $2\frac{1}{5}$ to $2\frac{1}{3}$ in the length of head, interocular width 3, interorbital width 6. Dorsal 10; origin nearer to end of snout than to base of caudal. Anal 18. Pelvics 8-rayed, inserted below middle of dorsal. About 35 scales in a longitudinal series.

* A series of nine water-colour drawings made by Mr Cuthbertson for the most part represent fishes from Scotia Bay, South Orkneys, viz. *Notolepis coatsii*, *Harpagifer bispinis*, *Trematomus newnesii*, *Notothenia coriiceps*, *N. nudifrons*, and *N. gibberifrons*: there is also a sketch of *Lycenchelys antarcticus*. In one or two cases I have referred to these in the text.

There are five examples of this new species, 70 to 100 mm. in total length :—

1. Station 398, 68° 25′ S., 27° 10′ W., 1 to 1000 fathoms; surface temperature 30° F.; vertical net; 29th February 1904.
2. Station 422; 68° 32′ S., 12° 49′ W., 0 to 800 fathoms; surface temperature 31·1° F.; temperature at 800 fathoms 32·4° F.; vertical net; 23rd March 1904.
3. Station 414, 71° 50′ S., 23° 30′ W., 0 to 1000 fathoms; surface temperature 29·1° F.; vertical net; 15th March 1904.
4. Station 417, 71° 22′ S., 16° 34′ W., 1410 fathoms; temperature at 1410 fathoms 31·9° F.; trawl; 18th March 1904.
5. Station 418, 71° 32′ S., 17° 15′ W., 1221 fathoms; temperature at 1221 fathoms 31·9° F.; trawl; 19th March 1904.

Bathylagus antarcticus, Günth., is distinguished by the less graceful form (depth 5 in the length) and the longer anal fin with 22 rays. *Bathylagus gracilis*, another Antarctic species recently described by Lönnberg, has the interorbital space very narrow and deeply concave, and about 41 scales in a longitudinal series.

Other species of *Bathylagus* have been described from the South Atlantic (Günther, Lönnberg), the North Atlantic (Goode and Bean), and the North Pacific (Gilbert).

Galaxiidæ.

4. *Galaxias attenuatus*, Jenyns.

Two examples from Port Stanley and Port Harriet, Falkland Islands, Station 118.

5. *Galaxias maculatus*, Jenyns.

Several from Port Harriet, Station 118.

Haplochitonidæ.

6. *Haplochiton zebra*, Jenyns.

One specimen from Port Stanley, Falkland Islands, in fresh water, Station 118.

Stomiatidæ.

7. *Stomias boa*, Risso.

One from Station 451, 48° 06′ S., 10° 5′ W., 1742 fathoms; trawl; 13th April 1904.

8. *Cyclothone microdon*, Günth.

Small examples of this widely distributed species were taken at three stations, viz.—

Six at Station 450, 48° 00′ S., 9° 50′ W., 1332 fathoms; surface temperature 40·0° F.; trawl; 13th April 1904.

One at Station 422, 68° 32′ S., 12° 49′ W., 0–800 fathoms; temperature at 800 fathoms 32·4° F.; vertical net; 23rd March 1904.

Four at Station 414, 71° 50′ S., 23° 30′ W., 0–1000 fathoms; surface temperature 29·1° F.; vertical net; 15th March 1904.

INIOMI.

SUDIDÆ.

9. *Notolepis coatsii*, Dollo.

Proc. Roy. Soc. Edin., xxviii., 1908, p. 58.

Prymnothonus (part.), Günth., "*Challenger*" *Pelagic Fish*, p. 39, pl. v. fig. D (1889).

„ *Hookeri* (*non* Richards.), Dollo, *Proc. Roy. Soc. Edin.*, xxvii., 1907, p. 35.

Depth of body $6\frac{1}{2}$ in the length, length of head 5; snout half the length of head; diameter of eye $6\frac{1}{2}$ in the length of head. Teeth rather small, pointed, uniserial, in jaws and on palatines. Dorsal 8; origin nearly equidistant from head and base of caudal; adipose fin rather long and low. Anal 28. Caudal with numerous procurrent rays. Pectorals narrow, about $\frac{1}{3}$ length of head. Vent below anterior part of dorsal. Scales deciduous. Myotomes 82, 34 in advance of dorsal fin. Silvery white; back bluish.

It is with some difficulty that I have put together the above description of the type of the species, 105 mm. in total length, taken at the surface in Scotia Bay, South Orkneys. The specimen is in very bad condition,* and everything that one touches falls off; hence it is not surprising that I cannot see the small pelvic fins described by DOLLO.

In a paper on the classification of the Iniomi (*Ann. Mag. Nat. Hist.* (8), vii., 1911, pp. 120–133) I have already called attention to the fact that DOLLO's family *Paralepidæ* is not a natural group, and that *Notolepis* differs from *Paralepis* apparently only in the greater length of the adipose fin, a character of very slight importance to anyone familiar with the species of Siluroids.

Larval and post-larval examples of this species that I have examined are:—

1.—44 mm.; 62° 26′ S., 95° 44′ E. *Challenger* collection.

2.—50 mm.; at Station 422, 68° 32′ S., 12° 49′ W., 10–800 fathoms; temperature at 800 fathoms 32·4° F.; 23rd March 1904. *Scotia* collection.

3–5.—38 to 56 mm.; at Station 414, 71° 50′ S., 33° 30′ W., 0–1000 fathoms; surface temperature 29·1° F.; 15th March 1904. *Scotia* collection.

Except that the teeth are relatively stronger and the eye larger, specimens 1 and 2 are extremely similar to the type, and agree with it in the number of fin-rays and of myotomes; I cannot find any pelvic fins, nor ascertain the position of the vent, but the eight-rayed dorsal fin is distinct in both.

Specimens 3 to 5 are the ones described by DOLLO as *Prymnothonus hookeri*; these evidently belong to the same species as the other examples, with which the larger one agrees in the head, dentition, and approximate number of myotomes. In the smaller ones the head is relatively smaller and the snout shorter. I am unable to make out the fins, or position of vent, and I am very doubtful as to whether the so-called embryonic anal fringe is an actual structure present in the living fish.

Dr DOLLO named this species in honour of the late Mr JAMES COATS, junr., of Paisley, whose generosity was the chief means of assuring the dispatch of the Scottish National Antarctic Expedition.

* This is regrettable, as this specimen was originally so perfectly preserved and was brought home in perfect condition, and was acknowledged to have been received by Dr DOLLO "*en bon état*."—W. S. B., Editor.

MYCTOPHIDÆ.

10. *Myctophum antarcticum*, Günth.

Specimens were taken at :—

Station 309, 63° 51′ S., 41° 50′ W., 2300 fathoms; temperature 31·05° F.; trawl; 16th March 1903.

Station 414, 71° 50′ S., 23° 30′ W., 0–1000 fathoms; surface temperature 29·1° F.; vertical net; 15th March 1904.

Station 422, 68° 32′ S., 12° 49′ W., 0–800 fathoms; surface temperature 32·7° F.; temperature at 800 fathoms 32·4°; vertical net; 23rd March 1904.

11. *Lampanyctus braueri*, Lönnberg.

One specimen was taken at Station 420, lat. 69° 33′ S., 15° 19′ W., 2620 fathoms, by the trawl, on 21st March 1904; temperature 31·5° F. The species was previously known only from the type.

ALEPIDOSAURIDÆ.

Eugnathosaurus, gen. nov.

Skull very elongate and strongly compressed, with the upper surface somewhat convex, bearing a fairly prominent median ridge. Snout and lower jaw much produced, each ending in a fleshy appendage; lower jaw projecting beyond upper; suspensorium directed obliquely forward. Teeth pointed, uniserial; præmaxillary teeth minute; mandibulary teeth sub-conical, erect or somewhat retrorse, strongest in the middle of the length of the jaw, more spaced posteriorly; palatine teeth strong, compressed, curved somewhat forward.

12. *Eugnathosaurus vorax*, sp. n.

The type of this remarkable new genus and species is a head, measuring 150 mm. in length from tip of snout to end of operculum, taken in the trawl on 18th March 1904,

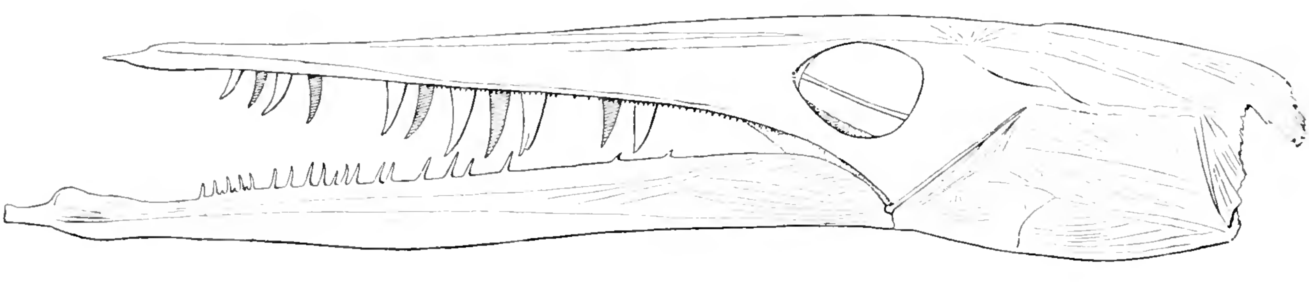


FIG. 1.—*Eugnathosaurus vorax.*

at Station 417, in lat. 71° 22′ S., long. 16° 34′ W., off Coats Land, at a depth of 1410 fathoms, by the trawl; temp. 31·9° F. That it is related to *Alepidosaurus* is evident, but the form of the skull, the produced jaws, and the different mandibulary and palatine dentition distinguish it from that genus; the antrorse palatine teeth are especially peculiar.

The dentaries of a second specimen were taken at the same locality.

APODES.

SYNAPHOBRANCHIDÆ.

13. *Synaphobranchus australis*, sp. n. (Pl. VIII. fig. 5.)

Synaphobranchus bathybius (part.), Günth., "*Challenger*" *Deep-Sea Fish*, p. 254 (1887).

The *Challenger* specimen, 350 mm. in total length, was taken midway between the Cape of Good Hope and Kerguelen, at a depth of 1375 fathoms. The *Scotia* example was obtained on 13th April 1904, at Station 451, in 48° 06′ S., 10° 5′ W., at a depth of 1742 fathoms, and measures a total length of 470 mm. The species belongs to the sub-genus *Histiobranchus*, Gill, which includes also *S. bathybius*, Günth., and *S. infernalis*, Gill. All three are closely related, differing as follows:—

Eye nearer to end of snout than to angle of mouth; origin of dorsal above base of pectoral, its distance from end of snout rather less than $\frac{1}{3}$ that from end of snout to vent . . . . *bathybius*.

Eye about equidistant from snout and angle of mouth; origin of dorsal above posterior part of pectoral, its distance from end of snout somewhat more than $\frac{1}{3}$ that from end of snout to vent . . . . . . *infernalis*.

Eye about equidistant from snout and angle of mouth; origin of dorsal a little behind end of pectoral, its distance from end of snout about $2\frac{1}{4}$ in that from end of snout to vent . . . . *australis*.

ANACANTHINI.

MACRURIDÆ.

Four species of this family were obtained by the *Scotia* in Antarctic seas, all belonging to the sub-family *Macrurinæ* (cf. *Ann. Mag. Nat. Hist.* (7), xi., 1903, pp. 459–466), and to genera with the teeth in the lower jaw uniserial.

14. *Nematonurus lecointei*, Dollo.

Rés. Voy. "*Belgica*," *Poiss.*, p. 44, pl. vii. (1904); *Proc. Roy. Soc. Edin.*, xxix., 1909, p. 488.

The type was taken in 70° 40′ S., 102° 15′ W., depth 1526 fathoms. The *Scotia* examples are from: (1) Station 313, 62° 10′ S., 41° 20′ W., 1775 fathoms; temperature 31·0° F.; trawl; 18th March 1903. (2) Station 451, 48° 06′ S., 10° 05′ W., 1742 fathoms; 13th April 1904.

The præmaxillary teeth are biserial, except posteriorly, where the inner series is replaced by three, forming a narrow band.

15. *Chalinura ferrieri*, sp. n. (Pl. II. fig. 1.)

Snout rather strongly produced (for a *Chalinura*); mouth wide, the maxillary nearly reaching the vertical from posterior edge of eye; infraorbital ridge fairly prominent. Diameter of eye less than length of snout, $4\frac{2}{3}$ in length of head; interorbital width 4. Dorsal II 9; distance from second dorsal a little more than $\frac{3}{4}$ the length of head. Origin of anal at distance from head equal to length of head without snout. Pectoral 18 or 19-rayed, $\frac{3}{5}$ the length of head, extending to above origin of anal. Pelvics 11-rayed, the outermost ray filamentous, reaching anal. Scales mostly with 3 parallel series of spinules, but the lateral series sometimes reduced to a single spine, or absent; 8 scales between dorsal fin and lateral line.

A single specimen, 230 mm. in total length, from Station 417, 71° 22′ S., 16° 34′ W., 1410 fathoms, off Coats Land; temperature at 1400 fathoms 31·9° F.; trawl; 18th March 1904.

This species is named after JAMES G. FERRIER, Esq., F.R.S.G.S., Hon. Secretary of the *Scotia* Committee.

16. *Chalinura whitsoni*, sp. n. (Pl. II. fig. 2.)

Snout rather produced (for a *Chalinura*); maxillary extending to below posterior margin of pupil; infraorbital ridge prominent. Diameter of eye more than length of snout, $2\frac{3}{4}$ to $3\frac{1}{4}$ in length of head; interorbital width 4 to $4\frac{1}{3}$. Dorsal II 9–10; distance from second dorsal $\frac{1}{4}$ the length of head. Origin of anal at distance from head equal to length of head without snout. Pectoral 18–19-rayed. Pelvic 9-rayed, the outermost ray filamentous, not reaching anal. Scales with 1 series of spinules, but some on sides of head with 3 series converging anteriorly; 7 scales between dorsal fin and lateral line.

Two specimens:—

1. 420 mm.; Station 451, 48° 6′ S., 10° 5′ W., 1742 fathoms; trawl; 13th April 1904.
2. 270 mm.; Station 417, 71° 22′ S., 16° 34′ W., 1410 fathoms, off Coats Land; temperature at 1400 fathoms 31·9° F.; trawl; 18th March 1904.

This species is named after T. B. WHITSON, Esq., C.A., Hon. Accountant of the *Scotia* Committee.

17. *Cynomacrurus piriei*, Dollo. (Pl. III. fig. 1.)

Proc. Roy. Soc. Edin., xxix., 1909, p. 316.

The type of the genus and species, a specimen of 300 mm., was obtained by the *Scotia* at Station 414, 71° 50′ S., 23° 30′ W., in a depth 0–1000 fathoms, surface temperature 31·5° F., vertical net, on 15th March 1904. The dentition is very characteristic; in the præmaxillaries a narrow band of unequal teeth separated by an interspace from a marginal series of small teeth with a strong pair of antero-lateral canines; in the lower jaw teeth strong, spaced, unequal, uniserial.

Other important characters are the large terminal mouth with lateral cleft, the absence of a barbel, the small eye, and the slender, smooth dorsal spine. The pelvic fins are 7-rayed, and in counting 12 Dr DOLLO must have reckoned divided rays as two.

This species was named by Dr DOLLO after Dr J. H. HARVEY PIRIE, bacteriologist, geologist, and surgeon of the *Scotia*.

PERCOMORPHI.

SERRANIDÆ.

18. *Cæsioperca coatsii*, sp. n. (Pl. VI. fig. 1.)

Depth of body $2\frac{2}{3}$ to $3\frac{1}{4}$ in the length, length of head $2\frac{3}{4}$ to 3. Diameter of eye $2\frac{1}{3}$ to $2\frac{2}{3}$ in length of head, interorbital width $4\frac{1}{3}$ to 5. Interorbital region flat; maxillary extending to below middle of eye; 21 to 24 gill-rakers on lower part of anterior arch. Dorsal X, 15–18; third or fourth spine longest, nearly twice as long as last, $\frac{2}{5}$ to $\frac{1}{2}$ length of head. Anal III 8; second spine longest, as long as or longer than longest dorsal spine. Pectoral shorter than head, asymmetrical, the rays increasing to the tenth, counting from above, or seventh, from below. Caudal truncate. About 40 scales in a lateral longitudinal series and 45 in the lateral line, which forms an angle on the caudal peduncle. Pale reddish brown, with traces of alternating darker and paler longitudinal bands; upper half of spinous dorsal blackish, or with a series of blackish spots.

Gough Island. Several specimens, up to 135 mm. in total length, taken at Station 461, 40° 20′ S., 9° 56′ W., off Gough Island, at a depth of 100 fathoms; surface temperature 54·5° F.; trawl; 23rd April 1904.

This species is of considerable interest, as its three congeners are found on the coasts of South Australia, Tasmania, and New Zealand. These are distinguished by their longer pectoral and emarginate caudal fins, and by the convex interorbital region; but I am unable to find any characters which would justify the establishment of a new genus for the new species. The pectoral fin of *C. rasor* is almost as asymmetrical, and I find that the flatness of the interorbital region of *C. coatsii* is not associated with any difference in the essential structure of the frontal bones, which are, as in *C. lepidoptera*, smooth and convex posteriorly, and anteriorly consist of a pair of supraorbital flanges and of a median depression bordered by muciferous canals.

I have pleasure in naming this species after Major ANDREW COATS, D.S.O., a member of the *Scotia* Committee, a most generous donor to the funds of the Scottish National Antarctic Expedition, and himself a polar explorer.

ATHERINIDÆ.

19. *Basilichthys laticlavia*, Cuv. and Val.

Several small specimens from Station 118, Port Stanley Harbour, Falkland Islands, 51° 41′ S., 57° 51′ W.; shore.

ZOARCIDÆ.

20. *Iluocætes fimbriatus*, Jenyns.

Station 118, Port Stanley, Falkland Islands, 51° 41′ S., 57° 51′ W.; shore.

21. *Austrolycus depressiceps*, Regan.

Several small specimens from Station 118, Port Stanley, Falkland Islands, 51° 41′ S., 57° 51′ W.; shore. This species is described on p. 327.

22. *Phucocætes latitans*, Jenyns.

Four small specimens from Station 118, Port Stanley, Falkland Islands, 51° 41′ S., 57° 51′ W.; shore.

23. *Lycenchelys antarcticus*, Regan.

This new species is described on p. 324, from a single specimen from Station 313, 62° 10′ S., 41° 20′ W.; depth 1775 fathoms; temperature 31·0° F.; trawl; 18th March 1903.

BROTULIDÆ.

24. *Neobythites brucei*, Dollo. (Pl. III. fig. 2.)

Proc. Roy. Soc. Edin., xxvi., 1906, p. 172.

Depth of body 6½ in the length, length of head 5, or 1⅗ in its distance from origin of anal. Diameter of eye 13 in length of head, equal to width of posterior nostril; maxillary extending well behind eye; palatine bands of teeth broad; no præopercular spines; gill-membranes united for a short distance to each other and to isthmus; 15 gill-rakers on lower part of anterior arch. About 125 scales in a longitudinal series. Dorsal 108; origin behind base of pectoral. Anal 86. Pectoral nearly as long as head; pelvics ⅖ the length of head, 2-rayed, each ray simple, expanded distally into an ovate blade.

The type, 350 mm. in total length, was taken at Station 291, 67° 33′ S., 36° 35′ W.; depth 2500 fathoms; trawl; 7th March 1903.

From most species of *Neobythites* this species differs in the gill-membranes attached to the isthmus and the oar-shaped pelvic rays, and I should be inclined to recognise GARMAN's genus *Holcomycteronus* for this species and *N. digittatus*, had not GARMAN stated that the form of the pelvic rays is variable in the latter.

This species was named by Dr DOLLO after Dr W. S. BRUCE, leader of the Scottish National Antarctic Expedition.

BOVICHTHYIDÆ.

25. *Cottoperca gobio*, Günth.

Station 349, 51° 41′ S., 57° 51′ W., Port William, Falkland Islands; shore.

26. *Cottoperca macrophthalma*, Regan.

At Station 346, 54° 25′ S., 57° 32′ W., Burdwood Bank; 56 fathoms; surface temperature 41·8° F.; otter trawl; 1st December 1903. This new species is described on p. 335.

27. *Bovichthys diacanthus*, Carmich.

A specimen of 120 mm. from Gough Island. On comparison with Chilian examples of the species usually known as *B. diacanthus*, I find that they are distinct (*cf.* p. 338).

NOTOTHENIIDÆ.

28. *Harpagifer bispinis*, Forst.

Several examples from Station 118, Port Stanley, Falkland Islands, and Station 325, Scotia Bay, South Orkneys—the latter a new record of locality for this species.

29. *Trematomus newnesii*, Bouleng.

Station 325, Scotia Bay, South Orkneys.

30. *Trematomus borchgrevinkii*, Bouleng.

Station 325, Scotia Bay, South Orkneys.

31. *Trematomus bernacchii*, Bouleng.

Station 325, South Orkneys.

32. *Trematomus hansoni*, Bouleng.

Station 411, Coats Land, 161 fathoms.

33. *Notothenia trigramma*, Regan.

This new species, from Station 118, at the Falkland Islands, is described on p. 348.

34. *Notothenia ramsayi*, Regan.

This new species, from Station 346, the Burdwood Bank, is described on p. 349.

35. *Notothenia tesselata*, Richards.

Station 118, Port Stanley, Falkland Islands.

36. *Notothenia wiltoni*, Regan.

Examples of this new species, described on p. 350, were taken by the *Scotia* at Station 118, Port Stanley, Falklands, and at Station 346, the Burdwood Bank.

37. *Notothenia brevicauda*, Lönnb.

Station 118, Port Stanley, Falkland Islands.

38. *Notothenia sima*, Richards.

Station 118, Port Stanley, Falkland Islands.

39. *Notothenia gibberifrons*, Lönnb.

Station 325, Scotia Bay, South Orkneys.

40. *Notothenia nudifrons*, Lönnb.

Station 325, Scotia Bay, South Orkneys.

41. *Notothenia coriiceps*, Richards.

South Orkneys; common at Station 325, Scotia Bay.

42. *Notothenia cornucola*, Richards.

Station 118, Port Stanley, Falkland Islands.

43. *Notothenia rossi*, Richards.

Station 325, Scotia Bay, South Orkneys.

44. *Eleginops maclovinus*, Cuv. and Val.

Station 118, Port Stanley, Falkland Islands.

BATHYDRACONIDÆ.

45. *Bathydraco scotiæ*, Dollo.

Station 417, 71° 22′ S., 16° 34′ W., off Coats Land, at a depth of 1410 fathoms. This species is described on p. 364.

SCLEROPAREI.

SCORPÆNIDAE.

46. *Sebastes maculatus*, Cuv. and Val.

Specimens from Station 461. Gough Island, at 25 fathoms and 100 fathoms, the latter with *Cæsioperca coatsi*.

47. *Sebastes capensis*, Gmel.

A small specimen taken at Station 461, Gough Island, with the preceding; both these species are found at the Cape of Good Hope.

Psychrolutidæ.

48. *Neophrynichthys marmoratus*, sp. n.

Neophrynichthys latus (*non* Hutton), Günth., *Proc. Zool. Soc.*, 1881, p. 20, pl. i.

In this species the dermal appendages on the head and anterior part of the body are much larger and set further apart than in *N. latus*. Another striking difference is the narrower interorbital region, its width measuring only $\frac{1}{4}$ of the length of the head in *N. marmoratus*, but $\frac{2}{5}$ in its congener from New Zealand. The dorsal rays number IX–X, 15–16, the anal 11 or 12; the caudal is more rounded than in *N. latus*.

The irregular marbling gives this fish a very different appearance from the New Zealand form, with its definite pale spots separated by a brown network.

Three specimens, two in the British Museum collection, from the Straits of Magellan, 320 and 390 mm. in total length, and one of 160 mm. obtained by the *Scotia* at Station 346, 54° 25′ S., 57° 32′ W., Burdwood Bank, 56 fathoms; surface temperature 41·8° F.; otter trawl; 1st December 1903.

II. A Revision of the Zoarcidæ of Southern America and the Antarctic.

The Zoarcidæ are principally a northern family, and so far as I am aware none is known from South Africa, Australia, or New Zealand. Two northern deep-water genera, *Lycenchelys* and *Melanostigma*, are represented in the Antarctic Regions, but the littoral species, with those of South America and the adjacent islands, all belong to genera distinct from the northern ones.* There has hitherto been much confusion as to the characters of these genera and species, which it is the object of this revision to clear up.

Synopsis of the Genera.

I. Pelvic fins present; mouth subterminal.

A. Snout and lower jaw without fringes.

1. Origin of dorsal fin well behind base of pectoral; gill-opening cleft downward nearly or quite to lower end of base of pectoral.

Teeth uniserial or biserial in jaws, uniserial on palatines; tail long and slender . . . . 1. *Lycenchelys*.

Teeth in jaws triserial; two teeth near anterior end of each palatine; tail moderately elongate . . . . 2. *Ophthalmolycus*.

2. Origin of dorsal fin above base or anterior part of pectoral; gill-opening cleft downward at least to middle of base of pectoral.

a. Mouth large, with wide lateral cleft; gill-opening cleft downwards almost or quite to lower end of base of pectoral; teeth in jaws uniserial, with anterior canines in the upper and lateral canines in the lower.

* The habitat of *Gymnelis pictus*, Günth., is unknown, and there is no justification whatever for the statement that it comes from Magellan Straits.

Teeth on vomer and palatines . . . . . . 3. *Iluocœtes.*
Palate toothless . . . . 4. *Lycodichthys.*

b. Mouth moderate, with short lateral cleft; teeth in jaws uniserial laterally, usually bi- or tri-serial anteriorly; no well-marked canines; teeth on palate.

Head not depressed; gill-opening cleft downward nearly to lower end of base of pectoral . . . . 5. *Austrolycichthys.*
Head depressed; gill-opening cleft downward only to middle of base of pectoral . . . . 6. *Austrolycus.*

3. Origin of dorsal fin above base of pectoral; gill-opening small, above the pectoral; teeth in upper jaw uniserial, in lower bi- or tri-serial; teeth on palate . . . 7. *Phucocœtes.*

B. Snout and lower jaw with dermal fringes; palate toothless.

Teeth conical, bi- or tri-serial; gill-opening almost entirely above the pectoral . . . . 8. *Crossolycus.*
Teeth incisor-like, uniserial; gill-opening cleft downward to middle of base of pectoral . . . . 9. *Platea.*

II. No pelvic fins; mouth terminal; origin of dorsal just behind head; teeth uniserial, in jaws and on vomer and palatines.

Gill-opening cleft downward to middle of base of pectoral . 10. *Maynea.*
Gill opening above base of pectoral . . . . . 11. *Melanostigma.*

1. *Lycenchelys*, Gill, 1884.

Proc. Acad. Philad., p. 110.

Form elongate, with the tail long and slender; mouth subterminal; teeth in jaws slender, uni- or bi-serial; teeth on vomer; palatine teeth uniserial. Gill-opening rather wide, cleft downwards to lower end of base of pectoral. Dorsal origin well behind head; pelvic fins present.

Lycenchelys antarcticus, sp. n. (Pl. IX. fig. 3.)

Depth of body 16 in the length, length of head 6 and equal to its distance from origin of anal fin. Head as broad as deep, its breadth a little more than $\frac{1}{3}$ its length. Snout twice as long as diameter of eye, which is 6 in length of head; interorbital width about 16. Muciferous channels of sides of head and lower jaw with large pores. Lower jaw included; teeth in jaws rather slender and obtuse, uniserial, biserial near symphysis of lower jaw; teeth on palate acute, wide-set. About 110 rays in dorsal fin, 9 in caudal, 103 in anal; origin of anal $\frac{1}{3}$ as distant from vertical through origin of dorsal as from that through base of pectoral, which fin is a little more than $\frac{1}{2}$ as long as head. Bluish grey; head darker; fins brownish grey.

A single specimen, 128 mm. in total length, from near the South Orkneys, Station

313, 62° 10′ S., 41° 20′ W., depth 1775 fathoms; bottom temperature 31·0° F.; trawl; 18th March 1903.

The few species of this genus hitherto described are from deep water north of the Equator.

2. *Ophthalmolycus*, gen. nov.

Form elongate, compressed. Mouth subterminal; teeth rather slender and acute, in about 3 series in both jaws; no canines; 3 teeth on vomer and 2 near anterior end of each palatine. Gill-opening rather wide, cleft downwards nearly to lower end of base of pectoral. Dorsal origin well behind head; pelvic fins present.

Ophthalmolycus macrops.

Lycodes macrops, Günth., "*Challenger*" *Shore Fish.*, p. 21, pl. xi. fig. B (1880).

Depth of body $11\frac{1}{2}$ in the length, length of head $5\frac{1}{3}$. Diameter of eye $3\frac{1}{3}$ in length of head and 7 times interorbital width. Maxillary nearly reaching vertical from posterior margin of eye. About 90 rays in the dorsal fin, 80 in the anal, and 10 in the caudal. Origin of dorsal above posterior $\frac{1}{4}$ of pectoral; origin of anal a head-length behind the head. Pectoral less than $\frac{1}{2}$ the length of head. Yellowish; 9 broad dark-brown cross-bars on back, extending on to dorsal fin; a series of brown spots on the side, alternating with the bars; a brown band from eye to operculum.

Straits of Magellan, 40 to 140 fathoms.

Here described from the type, 135 mm. in total length.

Lycodes concolor, Roule (*Bull. Mus. Paris*, 1911, p. 280) may belong to this genus. D. 73; A. 68. Coloration uniform.

3. *Iluocœtes*, Jenyns, 1842.

Zool. "*Beagle*," *Fish.*, p. 165.

Head about as broad as deep; body compressed; mouth subterminal, with wide lateral cleft; teeth conical, uniserial in jaws, in a patch on the vomer and a single series on the palatines; 1 or 2 pairs of canines at the symphysis of the upper jaw; 1 or 2 teeth on each side of lower jaw enlarged, canine-like. Gill-opening cleft downward to lower end of base of pectoral. Dorsal origin just behind head; pelvic fins present.

Iluocœtes fimbriatus.

Jenyns, *t.c.*, p. 166, pl. xxix. fig. 2.
Lycodes variegatus, Günth., *Cat. Fish.*, iv. p. 322 (1868).
Phucocœtes variegatus effusus, Smitt, *Bihang Svensk. Vet.-Akad.*, xxiv., 1898, iv., No. 5, p. 43, pl. v. fig. 32.
Phucocœtes variegatus micropus, Smitt, *l.c.*, pl. v. fig. 33.

Depth of body 8 to $11\frac{1}{2}$ in the length, length of head $4\frac{1}{2}$ to $5\frac{1}{2}$. Diameter of eye 4 to $5\frac{1}{2}$ in length of head, 3 or 4 times the interorbital width. Maxillary extending to below posterior margin of eye. Dorsal with 80 to 85 rays, anal with 65 to 70, caudal with about 10. Origin of dorsal above base of pectoral, of anal about a head-length behind head. Pectoral $\frac{3}{5}$ to $\frac{2}{3}$ the length of head. Head, body, and fins spotted and marbled; sometimes cross-bars on the body; a more or less distinct band from snout to eye and eye to operculum; a series of blackish spots at margin of dorsal and anal.

Falkland Islands; Magellan Straits; Chile.

Here described from specimens from the Falkland Islands, 80 to 130 mm. in total length, including the types of *Lycodes variegatus* and two obtained by the *Scotia* at Station 118, Port Stanley.

I am indebted to Mr L. DONCASTER for the loan of JENYNS' type; the appearance of some of the mucous canals as free fringing tubes is due to the bad state of preservation of the specimen.

SMITT'S *Phucocœtes variegatus elongatus* (*t.c.*, p. 44, pl. v. fig. 34) seems to be a distinct species, with the head $\frac{2}{3}$ of the distance from operculum to origin of anal.

4. *Lycodichthys*, Pappenheim, 1911.

Sitzungsb. Gesellsch. Naturf. Freunde, 1911, p. 382.

Closely related to *Iluocœtes*, differing especially in the toothless palate; teeth uniserial; anterior pair in upper jaw enlarged; lateral teeth of lower jaw spaced, canine-like.

Lycodichthys antarcticus.

Pappenheim, *t.c.*, p. 383, and *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 180, pls. ix. fig. 6 and x. fig. 4.

Depth of body 8 or 9 in the length; length of head 5 to $5\frac{1}{2}$. Diameter of eye 5 to 6 in length of head. Maxillary extending to below posterior margin of eye or a little beyond. Dorsal with 85 to 90 rays, anal with about 65, caudal with about 10. Origin of dorsal a little behind base of pectoral, of anal 1 to $1\frac{1}{3}$ head-lengths behind head. Pectoral $\frac{1}{2}$ the length of head. Head, body, and fins spotted or marbled.

Wilhelm Land.

Here described from two co-types, 160 and 200 mm. in total length.

5. *Austrolycichthys*, gen. nov.

Closely related to *Austrolycus*, differing in the more compressed form, the head being at least as deep as broad, and in the more inferiorly placed and somewhat larger gill-openings, cleft downward nearly to the lower ends of the bases of the pectorals.

(1) *Austrolycichthys brachycephalus.*

Lycodes brachycephalus, Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v., p. 179, pl. x. fig. 3.

Depth of body 8 to $10\frac{1}{2}$ in the length, length of head $5\frac{1}{5}$ to $6\frac{2}{3}$. Tail from less than $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as rest of fish. Diameter of eye 5 in the length of head. Maxillary extending to below anterior part of eye. About 90 rays in the dorsal fin, 70 in the anal, 10 in the caudal. Origiu of dorsal above anterior part of pectoral, of anal

$1\frac{2}{5}$ to $1\frac{1}{2}$ head-lengths behind head. Pectoral $\frac{2}{3}$ or $\frac{3}{4}$ the length of head. Grayish or brownish.

Wilhelm Land, 380 metres.

Here described from two co-types, 155 and 150 mm. in total length. These differ greatly in form and proportions, as is shown by the accompanying figures, but I cannot doubt that they belong to the same species.

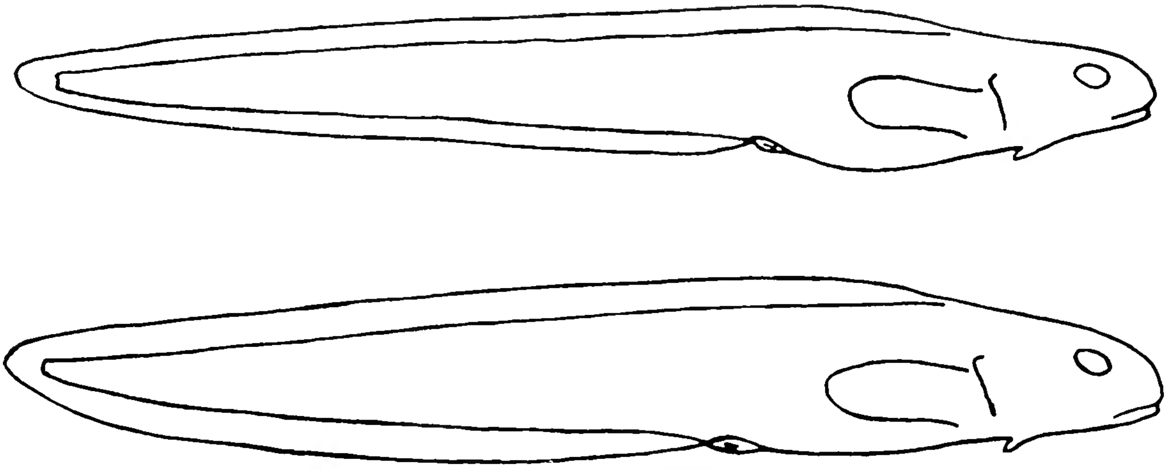


FIG. 2.—*Austrolycichthys brachycephalus.*

(2) *Austrolycichthys bothriocephalus.*

Lycodes bothriocephalus, Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 178, pl. x. fig. 2.

Apparently related to the preceding species, the more slender of the two examples of *A. brachycephalus* described above showing considerable resemblance to the photograph of the type. But this species is said to have more numerous fin-rays, about 110 in the dorsal and 90 in the anal.

Wilhelm Land, 380 metres.

Total length of the unique type, 181 mm.

6. *Austrolycus*, gen. nov.

Head depressed; body compressed posteriorly. Mouth subterminal, with short lateral cleft; teeth conical, uniserial on sides of jaws, bi- or tri-serial anteriorly; teeth on vomer in a group, on palatines in a single series. Gill-opening cleft downwards to middle of base of pectoral. Dorsal origin just behind head; pelvic fins present.

(1) *Austrolycus depressiceps*, sp. n. (Pl. V. fig. 1.)

Phucocoetes latitans (*non* Jenyns) Günth., *Cat. Fish.*, iv. p. 321 (1862); Smith, *Bihang Svensk. Vet.-Akad.*, xxiv., 1898, iv., No. 5, p. 51, pl. v. figs. 37–39; Garman, *Mem. Mus. Comp. Zool.*, xxiv., 1899, p. 138.

Depth of body about 10 in its length, length of head $5\frac{1}{2}$ to $6\frac{1}{2}$. Diameter of eye $6\frac{1}{2}$ to 9 in the length of head, much less than the interocular, but nearly equal to the interorbital width. Maxillary about reaching vertical from posterior margin of eye, 100 to 110 rays in the dorsal fin, 70 to 80 in the anal, 8 to 10 in the caudal; origin of dorsal above base of pectoral, of anal $1\frac{2}{3}$ to 2 head-lengths behind head. Pectoral $\frac{2}{3}$ the length of head. Brownish; abdomen pale; on side of head a sharp line between the dark brown above and pale yellow below, with the brown projecting downwards on the cheek as a bar; a pale transverse band across nape, another above end of pectoral extending on to dorsal fin, which may be followed by similar bands or spots.

Chile; Patagonia; Falkland Islands.

Here described from a large series of specimens measuring up to 250 mm. in total length, including several obtained by the *Scotia* at Station 118, Port Stanley, Falkland Islands.

(2) *Austrolycus platei.*

Lycodes (*Phucocœtes*) *platei*, Steind., *Zool. Jahrb.*, Suppl. iv. p. 320, pl. xix. fig. 8 (1897–98).

Evidently closely related to the preceding species, differing in that the length of the head is $\frac{2}{5}$ its distance from the vent, the tail is considerably longer than the head and trunk (only a little longer in *A. depressiceps*), and the coloration is different, the body being marked with broad cross bands, the interspaces between which correspond to the pale bands or spots on the back and dorsal fin of *A. depressiceps*.

Chile, Cape Espiritu Santo.

Total length 234 mm.

This may be the *Phucocœtes variegatus macropus* of Smitt (*Bihang Svensk. Vet.-Akad.*, xxiv., 1898, iv., No. 5, p. 44, pl. v. fig. 35).

7. *Phucocœtes*, Jenyns, 1842.*

Zool. "Beagle," Fish., p. 168 (1842).

Head and body compressed. Mouth subterminal; teeth conical, uniserial in upper jaw and on palatines, bi- or tri-serial in lower jaw; anterior pair of teeth in upper jaw, middle vomerine tooth, and 1 or 2 pairs in lower jaw more or less enlarged and canine-like. Gill-opening small, above base of pectoral. Dorsal origin just behind head; pelvic fins present.

Phucocœtes latitans, Jenyns, *l.c.*, pl. xxix. fig. 3.

Lycodes flavus, Bouleng., *Ann. Mag. Nat. Hist.* (7), vi., 1900, p. 53.

Depth of body 8 to 10 in the length, length of head $6\frac{1}{2}$ to 7. Snout $1\frac{1}{2}$ as long as diameter of eye, which is 6 to 7 in length of head, greater than interorbital width. Lower jaw included; maxillary extending to below posterior part of eye. Dorsal with

* Garman (*Mem. Mus. Comp. Zool.*, xxiv., 1899, p. 137) has described a fish from 16° N., 99° W., 660 fathoms, and has named it *Phucocœtes suspectus*. It is not a *Phucocœtes*, nor does it seem to be congeneric with any of the southern littoral forms.

about 100 rays, anal with about 80, caudal with 5 or 6. Origin of dorsal above base of pectoral; pectoral $\frac{3}{5}$, pelvics $\frac{1}{4}$ as long as head. Brownish; upper half of head dark brown, with a pale yellow band from eye to shoulder; lower part of head pale yellowish.

Falkland Islands.

Here described from two specimens, 65 and 110 mm. in total length, the latter the type of *L. flavus*. Four small examples were obtained by the *Scotia* at Station 118, Port Stanley, Falkland Islands.

8. *Crossolycus*, gen. nov.

Form elongate, compressed. Snout and lower jaw with fringes. Mouth subterminal; teeth in jaws conical, bi- or tri-serial; lower jaw with a posterior canine; palate toothless. Gill-opening almost entirely above base of pectoral. Dorsal origin above or a little in advance of base of pectoral; pelvic fins present.

(1) *Crossolycus chilensis*, sp. n.

Lycodes (Iluocœtes) fimbriatus (*non* Jenyns) Steind., *Zool. Jahrb.*, Suppl. iv., 1898, p. 322, pl. xx. fig. 10.

Depth of body equal to length of head, $6\frac{2}{3}$ in the length of the fish. Diameter of eye 7 in length of head and equal to interorbital width. Lips thick. Dorsal 80. Anal 60. Distance from head to origin of anal $1\frac{1}{2}$ the length of head. Pectoral $\frac{2}{3}$ as long as head. Head, body, and dorsal fin marbled with brown.

Chile, Cape Espiritu Santo.

Steindachner's specimen measured 252 mm.

(2) *Crossolycus fasciatus*.

Iluocœtes fimbriatus sub-sp. *fasciatus*, Lönnberg, *Swedish S. Polar Exped.*, *Fish.*, p. 20 (1905).

Depth of body $7\frac{1}{2}$ in the length, length of head 5. Diameter of eye $5\frac{2}{3}$ in the length of head and equal to interorbital width. Distance from head to origin of anal $1\frac{1}{3}$ the length of head. Pectoral a little more than $\frac{1}{2}$ the length of head. Dark brown, with 5 or 6 whitish transverse bars.

Falkland Islands.

Total length 74 mm.

A specimen of 60 mm. recorded by Lonnberg from Tierra del Fuego, uniform yellow in colour and differing somewhat in proportions, may belong to another species.

9. *Platea*, Steind., 1897.

Zool. Jahrb., Suppl. iv. p. 323.

Teeth in jaws uniserial, incisor-like; palate toothless. Snout and lower jaw with fringes. Gill-opening cleft downwards to middle of base of pectoral. Dorsal origin above anterior part of pectoral. Pelvic fins present.

Platea insignis.

Steind., *l.c.*, pl. xx. fig. 12.

Depth of body $14\frac{1}{2}$ in the length, length of head $7\frac{2}{5}$. Dorsal with about 100 rays, anal with about 90. Body with dark spots and bars.

Chile, Cape Espiritu Santo.

Total length 265 mm.

10. *Maynea*, Cunningham, 1870.

Trans. Linn. Soc., xxvii. p. 471.
Gymnelichthys, Fischer, *Jahrb. Hamburg Wiss. Anst.*, ii., 1885, p. 60.

Elongate, compressed. Mouth terminal; teeth conical, uniserial, in jaws and on vomer and palatines. Gill-opening cleft downwards to middle of base of pectoral. Dorsal origin just behind head. No pelvic fins.

(1) *Maynea patagonica.*

Cunningham, *l.c.*, p. 472; Günth., *Proc. Zool. Soc.*, 1881, p. 881, pl. ii. figs. C and D.

Depth of body 10 or 11 in the length, length of head $6\frac{2}{3}$ to $7\frac{1}{3}$. Diameter of eye 5 to 6 in length of head; interorbital region quite narrow. Maxillary extending to below anterior $\frac{1}{3}$ or middle of eye. About 120 rays in dorsal fin, 95 in anal, 8 in caudal. Origin of dorsal above base of pectoral, of anal $1\frac{2}{3}$ to $1\frac{4}{5}$ head-lengths behind head. Pectoral less than $\frac{1}{2}$ as long as head. Yellowish, with broad brown cross-bars separated by narrower interspaces.

Patagonia; Falkland Islands.

Here described from two specimens, the type from the Otter Islands, 150 mm. in total length, and an example of 90 mm. from the Magellan Straits.

(2) *Maynea antarctica.*

Gymnelichthys antarcticus, Fischer, *Jahrb. Hamburg Wiss. Anst.*, ii., 1885, p. 61, pl. ii. fig. 9.

Maxillary extending to below posterior margin of eye. About 97 rays in the dorsal, 74 in the anal; origin of latter only $1\frac{1}{3}$ head-lengths behind the head. No cross-bars.

South Georgia.

Total length 220 mm.

11. *Melanostigma*, Günth., 1881.

Proc. Zool. Soc., p. 21.

Compressed, elongate; skin loose, smooth, naked. Mouth terminal, oblique; teeth uniserial, in jaws and on vomer and palatines. Gill-opening small, above base of pectoral. Dorsal origin just behind head; no pelvic fins.

In addition to the species described below, this genus includes a few from deep waters of the North Atlantic and Pacific.

Melanostigma gelatinosum.

Günth., *l.c.*

Depth of body about 10 in the length, length of head 6. Diameter of eye $3\frac{1}{3}$ in length of head, interorbital width about 12. Maxillary extending to below middle of eye. Distance from head to origin of anal equal to length of head; pectoral nearly $\frac{1}{2}$ as long as head. Sides spotted and marbled with purplish grey; end of tail blackish; inside of mouth, gill-opening, and vent black.

Magellan Straits, 24 fathoms.

Here described from the type, a specimen of 140 mm.

III. A Monograph of the Nototheniiformes.

The division Nototheniiformes includes Percoids without pungent fin-spines, with the spinous dorsal, when developed, shorter than the long soft dorsal and anal, the

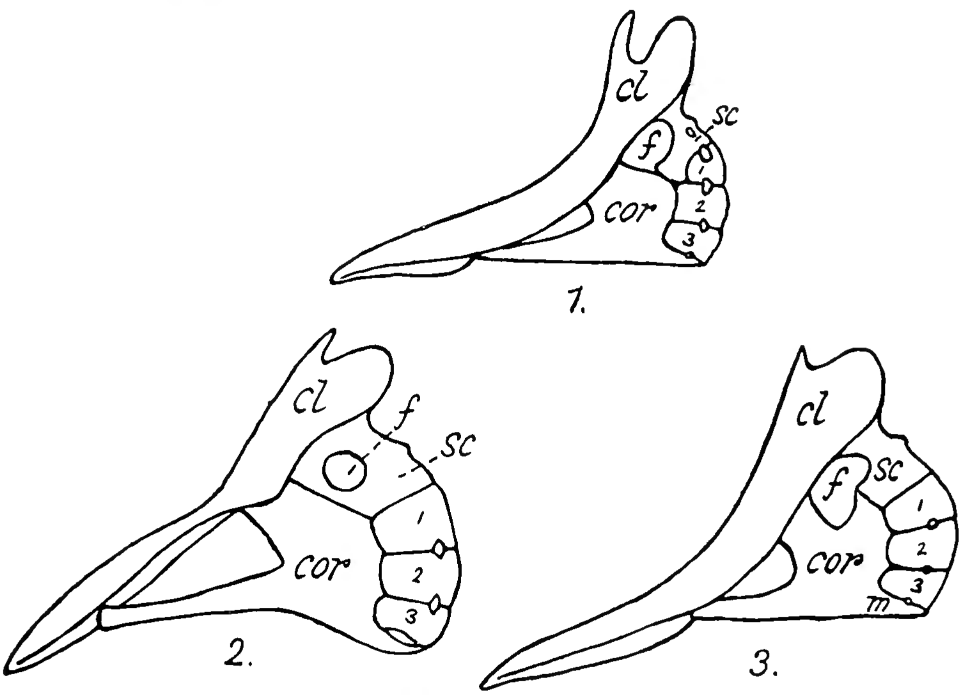


Fig. 3.—Pectoral fin-skeleton of 1, *Cottoperca gobio*; 2, *Trematomus newnesii*; and 3, *Notothenia coriiceps*. *cl*, cleithrum; *sc*, hypercoracoid (scapula); *f*, foramen; *cor*, hypocoracoid; *m*, metacoracoid process; 1, 2, 3, radials.

principal caudal rays reduced in number (usually 14), the pectorals typically broad-based and the pelvics jugular, separated by an interspace, and each formed of a spine and 5 branched rays. There is a single nostril on each side. The structure and position of the pectoral radials is highly characteristic; they are 3 in number, rather large flat plates; all or 2 are inserted on the hypocoracoid, and the lowest is the narrowest and has its lower edge in contact with the metacoracoid process. In other osteological characters the more generalised types are very similar to the Perciformes.

The group corresponds to the Nototheniidæ of BOULENGER and DOLLO, with the addition of *Pleuragramma*, which does not at all resemble *Leptoscopus*, and after the exclusion of *Centropercis*, evidently related to *Champsodon*, and of *Acanthaphritis* (*Pteropsaron*), which is related to *Hemerocates*. *Draconetta* is allied to the Callionymidæ, and its resemblances to *Harpagifer* are not due to affinity. As now restricted the Nototheniiformes are characteristic of and peculiar to the Antarctic seas

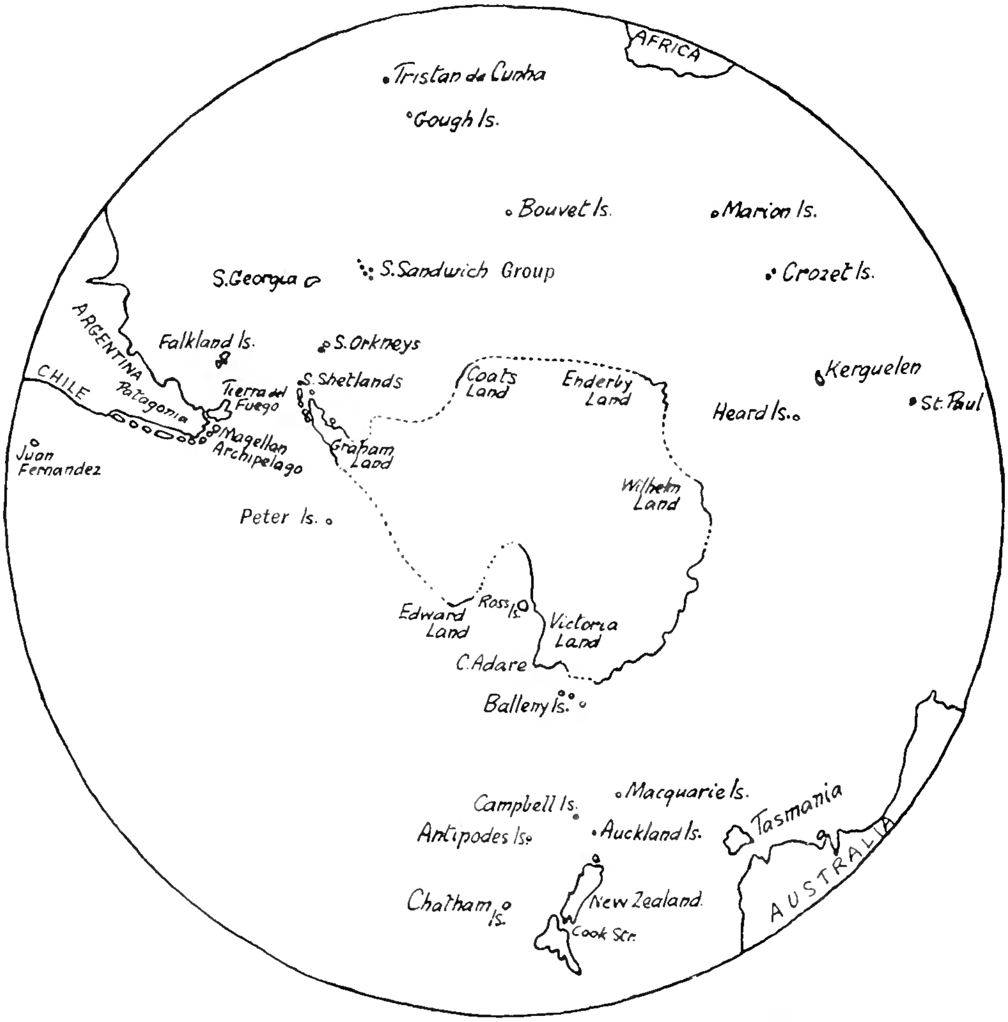


FIG. 4.—Map showing the localities where Nototheniiform Fishes have been collected.

and the region immediately to the north, ranging to S.E. Australia, New Zealand, Chile, Argentina, Tristan da Cunha, and St Paul Island.

There is every reason to suppose that the group has always been an Antarctic one, and seeing that it has become differentiated into four quite distinct families and into several genera, we may perhaps infer that there has been a large cold southern ocean throughout the greater part of the Tertiary period.

The group throws no light on the question of former extensions northward of the Antarctic Continent; at the present day there are littoral species common to Australia and New Zealand (*Bovichthys variegatus*), to New Zealand and South America (*Notothenia macrocephala*, *N. cornucola*), or to the Antarctic Continent and Kerguelen (*Notothenia coriiceps*, *Harpagifer bispinis*); and if under the existing conditions species may have this wide distribution, the fact that some are more restricted and are separated from the most nearly related forms by wide expanses of ocean can be explained without the theory of land-bridges.

Many of the more southern types appear to be circumpolar; for example, *Trematomus newnesii*, *T. borchgrevinkii*, *T. bernacchii*, *T. hansoni*, *T. loennbergii*, *Pleuragramma antarcticum*, *Notothenia coriiceps*.

With the exception of *Pseudaphritis urvillii* from the rivers of Tasmania and S.E. Australia the Nototheniiform fishes are marine, and the great majority of them are littoral; several have been described as frequenting the rocks and weeds, but others prefer deeper water, the species varying in this respect like the Cottids and Gobies of our northern seas. Fishes pertaining to four genera (*Bathydraco*, *Gerlachea*, *Racovitzaia*, *Cryodraco*) live in the open sea, and probably at some distance below the surface.

Most of the fishes of this group feed on crustaceans, molluscs, etc. (*cf.* LÖNNBERG, *Fish. Swedish South Polar Exped.*, p. 55), but *Gymnodraco* and the Chaenichthyidæ are no doubt piscivorous. According to LÖNNBERG (*l.c.*, p. 52) the breeding season varies, some species probably spawning in the spring, others in the summer, others in the autumn. The eggs are smaller in *Notothenia* and *Trematomus* than in *Artedidraco* and *Champsocephalus*; they are probably demersal in all, but certainly in the last two genera.

Synopsis of the Families.

I. One radial on hypercoracoid, two on hypocoracoid; gill-membranes separate, free from isthmus; teeth on vomer and palatines; mouth protractile; snout not produced; a spinous dorsal fin . . . . . 1. *Bovichthyidæ*.

II. All three radials on hypocoracoid; gill-membranes united, free or attached to isthmus, usually forming a fold across it; palate toothless.

A. Palatine and pterygoids normally developed.

Mouth protractile; snout not produced; a spinous dorsal fin 2. *Nototheniidæ*.

Mouth not protractile; snout produced; no spinous dorsal fin. 3. *Bathydraconidæ*.

B. Palatine in great part ligamentous; no mesopterygoid; mouth not protractile; snout produced and depressed . . . . 4. *Chænichthyidæ*.

Family 1. BOVICHTHYIDÆ.

This family includes Nototheniiformes more generalised than the rest in the presence of bands of cardiform or villiform teeth not only in the jaws, but on the vomer and palatines, and in the separate free gill-membranes. All other members of the group have the palate toothless and the gill-membranes united, or joined to the isthmus. The snout is not produced, the mouth is protractile, the lateral line is complete and continuous, and a spinous dorsal fin is present. The skeleton is well ossified; there are 2 radials on the hypocoracoid and 1 on the hypercoracoid (fig. 3, 1); the palatine and pterygoids are normally developed. The vertebræ number 38 to 42 (13–16 + 22–29); præcaudals with parapophyses from the fifth or sixth; ribs and epipleurals on parapophyses, when these are developed.

Littoral fishes, with one species in fresh water.

Three genera.

1. *Pseudaphritis*, Casteln., 1872.

Proc. Zool. Soc. Victoria, i. p. 72; Ogilby, *Proc. Linn. Soc. N.S. Wales*, xxii., 1897, p. 559.

Body subcylindrical, fully scaled. Head small, scaly, somewhat depressed, narrowed forward; interorbital region flat. Teeth in bands in jaws and on vomer and palatines; lower jaw projecting. Operculum normal, with a weak spine; gill-membranes not united, free from isthmus. Origin of spinous dorsal at some distance behind head; rays of all the fins branched.

S.E. Australia and Tasmania; fresh-water.

Pseudaphritis urvillii.

Aphritis urvillii, Cuv. and Val., *Hist. Nat. Poiss.*, viii. p. 484, pl. 243 (1831): Günth., *Cat. Fish.*, ii. p. 242 (1860).
Pseudaphritis bassii, Casteln., *l.c.*

Depth of body 5 to 6 in the length, length of head $3\frac{2}{3}$ to 4. Diameter of eye $5\frac{1}{2}$ to $7\frac{1}{2}$ in the length of head, interorbital width 8 to 12. Maxillary extending to below eye; about 10 short gill-rakers on lower part of anterior arch. Dorsal VII–VIII, 19–20. Anal 23–25. 60 to 65 scales in the lateral line. Body marbled; dorsal and caudal spotted.

Rivers from New South Wales to South Australia and Tasmania.

Here described from eight specimens, 100 to 240 mm. in total length, from South Australia, Victoria, and Tasmania.

2. *Cottoperca*, Steind., 1876.

Sitzungsb. Akad. Wien, lxxii. p. 66.

Head and body compressed, fully scaled. Head large; snout broad; interorbital region concave. Teeth in bands in jaws and on vomer and palatines; lower jaw somewhat the shorter. Operculum normal, with a weak spine; gill-membranes not united, free from isthmus. Spinous dorsal originating above operculum; rays of soft dorsal and anal unbranched; lower pectoral rays simple, more or less thickened and partly free distally.

Patagonia; Magellan Straits; Falkland Islands.

(1) *Cottoperca gobio.* (Pl. IV. fig. 3.)

Aphritis gobio, Günth., *Ann. Mag. Nat. Hist.* (3), vii., 1861, p. 88; and "*Challenger*" *Shore Fish.*, p. 21, pl. ix. (1880).

Cottoperca rosenbergii, Steind., *Sitzungsb. Akad. Wien*, lxxii., 1876, p. 67, pl. v. fig. 1.

Depth of body about 4 in the length, length of head about $2\frac{1}{2}$. Diameter of eye 4 to 8 in the length of head, interorbital width 13 to 16. Maxillary extending to below posterior part or posterior edge of eye; 5 or 6 short gill-rakers on lower part of anterior arch. Dorsal (VI) VII, 22–23. Anal 20–23. Dorsal spines and rays increasing in length with age, the longest varying from $\frac{1}{3}$ to $\frac{3}{4}$ the length of head. Pectoral about $\frac{1}{2}$ the length of head; six lowest rays simple, somewhat thickened. Caudal subtruncate. Least depth of caudal peduncle greater than the diameter of eye, except in quite young specimens. About 60 scales in a lateral longitudinal series, or 65 in the lateral line, which is complete and continuous. Orange-yellow, with three broad brownish cross-bars on upper part of body; head and sides of body spotted and marbled with brown.

Patagonia; Tierra del Fuego; Falkland Islands.

Here described from nine specimens, 130 to 480 mm. in total length, from Magellan and the Falklands, at depths varying from 6 to 147 fathoms, including the types of the species and a specimen from Station 349, Port William, Falkland Islands, taken by the *Scotia* in January 1903.

(2) *Cottoperca macrophthalma*, sp. n. (Pls. IV. fig. 2, and V. fig. 2.)

Depth of body 4 to 5 in the length, length of head (to opercular spine) $2\frac{2}{5}$ to $2\frac{2}{3}$. Diameter of eye $3\frac{1}{3}$ to 5 in the length of head, interorbital width 13 to 16. Maxillary extending to below posterior part or margin of eye, or a little beyond. 5 to 7 short gill-rakers on lower part of anterior arch. Dorsal VII (VIII), 21–24. Anal 20–22. In the young, first dorsal spine longest, $\frac{1}{3}$ the length of head and as long as soft rays; in the adult, fourth or fifth spine longest, sometimes $\frac{1}{2}$ the length of head; longest soft rays sometimes $\frac{3}{4}$ the length of head. Other fins, scales, coloration, etc., as in *C. gobio*. Least depth of caudal peduncle not more than diameter of eye.

Ten specimens from Station 346, the Burdwood Bank, south of the Falkland Islands, 54° 25′ S., 57° 32′ W., taken by the *Scotia* in 56 fathoms on 1st December 1903, and three from Magellan Straits, 100 to 450 mm. in total length.

(3) *Cottoperca macrocephala.*

Roule, *Bull. Mus. Paris*, 1911, p. 277 (1912).

Eye large. Head longer and fins lower than in *C. macrophthalma*. Seven simple pectoral rays. Patagonia.

3. *Bovichthys*, Cuv. and Val., 1831.

Hist. Nat. Poiss., viii. p. 486.

Differs from *Cottoperca* in the naked head and body, the abnormal operculum, which has a very strong spine and a superior process which articulates with the post-temporal, and in the enlarged and partly free posterior anal rays.

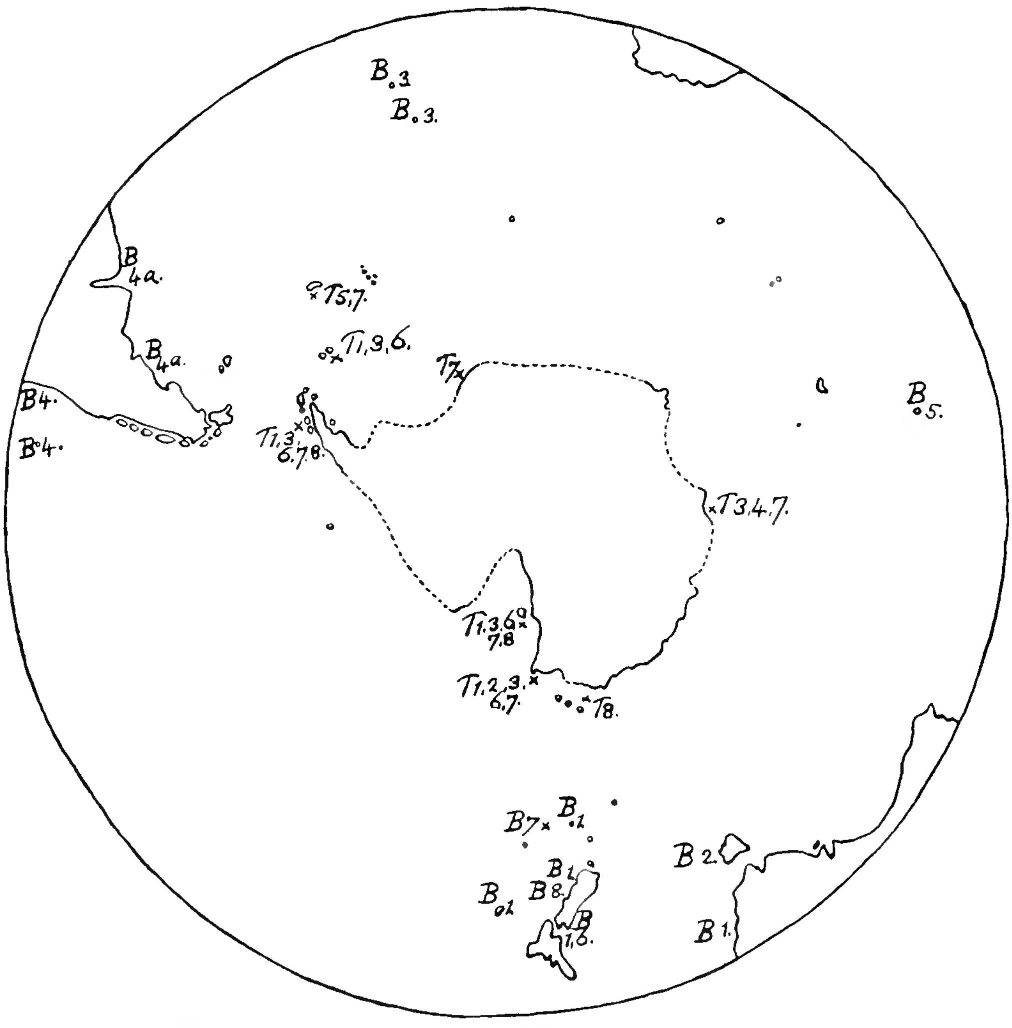


FIG. 5.—Distribution of *Bovichthys* and *Trematomus*, respectively the northernmost and southernmost Nototheniiform genera.

B = *Bovichthys*. 1. *B. variegatus*; 2. *B. angustifrons*; 3. *B. diacanthus*; 4. *B. chilensis*; 4*a*. *B.* sp.; 5. *B. veneris*; 6. *B. decipiens*; 7. *B. psychrolutes*; 8. *B. roseopictus*.

T = *Trematomus*. 1. *T. newnesii*; 2. *T. nicolai*; 3. *T. borchgrevinkii*; 4. *T. brachysoma*; 5. *T. vicarius*; 6. *T. bernacchii*; 7. *T. hansoni*; 8. *T. loennbergii*.

Note that in *Bovichthys* none, in *Trematomus* most, of the species appear to be circumpolar.

Chile; Argentina; Tristan da Cunha and Gough Island; St Paul; S.E. Australia and Tasmania; New Zealand and neighbouring islands.

Synopsis of the Species.

I. Interorbital region distinctly concave.

Interorbital width $\frac{1}{10}$, pectoral fin $\frac{3}{4}$ the length of head . 1. *variegatus.*

Interorbital width $\frac{1}{12}$ or $\frac{1}{13}$, pectoral fin $\frac{3}{5}$ the length of head . 2. *angustifrons.*

Interorbital width $\frac{1}{11}$, pectoral fin $\frac{5}{6}$ the length of head . 3. *diacanthus.*

II. Interorbital region nearly flat.

Interorbital width $\frac{1}{9}$ the length of head, pectoral fin $\frac{2}{3}$ . . . 4. *chilensis.*

Interorbital width more than $\frac{1}{2}$ the diameter of eye, which is $\frac{1}{4}$ the length of head; pectoral extending to vent . . . . 5. *veneris.*

Interorbital width $6\frac{1}{2}$ in length of head; pectoral extending well beyond origin of anal . . . . 6. *decipiens.*

Interorbital width 5 in length of head . . . 7. *psychrolutes.*

Interorbital width $3\frac{1}{3}$ in length of head . . . 8. *roseopictus.*

(1) *Bovichthys variegatus.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 56, pl. xxxiv. figs. 1–4 (1846); Günth., *Cat. Fish.*, ii. p. 250 (1860).

Depth of body 4 to 5 in the length, length of head $2\frac{3}{4}$ to 3. Diameter of eye 4 to $4\frac{1}{2}$ in the length of head, interorbital width 10. Interorbital region moderately concave; maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine equal to or less than diameter of eye; 8 gill-rakers on lower part of anterior arch. Dorsal VII–VIII, 18–20. Anal 14–15. Pectoral $\frac{3}{4}$ the length of head. Caudal subtruncate. Caudal peduncle longer than deep. Body with irregular dark cross-bars and usually with pale spots and vermiculations; spinous dorsal marbled, sometimes with a blackish blotch posteriorly; soft dorsal, caudal, and pectoral with series of dark spots; anal with a dark longitudinal band.

S.E. Australia; New Zealand and neighbouring islands.

Here described from six specimens, 75 to 200 mm. in total length, including the types of the species, from New South Wales (*Haslar*), New Zealand (*Otago Mus.*, *Hutton*), and Campbell Island (*Southern Cross*).

(2) *Bovichthys angustifrons*, sp. n. (Pl. IV. fig. 1.)

Depth of body $4\frac{2}{3}$ to 5 in the length, length of head $2\frac{3}{5}$ to $2\frac{3}{4}$. Diameter of eye 4 in the length of head, interorbital width 12 or 13. Interorbital region moderately concave; maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine nearly as long as diameter of eye; 8 gill-rakers on lower part of anterior arch. Dorsal VIII, 19. Anal 14. Pectoral $\frac{3}{5}$ the length of head. Caudal subtruncate. Caudal peduncle longer than deep. Dark spots on the head and blotches or bars on the body; soft dorsal and caudal with series of spots on the rays.

Here described from two specimens, 160 and 145 mm. in total length, the former from Tasmania (*Allport*), the latter without locality (*Chatham Museum*).

(3) *Bovichthys diacanthus.* (Pl. IX. fig. 5.)

Callionymus diacanthus, Carmich., *Trans. Linn. Soc.*, xii., 1818, p. 501, pl. xxvi.
Bovichthys diacanthus, Günth., *Cat. Fish.*, ii. p. 249 (1860).

Depth of body 5 in the length, length of head 3. Diameter of eye $4\frac{1}{3}$ in the length of head, interorbital width 11. Interorbital region concave; maxillary extending to below anterior $\frac{1}{4}$ of eye; opercular spine $\frac{3}{4}$ the diameter of eye; 9 gill-rakers on lower part of anterior arch. Dorsal VIII, 20. Anal 15. Pectoral $\frac{5}{6}$ the length of head. Caudal subtruncate. Caudal peduncle longer than deep.

Tristan da Cunha; Gough Island.

Here described from a specimen of 120 mm. obtained by the *Scotia* at Gough Island, shore.

The species was originally described from Tristan da Cunha, where it is said to be very common among the rocks and to attain a length of 7 inches. CARMICHAEL describes the colour as olive, with green blotches and white dots.

(4) *Bovichthys chilensis*, sp. n.

Bovichthys diacanthus (*non* Carmichael), Cuv. and Val., *Hist. Nat. Poiss.*, viii. p. 487, pl. 244 (1831); Steind., *Zool. Jahrb.*, Suppl. iv., 1897–8, p. 300, pl. xx. fig. 1.

Depth of body 5 in the length, length of head 3 to $3\frac{1}{3}$. Diameter of eye $4\frac{1}{4}$ to $4\frac{1}{2}$ in the length of head, interorbital width 9. Interorbital space nearly flat; maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine as long as or shorter than eye; 8 gill-rakers on lower part of anterior arch. Dorsal VIII, 21. Anal 14–16. Pectoral $\frac{2}{3}$ the length of head. Caudal truncate. Caudal peduncle longer than deep. Body marbled; spinous dorsal dusky, with a dark blotch posteriorly; soft dorsal with 2 or 3 series of dark spots; caudal dusky with orange posterior margin; lower fins orange, more or less spotted.

Chile; Juan Fernandez.

Here described from two specimens from Chile (*Delfin*), 92 and 96 mm. in total length.

BERG (*Ann. Mus. Buenos Aires*, ii., 1897, p. 298) has recorded a species of *Bovichthys* from Argentina as *Bovichthys diacanthus*. This may prove to be *B. chilensis*; more probably it is a new species, as yet undescribed.

(5) *Bovichthys veneris.*

Bovichthys psychrolutes (*non* Günth.), Kner, *Novara Fische*, p. 128, pl. vi. (1869).
,, *veneris*, Sauvage, *Arch. Zool. Exp.*, viii., 1879, p. 25.

Depth of body 5 in the length, length of head about $3\frac{1}{2}$. Diameter of eye 4 in the length of head. Interorbital region only slightly concave, its width rather more than $\frac{1}{2}$ the diameter of eye. Maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine $\frac{2}{3}$ the diameter of eye. Dorsal VIII, 19–20. Anal 14–15. Pectoral $\frac{4}{5}$ or $\frac{5}{6}$ the length of head. Caudal rounded or subtruncate. Caudal peduncle longer than deep.

Island of St Paul.

KNER's and SAUVAGE's descriptions are based on specimens of 9 or 10 inches.

(6) *Bovichthys decipiens*, sp. n. (Pl. IX. fig. 1.)

Depth of body 4 in the length, length of head $2\frac{3}{4}$. Diameter of eye $3\frac{1}{2}$ in the length of head, interorbital width $6\frac{1}{2}$. Interorbital space nearly flat; maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine a little shorter than eye; 8 gill-rakers on lower part of anterior arch. Dorsal VIII, 19. Anal 14. Pectoral $\frac{4}{5}$ the length of head. Caudal peduncle longer than deep. Body with cross-bars; spinous dorsal with a blotch posteriorly; dorsal and pectoral with series of spots; caudal barred.

A specimen of 41 mm. from Cook's Straits (*Hector*) is very similar in appearance to *B. variegatus*.

(7) *Bovichthys psychrolutes*.

Günth., *Cat. Fish.*, ii. p. 250 (1860).

Depth of body 4 in the length, length of head 3. Diameter of eye $3\frac{1}{2}$ in the length of head, interorbital width 5. Interorbital region nearly flat; maxillary extending to below anterior $\frac{1}{3}$ of eye; opercular spine as long as eye; 8 gill-rakers on lower part of anterior arch. Dorsal VIII, 20. Anal 14. Pectoral $\frac{4}{5}$ the length of head. Caudal subtruncate. Caudal peduncle longer than deep. Bluish-olive; fins pale.

Here described from the type, a specimen 38 mm. in total length, from S.W. of the Antipodes Islands (50° S., 170° W.).

(8) *Bovichthys roseopictus*.

Hutton, *Trans. N. Zeal. Inst.*, xxxvi., 1903, art. ix.

Depth of body $5\frac{1}{2}$, length of head $4\frac{1}{2}$ in total length. Diameter of eye 3 in length of head, interorbital width $3\frac{1}{3}$. Top of head smooth, with two small ridges. Dorsal VIII, 18 (?). Anal 13 (?). Pectoral as long as head. Caudal apparently truncated. Back dark olivaceous brown, sides and abdomen silvery; a pink spot at base of operculum and 5 bright rose-pink bands on each side.

New Zealand; known from a single specimen of 46 mm. picked up on the beach at Sumner, Canterbury.

Family 2. NOTOTHENIIDÆ.

Differ from the Bovichthyidæ in the toothless palate, the united gill-membranes, and in having all 3 radials on the hypocoracoid (fig. 3, 2 and 3). Vertebræ 45–56 (16–20 + 25–35).

In the typical genera the skeleton is well ossified, and the rather strong ribs and epipleurals are inserted on well-developed parapophyses, or only the first one or two are sessile. In *Pleuragramma* the skeleton is weak, with the bones thin and papery.

the vertebral centra are thin cylinders of bone, parapophyses are developed on the posterior præcaudals only, and the ribs and epipleurals are feeble.

Synopsis of the Genera.

I. Body scaly; gill-membranes forming a fold across the isthmus; opercles normal.
  A. Hypercoracoid enclosing its foramen.
    Lateral line scales with tubules or pits . . . . 1. *Trematomus.*
    Lateral line scales merely notched. . . . . 2. *Pleuragramma.*
  B. Foramen partly bordered by hypocoracoid.
    1. Two or three lateral lines; maxillary usually extending to below eye: pectoral rounded or vertically truncated.
      Teeth in bands . . . . 3. *Notothenia.*
      Teeth uniserial . . . . 4. *Dissostichus.*
    2. One lateral line; maxillary not reaching eye in the adult fish; pectoral very obliquely truncated, the upper rays longest . 5. *Eleginops.*

II. Body naked; gill-membranes broadly united to isthmus; operculum hooked upwards posteriorly, its upper edge deeply concave; foramen partly bordered by hypocoracoid.
  A mental barbel; opercles not spinate . . . . . 6. *Artedidraco.*
  No barbel; operculum and suboperculum each forming a strong spine. 7. *Harpagifer.*

1. *Trematomus*, Bouleng., 1902.

"*Southern Cross*" *Pisces*, p. 177.

Body scaly; 2 lateral lines with tubular or pitted scales. Mouth moderate or rather large; jaws with bands of villiform teeth. Gill-membranes united, free or forming a free fold across isthmus. Skeleton well ossified; vertebræ 52–56 (17–21 + 32–35); most of the præcaudals with parapophyses to which the ribs and epipleurals are attached; hypercoracoid enclosing its foramen (fig. 3, 2). A spinous dorsal fin: pectoral rounded or sub-vertically truncated.

Coasts of the Antarctic Continent; South Orkneys and South Georgia (fig. 5, p. 336).

The difference between *Notothenia*, with the hypocoracoid bordering the foramen, and *Trematomus*, with the foramen enclosed in the hypercoracoid, may not be very important, and PAPPENHEIM believed that he found both conditions in one species (*Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 166, figs.); but this seems to have been an error, the specimen with perforate hypercoracoid being *Trematomus hansoni* and not *Notothenia lepidorhinus*. PAPPENHEIM (*t.c.*, p. 170) states that *T. bernacchii* is a *Notothenia* in the structure of its pectoral arch: I have examined a large series of specimens, and find that the hypercoracoid encloses its foramen in all.

Synopsis of the Species.

I. Upper surface of head naked.

A. Cheeks and opercles fully scaled.

Interorbital width $3\frac{1}{3}$ to 5 in length of head. D VI–VIII, 32–38. A 32–36 . . . . 1. *newnesii.*

Interorbital width 8 or 9 in length of head. D IV, 37. A 32–33. . . . 2. *nicolai.*

B. Cheeks and opercles scaly above, naked below; interorbital width 3 to $5\frac{1}{2}$ in length of head.

D V–VI, 34–37. A 31–33 . . . . 3. *borchgrevinkii.*

D IV–V, 30–33. A 29–30 . . . . 4. *brachysoma.*

II. Occiput scaly.

A. Interorbital region naked, or not fully scaled. D IV–VI, 33–38. A 31–35.

Diameter of eye $4\frac{3}{5}$ in length of head, interorbital width about 5 (in a specimen of about 270 mm.); 55 to 59 scales in a longitudinal series . . . . 5. *vicarius.*

Diameter of eye 3 to $4\frac{1}{3}$ in length of head, interorbital width 5 to 9 (in specimens up to 340 mm.); 60 to 75 scales in a longitudinal series . . . . 6. *bernacchii.*

B. Interorbital region fully scaled; width 5 to 10 in length of head.

D V–VII, 36–41. A 33–36 . . . . 7. *hansoni.*

D V–VI, 33–34. A 31–33 . . . . 8. *loennbergii.*

(1) *Trematomus newnesii.*

Bouleng., "*Southern Cross*" *Pisces*, p. 177, pl. xi. (1902).

Notothenia cyaneobrancha, Vaill., *Expéd. Antarct. Française, Poiss.*, p. 26 (1906).

„ *microlepidota*, Vaill., *t.c.*, p. 35.

„ *hodgsoni*, Bouleng., *Nat. Antarctic Exped., Nat. Hist.*, ii., *Fish.*, p. 2, pl. i. fig. 2 (1907).

Depth of body 4 to $5\frac{1}{2}$ in the length, length of head $3\frac{1}{4}$ to $4\frac{1}{4}$. Diameter of eye 3 to $4\frac{1}{3}$ in the length of head, interorbital width $3\frac{1}{3}$ to 5. Maxillary extending to below anterior part or middle of eye (young) or beyond (adult); upper surface of head naked, cheeks and opercles scaly; 15 to 20 gill-rakers on lower part of anterior arch. Dorsal VI–VIII, 32–38. Anal 32–36. Pectoral $\frac{3}{4}$ the length of head or more, longer than pelvics, which reach the vent in the young, but not in the adult. Caudal truncate. Caudal peduncle about as long as deep. 68 to 86 scales in a longitudinal series from above base of pectoral fin to caudal, 40 to 52 in upper lateral line, which ends below posterior rays of dorsal, 3 to 19 in lower lateral line. Brownish, usually spotted or marbled or with irregular cross-bars; spinous dorsal blackish; other fins dusky, often with small dark spots.

Here described from a large series of specimens, 50 to 200 mm. in total length, including the types of the species and of *N. hodgsoni*. The types came from Duke of

York Island, near Cape Adare, 3 to 5 fathoms, and Cape Adare, 4 to 8 fathoms; those of *N. hodgsoni* from the *Discovery* winter quarters, Ross Island. The *Scotia* specimens are all from Station 325, Scotia Bay, South Orkneys; others in the British Museum are from the South Shetlands.

(2) *Trematomus nicolai.*

Notothenia nicolai, Bouleng., "*Southern Cross*" *Pisces*, p. 184, pl. xv. (1902).

Depth of body nearly 4 in the length, length of head $3\frac{1}{3}$ to $3\frac{1}{2}$. Diameter of eye 3 to $3\frac{1}{3}$ in the length of head, interorbital width 8 to 9. Maxillary extending to below anterior $\frac{1}{4}$ or $\frac{1}{3}$ of eye; upper surface of head naked; cheeks and opercles scaly; 11 or 12 gill-rakers on lower part of anterior arch. Dorsal IV, 37. Anal 32–33. Pectoral $\frac{3}{4}$ to $\frac{4}{5}$ length of head, somewhat longer than pelvics, which reach vent or origin of anal. Caudal rounded. Caudal peduncle nearly as long as deep. 58 to 62 scales in a longitudinal series from above base of pectoral fin to caudal, 39 to 43 in upper lateral line, which ends below posterior rays of dorsal, 8 to 18 in lower lateral line. Brownish, with dark cross-bars and sometimes with small dark spots; fins dusky. Victoria Land.

Here described from the types, three specimens 150 to 250 mm. in total length, from Cape Adare, 5 to 8 fathoms, and Duke of York Island, near Cape Adare, 4 fathoms.

The pectoral arch of this species is exactly similar to that of the closely related *T. newnesii*, as figured on p. 331.

(3) *Trematomus borchgrevinkii.*

Bouleng., "*Southern Cross*" *Pisces*, p. 179, pl. xii. (1902); Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 171 (1912).

Depth of body 4 to 5 in the length, length of head $3\frac{1}{2}$ to $4\frac{1}{4}$. Diameter of eye 4 to 5 in length of head, interorbital width 3 to 4. Maxillary extending to below anterior $\frac{1}{3}$ of eye; upper surface of head naked; upper parts of cheeks and opercles scaly; 16 to 19 gill-rakers on lower part of anterior arch. Dorsal V–VI, 34–37. Anal 31–33. Pectoral $\frac{3}{4}$ to $\frac{7}{8}$ the length of head, longer than pelvics, which rarely reach the vent. Caudal rounded or subtruncate. Caudal peduncle as long as deep, or deeper than long. 78 to 96 scales in a longitudinal series from above base of pectoral fin to caudal; lateral lines vestigial, without or with only a few tubules. Yellowish, with dark spots or irregular cross-bars; dorsal and caudal sometimes with series of spots.

Graham Land and neighbouring islands; Wilhelm Land; Victoria Land.

Here described from several specimens, 180 to 270 mm. in total length, including the types of the species, from Cape Adare and Duke of York Island, near Cape Adare (*Southern Cross*), and examples from the *Discovery* winter quarters, Ross Island. A specimen of 80 mm. was obtained in March 1903 by the *Scotia*, at Station 325, in Scotia Bay, South Orkneys; depth 10 to 15 fathoms.

(4) *Trematomus brachysoma.*

Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 172 (1912).

Depth of body $4\frac{1}{10}$ to $4\frac{7}{8}$ in the length, length of head 3 to $3\frac{2}{5}$. Diameter of eye $3\frac{2}{5}$ to $3\frac{3}{4}$ in the length of head, interorbital width 4 to $5\frac{1}{2}$. Maxillary extending to below anterior part or middle of eye; upper surface of head naked; upper parts of cheeks and opercles sealy; 16 to 19 gill-rakers on lower part of anterior arch. Dorsal IV–V, 30–33. Anal 26–30. Caudal rounded. Caudal peduncle a little deeper than long. 65 to 75 scales in a longitudinal series. Yellowish brown; head and back dark; a series of 6 dark spots from operculum to caudal, and 5 below them at level of base of pectoral; a dark spot at tip of spinous dorsal; soft dorsal with irregular dark cross-bars.

Wilhelm Land.

Total length 93 to 166 mm.

(5) *Trematomus vicarius.*

Trematomus bernacchii subsp. *vicarius*, Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 26 (1905).
?*Notothenia dubia*, Lönnberg, *t.c.*, p. 28, pl. iii. fig. 9.

Depth of body $3\frac{1}{2}$ in the length, length of head $3\frac{1}{3}$. Diameter of eye $4\frac{3}{5}$ in length of head, interorbital width about 5. Maxillary extending to below anterior $\frac{1}{3}$ of eye;

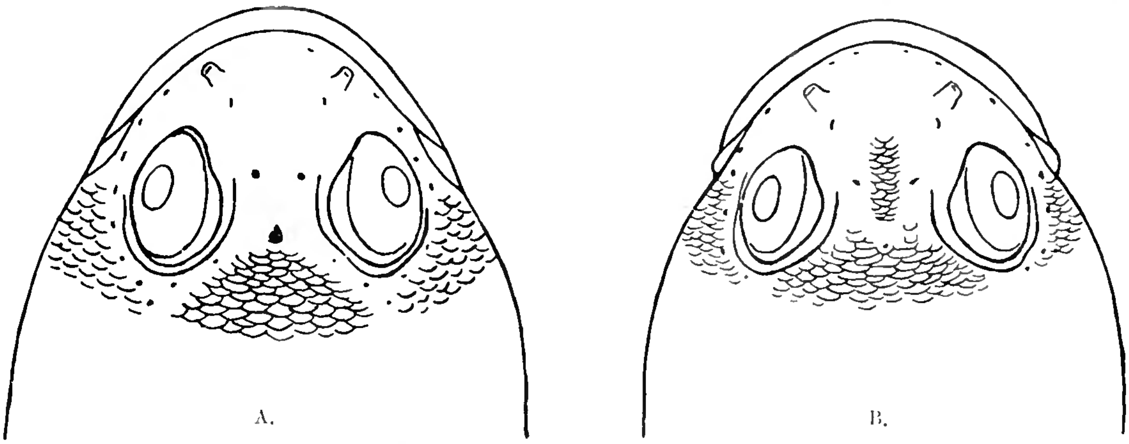


Fig. 6.—Head seen from above of A, *Trematomus bernacchii*, and B, *T. vicarius*.

cheeks, opercles, and occiput sealy; anterior part of interorbital region sealy in the middle; about 12 gill-rakers on lower part of anterior arch. Dorsal V, 33. Anal 31. Pectorals $\frac{3}{4}$, pelvics $\frac{4}{5}$ the length of head. Caudal rounded. Caudal peduncle much deeper than long. 56 to 59 scales in a longitudinal series, 34 in upper lateral line; lower lateral line without tubules.

South Georgia.

Lönnberg's description is based on a single specimen, 240 mm. in length to base of caudal fin.

Dr Lönnberg has kindly sent me a sketch of the upper surface of the head of the type, which is here reproduced, together with a figure of the head of a specimen of

T. bernacchii of the same size. After comparing the type with examples of *T. bernacchii* that I sent him, Dr LÖNNBERG writes that the caudal peduncle is notably deeper and that the scales are larger.

Dr LÖNNBERG has also sent me one of the types of *N. dubia* for examination. The specimen is 50 mm. in total length, and is a *Trematomus*, with the head scaled as in *T. bernacchii*, but with a smaller eye ($3\frac{2}{3}$ in the length of head) and broader interorbital region ($6\frac{1}{2}$ in the length of head) than young examples of that species. I count Dorsal V, 37. Anal 32. 55 scales in a longitudinal series, 30 in the lateral line. 13 gill-rakers on the lower part of anterior arch. It seems probable that this may be a young example of *T. vicarius*, although the interorbital region is scaleless.

(6) *Trematomus bernacchii.*

Bouleng., "*Southern Cross*" *Pisces*, p. 181, pl. xiv. (1902).
Notothenia elegans, Vaill., *Expéd. Antarct. Française, Poiss.*, p. 28 (1906).

Depth of body 3 to $4\frac{1}{2}$ in the length, length of head $3\frac{1}{3}$ to 4. Diameter of eye 3 to $4\frac{1}{3}$ in the length of head, interorbital width 5 to 9. Maxillary extending to below anterior part or middle of eye; occiput, cheeks, and opercles scaly; interorbital region naked or with a median series of scales; 13 to 15 gill-rakers on lower part of anterior arch. Dorsal IV–VI, 34–38. Anal 31–35. Pectoral about $\frac{2}{3}$ the length of head; pelvics just reaching anal in young, but not in adult. Caudal rounded. Caudal peduncle deeper than long. 60 to 75 scales in a longitudinal series from above base of pectoral fin to caudal, 30 to 42 in upper lateral line; lower lateral line usually without tubules. Large dark spots in 2 or 3 alternating series; upper $\frac{1}{2}$ of spinous dorsal blackish.

Graham Land and neighbouring islands; Victoria Land.

Here described from several specimens, 90 to 340 mm. in total length, including the types of the species from Cape Adare, 5 to 8 fathoms, and Duke of York Island, near Cape Adare, 3 to 4 fathoms (*Southern Cross*), examples from the *Discovery* winter quarters, Ross Island, and two from Station 325, Scotia Bay, South Orkneys, collected by the *Scotia*.

In this species the interorbital region seems to be always scaleless in the young, and is often so in the adult fish.

(7) *Trematomus hansoni.*

Bouleng., "*Southern Cross*" *Pisces*, p. 180, pl. xiii. (1902).
Trematomus hansoni subsp. *georgianus*, Lönnberg, *Swedish South Polar Exped., Fish.*, p. 25, pl. v. fig. 17 (1905).
Notothenia sima, Vaill., *Expéd. Antarct. Française, Poiss.*, p. 23 (1906).
„ *lepidorhinus* (part.), Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 169 (1912).

Depth of body $3\frac{1}{2}$ to $4\frac{2}{3}$ in the length, length of head $3\frac{1}{2}$ to 4. Diameter of eye $3\frac{2}{3}$ to 5 in the length of head, interorbital width 5 to $6\frac{1}{2}$. Maxillary extending to below anterior part or middle of eye; occiput, interorbital region, cheeks, and opercles scaly; 13 to 16 gill-rakers on lower part of anterior arch. Dorsal V–VII, 36–41. Anal 33–36. Pectoral $\frac{3}{4}$ to $\frac{7}{8}$ the length of head, longer than pelvics, which do not reach the vent. Caudal subtruncate. Caudal peduncle about as long as deep. 60 to 68 scales in a longitudinal series from above base of pectoral fin to caudal, 38 to 46 in upper lateral line; lower lateral line usually without tubules. Brownish, with large dark spots or cross-bars; head often spotted; fins usually barred with series of dark spots.

South Georgia; Graham Land; Coats Land; Wilhelm Land; Victoria Land.

Here described from several specimens, 160 to 380 mm. in total length, including the types of the species, from Cape Adare, 4 to 8 fathoms, and Duke of York Island, near Cape Adare, 3 to 4 fathoms (*Southern Cross*), examples from the *Discovery* winter quarters, Ross Island, and three from Coats Land, Station 411, 74° 01′ S., 22° 00′ W., 161 fathoms; temperature 28·9° F.; trap; March 1904.

Dr Lönnberg's supposed subspecies from South Georgia is fully identical with the typical form. He gives the number of anal rays as (31) 32–33, but the figure shows 36, and in an example that he has kindly sent me I count 35. There is no difference in the shape of the pectoral.

Dr Pappenheim has kindly sent me for examination the smallest specimen of his *N. lepidorhinus*, 160 mm. in total length, which he has noticed as differing from the types in the larger number of dorsal rays (38 instead of 32 or 33). It differs also in the naked snout and præorbital, shorter pelvic fins, lower lateral line without tubules, foramen enclosed in the hypercoracoid, etc., and is in every way similar to one of the types of *T. hansoni*, with which I have compared it.

(8) *Trematomus loennbergii*, sp. n. (Pl. VIII. fig. 4.)

Depth of body $4\frac{2}{3}$ to 5 in length, length of head 3 to $3\frac{3}{4}$. Diameter of eye 3 to $4\frac{1}{4}$ in the length of head, interorbital width 7 to 10. Maxillary extending to below anterior $\frac{1}{4}$ of eye; upper surface of head to nostrils, cheeks, and opercles scaly; 13 gill-rakers on lower part of anterior arch. Dorsal V–VI, 33–34. Anal 31–33. Pectoral as long as or a little shorter than head; pelvics extending to origin of anal or beyond. Caudal rounded. Caudal peduncle longer than deep. 60 to 70 scales in a longitudinal series from above pectoral fin to caudal; 36 to 42 in upper lateral line, which ends below posterior rays of dorsal; lower lateral line without tubules.

Victoria Land, Graham Land, and neighbouring islands.

Here described from three specimens, two from the *Discovery* collection—the larger, 132 mm. in total length, from south-west of the Balleny Islands, 254 fathoms; the smaller, 65 mm., in total length, from Tent Island, near Ross Island. The third example, also about 65 mm., is from Seymour Island, and has been sent to me for examination by Dr Lönnberg, who has recorded this species as *Notothenia nicolai*

(*Swedish South Polar Exped., Fish.*, p. 45). I have named the species after Dr LÖNNBERG in recognition of his kindness in sending me this and other specimens.

2. *Pleuragramma*, Bouleng., 1902.

"*Southern Cross*" *Pisces*, p. 187 (1902).

Closely related to *Trematomus*, differing especially in the very thin cycloid scales, the absence of pitted or tubular lateral line scales, and the feebly ossified skeleton, with parapophyses developed only on the posterior præcaudal vertebræ.

Coasts of the Antarctic Continent.

BOULENGER has placed this genus in the family Leptoscopidæ, but it has no affinity with *Leptoscopus*, and, on the other hand, is very near to *Trematomus*. A comparison of *Pleuragramma antarcticum* with *Trematomus newnesii* shows a very close agreement in external and internal characters, even to the number of fin-rays and vertebræ; the pectoral arch is precisely similar. In *Pleuragramma* the two lateral lines are marked by scales with notched posterior edges, or, if the scales have been lost, by series of pores.

Pleuragramma antarcticum.

Bouleng., *l.c.*, pl. xviii.; Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 48 (1906); Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 164.

Depth of body 5 to 6 in the length, length of head $3\frac{1}{2}$ to 4. Diameter of eye $3\frac{1}{4}$ to $3\frac{3}{4}$ in the length of head, interorbital width 5 to 6. Lower jaw projecting; maxillary extending to below anterior $\frac{1}{3}$ of eye; upper surface of head naked; cheeks and opercles scaly; 20 to 25 gill-rakers on lower part of anterior arch. Dorsal VI–VII, 34–37. Anal 36–38. Pectoral truncated, $\frac{1}{2}$ to $\frac{3}{5}$ length of head. Caudal slightly emarginate. About 55 scales in a lateral longitudinal series. Silvery, back darker; sides and back powdered with blackish dots.

Graham Land; Wilhelm Land; Victoria Land.

Here described from several specimens, 150 to 200 mm. in total length, including the types of the species from Victoria Land (*Southern Cross*) and examples from near Cape Armitage, Ross Island, and from south-west of the Balleny Islands (*Discovery*). VAILLANT gives D V, 39; A 38; Sq. 44, for specimens from Graham Land; and PAPPENHEIM, D V–VIII, 34–38; A 36–38; Sq. 56–60, for examples from Wilhelm Land.

3. *Notothenia*, Richards., 1844.

"*Erebus*" *and* "*Terror*" *Fish.*, p. 5; Günth., *Cat. Fish.*, ii. p. 260 (1860).
Macronotothen, Gill, *Proc. Acad. Philad.*, 1861, p. 521.

Differs from *Trematomus* only in that the hypercoracoid foramen is margined below by the hypocoracoid (fig. 3, 3, p. 331).

Coasts of the Antarctic Continent and northwards to Patagonia, the Falkland

Islands, South Sandwich Islands, Marion Islands, Kerguelen, southern New Zealand, and Chatham Islands.

Although the interorbital region is relatively broader in the larger fish, its width, compared with the length of the head, is an important specific character. By the "interorbital width" is here understood the actual width of the osseous interorbital space; this is nearly always less, and when narrow proportionately much less, than the interorbital width as measured by BOULENGER.

Synopsis of the Species.

I. Opercles fully scaled.

A. Upper surface and sides of head scaly, except snout and præorbital; interorbital width $\frac{1}{5}$ the length of head, or more.

1. Upper lateral line of 62 to 65 tubular scales; D VI, 32–34. A. 30–32.

3 lateral lines . . . . 1. *trigramma.*

2 lateral lines . . . . 2. *canina.*

2. Upper lateral line of 40 to 55 tubular scales. D V–VII, 32–37. A 31–35.

a. 21 to 25 gill-rakers on lower part of anterior arch. D VII (VIII), 34–36. A. 32–34 . . . . 3. *ramsayi.*

b. 14 to 19 gill-rakers on lower part of anterior arch.

α. Upper lateral line not or scarcely extending beyond end of dorsal fin; diameter of eye $4\frac{1}{4}$ to 6 in length of head (in specimens up to 250 mm.). D VI–VII, 32–34. A. 31–34 4. *tesselata.*

β. Upper lateral line nearly reaching caudal fin.

D VI–VII, 33–36. A 32–34. 16 to 19 gill-rakers on lower part of anterior arch. Eye $3\frac{4}{5}$ to $4\frac{2}{3}$ in length of head (in specimens of 125 to 250 mm.) . . . . 5. *wiltoni.*

D V (VI), 35–37. A 32–35. 16 to 19 gill-rakers on lower part of anterior arch. Eye 4 to $4\frac{1}{2}$ in length of head (in specimens of 90 to 180 mm.) . . . 6. *brevicauda.*

D V–VI, 34–35. A 32–34. 14 or 15 gill-rakers on lower part of anterior arch. Eye 3 to $3\frac{1}{2}$ in length of head (in specimens of 130 to 180 mm.) 7. *longipes.*

3. Upper lateral line of 30 to 35 tubular scales; D V–VI, 28–31. A 27–30. . . . . 8. *sima.*

B. Upper surface and sides of head scaly, including præorbital (and snout also except in *N. scotti*).

1. Interorbital width 6 in length of head; D VI–VII, 32–33. A 35–36. 9. *lepidorhinus.*

2. Interorbital width 9 to 13 in length of head.

D IV–V, 36–37. A 32 . . . . 10. *squamifrons.*

D VI, 37–39. A 38 . . . . 11. *larseni.*

D V, 33. A 31 . . . . 12. *scotti.*

C. Upper surface and sides of head scaly (except in *N. nudifrons*); præorbital naked; interorbital width $\frac{1}{10}$ the length of head, or less.

1. Lower lateral line of 32 to 41 tubular scales; D VII–VIII, 31–33. A 31–33 . . . . 13. *gibberifrons*.
2. Lower lateral line of 15 to 18 tubular scales; D VI–VII, 28–30. A 28–31. . . . 14. *acuta*.
3. Lower lateral line without tubular scales.

Upper surface of head scaly. D VII, 32. A 32 . . . 15. *vaillanti*.
Upper surface of head scaly. D IV–V, 35–37. A 33–35 . . 16. *mizops*.
Upper surface of head naked. D IV–VI, 37–39. A 34–36 . 17. *nudifrons*.

II. Opercles scaly above, naked below; upper surface of head scaly.

Interorbital width 10 in length of head. D VII, 29. A 27 18. *marionensis*.
Interorbital width 20 in length of head. D V–VI, 29–30. A 30–31. . . . 19. *angustifrons*.

III. Opercles scaled only on upper part of operculum; upper surface of head naked.

A. Anal of 27–33 rays.

a. Interorbital width 12 in length of head. D VI, 33. A 31. . . . . 20. *elegans*.

b. Interorbital width 4 to 7 in length of head.

Cheek usually scaly behind eye. D IV–VI, 31–34. A 27–31 21. *cornucola*.
Cheek scaly below and behind eye, its lower $\frac{1}{2}$ (young) or $\frac{1}{4}$ (adult) naked. D IV–VI, 33–36. A 30–33 . . . . . . 22. *cyaneobrancha*.
Cheek scaly behind eye. D III–VII, 35–41. A 27–31 . 23. *coriiceps*.

c. Interorbital width $3\frac{1}{2}$ in length of head. D VI–VII, 33–35. A 27–29. . . . 24. *rossii*.

B. Anal of 22 to 25 rays; interorbital width $2\frac{1}{2}$ to $4\frac{1}{2}$ in length of head.

D IV, 29–31. 48 to 56 scales in a lateral longitudinal series. . . . 25. *macrocephala*.
D VI–VII, 28–29. 52 to 58 scales in a lateral longitudinal series. . . . 26. *microlepidota*.
D VI–VIII, 26–27. 84 to 92 scales in a lateral longitudinal series 27. *colbecki*.

C. Anal of 18 to 20 rays; interorbital width about 4 in length of head. . . . 28. *filholi*.

(1) *Notothenia trigramma*, sp. n. (Pl. VI. fig. 2.)

Depth of body 5 in the length, length of head 4. Diameter of eye 5 in the length of head and equal to the interorbital width. Lower jaw projecting; maxillary extending to below anterior $\frac{1}{3}$ of eye; upper surface of head, except snout, cheeks and opercles scaly; 15 gill-rakers on lower part of anterior arch. Dorsal VI, 34. Anal 32. Pectoral longer than pelvics, $\frac{2}{3}$ as long as head, extending to above anal. Caudal rounded. About 85 scales in a lateral longitudinal series, 65 in upper lateral line, which nearly reaches caudal, 13 in line on middle of tail, and 40 to 45 in a third lower lateral line, which is separated by 4 or 5 longitudinal series of scales from the base of the anal fin. Brownish; fins darker.

Port Stanley, Falklands.

Total length 280 mm.

I was at first inclined to make this species the type of a new genus, but on examining related species of *Notothenia* I found a specimen of *N. brevicauda* with a third lateral line on one side only, formed of 10 tubular scales and separated from the posterior part of the anal fin by 3 series of scales.

(2) *Notothenia canina.*

Smitt, *Bih. Sv. Vet.-Akad. Handl.*, xxiii., iv., No. 3, p. 32, pl. ii. fig. 22 (1897).

Evidently closely related to *N. tesselata*, but the outer series of teeth stronger, spaced, more canine-like, and the upper lateral line with 62 to 65 tubular scales. Dorsal VI, 32–33. Anal 30–31.

East coast of Patagonia.

Total length 138 mm.

Notothenia acuta, Steind. (*non* Günther) (*Zool. Jahrb.*, Suppl. iv., 1897–8, p. 303), from Chile, is probably closely related to *N. canina*.

(3) *Notothenia ramsayi*, sp. n. (Pl. VII. fig. 1.)

Depth of body 4 to $5\frac{1}{2}$ in the length of the fish, length of head about $3\frac{1}{2}$. Diameter of eye 4 to $4\frac{1}{2}$ in the length of head, interorbital width $4\frac{1}{2}$ to 7. Jaws equal anteriorly; maxillary extending to below anterior $\frac{1}{4}$ of eye; cheeks, opercles, and upper surface of head, to between the nostrils, scaly; 21 to 25 gill-rakers on lower part of anterior arch. Dorsal VII (VIII), 34–36. Anal 32–34. Pectoral from less than $\frac{3}{5}$ to $\frac{2}{3}$ length of head; pelvics as long, extending to vent or to anal fin. Caudal rounded or subtruncate. Caudal peduncle as long as deep, or deeper than long, its least depth $\frac{1}{4}$ to $\frac{2}{7}$ the length of head. 60 to 72 scales in a longitudinal series, from above base of pectoral to caudal fin; 46 to 54 in upper lateral line, which almost reaches the caudal; 8 to 17 in lower lateral line. A lateral series of 5 to 7 dark blotches or vertical bars.

Several specimens, 200 to 300 mm. in total length, taken on 1st December 1903 from the Burdwood Bank, *Scotia* Station 346, 54° 24′ S., 50° 32′ W.; depth 56 fathoms; surface temperature 41·8° F.; one from Isthmus Bay, Magellan Straits, 14 fathoms (Coppinger).

This species is named in memory of Allan George Ramsay, chief engineer of the *Scotia*, who died at Scotia Bay, South Orkneys, on 6th August 1903.

(4) *Notothenia tesselata.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 19, pl. xii. figs. 3, 4 (1845); Günth., *Cat. Fish.*, ii. p. 260 (1860).
Notothenia veitchii, Günth., *Ann. Mag. Nat. Hist.* (4), xiv., 1874, p. 370.
,, *brevipes*, Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 15 (1905).

Depth of body $4\frac{1}{2}$ to 6 in the length, length of head $3\frac{1}{4}$ to $3\frac{2}{3}$. Diameter of eye $4\frac{1}{2}$ to 6 in the length of head, interorbital width $5\frac{1}{2}$ to 6. Lower jaw rather prominent; maxillary extending to below anterior part or middle of eye; cheeks, opercles, and upper surface of head, except snout, scaly; 14 to 16 gill-rakers on lower part of anterior arch. Dorsal VI–VII, 32–34. Anal 31–34. Pectoral from less than $\frac{3}{5}$ to more than $\frac{2}{3}$ the length of head, usually longer than pelvics, which seldom reach the anal. Caudal rounded. Caudal peduncle deeper than long. 62 to 78 scales in a longitudinal series from above base of pectoral to caudal fin, 41 to 48 in upper lateral line, which ends below or a little behind end of dorsal fin, 6 to 11 in lower lateral line. Body marbled; spinous dorsal dusky, pale at the base; soft dorsal, caudal, and sometimes anal, with series of dark spots.

Chile; Magellan Straits; Falkland Islands.

Here described from several examples, 140 to 250 mm. in total length, from the Falkland Islands, Magellan Straits, and Chile, including the types of the species and specimens from Station 118, Port Stanley, Falkland Islands, collected by the *Scotia*. In young specimens (*N. veitchii, N. brevipes*) the interorbital width is $\frac{1}{7}$ or $\frac{1}{8}$ the length of head.

(5) *Notothenia wiltoni*, sp. n. (Pl. VII. fig. 2.)

Depth of body $4\frac{2}{3}$ to $5\frac{1}{2}$ in the length of the fish, length of head $3\frac{1}{3}$ to $3\frac{2}{3}$. Diameter of eye $3\frac{4}{5}$ to $4\frac{2}{3}$ in the length of head, interorbital width 6 to 7. Jaws equal anteriorly; maxillary extending to below anterior $\frac{1}{3}$ of eye or beyond; cheeks, opercles, and upper surface of head, except snout, scaly; 16 to 19 gill rakers on lower part of anterior arch. Dorsal VI–VII, 33–36. Anal 32–34. Pectoral $\frac{3}{5}$ or $\frac{2}{3}$ the length of head; pelvics as long or somewhat longer, extending to vent or to anal fin. Caudal rounded or subtruncate. Caudal peduncle deeper than long, its least depth $\frac{2}{7}$ to $\frac{1}{3}$ the length of head. 62 to 70 scales in a longitudinal series from above base of pectoral to caudal fin, 47 to 54 in upper lateral line, which almost reaches caudal, 7 to 14 in lower lateral line. Body with irregular dark cross-bars; spinous dorsal dusky, pale at base.

Ten specimens, 125 to 250 mm. in total length—one from Orange Bay (Paris Mus.); another from the Straits of Magellan (COPPINGER); the others taken by the *Scotia* at Port Stanley (Station 118) and Port William (Station 349), Falkland Islands (shore, 51° 41′ S., 57° 51′ W.), and on the Burdwood Bank (Station 346, 54° 25′ S., 57° 32′ W., 56 fathoms; surface temperature 41·8° F.; otter trawl; 1st December 1903).

This species is named after Mr D. W. WILTON, zoologist of the *Scotia*.

(6) *Notothenia brevicauda.*

Lönnberg, *Swedish South Polar Exped., Fish.*, p. 6, pl. v. fig. 16 (1905).

Depth of body $4\frac{1}{2}$ to 5 in the length of the fish, length of head $3\frac{1}{3}$ to 4. Diameter of eye 4 to $4\frac{1}{2}$ in the length of head, interorbital width 7 or 8. Maxillary extending to below anterior $\frac{1}{3}$ of eye; cheeks, opercles, and upper surface of head, except snout, scaly; 16 to 19 gill-rakers on lower part of anterior arch. Dorsal V (VI), 35–37. Anal 32–35. Pectoral $\frac{3}{5}$ to $\frac{2}{3}$ the length of head; pelvics as long or a little longer, extending to the anal. Caudal rounded. Caudal peduncle $\frac{1}{2}$ to $\frac{3}{4}$ as long as deep, its least depth about $\frac{1}{3}$ the length of head. 60 to 70 scales in a longitudinal series from above base of pectoral to caudal fin, 44 to 50 in upper lateral line, which ends 2 to 4 scales in front of the caudal, 4 to 12 in lower lateral line. Body with irregular dark cross-bars; pectorals yellow; pelvics, anal, spinous dorsal, and base of soft dorsal dusky.

Magellan Straits; Falkland Islands.

Twelve specimens, 90 to 180 mm. in total length, including examples from Port Stanley (June 1903, 9–10 fathoms) and from Port William, Falkland Islands (January 1903, 6 fathoms). LÖNNBERG's type, a specimen of 120 mm., came from Tierra del Fuego, and there are examples from that locality in the British Museum.

(7) *Notothenia longipes.*

Steind., *Sitzungsb. Akad. Wien*, lxxii., 1876, p. 70, pl. vi. fig. 7; Günth., "*Challenger*" *Shore Fish.*, p. 21 (1880).

Depth of body $5\frac{1}{2}$ to $6\frac{1}{2}$ in the length, length of head $3\frac{1}{3}$ to $3\frac{2}{3}$. Diameter of eye 3 to $3\frac{1}{2}$ in the length of head, interorbital width 7 or 8. Maxillary extending to below anterior $\frac{1}{4}$ of eye; upper surface and sides of head, except snout and præorbital, scaly; 14 or 15 gill-rakers on lower part of anterior arch. Dorsal V–VI, 34–35. Anal 32–34. Pectoral $\frac{3}{5}$ to $\frac{2}{3}$ the length of head, somewhat shorter than pelvics, which reach the anal. Caudal rounded. Caudal peduncle $\frac{2}{3}$ to $\frac{4}{5}$ as long as deep, its least depth from $\frac{1}{4}$ to $\frac{2}{7}$ the length of head. 62 to 70 scales in a longitudinal series, 46 to 55 in upper lateral line, which almost reaches caudal, 6 to 13 in lower lateral line. Body with irregular brownish cross-bars.

Patagonia and Magellan Straits.

Here described from four examples, 130 to 180 mm. in total length.

(8) *Notothenia sima.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 19, pl. xi. fig. 1 (1845); Günth., *Cat. Fish.*, ii., p. 262 (1860).
Notothenia squamiceps, Peters, *Monatsb. Akad. Berlin*, 1876, p. 837.
,, *karlandrex*, Lönnberg, *Swedish South Polar Exped., Fish.*, p. 14, pl. iv. fig. 13 (1905).

Depth of body 4 to 5 in the length, length of head $3\frac{1}{3}$ to $3\frac{2}{3}$. Diameter of eye 4 to 5 in the length of head, interorbital width 6 to 8. Maxillary extending to below anterior part or middle of eye; occiput, interorbital region, cheeks, and opercles scaly;

10 to 12 gill-rakers on lower part of anterior arch. Dorsal V–VI, 28–31. Anal 27–30. Pectoral $\frac{2}{3}$ to $\frac{3}{4}$ the length of head, about as long as pelvics, which reach the vent. Caudal rounded. Caudal peduncle much deeper than long. 40 to 46 scales in a longitudinal series from above base of pectoral fin to caudal, 30 to 35 in upper lateral line, which ends below posterior rays of dorsal, 2 to 12 in lower lateral line, when developed. Body with irregular dark cross-bars; vertical fins more or less dusky, the caudal often barred and with 2 or 3 dark spots at the base.

Magellan Straits; Falkland Islands.

Here described from several specimens, 60 to 120 mm. in total length, including the type of the species, from the Falkland Islands, and a co-type of *N. karlandreæ*.

The *Scotia* examples are from Station 118, Port Stanley, Falklands, 51° 41′ S., 57° 51′ W., and there are others in the British Museum collection from Magellan.

(9) *Notothenia lepidorhinus.*

Notothenia lepidorhinus (part.), Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 169, pl. ix. fig. 1 and pl. x. fig. 1 (1912).

Depth of body 4 to $4\frac{1}{2}$ in the length, length of head $3\frac{1}{2}$ to $3\frac{3}{4}$. Diameter of eye 3 to $3\frac{1}{2}$ in the length of head, interorbital width about 6. Maxillary extending to below anterior margin of pupil; upper surface and sides of head, including snout and præorbital, scaly; 16 gill-rakers on lower part of anterior arch. Dorsal VI–VII, 32–33. Anal 35–36. Pectoral $\frac{5}{6}$ the length of head; pelvics extending beyond origin of anal. Caudal rounded. Caudal peduncle somewhat deeper than long. 72 to 82 scales in a longitudinal series, 45 to 56 in upper lateral line, 32 to 38 in lower lateral line. Body with irregular dark cross-bars; spinous dorsal dark anteriorly; soft dorsal with dark oblique stripes.

Wilhelm Land, 385 metres.

The types measure 186 to 240 mm. in total length.

(10) *Notothenia squamifrons.*

Günth., "*Challenger*" *Shore Fish.*, p. 16, pl. viii. fig. C (1880).

Depth of body $4\frac{1}{2}$ in the length, length of head $3\frac{3}{5}$. Diameter of eye 3 to $3\frac{1}{2}$ in the length of head, interorbital width 9 to 12. Maxillary extending to below anterior $\frac{1}{4}$ of eye; upper surface and sides of head, including snout and præorbital, scaly; 14 to 16 gill-rakers on lower part of anterior arch. Dorsal IV–V, 36–37. Anal 32. Pectoral $\frac{3}{4}$ the length of head, rather shorter than pelvics, which reach the anal. Caudal peduncle deeper than long. 55 scales in a longitudinal series from above base of pectoral to caudal, 44 or 45 in upper lateral line, which ends below end of dorsal, or just behind it, 15 to 18 in lower lateral line. Body with broad irregular cross-bars; cheek with two oblique stripes; spinous dorsal blackish.

Kerguelen.

Here described from the types, two specimens, 110 and 150 mm. in total length.

(11) *Notothenia larseni.*

Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 31, pl. i. fig. 3 (1905).

Depth of body $4\frac{1}{3}$ to 5 in the length, length of head $3\frac{2}{3}$. Diameter of eye 3 in length of head, interorbital width 11 to 13. Maxillary extending a little beyond vertical from anterior margin of eye; upper surface and sides of head entirely scaly. Dorsal VI, 37–39. Anal 38. Pectoral a little shorter than head, longer than pelvics, which just reach anal. Caudal rounded. Caudal peduncle as long as deep. 69 to 76 scales in a longitudinal series above upper lateral line, which has 55 or 56 tubes and nearly reaches caudal; lower lateral line without tubes. Body with irregular cross-bars; dorsal with oblique series of spots.

South Georgia; length 178 mm.

(12) *Notothenia scotti.*

Bouleng., *Nat. Antarct. Exped. Nat. Hist.*, ii. *Fish.*, p. 2, pl. i. fig. 1 (1907).

Depth of body $5\frac{1}{2}$ in the length, length of head $3\frac{1}{3}$. Diameter of eye $2\frac{4}{5}$ in the length of head, interorbital width 12. Maxillary extending to below anterior $\frac{1}{4}$ of eye; upper surface of head, except snout, and sides of head, including præorbital, scaly; 12 gill-rakers on lower part of anterior arch. Dorsal V, 33. Anal 31. Pectoral $\frac{3}{4}$ the length of head, somewhat shorter than pelvics, which reach anal. Caudal peduncle as long as deep. 50 scales in a longitudinal series from above base of pectoral to caudal, probably about 40 in upper lateral line. Body with irregular cross-bars; spinous dorsal blackish; soft dorsal and anal blackish posteriorly.

Near Edward Land.

Here described from the type, a specimen of 110 mm. taken at a depth of 300 fathoms off the Ross Barrier, 27th January 1902. In the original description and figure the fin-rays are miscounted.

(13) *Notothenia gibberifrons.*

Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 33, pl. iii. fig. 10 (1905); Vaillant, *Expéd. Antarct. Française*, *Poiss.*, p. 33 (1906).

Depth of body 5 to $5\frac{1}{2}$ in the length, length of head $3\frac{1}{3}$ to $3\frac{1}{5}$. Diameter of eye 4 to $4\frac{2}{3}$ in the length of head, interorbital width 12 to 16. Jaws equal anteriorly; maxillary not or barely reaching vertical from anterior margin of eye; cheeks, opercles, and upper surface of head to nostrils scaly; 10 gill-rakers on lower part of anterior arch. Dorsal VII–VIII, 31–33. Anal 31–33. Pectoral $\frac{5}{6}$ the length of head; pelvics $\frac{3}{5}$ to $\frac{2}{3}$ length of head, not reaching vent. Caudal truncate. Caudal peduncle nearly as long as deep; 55 to 66 scales in a longitudinal series from above base of pectoral to caudal, 36 to 44 (to 51 *fide* LÖNNBERG) in upper lateral line, which ends below posterior part of dorsal, 32 to 41 in lower lateral line. Upper part of body irregularly spotted; dorsal, caudal, and pectoral fins with series of dark spots. A water-colour drawing shows the ground colour yellow, the fins greenish, the spots brown.

Graham Land; South Georgia; South Orkneys; South Shetlands.

Here described from six specimens, 280 to 340 mm. in total length, taken in July 1903 at Station 325, Scotia Bay, 27 fathoms, and Station 326, Jessie Bay, 10 fathoms, South Orkneys; there are also two quite small specimens from the same locality. Lönnberg's types come from South Georgia, and there is a specimen in the British Museum from the South Shetlands.

(14) *Notothenia acuta.* (Pl. VIII. fig. 3.)

Günth., "*Challenger*" *Shore Fish.*, p. 17 (1880); Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 171, pl. ix. fig. 3 (1912).

Depth of body 6 in the length, length of head $3\frac{1}{3}$. Diameter of eye $3\frac{2}{3}$ in the length of head, interorbital width 16. Maxillary extending to below anterior $\frac{1}{4}$ of eye; sides and upper surface of head scaly, except snout and præorbital; 12 gill-rakers on lower part of anterior arch. Dorsal VI (VII), (28–29) 30. Anal (28–30) 31. Pectoral nearly as long as the head, longer than pelvics, which reach the vent. Caudal peduncle somewhat deeper than long. 60 scales in a longitudinal series from above base of pectoral to caudal, 38 in upper lateral line, which ends below posterior part of dorsal, 16 to 18 in lower lateral line. Body marbled; dorsal rays with series of small spots; caudal barred.

Kerguelen.

Here described from the type, about 62 mm. in total length, from Kerguelen.

(15) *Notothenia vaillanti*, n. sp.

Notothenia acuta (*non* Günth.), Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 31 (1906).

Depth of body $5\frac{1}{2}$ in the length, length of head $3\frac{1}{4}$. Diameter of eye 3 in the length of head, interorbital width 14. Maxillary extending to below anterior $\frac{1}{4}$ of eye; sides and upper surface of head scaly, except snout and præorbital; 10 gill-rakers on lower part of anterior arch. Dorsal VII, 32. Anal 32. Pectoral a little shorter than head, as long as pelvics, which reach the anal. Caudal peduncle a little longer than deep. 55 scales in a longitudinal series from above pectoral fin to caudal, 34 in upper lateral line, which ends below posterior part of dorsal; lower lateral line without tubular scales. Body with irregular cross-bars, broken up into 3 or 4 series of alternating spots; dorsal with small spots; caudal barred.

Graham Land; Booth, Wandel, and Wiencke Islands.

Here described from a specimen of 56 (46 + 10) mm. Measurements of this example are given by Vaillant (*t.c.*, p. 32), and also those of a much larger fish, 410 mm. in length to base of caudal, with the eye $\frac{1}{5}$ and the interorbital width $\frac{1}{10}$ of the length of the head.

(16) *Notothenia mizops.*

Günth., "*Challenger*" *Shore Fish.*, p. 16, pl. viii. fig. D (1880).

Depth of body $4\frac{1}{3}$ to $4\frac{3}{4}$ in the length, length of head $3\frac{2}{3}$ to 4. Diameter of eye 3 to $3\frac{1}{2}$ in the length of head, interorbital width about 15. Maxillary extending to below anterior $\frac{1}{4}$ or $\frac{1}{3}$ of eye; cheeks, opercles, occiput, and interorbital region scaly; 9 to 13 gill-rakers on lower part of anterior arch. Dorsal IV–V, 35–37. Anal 33–35. Pectoral $\frac{2}{3}$ to $\frac{4}{5}$ the length of head; pelvics longer, reaching the anal. Caudal rounded. Caudal peduncle deeper than long. 48 to 55 scales in a longitudinal series from above base of pectoral to caudal, 33 to 38 in upper lateral line, which ends below posterior part of dorsal; lower lateral line without tubular scales. Body with 2 series of large, partly confluent, irregular blackish spots; cheek with 2 oblique stripes; a blackish spot on spinous dorsal; vertical fins with or without series of dark spots.

Kerguelen.

Here described from the types, five specimens, 70 to 170 mm. in total length.

(17) *Notothenia nudifrons.*

Notothenia mizops var. *nudifrons*, Lönnberg, *Swedish South Polar Exped., Fish.*, p. 30, pl. i. fig. 2 (1905).

Notothenia mizops, Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 30 (1906).

Closely related to *N. mizops*, but occiput and interorbital region naked, fin-rays usually more numerous (Dorsal IV–VI, 37–39. Anal 34–36), and scales smaller, 55 to 65 in a longitudinal series; 11 or 12 gill-rakers on lower part of anterior arch. Coloration of *N. mizops*. A water-colour drawing shows the fish reddish, the spots dark brown.

South Georgia; South Orkneys; Graham Land.

Here described from nine specimens, 70 to 150 mm. in total length, from Station 325, Scotia Bay, South Orkneys, depth 9 to 10 fathoms (June 1903), from South Georgia (Swedish Expedition), and from Graham Land (Paris Mus.).

18. *Notothenia marionensis.* (Pl. VIII., fig. 2.)

Günth., "*Challenger*" *Shore Fish.*, p. 17 (1880).

Depth of body 5 in the length, length of head $3\frac{3}{5}$. Diameter of eye 4 in the length of head, interorbital width 10. Jaws equal anteriorly; maxillary extending to below anterior $\frac{1}{4}$ of eye; scales on upper half of cheek and opercles, on interorbital region and occiput; a transverse naked strip separating last from scales of nape; 11 gill-rakers on lower part of anterior arch. Dorsal VII, 29. Anal 27. Pectoral fin $\frac{3}{4}$, pelvic $\frac{3}{5}$ the length of head. Caudal rounded or subtruncate. Caudal peduncle deeper than long. 48 scales in a longitudinal series from above base of pectoral to caudal fin; 35 in upper lateral line, which ends below posterior part of dorsal; 16 in lower lateral line. Body with irregular dark spots; a blackish spot on upper part of base of pectoral; dorsal and caudal with series of small spots.

Marion Island.

Here described from the type, 82 mm. in total length, from Marion Island, 50 to 75 fathoms.

(19) *Notothenia angustifrons.* (Pl. VIII. fig. 1.)

Fischer, *Jahrb. Hamburg Wiss. Anst.*, ii., 1885, p. 55.

Depth of body 5 in the length, length of head $3\frac{2}{3}$. Diameter of eye 4 in the length of head, interorbital width about 20. Maxillary extending to below anterior margin or anterior $\frac{1}{4}$ of eye; upper surface of head scaly to between nostrils; cheeks and opercles in great part scaly, but naked below; 10 or 11 gill-rakers on lower part of anterior arch. Dorsal V–VI, 29–30. Anal 30–31. Pectoral nearly as long as head, longer than pelvics. Caudal rounded. Caudal peduncle about as long as deep. 46 to 52 scales in a longitudinal series from above base of pectoral to caudal, 26 to 33 in upper lateral line, which ends below middle or posterior part of soft dorsal, 16 to 23 in lower lateral line. Dark bars across the back, which break up into spots on the sides of the body; often a bar through spinous dorsal connecting the bases of the pectorals; dorsal, caudal, and pectoral fins with series of small dark spots on the rays; pelvics and anal pale, sometimes with a few spots.

South Georgia; South Sandwich Islands.

Here described from six specimens, 70 to 116 mm. in total length, one from South Georgia (Lönnberg), the rest from the South Sandwich group (Allardyce).

(20) *Notothenia elegans.*

Günth., "*Challenger*" *Shore Fish.*, p. 21, pl. xi. fig. C (1880).

Depth of body 6 to 7 in the length, length of head $4\frac{1}{4}$. Diameter of eye $3\frac{1}{2}$ in the length of head, interorbital width 12. Maxillary extending to below anterior $\frac{1}{3}$ of eye; a few scales behind eye and on upper part of operculum, rest of head probably scaleless; 10 gill-rakers on lower part of anterior arch. Dorsal VI, 33. Anal 31. Pectoral $\frac{3}{4}$ the length of head, rather shorter than the pelvics, which reach the anal. Caudal rounded. Caudal peduncle somewhat deeper than long. 46 to 48 scales in a longitudinal series from above base of pectoral to caudal, 40 or 41 in upper lateral line, which ends below last rays of dorsal, 4 to 9 in lower lateral line. Large dark spots or vertical bars on sides of body; tip of spinous dorsal pink; soft dorsal with 3 or 4 series of small dark spots.

Magellan Straits.

Here described from the types, two specimens 95 mm. in total length, from off Cape Virgins, Patagonia, 55 fathoms.

(21) *Notothenia cornucola.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, pp. 8, 18, pls. viii. figs. 4, 5, and xi. figs. 3, 4 (1845); Günth., *Cat. Fish.*, ii. p. 261 (1860).
Notothenia virgata, Richards., *t.c.*, p. 18, pl. xi. figs. 5, 6; Günth., *t.c.*, p. 262.
,, *marginata*, Richards., *t.c.*, p. 18, pl. xii. figs. 3, 4.
,, *modesta*, Steind., *Zool. Jahrb. Suppl.*, iv., 1898, p. 302, pl. xx. fig. 3.

Depth of body $3\frac{2}{3}$ to $4\frac{1}{2}$ in the length, length of head 3 to $3\frac{1}{2}$. Diameter of eye $4\frac{1}{2}$ to 5 in the length of head, interorbital width $5\frac{1}{2}$ to 7. Jaws equal anteriorly; maxillary extending to below middle of eye; usually a few scales behind eye and on upper part of operculum; 11 or 12 gill-rakers on the lower part of anterior arch. Dorsal IV–VI, 31–34. Anal 27–31. Pectoral about $\frac{2}{3}$ the length of head, extending to above origin of anal or a little beyond; pelvics about as long. Caudal rounded. Caudal peduncle much deeper than long. 47 to 55 scales in a longitudinal series from above base of pectoral to caudal, 36 to 42 in upper lateral line, which ends below last 2 or 3 rays of dorsal; 6 to 12 in lower lateral line, when it is developed; only 2 or 3 scales between lateral line and posterior rays of dorsal. Body usually spotted or marbled, sometimes with a pale lateral band; vertical fins dusky.

Patagonia; Magellan Straits; Falkland Islands; New Zealand; Chatham Islands.

Here described from numerous specimens, 90 to 140 mm. in total length, including the types of the species, of *N. virgata* and of *N. marginata*, mostly from the Falkland Islands and Magellan Straits; one small specimen from New Zealand. Some examples were taken at Station 118, Port Stanley, Falkland Islands, shore, by the *Scotia*.

(22) *Notothenia cynaneobrancha.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 7, pl. iv. (1844); Günth., *Cat. Fish.*, ii. p. 261 (1860).
Notothenia purpuriceps, Richards., *t.c.*, pl. ii. figs. 3, 4; Günth., *t.c.*, p. 262.

Depth of body 4 to 5 in the length, length of head 3 to 4. Diameter of eye 4 to 6 in the length of head, interorbital width 5 to 6. Jaws equal anteriorly; maxillary extending to below middle or posterior part of eye; upper surface of head naked except for a few temporal and post-temporal scales, which may be absent in the young; cheek scaly behind and below eye, the lower $\frac{1}{2}$ (young) or $\frac{1}{4}$ (adult) naked; upper part of operculum scaly; 10 to 13 gill-rakers on lower part of anterior arch. Dorsal IV–VI, 33–36. Anal 30–33. Pectoral $\frac{2}{3}$ the length of head, extending to above vent or origin of anal (adult) or a little beyond (young); pelvics about as long. Caudal rounded. Caudal peduncle much deeper than long. 60 to 70 scales in a longitudinal series from above base of pectoral to caudal, 32 to 39 in upper lateral line, which ends below posterior part of dorsal; lower lateral line, when developed, with 6 to 15 tubular scales. A dark oblique stripe from eye to angle of præoperculum, another below it.

Kerguelen.

Here described from several specimens, 120 to 260 mm. in total length, including the type of the species.

(23) *Notothenia coriiceps.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 5, pl. iii. figs. 1, 2 (1884); Günth., *Cat. Fish.*, ii. p. 261 (1860); Vaill., *Expéd. Antarct. Française, Poiss.*, p. 24 (1906).

Depth of body $3\frac{2}{3}$ to $4\frac{1}{2}$ in the length, length of head 3 to $3\frac{2}{3}$. Diameter of eye $4\frac{1}{2}$ to 7 in the length of head, interorbital width 4 to 5. Jaws equal anteriorly; maxillary extending to below middle (young) or posterior margin (adult) of eye; head naked except for a few scales behind eye, on upper part of operculum, and on post-temporal region; 10 to 14 gill-rakers on lower part of anterior arch. Dorsal III–VII, 35–40. Anal 27–31. Pectoral from less than $\frac{2}{3}$ (in large specimens) to $\frac{5}{6}$ the length of head, extending to above origin or anterior rays of anal; pelvics shorter, not or barely reaching vent. Caudal subtruncate. Caudal peduncle nearly as long as deep. 54 to 68 scales in a longitudinal series from above base of pectoral to caudal, 34 to 49 in upper lateral line, which ends below posterior part of dorsal, 8 to 17 in lower lateral line; 4 or 5 scales between lateral line and posterior dorsal rays. Colour varying from dark greenish black to a pale orange, with or without spots or marking; usually one or two oblique dark bars across cheek, sometimes broken up into spots; head sometimes with pale spots enclosed in dark rings; spots on body and dorsal fin sometimes large and tesselated, more often smaller and scattered, rarely uniting to form longitudinal stripes; soft dorsal and anal usually with a pale edge.

Graham Land and neighbouring islands; Kerguelen; Victoria Land.

Here described from a large series of specimens obtained by the *Scotia* at Station 325, Scotia Bay, South Orkneys, 160 to 450 mm. in total length, in addition to the type of the species from Kerguelen, examples from Duke of York Island and Cape Adare, Victoria Land (*Southern Cross*), and from Graham Land (*Français*).

(24) *Notothenia rossii.*

Richards., "*Erebus*" *and* "*Terror*" *Fish.*, p. 9, pl. v. figs. 1, 2 (1844); Günth., *Cat. Fish.*, ii. p. 263 (1860).

Macronotothen rossii, Gill, *Proc. Acad. Philad.*, 1861, p. 521.

Notothenia marmorata, Fischer, *Jahrb. Hamb. Wiss. Anst.*, ii., 1885, p. 53; Lönnberg, *Swedish South Polar Exped., Fish.*, p. 34.

Depth of body $4\frac{1}{4}$ to $4\frac{1}{2}$ in the length, length of head $3\frac{2}{3}$ to $3\frac{3}{4}$. Diameter of eye 5 to $5\frac{1}{2}$ in the length of head, interorbital width $3\frac{1}{2}$. Jaws equal anteriorly; maxillary extending to below anterior margin of pupil; scales on upper part of cheek and operculum and on temporal region; upper surface of head papillose; 12 gill-rakers on lower part of anterior arch. Dorsal V–VII, 33–35. Anal 27–29. Pectoral $\frac{2}{3}$ the length of head, longer than pelvics. Caudal truncate. Caudal peduncle as long as or a little longer than deep. 58 to 62 scales in a longitudinal series from above base of pectoral fin to caudal, 46 to 52 in upper lateral line, which ends below posterior rays of dorsal, 10 to 18 in lower lateral line. Body marbled; dorsal with 2 or 3 series of dark spots; anal and caudal with a dark band.

South Georgia; South Orkneys.

Here described from two specimens, 250 mm. in total length, from South Georgia; a little fish, 62 mm. in total length, obtained by the *Scotia* at Station 325, Scotia Bay, South Orkneys, seems to belong to this species.

Notothenia rossii was based on a large stuffed specimen, 850 mm. in total length, with the dorsal spines short and blunt as they often are in large Nototheniids.

(25) *Notothenia macrocephala.*

Günth., *Cat. Fish.*, ii. p. 263 (1860).
Notothenia maoriensis, Haast, *Trans. N.Z. Inst.*, v., 1873, p. 276, pl. xvi. fig.
„ *angustata*, Hutton, *Ann. Mag. Nat. Hist.* (4), xvi., 1875, p. 315.
„ *hassleriana*, Steind., *Sitzungsb. Akad. Wien*, lxxii., 1876, p. 69, pl. vi. fig.
„ *antarctica*, Peters, *Monatsb. Akad. Berlin*, 1876, p. 837.
„ *arguta*, Hutton, *Trans. N.Z. Inst.*, xi., 1879, p. 339.
„ *porteri*, Delfin, *Rev. Chilen. Hist. Nat.*, iii., 1899, p. 117.

Depth of body 3 to 4 in the length, length of head $3\frac{1}{3}$ to $3\frac{3}{4}$. Diameter of eye 4 to 6 in the length of head, interorbital width $2\frac{1}{2}$ to $3\frac{1}{2}$. Jaws equal anteriorly; maxillary extending to below anterior $\frac{1}{4}$ of eye; imbricate scales behind eye and on upper part of operculum; upper surface and sides of head otherwise naked, papillose; 10 to 12 gill-rakers on lower part of anterior arch. Dorsal IV (III–VI), 29–31. Anal 22–25. Pectoral $\frac{2}{3}$ to $\frac{5}{6}$ the length of head, considerably longer than pelvics. Caudal truncate or slightly emarginate. Caudal peduncle usually somewhat longer than deep, 48 to 56 scales in a longitudinal series from above base of pectoral fin to caudal; 36 to 44 in upper lateral line, which ends below posterior rays of dorsal, 6 to 12 in lower lateral line. More or less distinct longitudinal stripes or series of spots on the sides; dorsal dusky, sometimes reticulated; caudal, anal, and pelvics sometimes similarly coloured.

Patagonia; Magellan Straits; Falkland Islands; New Zealand; Auckland Island; Campbell Island.

Here described from several specimens, 130 to 280 mm. in total length, from New Zealand, Campbell Island, Magellan Straits, and the Falkland Islands. In addition to the type of the species, types of *N. arguta* and *N. angustata* have been examined.

(26) *Notothenia microlepidota.*

Hutton, *Trans. N.Z. Inst.*, viii., 1876, p. 213; Waite, *Subantarctic Isl. N. Zealand, Pisces*, p. 590, fig. (1909).
Notothenia parva, Hutton, *Trans. N.Z. Inst.*, xi., 1879, p. 339.

Depth of body 4 to 5 in the length, length of head $3\frac{1}{4}$ to $3\frac{1}{2}$. Diameter of eye $4\frac{1}{2}$ to $6\frac{1}{2}$ in the length of head, interorbital width $3\frac{1}{2}$ to $4\frac{1}{2}$. Upper surface of head naked, papillose; sides mostly naked, scaly behind the eye and on upper part of operculum; 11 or 12 gill-rakers on lower part of anterior arch. Dorsal VI–VII, 28–29. Anal 23–25. Pectoral $\frac{1}{2}$ (adult) to $\frac{2}{3}$ (young) the length of head; pelvics nearly as long, not reaching vent. Caudal rounded or subtruncate. Caudal peduncle deeper than long. 52 to 58 scales in a longitudinal series from above base of pectoral fin to caudal, 52 to 60 in upper lateral line, which ends near end of dorsal fin, 10 to 15 in lower lateral line. Head reticulated; body and fins spotted.

New Zealand; Auckland Island; Campbell Island.

Here described from five specimens, 90 to 500 mm. in total length, from Auckland and Campbell Islands, the smallest the type of *N. parva*.

(27) *Notothenia colbecki.*

Bouleng., "*Southern Cross*" *Pisces*, p. 185, pl. xvi. (1902); Waite, *Subantarctic Isl. N. Zealand, Pisces*, p. 594 (1909).

Depth of body 4 to 5 in the length, length of head $3\frac{1}{3}$ to $3\frac{3}{5}$. Diameter of eye 5 to 7 in the length of head, interorbital width 3 to 4. Maxillary extending to below anterior part or middle of eye; head mostly naked, with granular papillæ, scaly behind the eye and on upper part of operculum; 15 to 18 gill-rakers on lower part of anterior arch. Dorsal VI–VIII, 26–27. Anal 23–24. Pectoral $\frac{3}{5}$ to $\frac{2}{3}$ the length of head, somewhat longer than pelvics, which do not reach the vent. Caudal emarginate. Caudal peduncle longer than deep. 84 to 92 scales in a longitudinal series from above base of pectoral to caudal, 62 to 69 in upper lateral line, which ends near end of dorsal fin, 24 to 35 in lower lateral line. Brownish above, yellowish below; a pair of oblique stripes across the cheek; dorsal and caudal dusky.

Auckland Island; Campbell Island.

Here described from specimens 125 to 550 mm. in total length, including the types from Campbell Island and a large stuffed specimen from Auckland.

(28) *Notothenia filholi.*

Sauvage, *Bull. Soc. philom.* (7), iv., 1880, p. 228; *Passage de Vénus*, iii. p. 345 (1885); Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 22 (1906).

Depth of body about 6 in the length, length of head $3\frac{1}{2}$ to 4. Diameter of eye $4\frac{2}{3}$ to 5 in length of head, interorbital width about 4. Head mostly naked, with granular papillæ; scaly behind the eye and on upper part of operculum. Dorsal VI–VII, 24–27. Anal 18–20. Caudal emarginate. Caudal peduncle longer than deep. Scales in a longitudinal series 100 to 110 (Sauvage) or 78 (Vaillant), the discrepancy probably due to different methods of counting. Lower lateral line extending forward to above middle of anal, its anterior 15 scales overlapped by the upper. Brownish.

Campbell Island.

Total length 150 mm.

4. *Dissostichus*, Smitt, 1898.

Bih. Svensk. Vet.-Akad. Handl., xxiv., iv., No. 5, p. 1.

Differs from *Notothenia* in that the teeth are uniserial, spaced, canine-like.

Patagonia to Graham Land.

Dissostichus eleginoides.

Smitt, *l.c.*, p. 2, pl. i. figs. 1–11; Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 36.

Depth of body about 6 in the length, length of head 3. Diameter of eye about 5 in the length of head, interorbital width about $4\frac{1}{2}$ (? $5\frac{1}{2}$). Maxillary extending to below middle of eye; upper surface of head to nostrils, cheeks and opercles scaly. Dorsal IX–X, 27–28. Anal 28–30. Pectoral $\frac{3}{5}$ the length of head. Caudal truncate or slightly emarginate. Caudal peduncle much longer than deep. About 124 scales in a longitudinal series; upper lateral line extending back beyond dorsal, lower extending forward nearly to the pectoral.

Total length of the type, 228 mm.

Magellan Straits; Graham Land.

5. *Eleginops*, Gill, 1861.

Proc. Acad. Philad., 1861, p. 522.

Eleginus (*non* Fischer), Cuv. and Val., *Hist. Nat. Poiss.*, v. p. 158 (1830); Günth., *Cat. Fish.*, ii. p. 247 (1860).

This genus differs from *Notothenia* in the rather small mouth, in the complete absence of the lower lateral line, and in the shape of the pectoral fin.

Chile; Patagonia; Falkland Islands.

Eleginops maclovinus.

Eleginus maclovinus, Cuv. and Val., *l.c.*; Günth., *l.c.*

,, *chilensis*, Cuv. and Val., *o.c.*, ix. p. 480 (1833); Gunth., *l.c.*

Aphritis undulatus, Jenyns, *Zool. "Beagle," Fish.*, p. 160, pl. xxix. fig. 1; Günth., *l.c.*, p. 243.

,, *porosus*, Jenyns, *l.c.*, p. 162; Günth., *l.c.*

Eleginus falklandicus, Richards., *"Erebus" and "Terror" Fish.*, p. 30, pl. xx. figs. 1–3 (1845).

Depth of body $4\frac{1}{4}$ to $5\frac{1}{2}$ in the length, length of head $3\frac{1}{2}$ to 4. Diameter of eye 5 to 8 in the length of head, interorbital width 3 to 5. Maxillary just reaching vertical from anterior margin of eye in the young, but not in the adult; occiput, interorbital region, cheeks, and opercles scaly; 14 or 15 gill-rakers on lower part of anterior arch. Dorsal VIII–IX, 24–26. Anal 22–24. Pectoral obliquely truncated, with the upper rays longest, nearly as long as head. Caudal truncate or emarginate. About 60 scales in a lateral longitudinal series, and 65 in the lateral line, which nearly reaches the caudal fin. Body often spotted or marbled.

Chile; Patagonia; Falkland Islands.

Here described from several specimens, 120 to 450 mm. in total length.

6. *Artedidraco*, Lönnberg, 1905.

Swedish South Polar Exped., Fish., p. 39.

Differs from *Notothenia* in the naked body, the absence of the lower lateral line, the presence of a mental barbel, the broad union of the gill-membranes to the isthmus, and the hooked operculum.

Coasts of the Antarctic Continent and South Georgia.

(1) *Artedidraco mirus.*

Lönnberg, *t.c.*, p. 40, pl. i. fig. 4 and pl. iv. fig. 14.

Barbel club-shaped in the male. Depth of body 4 in the length, length of head $2\frac{3}{5}$ to $2\frac{2}{3}$. Diameter of eye $3\frac{1}{3}$ to 4 in the length of head; interorbital width $7\frac{1}{2}$ to $8\frac{3}{4}$. Dorsal III, 23–24. Anal 17.

Length of types 40 to 92 mm.

South Georgia.

(2) *Artedidraco skottsbergi.*

Lönnberg, *t.c.*, p. 48, pl. ii. fig. 7, pl. iv. fig. 15; Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 46 (1906).

Depth of body $4\frac{1}{2}$ to 5 in the length, length of head 3. Diameter of eye 3 to $3\frac{2}{3}$ in the length of head, interorbital width 9 or 10. Dorsal III, 24–25. Anal 18–19.

Graham Land, 125 m.

Length of type 57 mm.

(3) *Artedidraco shackletoni.*

Waite, *Brit. Antarctic Exped., Fish.*, p. 15, pl. ii. (1911).

Depth of body 4 in the length, length of head about 3. Diameter of eye $3\frac{3}{5}$ in the length of head, interorbital width 10. Dorsal V, 27. Anal 20.

Length of type 146 mm.

Victoria Land; off Cape Royds, Ross Island, 30 to 80 fathoms.

7. *Harpagifer*, Richards., 1844.

"Erebus" and "Terror" Fish., p. 11.

Differs from *Artedidraco* in the absence of the mental barbel and the development of the operculum and suboperculum as strong spines.

Patagonia to Graham Land and Kerguelen.

Harpagifer bispinis.

Batrachus bispinis (*Callionymus bispinus*, Forster), Schneid., *Bloch's Syst. Ichth.*, p. 45 (1801).

Harpagifer bispinis, Richards., *t.c.*, pp. 11, 19, pls. vii. figs. 1–3, xii. figs. 8–9; Günth., *Cat. Fish.*, p. 263 (1860); Smitt, *Bihang Svensk. Vet.-Akad. Handl.*, xxiv., 1898, iv., No. 5, p. 17; Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 44 (1906); Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 177 (1912).

Harpagifer palliolatus, Richards., *t.c.*, p 20, pl. xii. figs. 5–7.

Dorsal III–V, 21–25. Anal 16–20. Coloration variable, usually with bars or blotches.

Total length 100 mm.

Patagonia; Magellan Straits; Graham Land; Falkland Islands; South Georgia; South Orkneys; Marion Islands; Kerguelen.

The *Scotia* examples are from Station 118, Port Stanley, Falkland Islands, and Station 325, Scotia Bay, South Orkneys.

Family 3. Bathydraconidæ.

The depressed head, produced snout, non-protractile mouth, and absence of the spinous dorsal fin distinguish this family externally from the Nototheniidæ; the genera with spatulate snout may be distinguished from the Chænichthyids without a spinous dorsal fin by their scaly body.

The skeleton of *Gymnodraco* differs from that of *Notothenia* in the more depressed skull and more produced rostrum, the elongation of the palatine, which loses its lateral ethmoid attachment, and the separation of the mesopterygoid and the metapterygoid, so that the upper margin of the quadrate is free. The pectoral arch is as in *Notothenia*. There are 49 vertebræ (20 + 29), the præcaudals with parapophyses behind which the long slender epipleurals are inserted, and the feeble ribs attached to the epipleurals at some distance from the centra.

I have ascertained that *Bathydraco* agrees with *Gymnodraco* in the structure of the palatine and of the pectoral arch, and in the presence of ribs.

Synopsis of the Genera.

I. Body scaly; snout spatulate; teeth villiform or cardiform, in bands, without canines.

A single lateral line running to or towards middle of base of caudal fin; body completely scaled . . . . 1. *Bathydraco.*

Lateral line running near base of dorsal fin; body completely sealed. 2. *Gerlachea.*

Lateral line running near base of dorsal fin; scales in scattered groups. 3. *Racovitzaia.*

II. Body naked; snout pointed; teeth curved, compressed, close-set in a single series, with strong anterior canines . . . . . . 4. *Gymnodraco.*

1. *Bathydraco*, Günth., 1878.

Ann. Mag. Nat. Hist. (5), ii. p. 18.

Body scaly; a single lateral line, running to or towards middle of base of caudal. Snout spatulate; jaws with small villiform teeth in bands.

Antarctic, in deep water.

Günther has stated 10 branchiostegals for *B. antarcticus*, but I find only 7. Dollo gives 6 for *B. scotiæ*, but I count 7 in that species also.

(1) *Bathydraco antarcticus.*

Günth., *l.c.*, and "*Challenger*" *Deep-Sea Fish.*, p. 47, pl. viii. fig. A (1887).

Elongate, subcylindrical, the depth 9 in the length, length of head 3. Snout $1\frac{1}{3}$ as long as diameter of eye, which is 4 in length of head, interorbital width 20. Lower jaw projecting; maxillary reaching vertical from anterior margin of eye; cheek completely scaled; 16 gill-rakers on lower part of anterior arch. Dorsal 36. Anal 31. Caudal subtruncate. Pectoral truncated, as long as head without snout, reaching origin of anal. About 140 scales in a lateral longitudinal series, about 60 in the lateral line, which is complete. Brownish; fins dusky.

South-east of Heard Island, 1260 fathoms.

Here described from the type, 260 mm. in total length.

(2) *Bathydraco macrolepis.*

Bouleng., *Nat. Antarctic Exped. Nat. Hist.*, ii., *Fish.*, p. 4, pl. i. fig. 3 (1907).

Depth of body 9 in the length, length of head 3. Snout $1\frac{2}{5}$ as long as diameter of eye, which is $4\frac{1}{2}$ in the length of head, interorbital width 14. Lower jaw projecting; maxillary reaching vertical from anterior margin of eye; cheeks naked below the suborbitals; 11 gill-rakers on lower part of anterior arch. Dorsal 34. Anal 29. Caudal subtruncate. Pectoral as long as head behind middle of eye, reaching origin of anal. About 90 scales in a lateral longitudinal series, about 55 in the lateral line, which is complete. Brownish; fins dusky.

South-west of Balleny Islands, 252 fathoms.

Here described from the type, 210 mm. in total length. In the original description the number of gill-rakers was erroneously given as 6, and of dorsal rays as 39; the latter number is also shown in the figure.

(3) *Bathydraco scotiæ.* (Pl. IX. fig. 4.)

Dollo, *Proc. Roy. Soc. Edin.*, xxvi., 1906, p. 65.

Depth of body 9 to 10 in the length, length of head $3\frac{1}{6}$. Snout $1\frac{3}{4}$ as long as eye, the diameter of which is 5 in the length of head, interorbital width 12 or 13. Lower jaw projecting; maxillary not reaching the vertical from anterior margin of eye; cheek naked below the suborbitals; 19 to 22 gill-rakers on lower part of anterior arch. Dorsal 38. Anal 31. Caudal subtruncate. Pectoral as long as head without snout, extending a little beyond origin of anal. About 100 scales in a lateral longitudinal series, 36 to 40 in the lateral line, which ends at a distance from the caudal equal to $\frac{1}{2}$ its own length.

Two specimens, 133 and 145 mm. in total length, taken by the *Scotia* at Station 417, 71° 22′ S., 16° 34′ W., off Coats Land: depth 1410 fathoms; temperature 31·9° F.; trawl; 18th March 1904.

2. *Gerlachea*, Dollo, 1900.

Bull. Acad. Roy. Belg. Sciences, p. 195.

Differs from *Bathydraco* in that the lateral line runs near the base of the dorsal fin; a second short lateral line above base of anal.

Deep water off Graham Land.

Gerlachea australis.

Dollo, *t.c.*, p. 196, and *Rés. Voy. "Belgica," Poiss.*, p. 25, pl. ii. fig. 1 and pl. v. fig. 2 (1904).

Depth of body $8\frac{2}{3}$ in the length, length of head $3\frac{1}{4}$. Snout twice as long as diameter of eye, which is 5 in the length of head, interorbital width 11. Maxillary not reaching vertical from anterior edge of eye; cheek fully scaled. Dorsal 47. Anal 35. Pectoral $\frac{3}{5}$ the length of head. Caudal emarginate.

71° 14′ S., 89° 14′ W., 246 fathoms.

Total length 180 mm.

3. *Racovitzaia*, Dollo, 1900.

Bull. Acad. Roy. Belg. Sciences, p. 317.

Body with scattered groups of scales; a single lateral line running near base of dorsal fin; an incubatory pouch between pelvic fins and vent; in other characters similar to *Gerlachea*.

Deep water off Graham Land.

Racovitzaia glacialis.

Dollo, *t.c.*, p. 318, and *Rés. Voy. "Belgica," Poiss.*, p. 29, pl. ii. figs. 2, 3, pl. v. fig. 3 (1904).

Depth of body 12 in the length, length of head $3\frac{1}{4}$. Diameter of eye 4 in the length of head, interorbital width 25. Maxillary not reaching vertical from anterior margin of eye. Dorsal 30. Anal 27.

71° 19′ S., 87° 37′ W., 237 fathoms.

Total length 82 mm.

4. *Gymnodraco*, Bouleng., 1902.

"Southern Cross" Pisces, p. 186.

Body naked, depressed anteriorly, compressed posteriorly. Head depressed; snout produced, pointed; jaws with curved compressed teeth, close-set in a single series and with large anterior canines, those of the mandible exposed in front of the snout. Operculum with a strong spine with a hooked branch; suboperculum with a short spine; 6 branchiostegals; gill-membranes forming a fold across isthmus. Two lateral lines.

Coasts of the Antarctic Continent.

Gymnodraco acuticeps.

Bouleng., *l.c.*, pl. xvii.; Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 176, pl. ix. fig. 4 (1912).

Depth of body 8 in the length, length of head about 3. Snout as long as postorbital part of head. Diameter of eye 5 to 6 in length of head, interorbital width 6 to 7. Lower jaw strongly projecting; maxillary extending to below anterior margin of eye; gill-rakers short, sometimes almost vestigial except near the angle. Dorsal 28–30. Anal 24–26. Pectoral truncated, $\frac{1}{2}$ as long as head. Caudal truncate. Large dark spots on head and body; fins dusky.

Victoria Land; Wilhelm Land.

Here described from the types, 200 to 300 mm. in total length, from Cape Adare, 4 to 8 fathoms.

Family 4. Chænichthyidæ.

This family differs externally from the Nototheniidæ in the naked body, produced spatulate snout, and non-protractile mouth. The skeleton of *Champsocephalus esox* shows several peculiarities. The skull is depressed, with the long rostral lamina formed by the frontals and the ethmo-vomer; the parasphenoid meets the frontals between the small lateral ethmoids at the anterior margin of the orbit. The palatine is represented by the maxillary process, attached to the lateral edge of the rostral lamina near its anterior end, and by a posterior portion articulating with the lateral ethmoid, these being connected by a long and slender ligament; the pterygoid is slender, and there is no mesopterygoid. The præorbital is large, but the suborbitals are unossified. The pectoral arch is as in *Notothenia*. There are 57 vertebræ (28 + 29); the epipleurals are sessile, but the ribs are not ossified.

I have ascertained that *Chænichthys* and *Pagetopsis* are essentially similar in the structure of the rostrum, the palato-pterygoids and the pectoral arch, and in the absence of ribs. In all the genera the mouth is very distensible and the dentaries are freely movable on the articulars; this is the case, to a certain extent, in the Bathydraconidæ also.

Synopsis of the Genera.

I. Two lateral lines; pelvic fin-rays all branched or bifid, the middle ones the longest.

A. Lateral line without bony plates; a spinous dorsal fin, subcontinuous with the soft dorsal.

No spine on snout; spinous dorsal of 9 or 10 spines, not more than $\frac{1}{3}$ the length of soft dorsal . . . . 1. *Champsocephalus.*

A median spine near end of snout; spinous dorsal of 12 to 15 spines, more than $\frac{1}{2}$ as long as soft dorsal . . . . 2. *Pagetopsis.*

B. Lateral line with bony plates.

A spinous dorsal fin . . . . 3. *Chænichthys.*

No spinous dorsal fin . . . . 4. *Parachænichthys.*

II. Two lateral lines; outer rays of pelvic fins longest; dorsal fins separated by an interspace; lateral line without bony plates . 5. *Chænocephalus.*

III. Three lateral lines.

Pelvic fins of moderate length . . . . 6. *Chionodraco.*

Pelvic fins elongate, the rays simple . . . . . . 7. *Cryodraco.*

1. *Champsocephalus*, Gill 1861.

Proc. Acad. Philad., p. 509.

Body naked, elongate; 2 lateral lines, without bony plates. Eye nearly in middle of length of head; no spine on snout. Jaws with rather narrow bands of small sharp teeth, forming only 2 series laterally; lower jaw not projecting. Gill-rakers short, but well developed on all the branchial arches, dentigerous, about 20 on lower part of anterior arch. Spinous dorsal fin well developed, its base less than $\frac{1}{3}$ that of the soft dorsal, with which it is almost continuous; pelvics comparatively short, with the rays normally branched, the middle ones the longest.

Patagonia; Magellan Straits; South Georgia.

(1) *Champsocephalus esox.* (Pl. X. fig. 1.)

Chænichthys esox, Günth., *Ann. Mag. Nat. Hist.* (3), vii., 1861, p. 89.

Depth of body 7 to 8 in the length, length of head 3 to $3\frac{1}{3}$. Snout a little longer than postorbital part of head. Diameter of eye 7 in the length of head, interorbital width 4 to 5. Supraorbital edges not raised. Maxillary extending to below anterior part or middle of eye. Uppermost opercular spine shorter than and quite distinct from the middle one. Dorsal (IX) X, 33–36. Anal 32–35.

Body with dark cross-bars.

Patagonia; Magellan Straits.

Here described from five specimens, 200 to 300 mm. in total length, including the type of the species.

(2) *Champsocephalus gunnari.* (Pl. X. fig. 2.)

Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 37 (1905).

Depth of body $6\frac{1}{2}$ in the length, length of head $3\frac{1}{2}$. Snout as long as postorbital part of head. Diameter of eye 5 in the length of head, interorbital width $3\frac{1}{2}$. Supraorbital edges not raised. Maxillary extending to below anterior $\frac{1}{3}$ of eye. Uppermost and middle opercular spines only free distally, appearing as a single bifid spine. Dorsal IX (X), 37–40. Anal 36–38. Plumbeous, with some broad darker cross-bars.

South Georgia.

Here described from a specimen of 420 mm.

2. *Pagetopsis*, gen. nov.

Body naked, moderately elongate; two lateral lines, without bony plates. Eye behind middle of length of head; an antrorse curved spine near end of snout. Teeth in jaws small, sharp, biserial; lower jaw slightly projecting; gill-rakers vestigial or absent. Spinous dorsal fin well developed, its base more than $\frac{1}{2}$ that of the soft dorsal; pelvics rather long, the rays bifid or slightly branched.

Coasts of the Antarctic Continent.

Pagetopsis macropterus.

Champsocephalus macropterus, Bouleng., *Nat. Antarctic Exped. Nat. Hist.*, ii., *Fish.*, p. 3, pl. i.; Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 174 (1912).

Depth of body 4 to 5 in the length, length of head $2\frac{3}{5}$ to $2\frac{4}{5}$. Snout nearly $\frac{1}{2}$ the length of head. Diameter of eye 5 in the length of head, interorbital width 4. Maxillary extending to below anterior $\frac{1}{3}$ of eye. 3 or 4 opercular spines, the uppermost with an antrorse hook. Dorsal XII–XV, 28–31. Anal 25–27. Pectoral $\frac{3}{5}$, pelvics $\frac{3}{4}$ the length of head. Dark spots and vermiculations on head; irregular double cross-bars on body.

Victoria Land; Wilhelm Land.

Here described from the types, 160 to 250 mm. in total length, from the stomach of a seal near Cape Armitage, Ross Island.

3. *Chænichthys*, Richards., 1844.

"*Erebus*" *and* "*Terror*" *Fish.*, p. 12; Günth., *Cat. Fish.*, ii. p. 249 (1860).

Differs from *Champsocephalus* in having a spine on the snout, the teeth in broader bands, and in the bony plates of the lateral line. Dorsal fins separated by an interspace. Gill-rakers short, dentigerous.

Kerguelen.

(1) *Chænichthys rhinoceratus.*

Richards., *t.c.*, p. 13, pl. vi.; Günth., *Cat. Fish.*, ii. p. 249 (1860); Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 193.

Depth of body 6 in the length, length of head $2\frac{2}{3}$. Snout nearly $\frac{1}{2}$ the length of head. Diameter of eye $5\frac{1}{2}$ to $6\frac{1}{2}$ in the length of head, interorbital width 5 to $5\frac{1}{2}$. Maxillary extending beyond middle of eye (adult). Head moderately rugose; supraorbital edges slightly raised. Dorsal VII, 33–34. Anal 30–33. Second and third rays of spinous dorsal longest, thence decreasing rapidly. 79 to 84 plates in upper lateral line; a few plates on middle of side. Brownish, with darker spots and reticulations.

Description from the type, a specimen of 450 mm. and a second example of 175 mm., from Kerguelen.

(2) *Chænichthys rugosus*, sp. n.

Eye smaller than in *C. rhinoceratus*, diameter 8 in head. Head rougher and supraorbital edges more elevated. Maxillary shorter, not quite reaching middle of eye. Dorsal VIII, 30; third and fourth spines longest, fifth as long as first. Anal 29. 62 plates in upper lateral line; a nearly continuous series of plates on middle of side.

A specimen of 400 mm. from Kerguelen.

A stuffed example with VIII, 34 dorsal and 30 anal rays, and 72 plates in the lateral line, appears to belong to this species.

4. *Parachænichthys*, Bouleng., 1902.

"*Southern Cross*" *Pisces*, p. 176.

Differs from *Chænichthys* in the absence of the spinous dorsal fin.

South Georgia; Graham Land.

Parachænichthys georgianus.

Chænichthys georgianus, Fischer, *Jahrb. Hamburg Wiss. Anstalt*, ii., 1885, p. 50, pl. i. figs. 1, 2.
? ,, *charcoti*, Vaillant, *Expéd. Antarct. Française, Poiss.*, p. 39, fig.

Maxillary not nearly reaching the vertical from anterior margin of eye. Interorbital region narrow, its width less than ½ the diameter of eye. Dorsal 44. Anal 32.

South Georgia; Graham Land.

Total length 490 mm.

It seems probable that the imperfect fish described by VAILLANT, from Graham Land, belongs to this species. The figure of the upper surface of the head is at first sight rather different from FISCHER'S, but the differences may be due to the expansion of the jaws and opercles and the smaller size of the specimen (head 136 as against 173 mm.).

5. *Chænocephalus*, gen. nov.

Body naked, elongate; two lateral lines without distinct bony plates. Eye somewhat behind middle of head; a small prominence at anterior end of ethmoid; jaws with small sharp teeth forming rather broad bands, there being several series even at the sides; lower jaw not projecting; gill-rakers absent except for 3 or 4 very short ones below the angle of the first arch. Spinous dorsal fin well developed, its base about ¼ that of the soft dorsal, from which it is separated by an interspace; pelvics comparatively short, with the two outer rays the longest, enveloped in thick skin, but bifid, the others normally branched.

South Georgia.

Chænocephalus aceratus. (Pl. XI.)

Chænichthys aceratus, Lönnberg, *Kungl. Svensk. Vet.-Akad. Handl.*, xl., 1906, No. 5, p. 97.

Depth of body 5 to 6 in the length, length of head $2\frac{1}{2}$ to $2\frac{3}{4}$. Snout a little less than $\frac{1}{2}$ the length of head. Diameter of eye 5 to 6 in the length of head, interorbital width about 5. Supraorbital edges raised; operculum with 3 radiating ridges ending in spines, the uppermost bifid. Maxillary extending to below middle of eye or beyond. Dorsal VII–VIII, 39–40; third spine longest, $\frac{1}{3}$ to more than $\frac{2}{5}$ the length of head. Anal 37–38. Pectoral and pelvic fins subequal in length, nearly $\frac{1}{2}$ the length of head. Greyish, with 4 or 5 dark cross bands, the first from spinous dorsal through base of pectoral, the second downwards from origin of soft dorsal, the others less regular and sometimes with narrower bars developed between them.

South Georgia.

Four specimens, 480 to 530 mm. in total length, collected by Mr David Ferguson, and presented to the Scottish Oceanographical Laboratory by Messrs Salvesen.

6. *Chionodraco*, Lönnberg, 1906.

Kungl. Svensk. Vet.-Akad. Handl., xl., No. 5, p. 99.

Apparently intermediate between *Chænocephalus* and *Cryodraco*, resembling the former in fin-structure, the latter in the three lateral lines and the well-developed rostral spine.

Graham Land.

Chionodraco hamatus.

Chænichthys rhinoceratus subsp. *hamatus*, Lönnberg, *Swedish South Polar Exped.*, *Fish.*, p. 47 (1905).
Chionodraco hamatus, Lönnberg, *Kungl. Svensk. Vet.-Akad. Handl.*, xl., 1906, No. 5, p. 99.

Head 3 in total length (with caudal). Snout nearly $\frac{1}{2}$ length of head, nearly twice diameter of eye, and $1\frac{4}{7}$ interorbital width. Dorsal VII, 37. Anal 33.

Snow Hill.

Total length 330 mm.

7. *Cryodraco*, Dollo, 1900.*

Bull. Acad. Roy. Belg. Sciences, p. 129.

Differs from *Chænocephalus* especially in the structure of the pelvic fins, with the rays simple, the two outer enlarged and prolonged, and in the presence of an additional lateral line at the base of the anal fin.

Graham Land; Wilhelm Land.

(1) *Cryodraco antarcticus.*

Dollo, *t.c.*, p. 130, and *Rés. Voy. "Belgica," Poiss.*, p. 20, pl. i. pl. v. fig. 7 (1904).

Depth of body 8 in the length, length of head $3\frac{1}{3}$. Snout 2, eye 4, interorbital width 5 in the length of head. Dorsal III, 44. Anal 43. Pelvic fin more than $\frac{1}{2}$ the length

* A fish from Wilhelm Land, 69 mm. long, is recorded by Pappenheim under the name *Pagetodes antarcticus*. The number of fin-rays (D IV, 31. A 31) scarcely justifies this determination, and the fish may well belong to an undescribed species. But as it is so juvenile and even its generic position uncertain, I refrain from giving it a specific name.

of the fish, extending nearly to end of dorsal fin. Body with 7 dark transverse bands.

71° 18′ S., 88° 2′ W., 450 metres.

Total length 200 mm.

(2) *Cryodraco pappenheimi*, sp. n.

Pagetodes * *antarcticus* (*non* Dollo), Pappenheim, *Deutsche Südpolar-Exped.*, xiii., *Zool.*, v. p. 175.

Length of head $2\frac{3}{5}$ in the length of the fish. Snout 2 in the length of head, diameter of eye 5, interorbital width 4. Dorsal V, 45. Anal 39. Pelvics only reaching fourteenth ray of dorsal (the prolonged rays perhaps not entire).

Wilhelm Land.

Length of the type, 168 mm. to base of caudal. This species is known to me only from Dr PAPPENHEIM's description and from some notes and measurements that he has kindly sent me. Some of these may be given for comparison with those of the type of *C. antarcticus*. The measurements are in millimetres.

	Length to Base of Caudal.	Head to End of Opercular Flap.	Head to End of Bony Operculum.	Snout.	Eye.	Interorbital Width.
C. antarcticus	173	?56	53	26·5	13·25	10·6 †
C. pappenheimi	168	68	?64	32	13	16

IV. THE SYSTEMATIC POSITION AND GEOGRAPHICAL DISTRIBUTION OF THE GALAXIIDÆ AND HAPLOCHITONIDÆ.

The Galaxiidæ and Haplochitonidæ are Teleostean fishes of the order Isospondyli, that is to say, they are malacopterous physostomes with a truly homocercal caudal fin, with abdominal pelvic fins, and with ribs inserted on autogenous parapophyses. In this order the name Salmonoid may be given to a group of fishes with an adipose fin usually present, with one supramaxillary or none, with parietals well developed, and with oviducts absent or incomplete. The relations of the Salmonoid families are indicated in the following synopsis :—

I. An orbitosphenoid ; an opisthotic ; a mesocoracoid ; vertebræ upturned at base of caudal fin . . . . 1. *Salmonidæ.*

II. An orbitosphenoid ; no opisthotic ; no upturned vertebræ ; meso-pterygoids toothless.

A mesocoracoid ; parapophyses inferior . . . . . 2. *Argentinidæ.*

No mesocoracoid ; parapophyses lateral . . . . . 3. *Microstomidæ.*

* The fish named *Pagetodes* by RICHARDSON ("*Erebus*" *and* "*Terror*" *Fish.*, p. 15, pl. viii. fig. 3) may have belonged to the genus *Cryodraco*, but in the form of the body, the length of the pelvic fins, and the continuous dorsals it shows more resemblance to *Pagetopsis*. Until RICHARDSON's species is rediscovered, the name *Pagetodes* cannot be used.

† DOLLO's figure of the upper surface of the head is enlarged, the length of the head, to the end of the bony operculum, to 80 mm. and the interorbital width to 16 mm.

III. No orbitosphenoid; no opisthotic; no upturned vertebræ; mesopterygoids toothed (absent in Salangidæ).

A. A mesocoracoid; maxillaries dentigerous, entering gape . 4. *Osmeridæ.*

B. No mesocoracoid; maxillaries dentigerous, entering gape.

Head compressed; mesopterygoid well developed, dentigerous; ribs ossified. 5. *Retropinnatidæ.*

Head strongly depressed; no mesopterygoid; ribs not ossified 6. *Salangidæ.*

C. No mesocoracoid; maxillaries toothless, behind præmaxillaries.

Præmaxillaries not extending whole length of maxillaries; roof of myodome unossified; no adipose fin . . . . . . 7. *Galaxiidæ.*

Præmaxillaries nearly reaching extremities of maxillaries; roof of myodome ossified; an adipose fin . . . . . 8. *Haplochitonidæ.*

The Argentinidæ and Microstomidæ are inhabitants of rather deep water, but the rest are littoral fishes, many of them entering fresh water and often forming colonies, races, or species confined to fresh water.

It is of some interest to note that the Galaxiidæ and Haplochitonidæ are related to, but more specialised than, the Osmeridæ, or Smelt family, of northern seas. *Retropinna*, from the coasts and rivers of Australia and New Zealand, is still nearer to the Galaxiidæ and Haplochitonidæ; both these families occur in Australia, Tasmania, New Zealand, South America, and the Falkland Islands, and there are even two species of *Galaxias* at the Cape of Good Hope. All the species enter fresh water, and the majority seem to be strictly fluviatile or lacustrine, but in a few cases species of *Galaxias* have been observed in the sea.

In 1906 (*Proc. Zool. Soc.*, 1905, ii. pp. 363–384, pls. x.–xiii.) I published a revision of the Galaxiidæ, and then wrote:—

"The occurrence of *Galaxias maculatus* in the sea has been recorded by Valenciennes and by Philippi, off the Falkland Islands and off the coast of Chile respectively. The observations of Johnston in Tasmania and of Hutton and Clarke in New Zealand are to the effect that *Galaxias attenuatus* descends to the sea periodically to spawn. Mr Rupert Vallentin has seen shoals of little fishes, which I identify with the *Galaxias gracillimus* of Canestrini, in the sea at the Falkland Islands. Recently *Galaxias brevipinnis* also has been found to be marine, *G. bollansi*, described by Hutton from the Auckland Islands, proving to be identical with this species."

Waite (*Subantarctic Islands of New Zealand*, p. 586) has recently shown that Hutton's conclusion as to the marine habit of *G. brevipinnis* was probably incorrect. Eigenmann (*Rep. Princeton Exped. Patagonia*, iii., *Zool.*, 1909, p. 274) says of *G. gracillimus*: "This is undoubtedly the young of *attenuatus*"; and if this opinion, which does not appear to be the result of an examination of specimens, be accepted, the known marine species of *Galaxias* would be reduced to two only.

In my revision I distinguished *G. gracillimus* from *G. attenuatus* by the more slender form, the smaller head, etc. My specimens, 53–55 mm. in total length, were of the same size as the smallest examples of *G. attenuatus*, but, bearing in mind the extraordinary larval history of *Anguilla*, *Albula*, etc., I wrote: "Possibly this species may be based on a larval form of *G. attenuatus*, but if so it is remarkable that it has been recorded only from South America, and that larval forms of other species have not been described." A series of *Galaxias attenuatus* from the Falkland Islands, since received from Mr VALLENTIN, includes specimens of 20 to 30 mm. which agree with those of 55 to 60 mm. in form, size of head, etc., and show pretty conclusively that *G. gracillimus* does not represent a stage in the life-history of this species. Mr VALLENTIN's collection also includes some young examples of *G. smithii*, hitherto known only from the type from Sir ANDREW SMITH's collection; these are yellowish, with numerous brownish irregular vertical stripes.

The South American species of *Galaxias* are seven in number, viz.:—

1. *Galaxias attenuatus*, Jenyns, 1842.

S.E. Australia; Tasmania; New Zealand and neighbouring islands; Chile; Patagonia; Tierra del Fuego; Falkland Islands.

2. *Galaxias gracillimus*, Canestrini, 1864.

Chile; Falkland Islands.

3. *Galaxias maculatus*, Jenyns, 1842.

Chile; Patagonia; Tierra del Fuego; Falkland Islands.

4. *Galaxias alpinus*, Jenyns, 1842.

Alpine lakes of Tierra del Fuego.

5. *Galaxias bullocki*, Regan, 1908.

Ann. Mag. Nat. Hist. (8), i. p. 372.

Temuco, Chile.

6. *Galaxias platei*, Steind., 1897.

Galaxias titcombi, Everm. and Kendall, *Proc. U.S. Nat. Mus.*, xxxi., 1907, p. 92, fig.

Patagonia; Argentina.

7. *Galaxias smithii*, Regan, 1906.

Falkland Islands.

It should be noted that only the marine species occur both at the Falkland Islands and on the continent of South America, and there can be little doubt that *Haplochiton zebra*, with this distribution, will prove to be marine.

The conclusion that the Galaxiidæ are originally marine and are establishing themselves in fresh water is strengthened by their relationship to the Osmeridæ; their distribution has little bearing on the question of a former extension of the Antarctic Continent.

The expense of the publication of this Memoir is defrayed from the Government Publication Grant administered by the Royal Society of London.

LIST OF THE PLATES.

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Raia magellanica × $\frac{1}{2}$.

Plate II.

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Fig. 2. ,, *wiltoni.*

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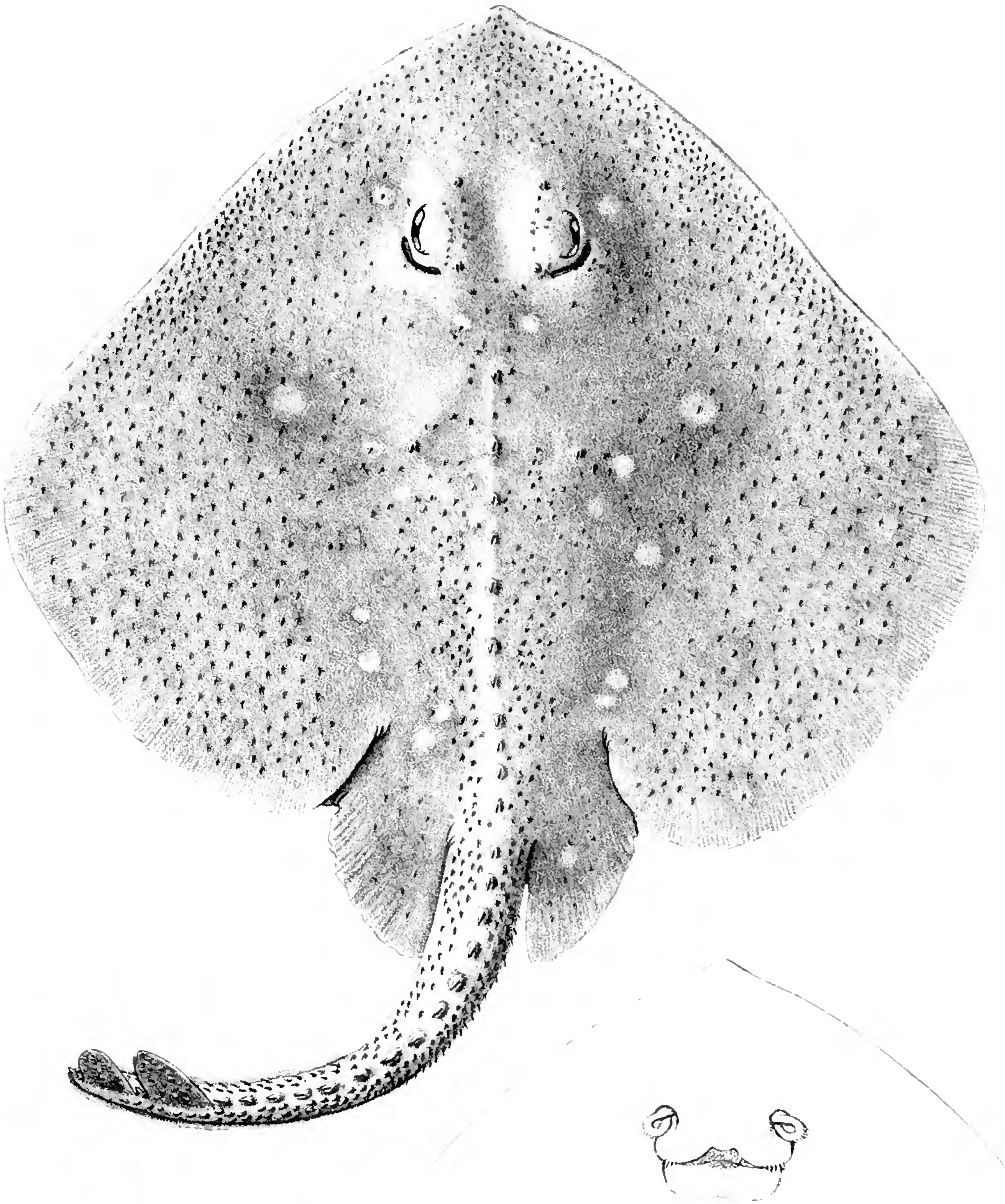
Plate X.

Fig. 1. *Champsocephalus esox.*
Fig. 2. ,, *gunnari* × $\frac{7}{12}$.

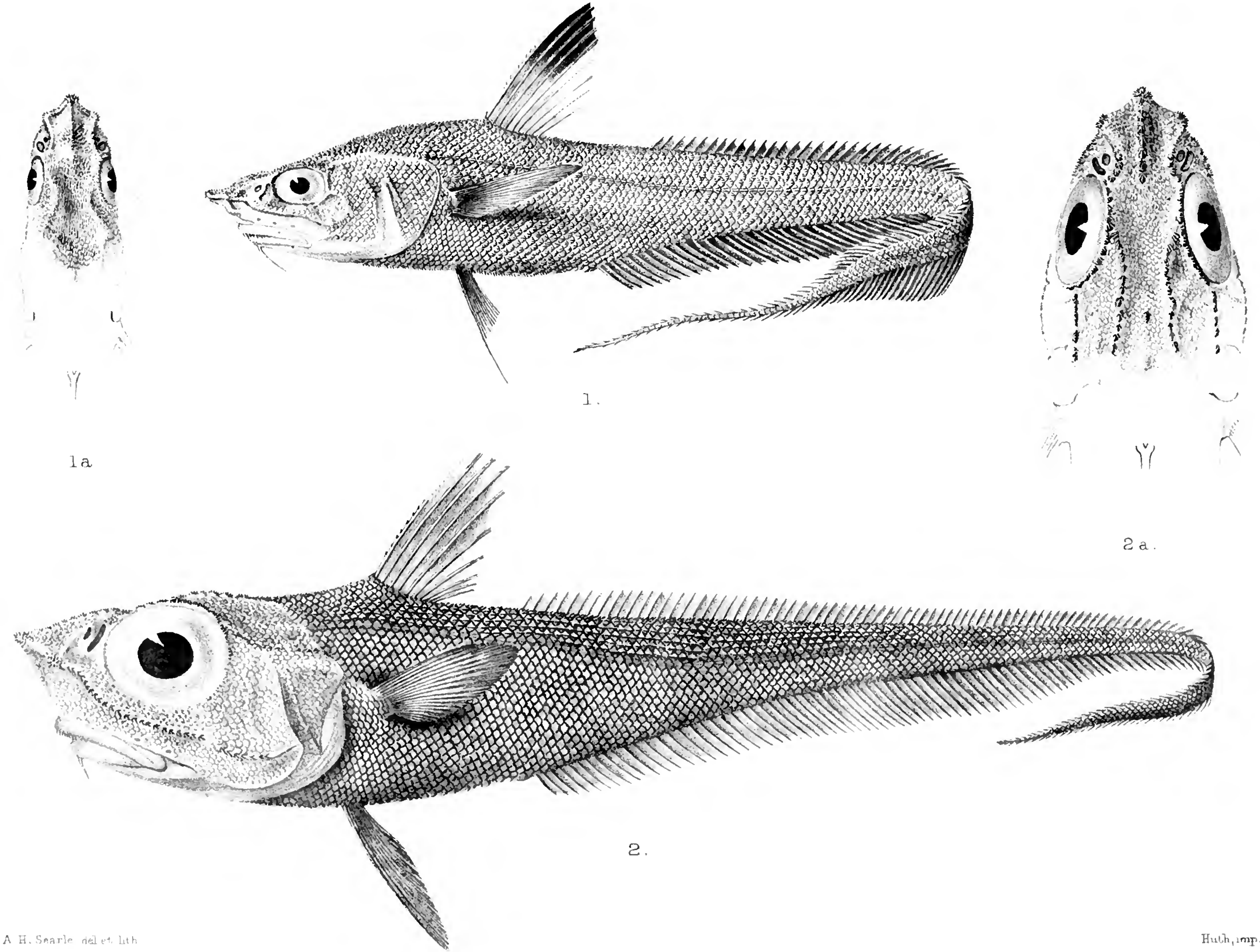
Plate XI.

Chænocephalus aceratus.



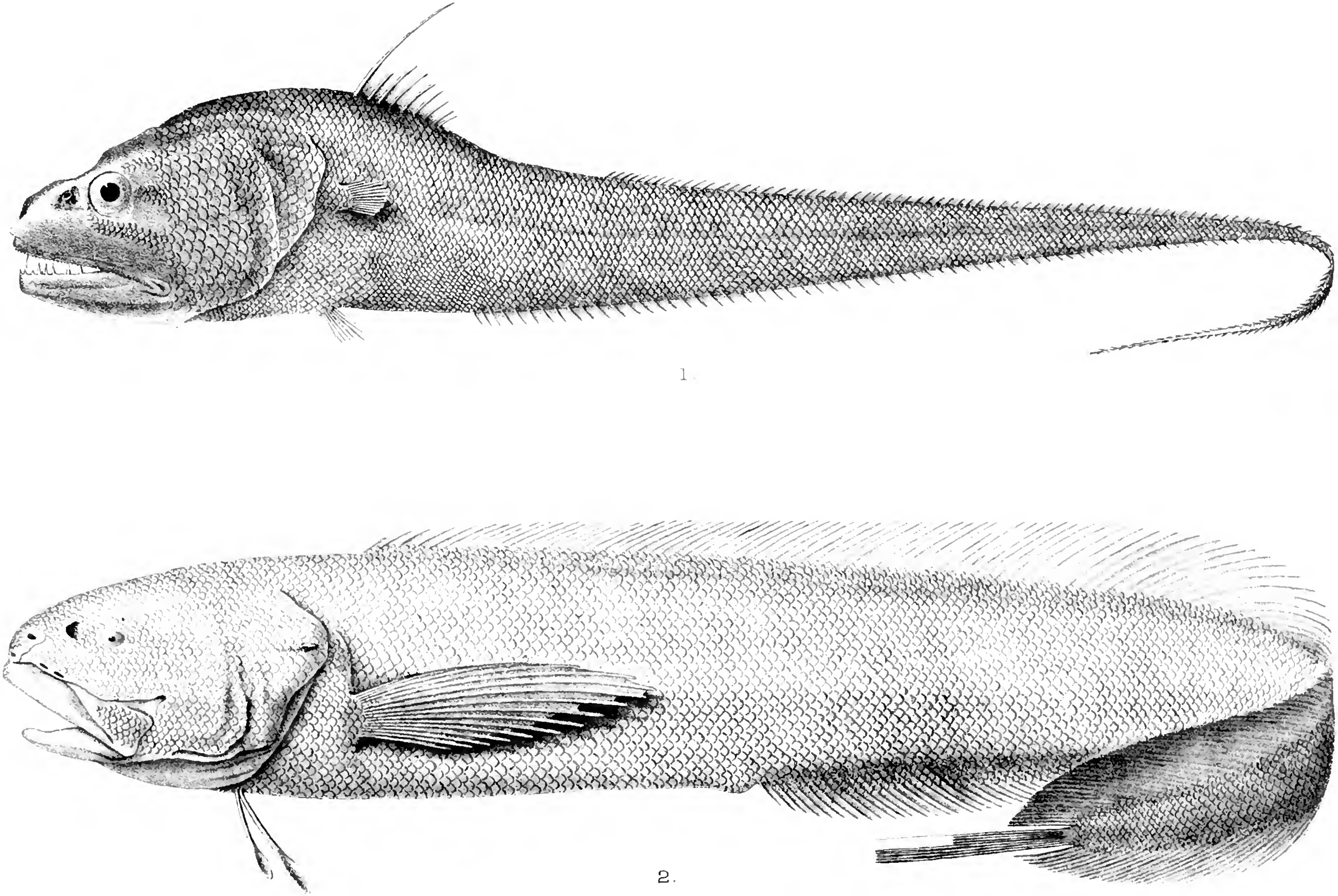
A. H. Searle, del. et lith. Huth, imp.

RAIA MAGELLANICA.



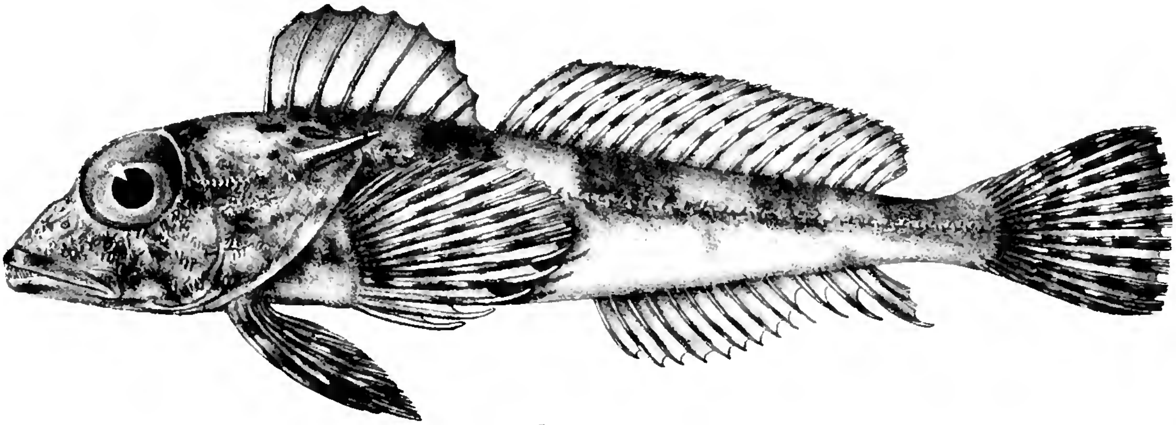
A. H. Searle del. et lith.   Huth, imp.

1. CHALINURA FERRIERI   2. CHALINURA WHITSONI.



A H Searle del. et lith. Huth imp.

1. CYNOMACRURUS PIRIEI. 2. NEOBYTHITES BRUCII.



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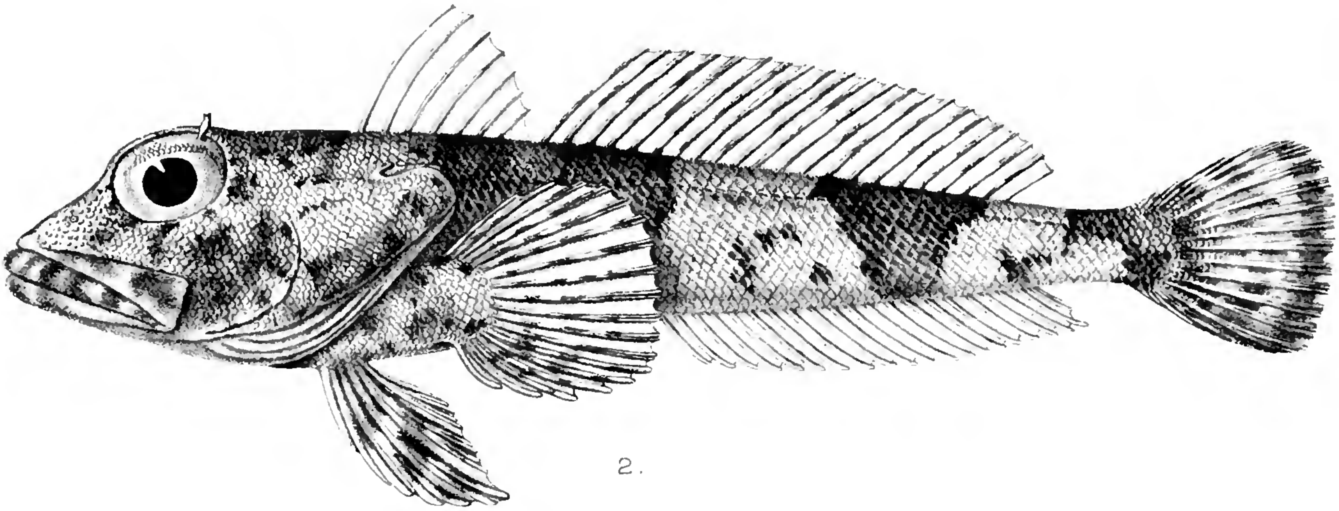

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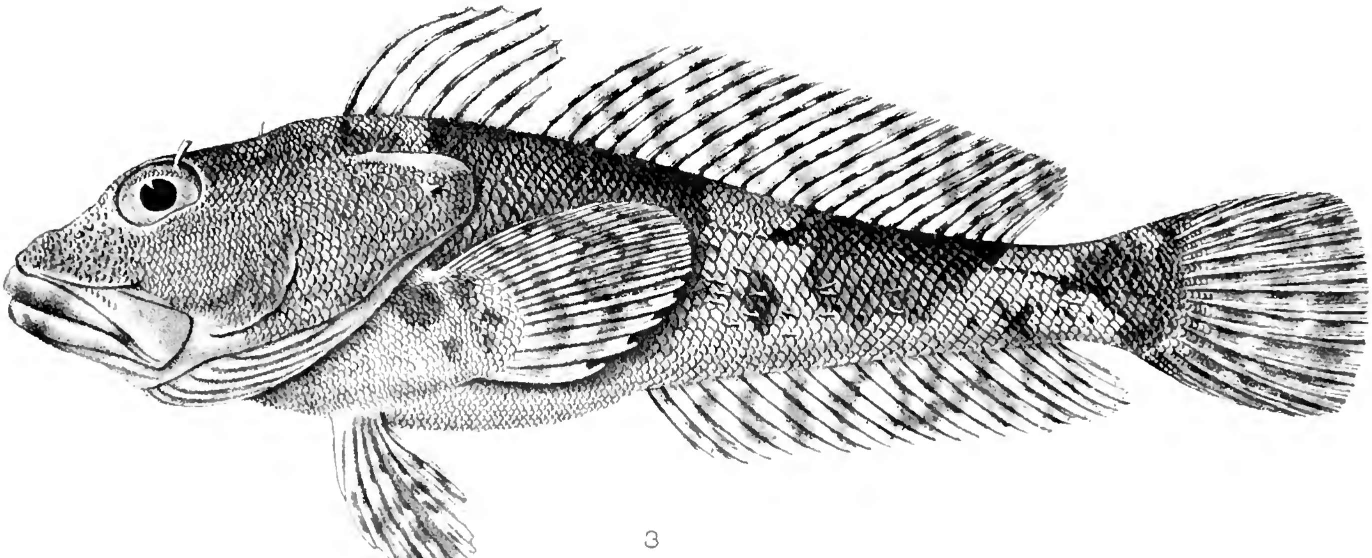

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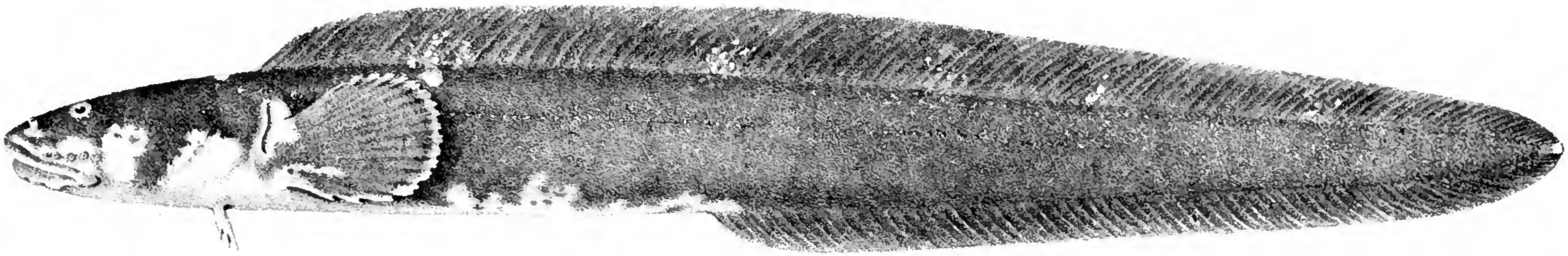
A. H. Searle, del. et lith. Huth imp.

1. BOVICHTHYS ANGUSTIFRONS.
2. COTTOPERCA MACROPHTHALMA. 3. C. GOBIO



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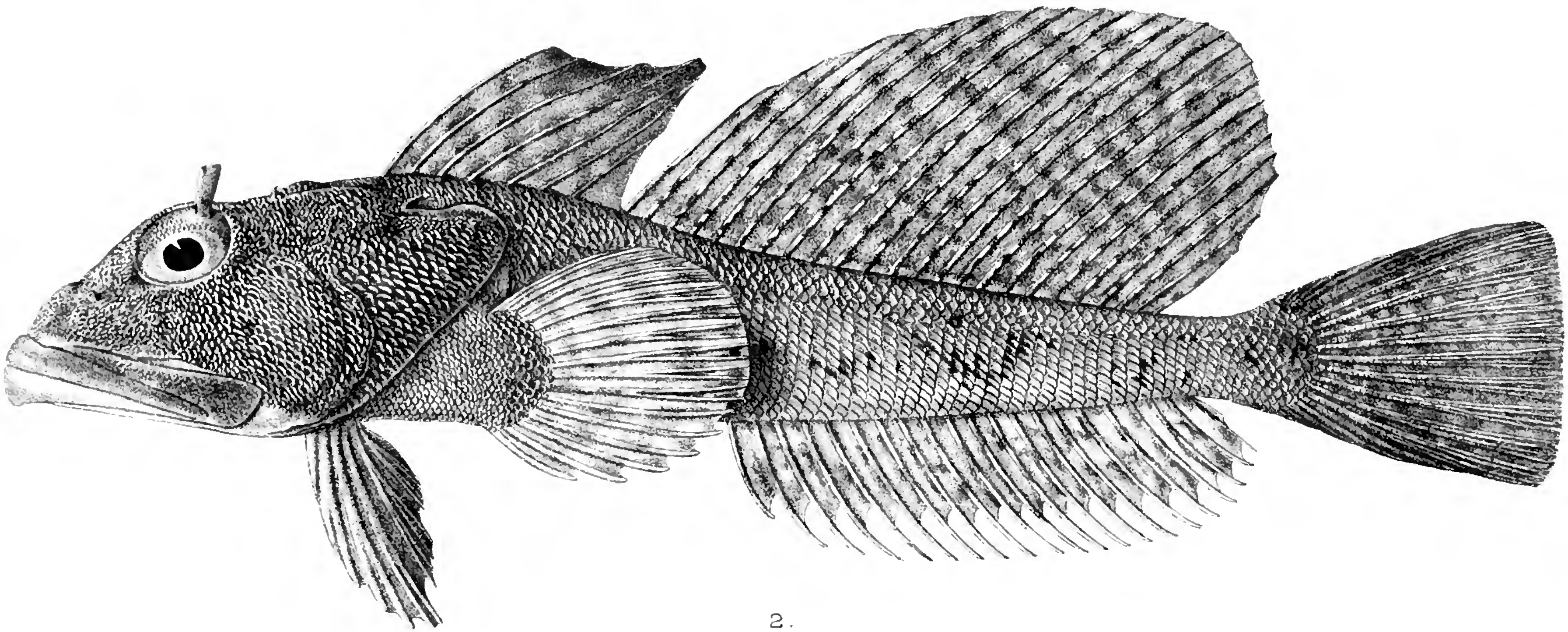

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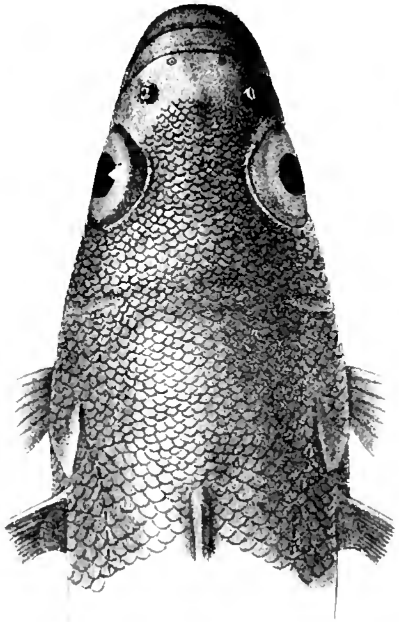
A. H. Searle del. et lith. Huth imp.

1. AUSTROLYCUS DEPRESSICEPS. 2. COTTOPERCA MACROPHTHALMA. *ADULT.*



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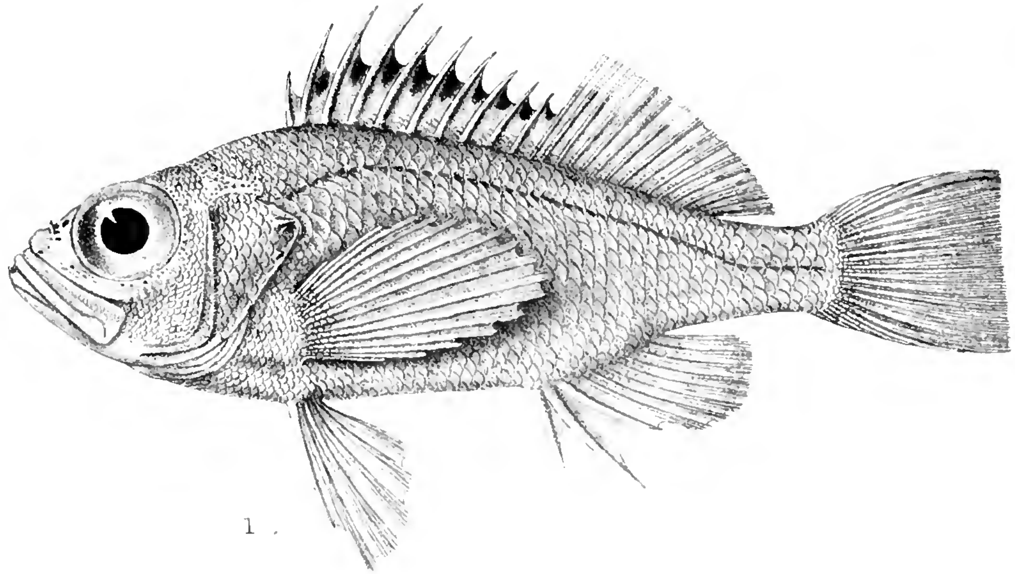

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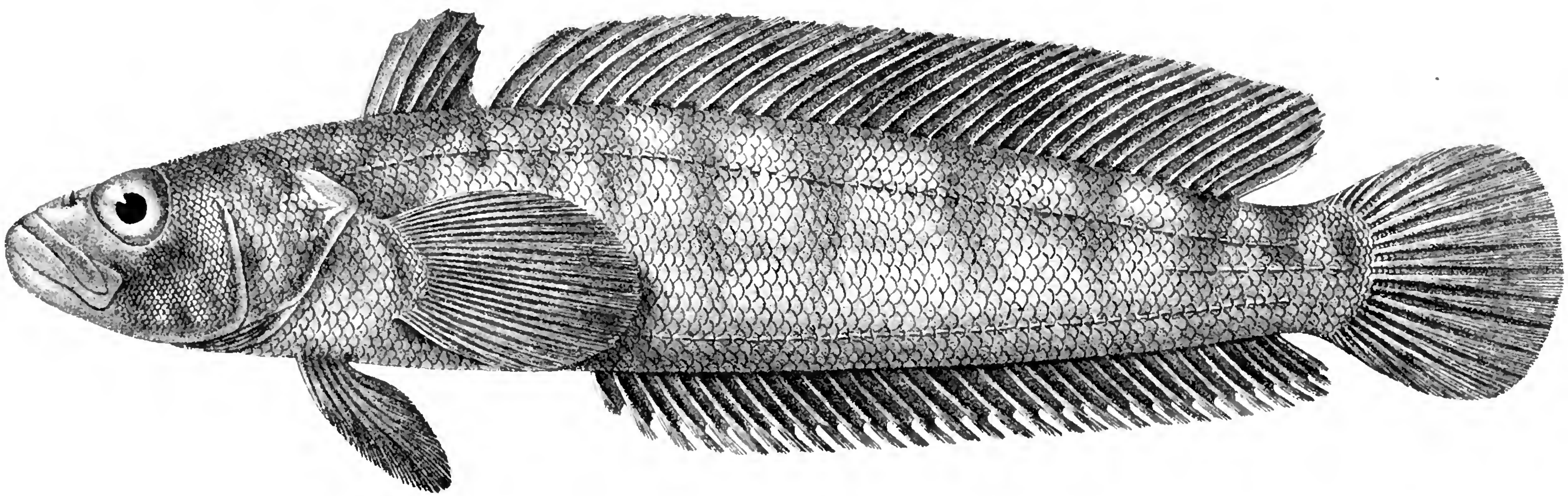
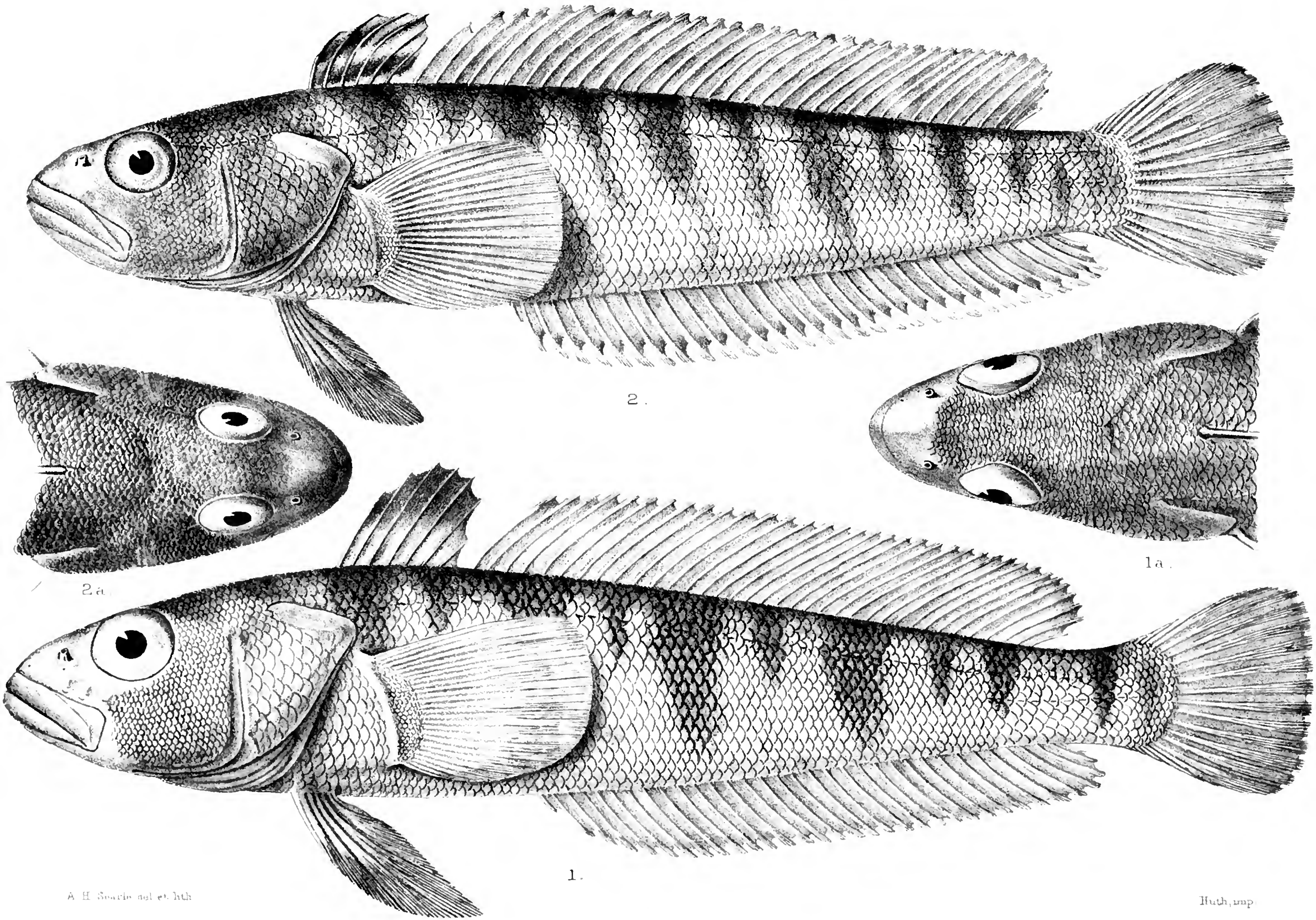


2.

A. H. Searle del et lith

1. CAESIOPERCA COATSII. 2. NOTOTHENIA TRIGRAMMA.

Huth imp

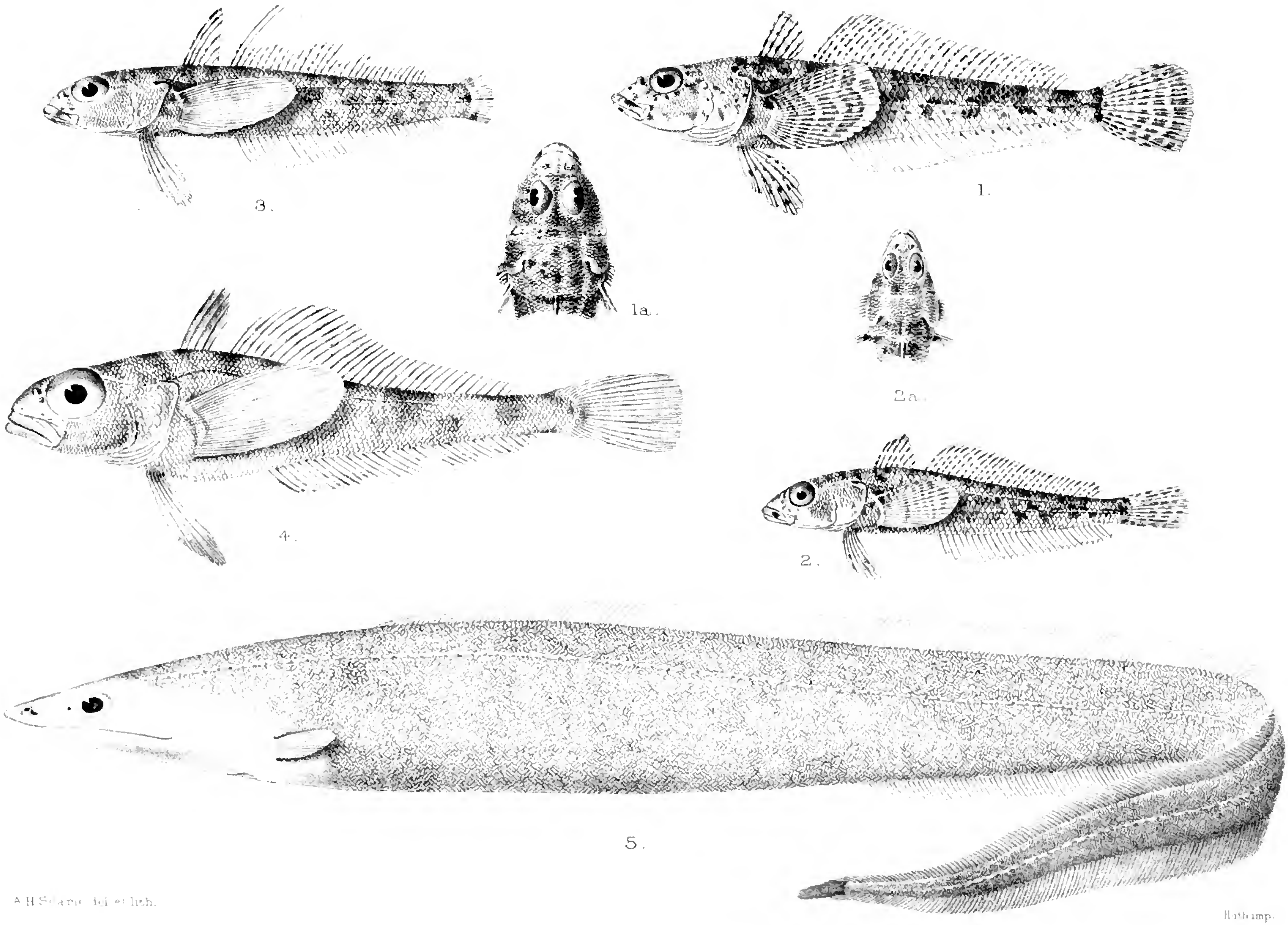


A. H. Searle del. et lith.

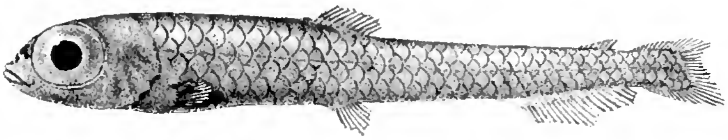
Huth, imp.

1. NOTOTHENIA RAMSAYI. 2. NOTOTHENIA WILTONI.

Regan: "Scotia" Antarctic Fishes, Pl. VIII.



1. NOTOTHENIA ANGUSTIFRONS. 2. N. MARIONENSIS. 3. N. ACUTA.
4. TREMATOMUS LOENNBERGII. 5. SYNAPHOBRANCHUS AUSTRALIS.



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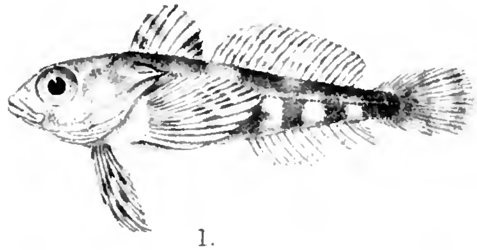

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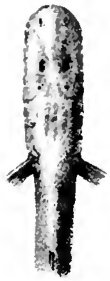
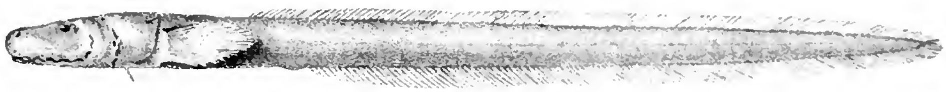


3a.



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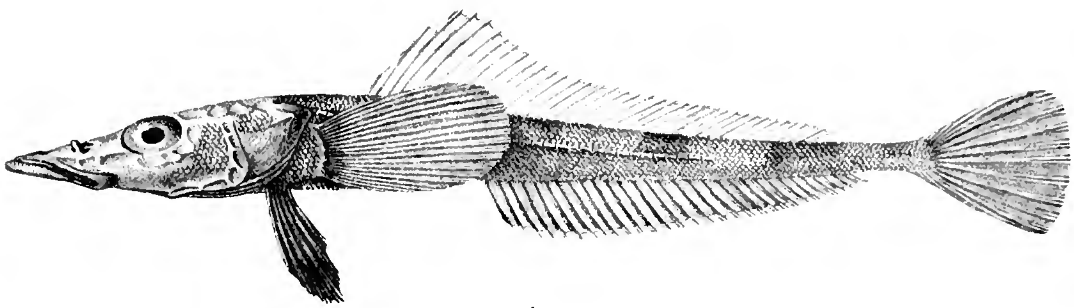

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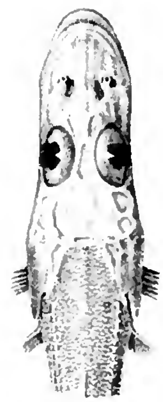

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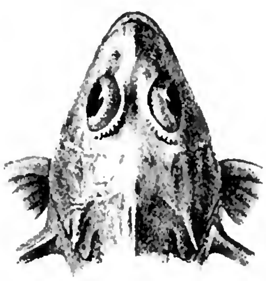

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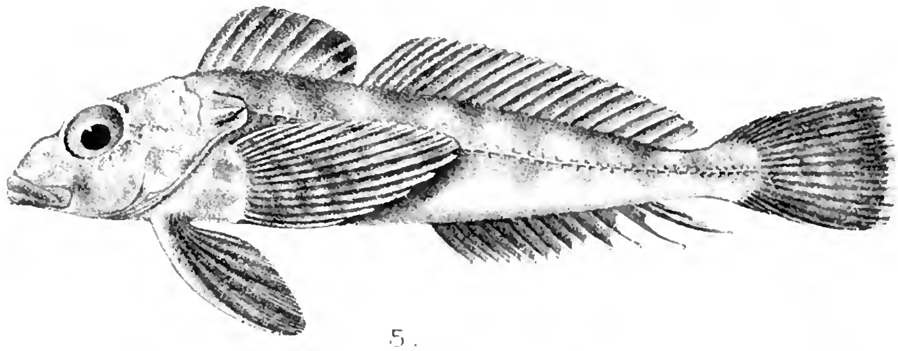


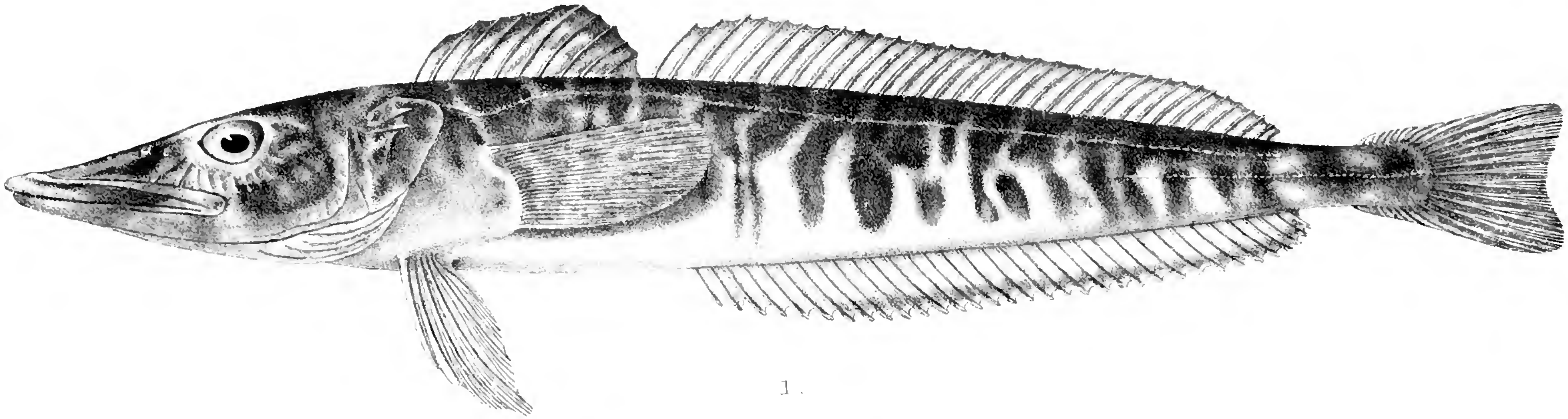
5.

A.H. Searle del. et lith.

Huth imp.

1. BOVICHTHYS DECIPIENS 2. BATHYLAGUS GLACIALIS.
3. LYCENCHELYS ANTARCTICUS 4. BATHYDRACO SCOTIAE.
5. BOVICHTHYS DIACANTHUS.

Regan: "Scotia" Antarctic Fishes. Pl. X.



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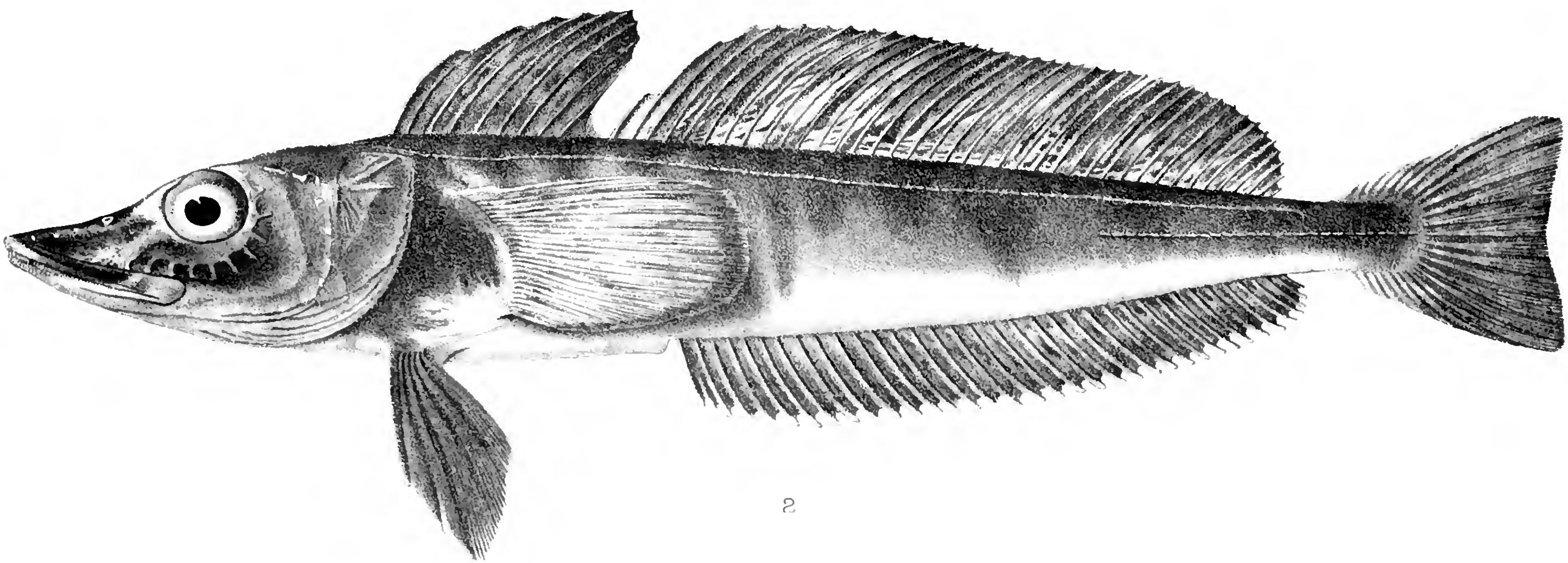
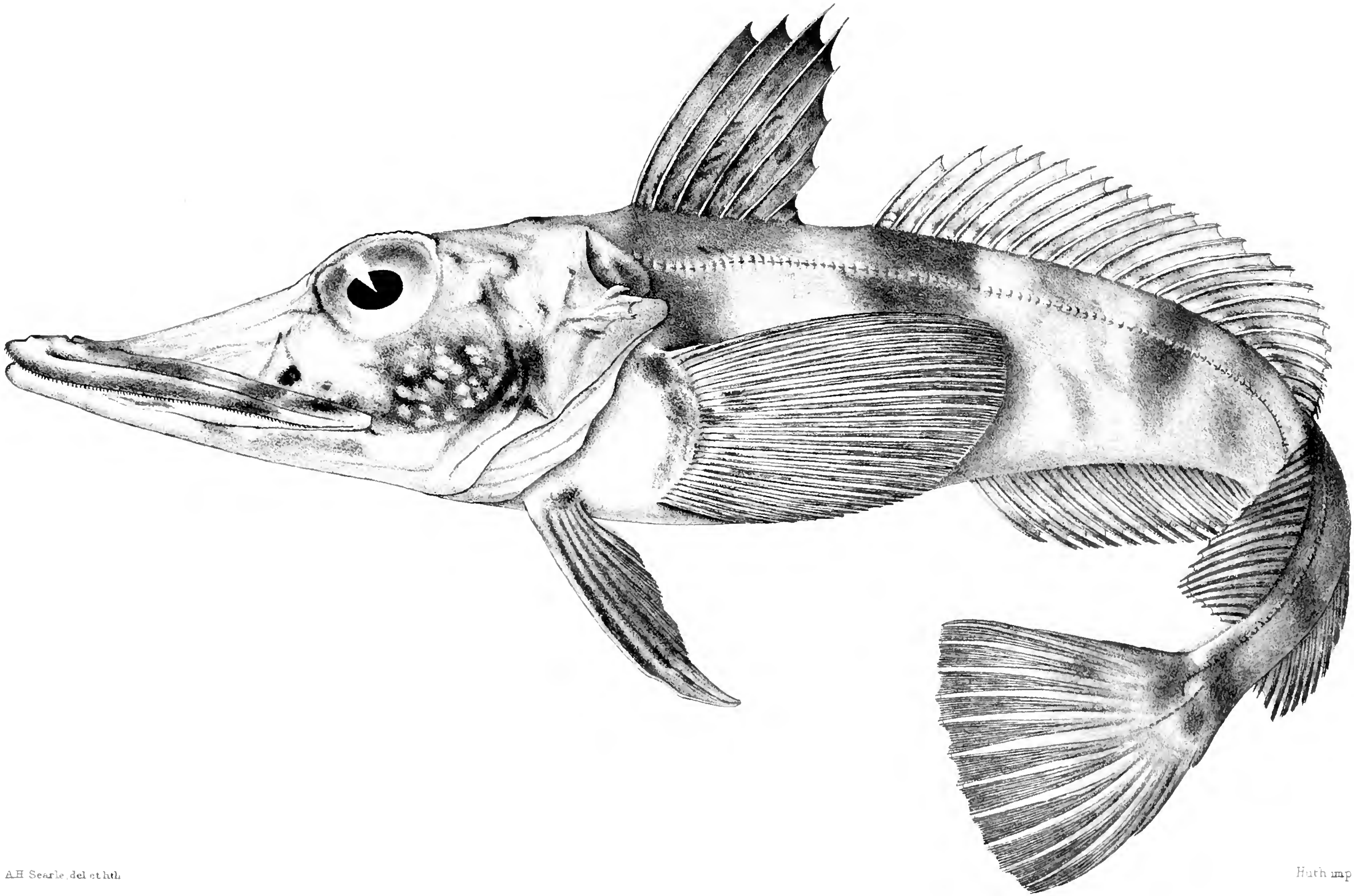


2

A H Searle del et lith

1. CHAMPSOCEPHALUS ESOX. 2. C. GUNNARI.

Huth imp



A.H. Searle, del et lith.

Huth imp.

CHAENOCEPHALUS ACERATUS.

PART XVI.

F I S H E S.

XVI.—ATLANTIC FISHES OF SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

By R. S. CLARK, M.A., B.Sc.,
Scottish Oceanographical Laboratory, Edinburgh.

Scottish National Antarctic Expedition: "Scotia" Collection of Atlantic Fishes.

By **R. S. Clark**, M.A., B.Sc., Zoological Assistant, Scottish Oceanographical Laboratory, Edinburgh. (With Five Text-figures and Map.)

(MS. received January 14, 1913. Issued separately June 30, 1913.)

Introduction.

The fishes examined and discussed in the following pages were collected by Dr W. S. Bruce on the *Scotia* between latitudes 40° N. and 36° S.* The specimens number about seven hundred and fifty, and have been divided into two classes:

Littoral Fishes (p. 380).
Pelagic Fishes (p. 399).

The line of demarcation, however, is by no means clearly drawn, as several pelagic forms occur in the littoral, and several littoral forms in the open sea.

And first as to Littoral fishes. These, numbering about six hundred and fifty, were caught near the seven different points at which the *Scotia* touched, namely: Azores, Madeira, Cape Verde Islands, Ascension, St Helena, Cape Colony, and St Paul's Rocks. 79 genera are represented, comprising 116 species, none of which are new. Nevertheless, the collection is of importance as considerably increasing our knowledge of the geographical distribution of several of the species. As all have been previously described in detail, it is not intended to enter into particulars, except in the case of the St Helena fishes, where several points of special interest have been noticed. In certain other cases, a few notes have been appended, dealing with divergent characteristics of certain of the species.

With regard to Pelagic fishes, the number of specimens taken is considerably fewer than in the previous case, extending only to about a hundred. These are referred to 11 genera and 14 species. Here again, there are no new species.

Much of the work of identification has been carried out at the British Museum, where, through the courtesy of Dr Harmer, Keeper of Zoology, comparison was made available with the type specimens. To Mr C. Tate Regan, my heartiest thanks are due for the active assistance he has given me in the identification of many of the species, to Dr Bruce for the opportunity of making these investigations, and to Mr J. R. Park for help in compiling this report.

The whole collection is deposited in the Scottish Oceanographical Laboratory, Edinburgh, along with the more important Antarctic collections of the Scottish National Antarctic Expedition.

* *Vide* chart of the route of the *Scotia*, Vol. IV.

A.—Littoral Fishes.

I. Collection of Fishes from Horta Fayal, Azores.

Eleven species were secured by the Expedition from traps both inside and outside the breakwater on July 5th and 6th, 1904. One species, *Box vulgaris*, was taken in abundance. All have been previously recorded from these islands.*

Murænidæ

Muræna helena Linn.
,, *unicolor* (De la Roche).
Conger vulgaris Cuv.

Sphyrænidæ.

Sphyræna vulgaris (Linn.).

Gadidæ.

Phycis mediterraneus De la Roche.

Sparidæ.

Box vulgaris Cuv. and Val.
Pagrus vulgaris (Linn.).
Pagellus bogarareo (Brünn.).

Labridæ.

Coris julis (Linn.).

Carangidæ.

Trachurus trachurus (Linn.).

Scorpænidæ.

Scorpæna scrofa Linn.

II. Collection of Fishes from Madeira.

The collection of fishes from Madeira contains examples of twenty-five different species. Most of these were bought at the fishmarket of Funchal during the three

* Regan: "On a Collection of Fishes from the Azores," *Ann. Mag. Nat. Hist. Lond.* (Ser. 7), 12, 1903.
Collett: *Rés. Camp. Sci. de S.A.S. le Prince de Monaco*, fasc. x., Monaco, 1896.

days, November 20th to 22nd, 1902, that the *Scotia* remained there. As all of these species have been recorded either from Madeira* or from localities not far distant, a list only of those secured is given.

SQUALIDÆ.

Centrophorus squamosus (Gmelin).

RAIIDÆ.

Raia maderensis Lowe.

SCOMBRESOCIDÆ.

Belone gracilis Lowe.

MUGILIDÆ.

Mugil chelo Cuv.

SPHYRÆNIDÆ.

Sphyræna vulgaris (Linn.).

GADIDÆ.

Phycis mediterraneus De la Roche.

BERYCIDÆ.

Beryx decadactylus Cuv. and Val.

SERRANIDÆ.

Anthias sacer (Linn.).
Polyprion americanus (Bl. Schn.).
Serranus atricauda Günther.
Priacanthus cruentatus (Lacép.).

PRISTIPOMATIDÆ.

Smaris insidiator Cuv. and Val.

SPARIDÆ.

Pagrus vulgaris Cuv. and Val.
Pagellus centrodontus (De la Roche).

* Lowe : (*a*) "Fishes of Madeira," *Proc. Zool. Soc. Lond.*, 1833.
(*b*) "Synopsis of the Fishes of Madeira," *Trans. Linn. Soc*, vol. ii., London, 1841.

MULLIDÆ.

Mullus surmuletus Linn.

LABRIDÆ.

Labrus mixtus Fries och Ekstrom.
Cossyphus scrofa Cuv. and Val.

CARANGIDÆ.

Trachurus trachurus (Linn.).
Caranx dentex (Bl. Schn.).

TRICHIURIDÆ.

Aphanopus carbo Lowe.
Thyrsites prometheus (Cuv. and Val.).

ZEIDÆ.

Zeus faber Linn.

ECHENEIDIDÆ.

Echeneis brachyptera Lowe.

SCORPÆNIDÆ.

Sebastes kuhlii (Bowd.).
Scorpæna dactyloptera De la Roche.
Sebastes dactylopterus.

III. FISHES COLLECTED AT ST VINCENT, CAPE VERDE ISLANDS.*

Twenty species were secured during the short stay on 24th December 1902. Interesting occurrences at these islands are the West Indian species *Belone caribbæa* and *Mugil nigrostrigatus*, while the record of *Merluccius vulgaris* may prove the southern limit of this species.

SCOMBRESOCIDÆ.

Belone caribbæa Lesueur.
Hemirhamphus brasiliensis (Linn.).
Exocœtus obtusirostris Günther.

* *Vide* Günther, *Challenger Report*, "Shore Fishes."

Mugilidæ.

Mugil nigrostrigatus Günther.

The original locality of this species seems doubtful,* though it has been considered as belonging to the West Indian fish fauna. It is closely allied to *M. chelo*, a Mediterranean form, and the possibility is that the two are not distinct species. The *Scotia* specimen is identical with the types of *M. nigrostrigatus* in the British Museum, though much larger. Total length of specimen 400 mm.

Polynemidæ.

Galeoides polydactylus (Vahl.).

Sphyrænidæ.

Sphyræna vulgaris (L. Gmel.).

Gadidæ.

Merluccius vulgaris (Linn.).

Serranidæ.

Epinephelus alexandrinus (Cuv. and Val.).

Sparidæ.

Sargus rondeletii Cuv. and Val.

Mullidæ.

Upeneus prayensis Cuv. and Val.

Carangidæ.

Caranx sanctæ-helenæ Cuv. and Val.
,, *crumenophthalmus* Lacép.
,, *dentex* (Bl. Schn.).
Trachynotus glaucus Linn.†
Lichia glauca.
Argyreiosus setipinnis (Mitchill).

Scombridæ.

Thynnus pelamys (Linn.).

* *Brit. Mus. Cat.*, iii. p. 457.
† Regan: "On the genus *Lichia* of Cuvier," *Ann. Mag. Nat. Hist. Lond.* (Ser. 7), 12, 1903.

PLEURONECTIDÆ.

Hemirhombus soleæformis (Agass.).

GOBIIDÆ.

Gobius nigri Günther.

DACTYLOPTERIDÆ.

Dactylopterus volitans (L. Gmel.).

BLENNIIDÆ.

Blennius sanguinolentus Pall.

IV. COLLECTION OF FISHES FROM ASCENSION.*

The trawling in 40 fathoms off Pyramid Point, Ascension, on June 9th, 1904, revealed the presence of a large number of flat-fish. These were chiefly *Rhomboidichthys podas*, though *Hemirhombus soleæformis* and *Arnoglossus capensis* were tolerably abundant.

An interesting occurrence at this locality was *Chætodon dichrous*, which Cunningham † considered peculiar to the St Helena fauna.

In the list of twenty-six species, about 50 per cent. occur at the West Indies, a third at the Cape of Good Hope, and a fifth at Cape Verde and Madeira islands.

LAMNIDÆ.

Lamna glauca Müll. and Henle.

Caught in trammel net on June 9th, 1904. Total length 79 inches; weight, 110 lbs.‡

MURÆNIDÆ.

Muræna moringa Cuv.

One large specimen, 1240 mm. in total length. Stomach contents: one complete specimen of *Holocentrum longipinne*.

SCOPELIDÆ.

Trachinocephalus myops (Forster).§

Saurus myops.

* *Vide* Gunther, *Challenger Report*, "Shore Fishes."

† "Fishes of St Helena," *P.Z.S.*, 1910, part 1.

‡ Extract from Fish and Seal Log, kept by Dr Bruce and Mr D. W. Wilton.

§ *Vide* Jordan and Evermann, *Fishes of North and Middle America*, 1896.

Scombresocidæ.

Exocœtus obtusirostris Gthr.

Berycidæ.

Holocentrum longipinne Cuv. and Val.
,, sp. juv.

Serranidæ.

Epinephelus ascensionis (Osbeck).

Caproidæ.

Antigonia capros Lowe.

Chætodontidæ.

Chætodon dichrous Gthr.

Several specimens were taken in the trawl off Pyramid Point, Ascension. They were kept alive in a tank on board the *Scotia* and presented to the Marine Station at Millport, where they survived only for a short time.* These are wrongly named Chelmon in the Zoological Log.

Carangidæ.

Caranx ascensionis (Osbeck).
,, *dentex* Bl. Schn.
,, *hippos* (Linn.).
,, *crumenophthalmus* (Bl.).
,, *sanctæ-helenæ* Temm. and Schleg.
Trachynotus glaucus (Linn.).
Lichia glauca.

Scombridæ.

Scomber colias Gmelin.
Thynnus albacora Lowe.

Three specimens were caught by line on June 9th, 1904, in Clarence Bay. The largest weighed 105 lbs., and measured 63 inches from tip of snout to tip of tail.†

Pleuronectidæ.

Rhomboidichthys podas (De la Roche).
Hemirhombus soleæformis (Agass.).
Arnoglossus capensis Blgr.

* *Vide* Zoological Log of *Scotia*.
† Extract from the Fish and Seal Log, kept by Dr Bruce and Mr D. W. Wilton.

ECHENEIDIDÆ.

Echeneis remora Linn.

SCORPÆNIDÆ.

Scorpæna scrofina Cuv. and Val.

BALISTIDÆ.

Balistes vetula Linn.
Monacanthus scriptus (Osbeck).

OSTRACIONTIDÆ.

Ostracion quadricornis Linn.
var. *notacanthus* Bleek.

DIODONTIDÆ.

Diodon maculatus Lacép.

V.—Fishes Collected at St Helena.

(MS. received 13th January 1913. Read 24th February 1913. *Issued separately, 30th June* 1913.)

The 23 species here recorded were taken by the "Scotia" during a short stay at St Helena on her return voyage from the Antarctic. Though all have been previously described, yet, as a result of this capture, four now fall to be included in the fish fauna of the island.

These are—

Gonorhynchus greyi.
Exocœtus speculiger.
Thynnus pelamys.
Sargus rondeletii.

Little importance can be attached to the occurrence of *Exocœtus speculiger* and *Thynnus pelamys*, as these are typical open Atlantic forms and widely distributed, though their appearance at this island seems rare.

As Mr J. T. Cunningham (1) has already stated, the fish fauna of the island is extremely interesting owing to its wide relationships. Its members show affinities with the fishes from Ascension, Cape Verde Islands, Madeira, Azores, and the Mediterranean; and also with those from Brazil and the West Indies, and from the Cape of Good Hope.

To Dr Harmer, Keeper of Zoology, British Museum, I wish to express my indebtedness for granting me all facilities to compare my material with the type specimens; and also my cordial thanks to Mr C. Tate Regan, whose method of description I have adopted throughout, for kindly assisting me in the identification of several of the species, and for personal supervision of my work.

The following are the "Scotia" species, with a detailed description of two—*Gonorhynchus greyi* and *Synodus synodus.*

Gonorhynchus greyi (Richardson).

Depth of body $7\frac{2}{3}$ to 10 in the length; length of head $4\frac{2}{3}$ to $5\frac{1}{3}$. Snout $1\frac{3}{4}$ to $2\frac{1}{5}$ as long as diameter of eye, which is $4\frac{1}{2}$ to $5\frac{1}{3}$ in length of head; interorbital width 4 to 5. Lips fringed and papillose; barbel reaching margin of upper lip. Gill rakers, 12 to 15 in lower anterior arch.

Dorsal 11 to 12; first ray three-fifths of second, which is about two-fifths length of fourth; fourth and fifth rays the longest, $1\frac{2}{3}$ to 2 in length of head.

(REPRINTED FROM THE PROCEEDINGS OF THE ROYAL PHYSICAL SOCIETY, VOL. XIX., PP. 47–53).

Origin of dorsal almost above end of base of pelvics. Anal 9 to 10. Origin of anal equidistant from base of pelvic and base of caudal.

Pectorals $1\frac{1}{5}$ to $1\frac{1}{2}$ in length of head; second and third rays the longest. Pelvics $1\frac{1}{2}$ to $2\frac{1}{5}$ in length of head. Caudal emarginate. Caudal peduncle $1\frac{3}{4}$ to $2\frac{1}{3}$ as long as broad.

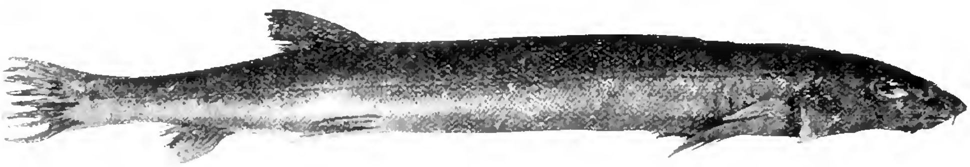


FIG. 1.
Side view of *Gonorhynchus greyi*.

170 to 200 scales in a longitudinal series; 20 to 21 between origin of dorsal and lateral line. Body yellowish brown—darker above than below. Scales, especially above the lateral line, with minute dark spots. Fins, except caudal, with terminal black spots, margined with white. Caudal with central black blotch.

Description based on 6 specimens, 289 mm. to 437 mm. in total length.

These include specimens from New Zealand, Tasmania, West Australia, Cape of Good Hope and St Helena. The "Scotia" collection is represented by 1 specimen, 338 mm. in total length, from St Helena.

A list of measurements in millimetres is added to show individual variations.

	a	*b*	*c*	*d*	*e*	*f*	*g*
Length to base of Caudal	403	371	338	286	279	260	268
Length of Head	80	79	69	55	52	54	63
Length of Snout	34	32	28	22	21	21	26
Length of Eye	15	16	13	12	11	12	13
Interorbital width	16	17	15	13	13	13	16
Length of Pectoral	55	59	48	44	39	42	50
Length of Pelvic	38	37	36	30	28	29	26
Length of longest Dorsal Ray	40	41	40	31	29	30	33
Length to origin of Dorsal	277	244	230	197	196	183	194

[1] *a* Specimen from False Bay—Cape of Good Hope.
b „ „ East London, Cape Colony.
c „ „ St Helena—"Scotia."
d „ „ New Zealand.
e „ „ West Australia.
f „ „ Tasmania.
g *Gonorhynchus abbreviatus* Schlegel (*Fauna Japonica*).

The measurements of *Gonorhynchus abbreviatus* Schlegel, are placed alongside the others. There seems very little of a distinctive character except the longer pelvics. The number of scales in a longitudinal series is 165. The dark extremities of the fins seem to be deeper in colour, while the caudal has a black spot on each lobe.

Synodus synodus (Linnæus).

Saurus synodus Cuv. & Val.

Depth of body $4\frac{2}{5}$ to $5\frac{3}{5}$ in the length; length of head $3\frac{1}{2}$ to $3\frac{4}{5}$. Snout $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as diameter of eye, which is $5\frac{4}{5}$ to $6\frac{3}{5}$ in length of head; interorbital width $7\frac{1}{2}$ to $8\frac{1}{2}$. Upper jaw projects slightly. Præmaxillary $1\frac{2}{5}$ to $1\frac{1}{2}$ in length of head. Teeth in both jaws in a double row, lanceolate, and with a tendency to arrow-shape. Teeth alternately long and short, especially in upper jaw. Palatine teeth much more slender and in several rows; inner rows longer, anterior teeth largest. Tongue covered with retrorse teeth.

Top of head striated; the striations few and very pronounced. Supraorbital bones prominent and slightly striated.

Gill rakers reduced to rows of minute teeth.

Dorsal 14-15. Origin of dorsal just behind base of pelvic.

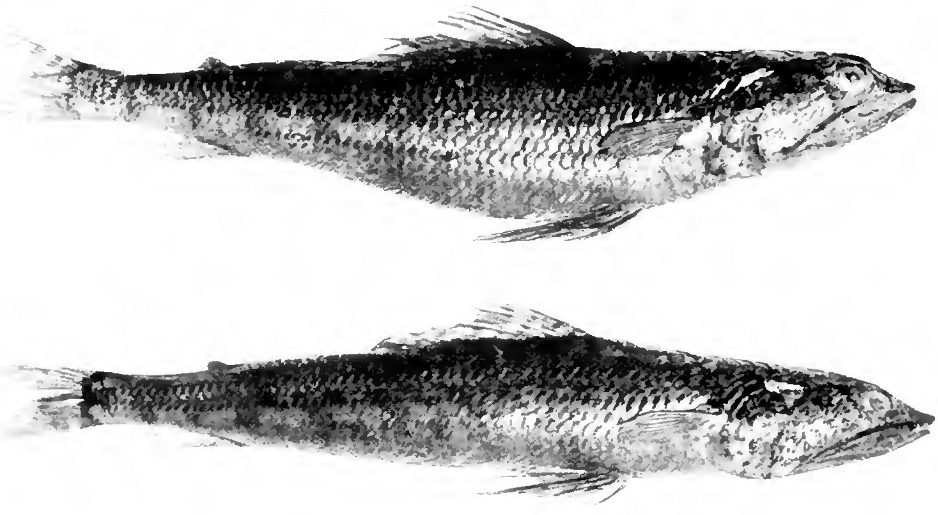
Dorsal fin equidistant from tip of snout and root of caudal; fourth ray the longest, $2\frac{1}{5}$ in length of head. First dorsal ray two-thirds length of the fourth; subsequent rays diminish in length. Adipose very small. Distance from adipose to root of caudal three-fifths distance from adipose to base of dorsal. Anal 9-10. Length of base half the length of dorsal base. Pectorals $2\frac{4}{5}$ in length of head. Pelvics eight-rayed; sixth ray the longest, which is seven-tenths length of head. Caudal forked.

60 to 62 scales in a longitudinal series; 5 between origin of dorsal and lateral line.

[1] *a, b, d, e, f, g* are British Museum specimens.

Body and fins speckled dark grey on a silvery grey background; black spot on shoulder and on tip of snout; several indistinct and irregular cross bars on the body. Description based on six examples, 244 mm. to 274 mm. in total length. The Indo-Pacific form (*Saurus varius* Günther) is closely allied to this species, but differs in having longer pectorals and pelvics, fewer dorsal

FIG. 2. *Synodus synodus.*
Reproduction of coloured drawing by Mr Cuthbertson—from fresh specimen.



FIGS. 3 and 4.
Side view of two specimens of *Synodus synodus.*

and anal rays, body more elongate, and coloration lighter. *Saurus meleagrides* Val., from Buenos Aires, is also nearly related. The pectorals are longer, and the dorsal and anal rays are different. It is figured in D'Orbigny's *Voyage dans l'Amérique méridionale.*

There seems sufficient proof that the "Scotia" specimens are identical with those described from St Helena and from Bahia by Cuvier and Valenciennes.

The following are a few of the measurements of the specimens in millimetres, to show individual variations :—

	a	*b*	*c*	*d*	*e*	*f*
Length to base of Caudal . .	254	253	250	250	245	226
Length of Head	72	61	70	69	67	59
Length of Snout	19	18	18	17	16	15
Length of Eye	11	11	12	11	10	10
Interorbital width . . .	8	9	8	7	7	7
Tip of Snout to origin of Dorsal	101	103	105	100	100	89
Length of Pectoral	28	29	28	26	25	24
Length of Pelvic	53	56	55	53	46	45
Length of Praemaxillary . .	48	43	47	46	43	38

Aulostoma coloratum Müll. & Trosch.

2 specimens, young and adult, taken off St Helena, 171 mm. and 566 mm. in total length.

Exocœtus obtusirostris Günther.

Dorsal 13; anal 13. Depth of head equal to distance from extremity of snout to hind margin of præoperculum. Snout $\frac{2}{3}$ diameter of eye, which is $3\frac{1}{2}$ in length of head. Origin of dorsal opposite origin of anal.

1 specimen, total length 137 mm.

Exocœtus speculiger Cuv. & Val.

Depth of body 6 in the length; length of head $4\frac{2}{3}$. Snout equal to diameter of eye, which is $3\frac{1}{2}$ in length of head; interorbital width slightly more than diameter of eye.

Dorsal 10; first pectoral ray over half the total length of the pectoral fin, which reaches just beyond the extremity of the dorsal. Anal 11. Origin of anal slightly in advance of the dorsal. Pectoral on upper side blackish, with an oblique white band and white margin. 1 specimen, total length 240 mm.

Holocentrum longipinne Bl. Schn.

Several specimens averaging 230 mm.

Epinephelus ascensionis (Osbeck).

1 specimen, total length 203 mm.

Rhypticus saponaceus (Bl. Schn.).

Dorsal III 23. Anal 16.
The maxillary in this specimen reaches to two-thirds diameter of eye.

Priacanthus cruentatus (Lacép).

First few dorsal spines rather low. Last spine twice as long as the second. All are strongly spinulose. Rays not much larger than longest spines.
2 specimens, total length 210 mm.

Sargus capensis Smith.

Several specimens, total lengths 232 mm. and 280 mm.

Sargus rondeletii Cuv. & Val.

2 specimens, total lengths 176 mm. and 205 mm.

Chætodon sanctæ helenæ Günther.

A painting of this specimen by Mr Cuthbertson, the "Scotia" artist, represents the colour of the body as a light lavender, which becomes darker towards the vertical fins. A narrow yellow band runs from the supra-orbital along the dorsal fin, across the caudal, and ends at the origin of the anal. The soft dorsal and anal fins have a thin black margin.

Cossyphus pectoralis (Gill).

1 specimen, total length 255 mm.

Scarus strigatus Günther.

Several specimens averaging 350 mm.

Caranx dentex (Bl. Schn.).

1 specimen, total length 594 mm.

Caranx sanctæ-helenæ Cuv. & Val.

Numerous young specimens.

Trachynotus glaucus (Linn.).
Lichia glauca (Linn.).

1 specimen taken off St Helena, total length 333 mm.

Scomber colias Gmelin.

Scomber pneumatophorus De la Roche.

Several specimens, young and adult.

Thynnus pelamys (Linn.).

1 specimen, total length 424 mm.

The Belted Bonito has a wide tropical and sub-tropical distribution. It has been recorded from Luce Bay in the South of Scotland.

Thyrsites prometheus (Cuv. & Val.).

1 specimen, total length 285 mm.

Scorpæna mellissii Günther.

1 specimen, total length 217 mm.

Scorpæna scrofina Cuv. & Val.

Several specimens, 249 mm. to 305 mm. in total length.

Tetrodon sp.

Probably *T. cutaneus*, but too mangled for identification. This was found in the stomach of *Thynnus pelamys*.

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3. Gunther, A. Report on a Collection of Fishes made at St Helena, by J. C. Melliss, Esq., *Proc. Zool. Soc. London*, 1868.
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VI.—Collection of Fishes from Cape Colony.

Thirty-seven species were secured in May 1904 chiefly from trawlings made at Table Bay, False Bay, off Dassen Island and at Saldanha Bay.

The collection contains a large number of specimens of sharks of the families *Carchariidæ*, *Scyliorhinidæ* and *Squalidæ*.

Two species have not been previously recorded from the Cape,—*Mustelus maculatus* and *Scatharus græcus*—while a third, *Caranx dentex*, has been considered a doubtful record.

The occurrence of *Mustelus maculatus* at Station 483 is extremely interesting, as the locality of this species was hitherto unknown.[1]

All the others have been recorded either from the Cape, by Dr Gilchrist,[2] or from Natal, by Mr C. Tate Regan.[3] Three species are recorded by Dr Günther in the Challenger Report on Shore Fishes.

The following details are extracted from the Station Log of the *Scotia*, and are inserted here for greater convenience.

Station	Time May 1904	Locality	Depth in Fathoms	Method of Capture	Remarks
478	May 5 to 17	Table Bay	...	...	...
479	,, 6 to 16	False Bay	...	...	...
480	,, 18	Off Dassen Island	...	...	...
481	,, 18 to 21	N.W. of Ijzer Fontein Point	35	Otter Trawl	Sand
482 (*a*)	,, 18 to 21	Houtjes Bay and off Salamander Pt.	8	Trawl	Shells (*a*)
(*b*)			5	Trap	Sand (*b*)
(*c*)			2	Trammel	Sand (*c*)
483	,, 21	Entrance to Saldanha Bay	25	Otter Trawl	Sand and Kelp

Bdellostomatidæ.

Bdellostoma cirrhatum Forst.

Station 482 (*b*).

Scyliorhinidæ.

Scyliorhinus africanus (Gmel.).

Station 483.

Scyliorhinus edwardsii (Cuv.).

Stations 482 (*a*) and 483.

[1] *Brit. Mus. Cat.*, vol. viii., p. 388.

[2] *Marine Investigations in South Africa*, vol. i. *Annals of the South African Museum*, vol. vi., pts. 2 and 3.

[3] *Annals Natal Government Museum*, vol. i., pt. 1, 1906; pt. 3, 1908.

CARCHARIIDÆ.

Mustelus lævis Risso.

Station 483.

Mustelus maculatus Kner. & Stein.

Description similar to that given in the British Museum Catalogue, vol. viii., p. 387.

Black spots fairly large.

Station 483.

SQUALIDÆ.

Squalus acutipinnis Regan.

Stations 482 (*a*) and 483.

RAIIDÆ.

Raia batis Linn.

This young specimen is similar to the adult, now in the British Museum, which was recorded by Dr Gilchrist from the Buffalo River locality.

Station 482.

Raia sp. juv.

Probably *Raia rhizacanthus* Regan.

Station 482.

TORPEDINIDÆ.

Torpedo marmorata Risso.

Station 483.

CHIMÆRIDÆ.

Callorhynchus antarcticus Lacep.

Station 483.

SILURIDÆ.

Galeichthys feliceps Cuv. & Val.

Station 483.

SYNGNATHIDÆ.

Syngnathus acus Linn.

Station 482 (*b*).

Atherinidæ.

Atherina breviceps Cuv. & Val.

1 young specimen with monstrosity in lower jaw.

Station 482 (*c*).

Mugilidæ.

Mugil capito Cuv.

Station 478.

Gadidæ

Merluccius capensis Regan.

Stations 481 and 483.

Genypterus capensis Smith.

Stations 481 and 483.

Sciænidæ.

Sciæna aquila Risso.

Station 483.

Sparidæ.

Box salpa Linn.

Station 478.

Scatharus græcus[1] Cuv. & Val.

Station 482.

This Mediterranean species has not been previously recorded from the Cape.

Sargus cervinus Lowe.

Station 481.

Sargus nigrofasciatus Regan.

Previously recorded only from Natal.

Station 482 (*b*).

Pagrus laniarius Cuv. & Val.

Station 478.

Carangidæ.

Caranx dentex (Bl. Schn.).

One specimen was secured at Station 478.

[1] It is possible, though scarcely probable, that a confusion of labels may have here occurred, for the species is only previously recorded from the Mediterranean.

Scombridæ.

Scomber colias Gmelin.

Station 479.

Trichiuridæ.

Lepidopus caudatus (Euphrasen).

Station 481.

Thyrsites atun (Euphrasen).

Station 481.

Pleuronectidæ.

Cynoglossus capensis Kaup.

Stations 478, 481, 482, and 483.

Synaptura microlepis Blkr.

Stations 478 and 483.

Gobiidæ.

Gobius nudiceps Cuv. & Val.

Station 479.

Triglidæ.

Trigla peronii Cuv. & Val.

Stations 482 and 483.

Gobiesocidæ.

Chorisochismus dentex Pall.

Station 482 (*c*).

Blennidæ.

Clinus superciliosus Linn.

Stations 478 and 482 (*c*).

Clinus acuminatus Cuv. & Val

Station 482 (*c*).

Clinus dorsalis Bleeker

Station 482 (*c*).

Ostraciontidæ.

Ostracion diaphanus Bl.

Station 483.

Tetrodontidæ.

Tetrodon honckenii Bl.

Station 479.

Diodontidæ.

Diodon maculatus Gthr.

Station 482 (*a*).

VII.—Sharks from St Paul's Rocks.

At St Paul's Rocks, *Scotia* Station 53, eight specimens of *Carcharias menisorrah*, Müll. and Henle, were captured on 10th December 1902. These sharks have been reported from this locality by various expeditions, but their identification has not been definitely recorded. *Carcharias menisorrah*, though an Indian species, seems therefore to be cosmopolitan. The dimensions of these specimens are given just as they were tabulated by Dr Bruce and Mr D. W. Wilton in the *Scotia Fish and Seal Log*. For permission to reproduce the photograph of St Paul's sharks from "Three Voyages of a Naturalist," I am indebted to the author, Mr M. J. Nicoll, while I wish also to thank Messrs Witherby for the use of the half-tone block.

Several small specimens of *Echeneis remora* were found attached to these sharks.

Measurements in inches of 8 specimens, and weights in lbs. of 5 specimens of *Carcharias menisorrah* Müll. and Henle.

	A♀	B♂	C♂	D♀	E♀	F♀	G♀	H
a	78	73	$65\frac{1}{2}$	54	59	65	$62\frac{1}{2}$	$52\frac{1}{4}$
b	57	$53\frac{1}{2}$	$46\frac{3}{4}$	$39\frac{1}{2}$	43	47	45	$38\frac{1}{2}$
c	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{4}$
d	10	$9\frac{1}{4}$	$8\frac{1}{4}$	$6\frac{1}{4}$	$7\frac{1}{2}$	$7\frac{1}{2}$	7	$5\frac{1}{2}$
e	8	$7\frac{1}{2}$	6	5	$5\frac{1}{4}$	5	5	$4\frac{1}{4}$
f	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$
g	16	$13\frac{3}{4}$	13	8	$11\frac{1}{4}$	$10\frac{1}{2}$	10	$7\frac{3}{4}$
h	$7\frac{1}{4}$	$6\frac{1}{4}$	$5\frac{1}{2}$	4	$5\frac{1}{4}$	5	5	$3\frac{3}{4}$
i	$2\frac{1}{4}$	2	$1\frac{3}{4}$	1	$1\frac{5}{8}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{7}{8}$
j	3	$2\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{3}{8}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	1
k	...	...	...	4 2	38	45	43	21

A, B, C, etc. Number of specimens.

a = Tip of snout to tip of tail.
b = Tip of snout to root of tail.
c = Diameter of eye.
d = Interorbital space.
e = Breadth of angle of lower jaw.
f = Length of 1st gill slit.
g = Length of pectoral fin.
h = Length of base of 1st dorsal fin.
i = Length of base of 2nd dorsal fin.
j = Length of base of anal fin.
k = Weight in lbs.

B.—Pelagic Fishes.

This list contains only a small percentage of the surface fishes, as most of the larval forms obtained in the tow-nettings could not be identified with any degree of accuracy.

Scopelidæ.

Myctophum punctatum (Rafinesque).

29° 54′ N. 34° 10′ W. Station 537.

Centriscidæ.

Centriscus scolopax L.

34° 2′ S. 49° 7′ W. Station 98.

Syngnathidæ.

Syngnathus pelagicus L.

33° 53′ N. 32° 27′ W. Station 539.

Scombresocidæ.

Hemirhamphus sp. juv.

15° 15′ N. 25° 9′ W. Station 25.

7° 20′ S. 34° 38′ W. ,, 61.

Exocœtus nigricans Benn.

18° 28′ N. 24° 28′ W. Station 21.

This specimen was picked up on the deck of the *Scotia*.

Exocœtus obtusirostris Gthr.

Station 21. 18° 28′ N. 24° 28′ W.

Several secured on deck of the *Scotia*.

Exocœtus evolans L.

18° 28′ N. 24° 28′ W. Station 21.

5° 25′ N. 26° 7′ W. Station 42.

Exocœtus speculiger Cuv. and Val.

1° 22′ N. 28° 10′ W. Station 52.

Carangidæ.

Naucrates ductor juv. L.

Station 521. 5° 47′ N. 20° 28′ W.

Echeneididæ.

Echeneis remora juv. Linn.

Station 70. 9° 6′ S. 34° 38′ W.

Dactylopteridæ.

Dactylopterus volitans juv. (L. Gm.).

Station 82. 20° 40′ S. 38° 20′ W.

,, 87. 24° 42′ S. 40° 34′ W.

Antennariidæ.

Antennarius marmoratus juv. (Shaw).

Station 539. 33° 53′ N. 32° 27′ W.

Tetrodontidæ.

Tetrodon sp. juv.

Station 67. 7° 20′ S. 34° 38′ W.

Station 78. 15° 24′ S. 37° 12′ W.

MOLIDÆ.

Orthagoriscus mola Linn.

Station 106. 39° 01′ S. 53° 40′ W.

Orthagoriscus mola L.[1]

The following measurements (in inches) are from the *Scotia Fish and Seal Log.*[2]

Length (total)	80
Depth	51
Girth	120
Dorsal fin	34
,, base	16
Anal fin	31
,, base	13
Pectoral fin	$9\frac{1}{2}$
,, base	6
Length from eye to pectoral fin	12
Diameter of eye	$3\frac{1}{2}$
Length of gill slits	$3\frac{1}{2}$
Weight	$\frac{1}{2}$ ton

Two specimens of *Echeneis remora* L. were found attached to the inside of the mouth.[1]

[1] Vide *Zoological Log*, pl. iv., p. 5.

[2] *Fish and Seal Log*, by Dr W. S. Bruce and Mr D. W. Wilton.

PART XVII.

PTEROBRANCHIA.

XVII.—THE PTEROBRANCHIA OF THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

By S. F. HARMER, Sc.D., F.R.S., Keeper of the Department of Zoology in the British Museum; and W. G. RIDEWOOD, D.Sc., Lecturer on Biology in the Medical School of St Mary's Hospital, University of London.

(*WITH FIVE TEXT FIGURES AND TWO PLATES.*)

The Pterobranchia of the Scottish National Antarctic Expedition (1902 to 1904). By S. F. Harmer, Sc.D., F.R.S., Keeper of the Department of Zoology in the British Museum; and W. G. Ridewood, D.Sc., Lecturer on Biology in the Medical School of St Mary's Hospital, University of London. *Communicated by* Dr J. H. Ashworth. (With Five Text-Figures and Two Plates.)*

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Introduction.

The genus *Cephalodiscus* was instituted by M'Intosh for a species, *C. dodecalophus*, which had been obtained by the *Challenger* Expedition. After the publication of the full account of this species, by M'Intosh and Harmer (87) in the *Challenger Report*, succeeding papers for nearly twenty years were all based on the original *Challenger* material. The subject was in particular re-investigated by Masterman in a series of papers (97[1], 97[2], 98, 99, 03). The *Siboga* report, published by Harmer (05) in 1905, added three Oriental species to the genus. Schepotieff (05, 07, 08) devoted several papers to a further description of the *Challenger* material; while, more recently (09), he has described an interesting new species, *C. indicus*, from Ceylon. In 1906 Ridewood (06) described *C. gilchristi* from South Africa; and in the following year he gave an account (07[1]) of the two species which had been dredged by the *Discovery* Expedition; and (07[2]) of the development of the plumes in four species of *Cephalodiscus*. One of the *Discovery* species, *C. nigrescens*, had been described two years earlier by Lankester (05), in a preliminary paper; and Ridewood (12) has recently brought forward evidence to show that this species had been dredged by the *Erebus* and *Terror* Expedition in 1841 or 1842. In 1907 Andersson (07) added no less than six species to the genus, in describing the results of the Swedish South Polar Expedition, though we give some evidence (pp. 435–439) to show that one of them, *C. inæquatus*, is synonymous with *C. hodgsoni*, which had been described by Ridewood (07[1]) earlier in the same year, from the *Discovery* collection. The most recent addition to the list of species has been given by Gravier (12), who has published an account of *C. anderssoni*, a new species which was obtained by the second French Antarctic Expedition.

Full references to the literature of the subject, up to the dates of the respective publications, have been given in the works of Harmer (05), Ridewood (07[1]), and Andersson (07). A general account of the group has more recently been given by Spengel (12).

The characters of the cœnœcium are so well marked that it appears justifiable to

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use them, as a rule, as a ready means of distinguishing one species of *Cephalodiscus* from another. It is remarkable that what one would suppose to be the uncorrelated efforts of the numerous zooids of a colony do in fact produce so uniform a result. The comparison of larger series of specimens may perhaps show in the future that the cœnœcial characters are less reliable than they appear to be at present; but the fact remains that the common house of the colony has, as a rule, so distinct a character of its own that it is difficult to believe that it cannot be used for systematic purposes. It has thus been possible to distinguish the following subgenera of *Cephalodiscus*:—

(1) *Demiothecia*, Ridewood (07[1]), in which the cœnœcial cavity is continuous and the zooids occur separately or in groups in any part of it, being free to wander about in it.

(2) *Idiothecia*, Ridewood (07[1]), in which each zooid, with a certain number of its buds, occupies an independent tube-like cavity in the cœnœcium.

(3) *Orthoëcus*, Andersson (07), in which each zooid has a tube of its own, but the tubes are free for the greater part of their length, instead of being embedded in the common cœnœcial mass as in *Idiothecia*.

The descriptions which have been published by the observers who have been referred to above show that there is a singular uniformity of structure in the zooid throughout the genus. In such fundamental characters as the three divisions of the body, and their associated cœlomic cavities, the notochord, the proboscis-canals, the collar-canals, and the gill-slits, there is practically no variation. The remarkable character of the male *C. sibogæ*, as described by Harmer (05), indicates that in that species at least there is a striking sexual dimorphism. In those other species in which both sexes are known there appears to be no essential difference between the two sexes except as regards their gonads. An exception must, however, be made in the case of *C. inæquatus* (probably = *C. hodgsoni*), where most of the female zooids have five pairs of arms, while most of the males have six pairs (see pp. 436–438).

Making use of the cœnœcial characters which have been mentioned above, it appears to be possible to distribute the known species of *Cephalodiscus* among the three subgenera there indicated, and in this way to separate species which it might be hard to characterise from the structure of their zooids. But within a single subgenus it becomes necessary to rely more largely on the characters of the zooid; and the discrimination of species on anatomical grounds may offer considerable difficulty.

In the earlier accounts of species of *Cephalodiscus* some stress was laid on the proportions of the zooid and of its stalk. This procedure has been criticised by Andersson (07), who has had the unique opportunity of examining certain species in the living state. When account is taken of the highly muscular character of the zooid, and of the evidences of contraction afforded by wrinkling of the skin of the stalk and other parts, it is easy to believe that Andersson's criticism is to a large extent well founded. It may, nevertheless, be true that some weight may be ascribed in certain cases, as in discriminating between zooids in a similar degree of contraction, to features of this kind.

The difficulty of finding reliable specific characters in the structure of the zooid is increased by the fact that the material has as a rule not been preserved with any special refinements of technique. The study would be greatly facilitated by being able to make use of specimens which had been preserved in a fully extended condition. It would then be comparatively easy to ascertain the number of the arms or plumes with certainty. Under other circumstances this point, for instance, cannot always be made out without the possibility of mistake. Even in a well-prepared series of sections it is sometimes excessively difficult to count the arms, which may be cut in planes most unfavourable for study. The method of dissection is capable of giving valuable evidence; but here, too, mistakes are not out of the question. There is reason to believe that in some species of the genus the number of arms is variable (*cf.* RIDEWOOD, 07[1]). It must also be remembered that in some cases the number of the arms has been given as the result of the study of sections of a very small number of individuals. The comparison of series of sections of the same species might suggest differences which are really due to the degree of maturity or of contraction, or to the planes in which the sections are cut. Some caution is thus necessary both in making statements and in accepting those which have been made by other observers.

It can hardly be doubted, however, that the number of pairs of arms does provide a character which is of value systematically. Other characters which can be specially relied on are probably:—the number of buds, whether few or many, which are borne at any one time by the budding region of the stalk; the presence of one or three nerve-tracts in the stalk, as pointed out by HARMER (05) and ANDERSSON (07); the presence or absence of deep pigmentation of the skin; the shape of the operculum or postoral lamella: the size of the free ova and the structure of the embryos; and the mode of development of the arms in the buds.

Using some of these characters, the single species dredged by the *Scotia* may be thus characterised:—

Cephalodiscus agglutinans, n. sp. Colony massive, branching, somewhat resembling that of *C. nigrescens* in the size of its branches, but the material of the cœnœcium includes large quantities of shells of Foraminifera, small fragments of shells of Mollusca and spines of Echinoids, and rounded particles of slate. The pieces of colony vary in size up to 100 or 115 mm. in greatest length, and 45 or 55 mm. in greatest breadth. Cavity of the cœnœcium in the form of a tubular labyrinth continuous throughout (except for a few isolated septa), much branched in the interior, but the superficial parts of the tubes are radially set, and open at a fairly definite angle (about 80°) to the surface. Diameter of the peripheral tubes 1 mm. Ostia elliptical, size 1·2 by ·8 mm., each with a single thick lip or spine* projecting about 3 mm. beyond the general surface. No peristomial tubes. Mean distance from the middle of an ostium to the middle of the ostium nearest to it, 3 or 4 mm.; at the free extremity of the

* The spines are broken off in the greater part of the material examined.

branch, however, the ostia are more crowded. Length of zooids from the free ends of the arms to the end of a fairly extended body, 4·5 mm.; length from base of arms to end of body, 3·2 mm.; width of body, ·8 mm., but if the body is much contracted its width is that of the tubes, *i.e.* 1 mm. Arms usually nine pairs, but often fewer and exceptionally more; no end-bulbs with refractive beads. Stomach and the succeeding U-shaped intestinal loop long. Females not known; and no buds having more than five pairs of arms have been found.

Material.

The specimens of *Cephalodiscus* submitted to us for study were sent in six bottles, five of which were of $2\frac{1}{2}$ litres capacity, and the sixth of about half that size. This material was dredged on December 1, 1903, and was obtained in a single haul on the Burdwood Bank, to the south of the Falkland Isles (Station 346; lat. 54° 25′ south; long. 57° 32′ west; fathoms 56). The contents of the trawl on this occasion amounted to about half a ton,* the largest and richest catch of the expedition; and the members of the staff worked up to two o'clock in the morning sorting and bottling the specimens. All the *Cephalodiscus* material was preserved in alcohol, and no special measures were taken for killing the zooids in an extended condition.

Cœnœcium.

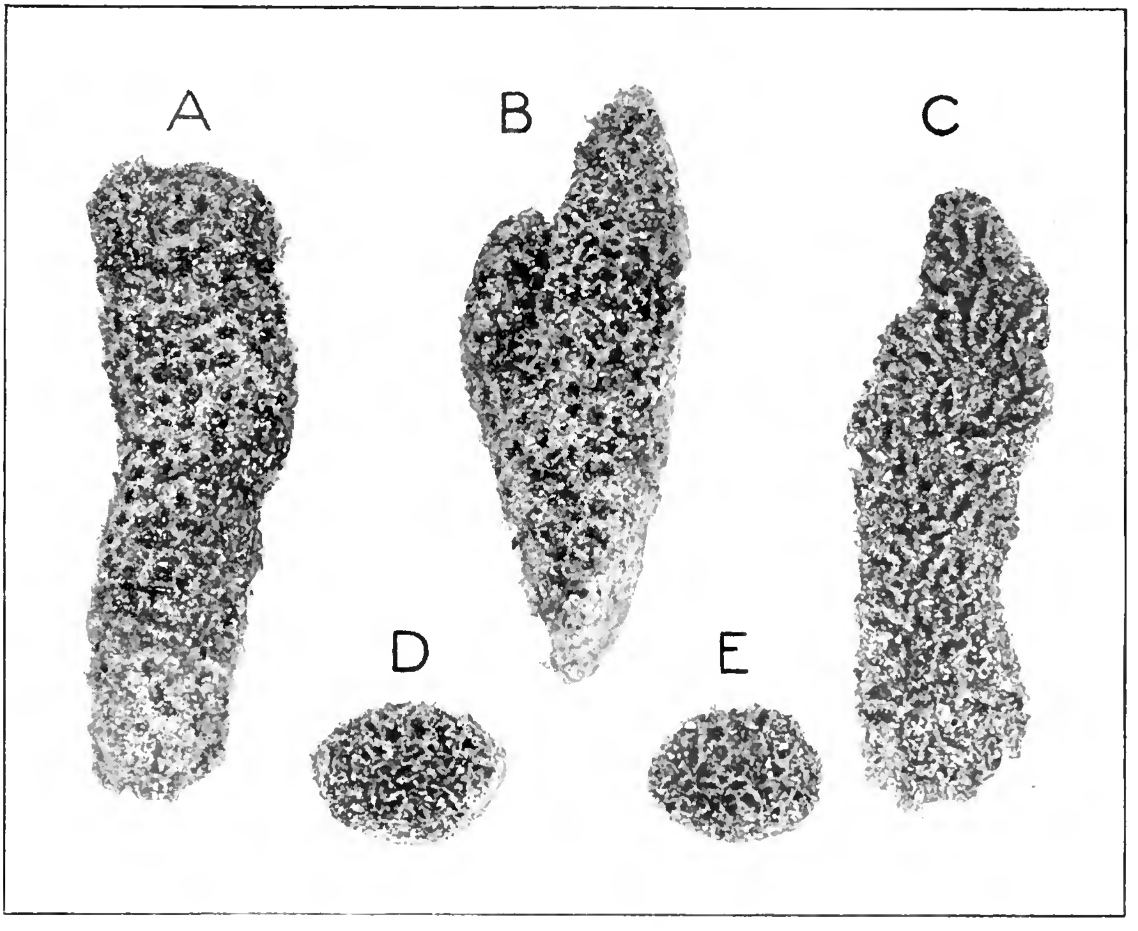
The distinguishing feature of the present species, the agglutination of foreign particles in the soft substance of the cœnœcium, is apparent at a glance, and the semitransparent or translucent appearance of the cœnœcium of other species of *Cephalodiscus* is only to be detected in certain parts of branches where the inclusions are more scanty than usual. The general appearance of pieces of colony is whitish or whitish yellow, with dark spots which mark the ostia or openings of the tubular cavities inhabited by the zooids (text-fig. 1, A and B). The branches are massive, resembling those of *C. nigrescens* in size and bulk. The substance of the branch is weak and easily crumbled, the included shelly particles adding to the weight and not adding to the strength of the cœnœcium. A branch taken out of alcohol and held horizontally in the hand by one end breaks across by its own weight.

The majority of the pieces of colony are about 80 to 90 mm. in length, and oval in cross section, measuring about 30 mm. in the long diameter and 20 mm. in the short diameter. Some of the small pieces measure about 70 mm. by 20 mm. by 15 mm. The largest pieces measure about 100 to 115 mm. long, and have three or even four branches. The total width of such branching pieces of colony is 45 or 55 mm. On Plate I. are represented five pieces which are the largest in the whole collection and best suited for showing the characters of the branching. Since these are drawn of the natural size, a detailed description of them individually is

* *Report of the Scientific Results of the Voyage of the S.Y. "Scotia," 1902–4*, vol. iv., *Zoology*, part i., *Zoological Log*, 1908, p. 61.

unnecessary. Most of the pieces of material show no branching, but resemble the piece of which a photographic reproduction is shown in text-fig. 1, A.

The surface of the colony appears rough, and, if the ostia or openings of the tubes are not clearly visible, does not differ much from the surface presented when a piece is broken across (text-fig. 1, D and E). But in sheltered situations, as between the branches of a piece of colony, such as is shown in Pl. I. figs. 1, 4, there are blunt



Text-fig. 1.—Photographic reproduction of pieces of colony of *C. agglutinans*: of the natural size. A, a piece broader at the free end (uppermost in the figure) than at the basal end, showing no branches; B, a piece showing a branching into two; C, a longitudinal median section of a piece of colony; D and E, transverse sections through a piece of colony. The darker areas are the tubular spaces occupied by the zooids, the white specks are small pieces of shell included in the cœnœcial substance.

brownish processes or "spines" projecting to an extent of 3 mm. beyond the general surface. Inspection shows that these are really the projecting lips of the inhabited tubes, one to each tube, similar to the lips that occur on the surface of a piece of *C. nigrescens* (07, pl. iv. fig. 11), but differing in being less regular in form. These spines are built up by the superposition of solid caps of cœnœcial substance upon the summit of pre-existing spines, just as are the long spines of species of *Cephalodiscus* such as *C. dodecalophus*, *C. hodgsoni* (07, pl. iv. fig. 21), and *C. gilchristi* (06, pl. iii. figs. 9, 10, 11), but they differ in not exceeding a length of 3 mm., and in being restricted in number, one to each ostium. They further differ in that they include shelly particles (see text-fig. 3), although these are present to a less extent than in the general substance of the cœnœcium. They are fairly pointed at the extremities, although the actual shape may be the result of the size and form of the included shelly particles, and they broaden out at the base and curve round the ostium for about one-third of its margin. In protected situations the inhabited tubes are seen to widen out suddenly as they reach the surface, and resemble very short funnels, and it is from the rim of the funnel that the lip projects. This accounts for the distance between the spine and the tube in the surface-view of the branch shown in text-fig. 2, B.

A careful examination of the outer surface of a piece of colony and a dissection into the substance of the cœnœcium between the tubes reveals the presence of broken spines in association with the several ostia, and leads to the conclusion that the whole of the surface of the colony is in the natural state provided with short lips or spines, but that, owing to the rough treatment which the specimens must have experienced in coming up in the trawl with a great weight of other specimens, their surface has been scoured and deprived of the projecting spines, which are now only to be seen in their full development in protected situations between branches which have not been broken apart, as in Pl. I. fig. 1.

Of particular interest in this connection is the fact that although in *C. agglutinans* the zooids do not live in isolated tubes, but in tubes forming parts of a common tubular system, the single lip or spine to each ostium is in other known species of *Cephalodiscus* only met with in species of the subgenus *Idiothecia* (*C. gilchristi*, *C. nigrescens*, and *C. levinseni*) and *Orthoëcus* (*C. solidus*), whereas in the known species of *Demiothecia* the spines are multiple, four or five being present around each ostium in the case of *C. hodgsoni*, for instance.

The tubular cavities which open to the exterior, and in which the zooids occur, are approximately 1 mm. across, and the average distance from the middle of the orifice of a tube to the middle of that nearest to it is 3 or 4 mm., except at the free end of a branch, where the tubes are more crowded. The walls immediately bounding these cavities are composed of a thin layer of yellowish-brown cœnœcial substance, much tougher than the jelly-like albuminoid that fills in the intervals between the tubes and makes the whole so compact. The tubes proper do not include in their walls any of the foreign bodies that give to the cœnœcium of this species its characteristic appearance; but some of the shelly particles of the softer material of the cœnœcium are so tightly fixed to the outer surface of the tubes that in dissecting a branch the tubes are liable to be torn in the attempt to remove the particles.

The tubes in the outer part of a piece of colony are fairly uniform in diameter (one millimetre), except at the junction of two tubes, where irregularities in shape and size may occur. A longitudinal section of a branch shows that the peripheral parts of the tubes are not set at right angles to the surface, but slope somewhat towards the free end of the branch (see text-fig. 1, C). In the middle of the piece the tubes are very irregular in their disposition, but the cavities may still be termed tubular in spite of irregularities in their shape.

The internal tubular system is continuous throughout the whole branch, and if it were not for probable resistance offered by other zooids one could conceive of a zooid travelling internally from any one part to any other part of the system. In the middle portion or core of a branch the tubes not only exhibit branching, but here and there a complete tubular circuit can be seen, as is shown at *b*, *b*, *b*, *b* in the diagrammatic text-fig. 2, A. The existence of such continuous circuits is explained by the part of the circuit nearest the base of the branch being due to the bifurcation of a tube during an early stage of the growth of the branch, when this part occupied an apical position; whereas the part of the circuit farthest from the base of the branch is due to the burying of a superficial groove that connected two young ostia at a time when this part of the branch constituted the apex. There can be no doubt, from a study of the apex of a branch, that growth is apical. The tubes that open to the surface at the apex are much shorter and closer together than in other parts of the branch, although of the same diameter. Evidence of the branching of a tube at the apex is forthcoming, and also evidence of the enclosure of a superficial groove between two young ostia, such as produces the continuous circuits above referred to.

The ostia show on the surface of a piece of colony as dark areas, due partly to the fact that one is looking into a tubular cavity, and partly to the fact that the actual wall of the tube does not contain the shelly particles that make the softer substance of the cœnœcium so white in colour. In rare cases in the material studied the zooid occupying a peripheral tube could be seen without cutting into the branch, but in most cases the zooids had all retreated into the middle parts of the tubular system, and had become entangled and intertwined with one another. The ostia proper are slightly funnel-shaped and oval, measuring about 1·2 mm. in long diameter and ·8 mm. in short diameter, whereas the tube itself is roughly circular in section, and of about 1 mm. diameter.

So far as can be seen from the study of the surface in protected parts between two branches that have not broken apart, the tubes do not project beyond the general surface, as "peristomial tubes," in the manner of the tubes of *C. levinseni* (05, pl. ii. fig. 11) and the tubes in certain parts of the colony of *C. nigrescens* (07, pl. iii. fig. 5), and this conclusion is supported by a study of the short tubes at the free extremity of a branch. The filling up of the intervals between the new tubes seems to take place *pari passu* with the additions made to the mouths of the tubes themselves. (Incidentally it may here be mentioned that the "habit" or "facies" of a colony of *Orthoëcus* differs from that of a colony of *Idiothecia* owing to the peristomial tubes of the former being of extraordinary length; indeed, in *C. rarus* the whole colony consists of peristomial tubes with only a small amount of softer cœnœcial substance binding the blind ends of the tubes together.)

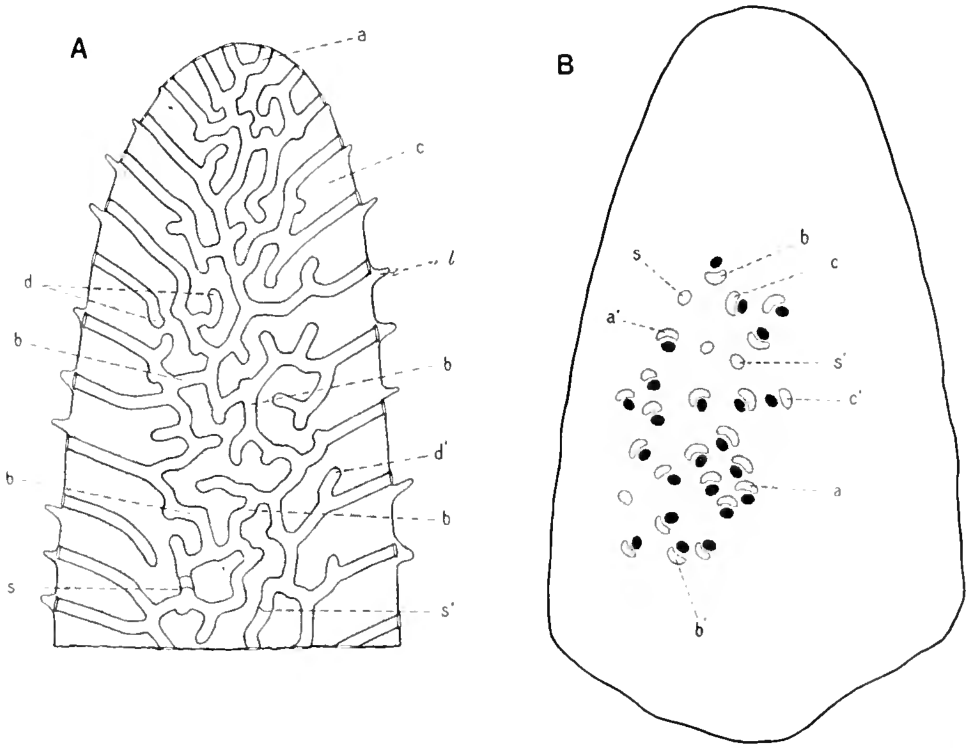
The distinction between the sub genera *Idiothecia* and *Demiothecia* was drawn in 1907 (07[1], p. 7) because the isolation of the zooids in separate tubes in the cœnœcium of the species grouped in the former subgenus appeared to be of systematic importance. The study of the present material, however, goes some way to break down the distinction. In *Cephalodiscus agglutinans* the internal system of spaces in the cœnœcium is continuous throughout (except for occasional septa, see below), and zooids can move fairly freely through the system, as may be seen by the manner in which they have retreated to the internal parts of the branches in the material under consideration. So far as one can judge from a study of pieces of colony preserved in alcohol, the growth of a branch in a species of *Idiothecia* is by the buds (or possibly larvæ) settling at the apex of the branch, and each secreting a tube of its own, independent of those already existing, whereas in the present species the (presumably young) zooids at the apex secrete tubes continuous with the existing system of spaces within the branch. But *C. agglutinans* differs from all known species of *Demiothecia* in having long tubes, *i.e.* spaces of approximately even calibre extending for considerable distances; for in the recorded species of *Demiothecia* there is a single irregular branching cavity in the interior of the piece of colony, and this opens abruptly to the exterior here and there on the surface of the branch, or by means of very short tubular passages (see *C. hodgsoni*, 07[1], pl. iv. fig. 22).

The disposition of the tubes within a branch of the colony may be studied by dissecting away the soft part of the cœnœcium and the included shelly particles, but the process is laborious and not altogether satisfactory in other respects. Much better results can be obtained by decalcifying a branch in a 1 per cent. solution of nitric acid for ten days or a fortnight, and then bisecting the branch lengthwise and dissecting out such of the tubes as are laid bare. The process of decalcification removes all the shelly particles, and leaves only the grains of slate (see p. 418), which are not numerous and can be easily picked out. The piece of colony after decalcification is of a dirty brown colour, and is translucent, without the opacity and whiteness which is such a marked feature of the cœnœcium before it is placed in acid. In text-fig. 2, A, is shown a diagrammatic representation of the cut surface of such a bisected branch. (Compare this with the diagrammatic longitudinal section of a branch of *C. nigrescens*, in 07[1], pl. iv. fig. 10.)

This diagram (text-fig. 2, A) explains the main features of the tubular passages of the cœnœcium. It shows that in the most superficial parts the tubes are fairly straight, and of uniform diameter, and that they slope more or less radially outwards and incline somewhat towards the apex. The tubes in the middle are irregular in their arrangement, but on the whole are set at a uniform distance from one another. What appear to be blind ends of tubes at *d* and *d′* are merely parts of tubes that are cut across obliquely because they are leaving the plane of section.

In some of the passages, especially in the more basal parts of a branch, as at *s* and *s′*, there are thin concavo-convex partitions or septa, sometimes two or three in close succession. These septa, however, are not common. Their concave faces may be directed towards the apex of the branch, as at *s′*, or away from it, as at *s*.

In the apical region of a branch, as shown in the upper part of text-fig. 2, A, the ostia are closer together than on the sides of the branch, and the tubes that open to the exterior are much shorter than elsewhere; but the tubes are of the same calibre as in the other parts of the branch. The substance of the cœnœcium is more delicate and the lining of the tubes thinner and less brown in colour than in other parts, and the tubes have no spines. These circumstances lead to the conclusion that the growth in the length of a branch takes place at the apex.



TEXT-FIG. 2.—A, a diagrammatic longitudinal section of a branch of *C. agglutinans*. *a*, a short peripheral tube at the apex of the branch; *b*, *b*, *b*, *b*, a part of the inner tubular system showing a complete open circuit; *c*, cœnœcial substance, a soft albuminoid with shelly particles included; *d*, *d'*, parts of tubular passages cut obliquely: they are not blind ends; *l*, lip or spine set at the opening of a peripheral tube; *s*, *s'*, thin concavo-convex septa set across the tubes. Approximately × 1½. For further explanation see the text, page 414.

B, a stout branch of *C. agglutinans* with the ostia and their spines or lips indicated over a portion of the surface. The tube-openings are shown in black: the oval and crescentic areas represent the broken bases of spines. *a*, *a'*, spines situated on the side of the tube towards the apex of the branch; *b*, *b'*, spines situated towards the basal side of the tube; *c*, *c'*, spines more or less lateral in position; *s*, *s'*, spines with no tubes alongside them. Approximately × 1½. See text, p. 417.

In the case of species of *Idiothecia* and *Orthoëcus* it may be surmised from a study of the characters of the tubes of the cœnœcium that young zooids, on separating from the stalk of the parent zooids, migrate over the surface, and settle down, in the case of species of *Idiothecia** at the apex of the branch, and in the case of species of *Orthoëcus* at the margin of the colony-mass. In *C.* (*Demiothecia*) *inæquatus*,

* Except in *C. indicus* (SCHEPOTIEFF, 09), about which we know too little to be able to speculate upon the mode of growth of the colony.

ANDERSSON has actually seen living zooids creeping over the surface of the cœnœcium (07, p. 7).

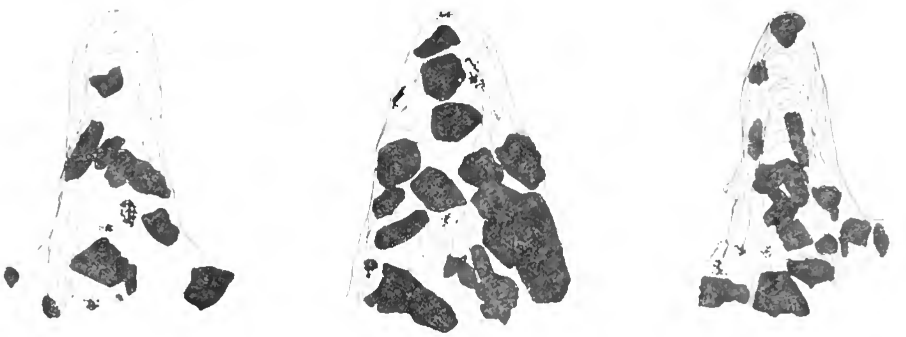
In the case of *C. agglutinans* the state of preservation of the material does not enable us to conclude with certainty that each superficial tube opening to the surface was inhabited by a single zooid and its set of buds, but the probabilities are much in favour of this. The even calibre of each tube that opens to the surface points to its gradual growth outwards, as the branch thickens, being the work of a single zooid, as in the case of species of *Idiothecia* and *Orthoëcus*. There would, therefore, be in any one piece of colony approximately as many fully formed zooids as there are ostia. What occurs in the middle part of the tubular system it is not easy to conjecture; these parts can scarcely be inhabited in the ordinary sense of the term, since there is probably in the deeper tubes no circulation of sea-water such as would suffice for nutrition and respiration of zooids living there. One must conclude that these internal tubes are rather in the nature of deep retreats for the zooids in time of danger, and that when conditions of life are favourable and all the full-grown zooids have their proboscis and arms, and perhaps the whole of their body except the stalk, projecting out of the mouth of the tube, the inner part of the tubular system is empty, or serves only as a safe situation in which the young buds may grow.

When a bud is so far grown that it severs its connection with the parent and wanders off on its own account towards the apex of the branch to settle down as an independent zooid with a peripheral tube of its own, it may possibly reach the apex by the internal tubes, where, as suggested above, it would meet with but little resistance from other zooids; but it is much more likely that the young zooid takes a superficial route to the end of the branch, as one must suppose a young zooid of *C. nigrescens* does. But in the present case the young zooid on arriving at the apex does not commence to form a new short cæcal tube for itself, as is the case in *C. nigrescens*, but, in conjunction with other young zooids like itself, elaborates the tubular labyrinth already existing. At any one time one must suppose that every tube that opens upon the apex has in it a single young zooid which is adding to the mouth of the tube to increase its length, and is filling up with softer cœnœcial material and shelly fragments the interval between its tube and those around. A newly arrived young zooid would therefore have to contend with some other zooid for the possession of a tube, and what seems to happen is that a *modus vivendi* is arrived at by the two agreeing upon a branching in an apical direction of what is at present a single tube. This, of course, is but speculation, but it seems to be the most plausible conclusion from a careful study of the form and disposition of the tubes at the free extremity of a branch.

In the older parts of a branch it would be interesting to know what happens to a peripheral tube when the adult zooid dies. The probability is that the vacant tube would soon be appropriated by some newly liberated bud or young zooid, either from within or from without. In some cases, as is shown on p. 418, the vacant tube is sealed up, but this is very exceptional.

The life of a colony is apparently not indefinite, for some of the pieces of the *Scotia* collection are "dead," *i.e.* no zooids at all are to be found in them. The tubes are either empty, or are occupied by a powdery brownish black mass, which, judging from its colour, may possibly consist of the products of decomposition of zooids. Among this débris are numerous specimens of a Tanaid Crustacean, of which no adult males have been found, so that the determination of the species is difficult. The specimens have been submitted to Mr T. V. HODGSON, who will doubtless refer to them in his report upon the Tanaidacea obtained on the *Scotia* Expedition.

The spines represented in text-fig. 3 show the mode of their construction by the superposition of successive caps of cœnœcial substance and the inclusion of foreign particles in these caps. Each fragment of shell is, of course, embedded in the particular increment that was being applied at the time that the fragment was picked up, and consequently it may cause a distortion of the surface of that particular cap, and the



TEXT-FIG. 3.—Three spines showing the successive caps of cœnœcial substance and the foreign particles included.

subsequent one, but it does not project into the preceding, more basally placed cap. In text-fig. 3 it might appear in certain places as though the particle were projecting into the cap below it, but this effect is produced by the particle and the optical section of the cap drawn in the figure being in different planes; the particle is more or less behind or in front of the median longitudinal section of the spine.

The diagrammatic text-fig. 2, A, shows that, except at the apex of a branch, the lip or spine at the edge of the ostium may be situated towards the apex or towards the base of the branch, or more or less laterally, and that it has not the regularly basal position that it has in *C. nigrescens* (07[1], pl. iv. fig. 10). This irregularity is illustrated further in text-fig. 2, B, which represents the carefully drawn details of a part of the surface of a stout branch. Owing to the fact that most of the spines on the surface of a piece of colony are broken off short, it is necessary to dissect into the substance of the cœnœcium to see the relation of the spine to the ostium. In the portion dissected it will be noticed that the spine is situated towards the apical end of the branch at *a* and *a′*, but towards the basal side of the ostium at *b* and *b′*, and it is laterally placed at *c* and *c′*. The spines broaden out as one dissects into the branch, and can be traced along the tubes for about a centimetre, when they cease to be distinguishable from the soft general material of the cœnœcium. This is in conformity with what one sees at the apex of a branch, where the very young tubes have no spines (text-fig. 2, A).

The part drawn in text-fig. 2, B, shows four spines which have no ostia alongside (e.g. *s*). Three of these spines did not reach the surface, but had been buried over during the increase in the thickness of the branch. Occasionally, but rarely, a buried spine is found to have a closed-up tube by its side. Such an occluded tube is closed by a thin, curved partition, such as is seen in some of the inner tubes (as at *s* and *s′* in text-fig. 2, A), the convexity in the present case being towards the outer surface ; and over this and also over the spine the soft material of the cœnœcium is deposited uniformly. One must suppose that in this case the tube was not occupied at the time that the zooids in the immediate vicinity were lengthening their tubes and filling in the intervals between them, and that the septum was formed subsequently from within. The relations of the spine alongside the occluded tube, and the succession of caps composing the spine, prove that the blind end of the tube is a closed-up ostium, and is not the initial end of a tube, blind from the commencement, such as one sees in the middle part of a branch of *C. nigrescens* (07[1], pl. iv. fig. 10).

Although the present species is denominated *C. agglutinans*, from the manner in which the zooids have embedded great quantities of shelly fragments in the material of the cœnœcium, the habit is not peculiar to this species, for HARMER has stated in his account of the new species which were obtained on the *Siboga* Expedition (05, p. 8), that the cœnœcium includes foreign particles as a rule, and that they are specially obvious in *C. sibogæ* (05, pl. ii. fig. 17, 18). ANDERSSON quotes as one of the characters by which *C. solidus* is distinguishable from *C. rarus*, that the tubes are encrusted with sand, diatoms, etc. (07, pp. 11, 12) ; and he further states that the tubes of *C. densus* are covered with sand-grains. GRAVIER, again (12, p. 2), says that in *C. anderssoni* (which, if not synonymous with *C. densus*, is very closely allied to it) sand-grains and shells of Foraminifera resembling *Polystomella* adhere to the outer face of the tubes, and are even incorporated in the substance of the wall. The basal parts of the pieces of colony of *C. nigrescens* are also known to contain fragments of shells (RIDEWOOD, 12, p. 551, Specimen C).

The inclusions in the cœnœcium of *C. agglutinans* are present in such quantity as to make the branches of the colony much more readily crumbled and broken than are those of *C. nigrescens*, which in general massiveness bear some resemblance to the branches of the present species. The particles included are mostly calcareous, and disappear when a branch is soaked in a 1 per cent. solution of nitric acid for ten days or a fortnight. The only foreign particles remaining after this treatment are some rounded, dark grey, or blackish grains, which Dr J. W. EVANS, Mineralogist of the Imperial Institute, has been good enough to examine for us. He reports that they are water-worn grains of slate. They mostly vary in size from ·3 to 1 mm. in diameter, but one was found as large as 6 mm. across. A few of them are paler in colour, and softer, than the majority, and are nearly white when dry; these are grains of slate more decomposed than the others.

While the slate-grains are all rounded and water-worn, the calcareous inclusions are remarkably free from signs of attrition. Delicate shells of Foraminifera, minute bivalve Molluscs, extremely thin, and with the two valves still in their natural relation, pieces of Echinid spines, and portions of Polyzoan colonies occur in a remarkably fresh and undamaged state, and can be picked out clean from the soft albuminoid material of the cœnœcium. Among the other inclusions one can recognise pieces of fairly large Lamellibranch shells, fragments of Gastropod shells, and pieces of Serpulid tubes. These broken pieces of shell show sharp edges in the great majority of cases, but a few are rounded. The fragments are, many of them, but little larger than the shells of the Foraminifera, but most are from ·5 to 1 mm. in longest diameter. The largest pieces picked out were 8, 10, or 12 mm. long.

The included particles are all clean and free from mud, and from their even disposition in the cœnœcium one is tempted to conclude that they have not drifted by accident against newly secreted cœnœcial material which has not yet "set" or hardened, but that the particles are definitely selected by the zooids and built into the wall of their colonial residence, somewhat in the manner in which the arenaceous Foraminifera form their shells, and the larvæ of the Caddis-flies their tubes; and similar instances might also be quoted from among the tubicolous Polychæt Worms and the Rotifers.

The inclusion of foreign particles is not always uniform in the same piece of colony. It frequently happens that one side of a branch is whiter than the other, and a longitudinal section shows that the whiter half has more calcareous particles embedded than the other, and fewer tubes.

The pieces of colony brought home by the *Scotia* are too fragmentary to enable us to draw any conclusions as to the total dimensions of a colony of *C. agglutinans*. None of the pieces show at their basal ends any signs of an area of attachment to a solid substratum, and while each of the larger pieces, such as are figured in Pl. I., may be a separate colony, it is just possible that they may be portions of a large branching colony. This is rather suggested by all the zooids found being males, and by the fact that all the buds are in about the same stage of development—namely, very young buds, up to buds with four pairs of arms: only two buds were found having as many as five pairs of arms. There is, however, no evidence of the existence of stouter branches than those shown in Pl. I., such as would be capable of sustaining the great weight of the specimens in question, and, further, it must not be overlooked that the shelly fragments in the cœnœcium add to the weight of the branches without adding to their strength, and this may impose a limit to the size of an individual colony.

There is yet, however, a further possibility that the whole colony may consist of a broad, plate-like part closely adherent to some other object, and that from this there may stand up a forest of pieces such as are figured in Pl. I. The trawl in passing over such a colony would snap off several of the upright pieces, but would not dislodge the basal plate. This view of the constitution of the colony is supported by the fact that the diminutive colony of *C. sibogæ* is composed of a basal encrustation growing on a stone, and a series of upstanding pieces (05, p. 13, and pl. i. fig. 2).

External Appearance of the Zooids.

The *Scotia* specimens are, unfortunately, in a rather poor state of preservation. In many cases the zooids had obviously retreated, on being killed, into the deeper recesses of the cœnœcium, where they did not come properly into contact with the preserving fluid. The result is that they are usually in a highly and often very irregularly contracted state, and their tissues are a good deal macerated. They are frequently in closely aggregated and deeply pigmented masses, which have somewhat the appearance of the zooid with its buds of *C. nigrescens* shown by Ridewood (07[1], pl. iii. fig. 7). They are, in fact, more similar in external appearance to the zooids of that species than to those of any of the species of *Demiothecia* previously described. In well-extended and fairly straight individuals the average length from the end of the metasome to the free ends of the arms is 4·5 mm., the length from the end of the metasome to the bases of the arms about 3·2 mm. The thickness of a zooid is about ·8 mm.

The zooids are, however, probably all shorter than they would have been in their fully extended condition, since the wrinkling of the skin indicates a strong contraction of the muscles, particularly of the longitudinal muscles of the anterior side of the metasome and of their continuation into the stalk.

All parts of the epidermis contain a dark pigment, so that the zooids have a deep brown or black colour in the preserved material. It is obvious that the pigment is not completely dissolved out by alcohol; but it is probable that its diffuse arrangement, as seen in the preserved specimens, does not represent the exact disposition during life. This is suggested by the comparison of sections of certain individuals of *C. nigrescens* (*Discovery* Expedition) which had been preserved with special care with sections of zooids which had not been so treated (see also p. 426). The former series show pigment-granules in sharply restricted areas (*cf.* Ridewood, 07[1]. pl. v. fig. 28), while the latter show a diffuse arrangement, suggesting that the pigment had been partially dissolved out, and then redeposited as a general staining of the tissues.

Proboscis.

The proboscis or buccal shield of the zooids in the material brought back by the *Scotia* is in such a poor state of preservation that it is not possible to make a statement as to its average shape and size. By an examination of whole zooids under a dissecting microscope, sufficient can be seen to show that the proboscis offers no exceptional features; there is a main lobe, and a lower lobe, thinner than the main portion, and possessing the red line which is so curiously constant a feature in the various species of *Cephalodiscus*. But the epidermis is hopelessly disintegrated in most cases, and it is only in the buds that the proboscis is sufficiently well preserved for its form and proportions to be adequately determined (Pl. II. figs. 1–4; and text-fig. 5).

As in other species of *Cephalodiscus*, the proboscis is a highly mobile organ, and its parts appear in very varying positions in different individuals. It is shown in the sagittal section, fig. 15, and in the frontal sections, figs. 6–10, of Pl. II.

Pl. II. fig. 14 represents a section which has cut the proboscis-stalk at its narrowest region, and it demonstrates the two proboscis-canals (*p.p.*) in their usual relation to the pericardium (*per.*) and the anterior dorsal horns (*b.c.*^{2}*a*) of the collar-cavity.

Collar-region.

The principal parts of the collar are the arms or plumes, dorsally; and the operculum or postoral lamella, ventrally.

(i.) *Tentacle-bearing Arms or Plumes.*

The number of these structures is greater than in any of the species previously described, since the full number appears to be nine pairs. This number is, however, not quite constant, as is indicated below. The species which most nearly resemble it in the number of their arms are the three species of *Orthoëcus* (*C. densus*, *C. rarus*, *C. solidus*), which were described by Andersson (07), in which the number is stated to be constantly eight pairs; and *C. nigrescens*, in which the number is usually seven pairs, although it may rise to eight pairs (Ridewood, 07[1]). None of the species of *Demiothecia* which have been previously described have more than six pairs; and this is the commonest number in the subgenus in question.

The sections shown in figs. 6–11 of Pl. II. are chosen to demonstrate that nine pairs of arms may really be present. They have been cut at right angles to the long axis of the zooid, and therefore in a plane which has been described in the *Siboga* report (Harmer, 05) as "frontal."

Fig. 6 shows the first seven and the ninth arms of the left side, and the first seven arms of the right side. The study of the entire series of sections shows that all these arms except L.^{9} and R.^{1} are directed dorsally, in a line prolonging the main axis of the zooid. The eighth and ninth pairs of arms could probably have assumed the same general direction during life; but they are actually lying in a position which makes their interpretation more difficult than in the case of the first seven pairs.

In fig. 7, which is the eighth section from that represented in fig. 6, the first seven arms of the left side are connected with one another. The lophophoral region of the collar has, in this section, not yet split up into the separate arms. Four of the membranous partitions which separate the arm-cavities for a short distance at their bases, and are formed by the "Grenzmembran,"* are seen in this section. On the right side the first five arms are similarly connected, but R.[6] and R.[7] are already free. A comparison of this figure with fig. 8 will show that the first right arm has its axis directed more or less horizontally (or backwards) at the base, and that the arm then curves dorsally to assume the position in which it was seen in fig. 6. On the left side of fig. 7 the lophophore is about to separate from the rest of the collar, and the anterior dorsal horn of the collar-cavity is cut nearly at its tip. On the right side most of the lophophore is separated, in the section, from the rest of the collar, but the first arm is cut in a plane parallel to its food-groove, at its base. As the two sides of the groove are continuous with one another in an adjacent section, the difference between the two halves of the lophophore is thus not so great as it appears to be at first sight. The food-grooves are obvious in all the arms except in L.[6], where the groove has opened out.

Fig. 8, which is eight sections further on, shows the dorsal parts of the collar-cavity (*b.c.*[2]) separated by a well-marked dorsal mesentery, at the ventral end of which lies the notochord (*nch.*), followed by the pericardium (*per.*) containing the heart. Some of the arm-grooves have disappeared. The eighth arm (L.[8]) is visible on the left side, and the ninth arm (L.[9]) of the same side shows indications of joining the lophophore. The relations of the first right arm (R.[1]) have been explained in describing the previous section. The sixth right arm has joined the lophophore, but the seventh arm of that side is still distinct.

Fig. 9 represents the tenth section from that shown in the preceding figure. The eighth arm of the left side is now separate and is cut longitudinally, while the ninth arm of the same side is cut in a plane parallel to its long axis, so that its two sides are completely separated by the food-grove. It will be noticed that this arm, the last of the series, is closely related at its base to the opercular lobe (*op.l.*) of the same side. On the right side, R.[7] has joined the lophophore; R.[8] is beginning to appear, although still separated from the lophophore; and the tentacles of R.[9] are commencing to be visible.

Fig. 10, which is four sections further on, shows the last two arms of both sides, both ninth arms being connected with the corresponding opercular lobe at their base.

In fig. 11, which is seventeen sections nearer the aboral end of the animal, the eighth left arm has passed across the dorsal side to the right of the metasome, where it lies close to the eighth right arm; while the ninth right arm has passed across the ventral side of the zooid. The section passes through the region of the gill-slits and collar-canals. Parts of the gill-slits (*g.s.*) are seen, in the region of their external openings and of their origin from the pharynx (*ph.*), on both sides of the section. The left collar-canal appears as a single cavity, but the right canal is cut twice, the two parts being connected by the strong muscle of the canal. The reason for this appearance is that the organ has a concave outline on its dorsal side, where the section

* SPENGEL, J. W., "Die Enteropneusten d. Golfes v. Neapel," *Fauna u. Flora d. Golfes v. Neapel*, 18 Monogr., 1893, p. 452.

passes. Part of the cœlomic opening (*c.c.i.*) is visible in the figure, while a line crossing the epidermis just outside the canal indicates the commencement of the external orifice. On the dorsal side of the section are visible the two testes (*t.l.*, *t.r.*), with the genital mesenteries passing from the median dorsal mesentery ($d.m.^3$) of the metasome to the gonads. The left testis (*t.l.*) of this individual is large and functional, but the right testis (*t.r.*), which is cut close to its external opening, has remained undeveloped. It appears in only a few sections of the series, and it does not anywhere reach a size much larger than is shown in the section under consideration. The asymmetry of the gonads is to be regarded as an individual peculiarity of this zooid (see also p. 429).

The demonstration of the number of arms, beyond the possibility of doubt, being a matter of some importance, a plasticine reconstruction of this individual was made according to the method described on p. 21 of the *Siboga* report (HARMER, 05). A slight improvement was, however, introduced by drawing the sections on thin drawing card ("Bristol board"). After cutting out the outlines drawn, the card was covered with a layer of plasticine and was attached to the part of the model already made. The cards representing the sections were left *in situ* in the model. The special advantage of this mode of procedure is that the cut edges of the cards remain in the model as a record of the outlines of the sections from which it has been constructed. This obviates the danger of destroying the outlines of the sections when smoothing out the intervals between two successive sections. If it should appear, moreover, that two sections have not been fitted together in correct "registration," it is easy to separate them at any time and to fit them together more accurately without losing the evidence on which the model was built up. The study of this reconstructed model has enabled us to obtain a clear idea of the position of the individual arms, of the parts of the operculum, and of the arrangement of the gill-slits and collar-canals, with other features of the zooid.

Making use of this evidence, the correctness of which can be estimated from the figures (figs. 11–6), the following description of the arms may be given. It will, of course, be understood that their position in the individual under consideration is to a large extent fortuitous, and that during life the arms could undoubtedly have assumed many other positions.

The first seven arms of both sides are directed dorsally, in line with the long axis of the zooid. On the right side, however, the first arm passes at first posteriorly, at right angles to the long axis, and then curves dorsally. On both sides the eighth and ninth arms are in the main directed ventrally. The ninth right arm passes ventrally from its origin, but soon curves across the ventral or anterior side of the zooid to assume the position shown in fig. 11. The eighth arm begins by passing dorsally for a short distance, and then doubles back sharply in a ventral direction. Fig. 10 represents the arm at the point where this flexure is taking place. It will be seen that the food-groove faces posteriorly. The part which is marked $R.^8$ represents the arm after the flexure has taken place; and in the later sections of the series (fig. 11), the arm is seen in transverse section as a continuation of the part marked R.^{8} The elongated part which stretches from this region towards the ninth arm shows the food-groove (R.^{8*}) opened out and cut obliquely at or near its flexure.

The eighth left arm (figs. 11–8) also has its food-groove directed posteriorly; but it lies in such a position that it is cut almost longitudinally as it passes across the dorsal side of the principal part of the collar. The ninth left arm (figs. 10–6) at first lies between the eighth arm of the same side and the region of the central nervous system (figs. 10–8). It runs more or less horizontally near its base, but soon curves dorsally, so as to appear even in the first section (fig. 6) which has been represented.

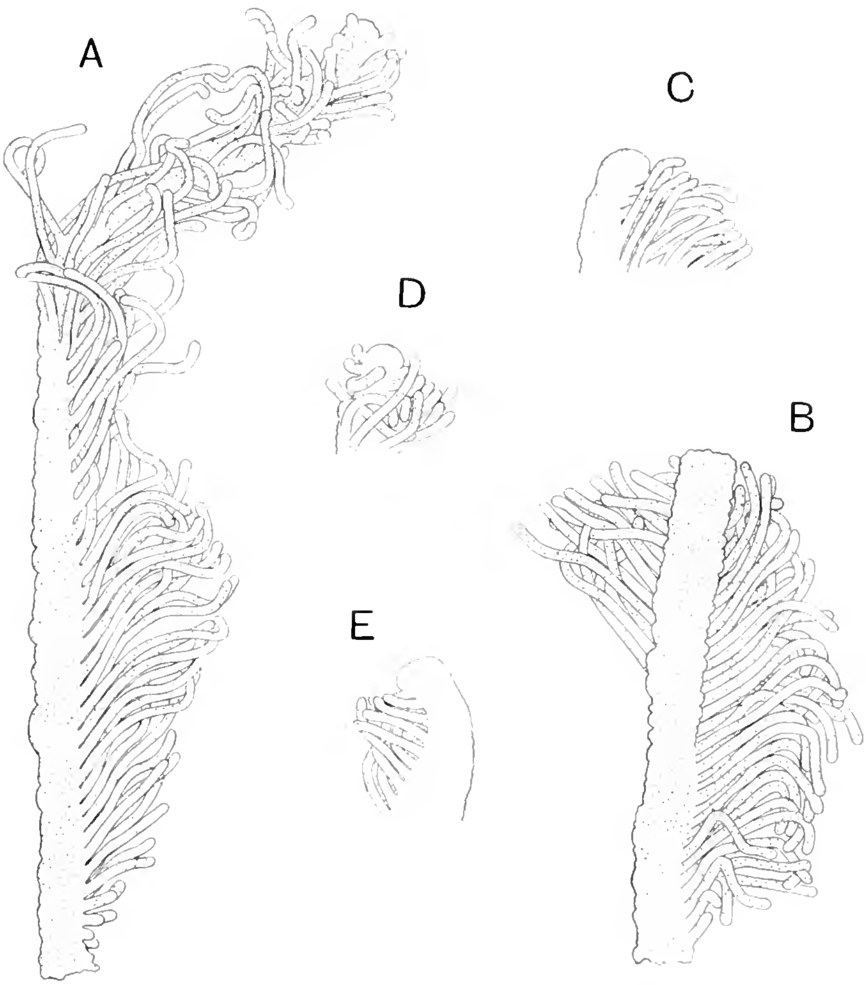
Although there are eighteen arms in the zooid which has thus been described in detail, this number is not constant in the species. A series of selected zooids were dissected and were found to give the results set forth below. It is possible, however, that arms may have been lost in some of the zooids examined, either by accident during life or as the result of violent contraction at the moment of preservation, and that some margin of error may thus have been introduced into the table. The facts as observed are as follow:—

12 arms	3 individuals	3
13 ,,	1 ,,	4
14 ,,	3 ,,	
15 ,,	4 ,,	15
16 ,,	11 ,,	
17 ,,	11 ,,	17
18 ,,	6 ,,	
19 ,,	1 ,,	1
Total	40 individuals	40

If it may be inferred that in a zooid with thirteen arms, for instance, there were seven arms on one side and six on the other, it follows that of the forty individuals dissected there were only three which had less than seven arms on one side at least, and these appear to have had six pairs. In four cases there were seven arms on one or both sides; in fifteen cases there were eight arms on one or both sides; in seventeen cases there were nine arms on one or both sides; and in one case there were ten arms on one side. Representing these as percentages, it follows that the observations indicate:—

Total Number of Arms.	Maximum Number of Arms on One Side.	Individuals.	Percentages.
17 or 18	9	17	42·5
15 or 16	8	15	37·5
13 or 14	7	4	10·0
12	6	3	7·5
19	10	1	2·5
	Total	40	100·0

It results from these figures that 42·5 per cent. of the zooids had nine arms on one side at least; while 80 per cent. had either eight or nine arms on one side at least. We accordingly draw the conclusion that the typical number of arms, in this species, is nine pairs, but that more than a third of the cases observed had a pair less; while a smaller percentage had seven, six or even ten arms as the maximum number on one side.



TEXT-FIG. 4.—Arms of *Cephalodiscus agglutinans*. A, an arm well extended; B, an arm in a moderate state of contraction; C–E, terminal portions of arms.

The number of tentacles or pinnules on an arm of a full-grown zooid is usually between thirty-five and forty-five pairs, but in some instances the number may be fifty pairs, and in younger zooids the number is less than thirty-five pairs.

It is difficult to say with certainty whether the dorsal epidermis of the axis of the arm is thick and black in *C. agglutinans*, as it is in *C. nigrescens*, because in most cases the epidermis has disintegrated, and there is more than a suspicion that in those cases in which the epidermis is still present the pigment-granules, which might have been present in them, have become bleached. This suspicion is founded upon the fact that in the *Discovery* material some of the pieces of *C. nigrescens* were carefully fixed in Perenyi's fluid and some in picric acid solution, but most of the material was preserved in 5 per cent. formalin ; and in slides made from the former material (fixed in Perenyi's fluid). the pigment is strongly marked (RIDEWOOD, 07^1, pl. v. fig. 28), whereas in sections prepared from the formalin-preserved material, the thick dorsal epidermis is not darker than the other parts of the section. The material of *C. agglutinans* was preserved in alcohol and not in formalin, it is true, but the preservation is not good, and the appearance of the large cells on the dorsal surface of the axis of the arms seen in paraffin-prepared serial sections is remarkably like that in the sections of the formalin-preserved zooids of *C. nigrescens*.

The dorsal epidermis of the arms of *C. agglutinans* is least disintegrated in contracted arms, and in the arms of fairly young zooids having but twenty-five to thirty-five pairs of tentacles. Text-fig. 4, A shows the appearance of a well-extended arm, and B an arm in a moderate state of contraction. The terminal part of the arm has no end-bulb with highly refractive beads such as distinguish the arms of *C. dodecalophus* (M'INTOSH, 87, pl. iv. fig. 1 ; pl. v. fig. 1 ; and RIDEWOOD, 07^1, text-fig. 1, p. 4) and *C. hodgsoni* (07^1, pl. v. fig. 32). In extended arms the extremity is bluntly pointed ; in contracted arms it is rounded and even hemispherical. Some terminations better preserved than usual are shown in text-fig. 4, C–E (cf. *C. nigrescens*, 07^1, Pl. v. figs. 23–27).

(ii.) *Operculum or Postoral Lamella.*

The interpretation of the sections shown in figs. 8–11 is at first sight by no means easy, so far as the operculum is concerned. The study of the plasticine reconstruction has, however, enabled us to come to a clear conclusion as to its general form. It is seen to be deeply emarginate in the middle line, and the median sagittal sections examined thus show only a feebly developed lower lip (*e.g.* fig. 15, *op.*). On either side of the mouth, however, the operculum is produced into a large lateral lobe, a great part of which is free. The comparison of this series with other series of sections, and with what is known of other species of *Cephalodiscus*, shows that the operculum is a highly mobile organ, the parts of which can assume very different positions at the will of the zooid. In the specimen under consideration the right lobe (*op.r.*) is directed in the main dorsally (figs. 10–8), while the left lobe is sharply reflected ventrally, close to its origin from the collar. Figs. 10 and 9 cut this left lobe at or near the point where the flexure takes place. A consideration of fig. 9 will show that if the lobe of the left operculum (*op.l.*) nearer to the proboscis be imagined to have been unbent, so as to pass in a dorsal direction as a prolongation of the part of the operculum of the same side which is nearer the central nervous system, it would not have appeared in fig. 9 ; and the two sides of the section would have been fundamentally similar. If the zooid had died with the left lobe in the position indicated, both lobes would have appeared in fig. 8 in the position actually seen on the right side. This section shows the large right lobe of the operculum in a region where it is free from the rest of the collar. The species appears to be characterised by having these free lateral lobes of the operculum well developed. It may be supposed that the size of the lateral lobes is to some extent correlated with the number of the arms; since it can hardly be doubted that one of the most important functions of the operculum is to help to convert the ventral grooves of the arms into channels leading the food to the mouth. A large development of the arms would accordingly require a corresponding development of the opercular lobes, which, during the act of feeding, would presumably be thrown into the position seen on the right side in fig. 8.

Comparison with other species of *Cephalodiscus* in this respect cannot be attempted very satisfactorily, but it may be noted that the operculum of *C. hodgsoni*, figured by Ridewood (07[1], pl. vi. fig. 53), has a close resemblance to that of *C. agglutinans*, here described. Except with the aid of solid reconstructions, which have not been made in many cases, it is often difficult to ascertain the exact form of this organ; but it may be remarked that in *C. gracilis*, of which a plasticine reconstruction has been figured in pl. iii. fig. 25, of the *Siboga* report (Harmer, 05), the operculum is hardly emarginate in the middle line, and has no special development of its lateral lobes. The arms in that species are comparatively few, only five being present on each side.

Two further points may be noted with regard to the operculum of *C. agglutinans*:—

(*a*) The last arm of each side is continuous with the corresponding opercular lobe, as in other species of *Cephalodiscus* (*cf.* Harmer, 05, pp. 31, 36; and Ridewood, 07[2]. p. 229). This is sufficiently illustrated by fig. 10.

(*b*) The free edge of the operculum is more or less scalloped, as is indicated by fig. 11, where two of the end-lobes are cut separately. Evidence that the edge has this form has also been obtained in some of the dissected specimens. The same character has been figured by Ridewood (07[1], pl. vi. fig. 53) in *C. hodgsoni*.

(iii.) *Collar-canals.*

These structures agree in general form and position with those of other species of the genus. Seen in side view the ventral outline is very convex, while the dorsal outline may be concave. In a frontal section of the zooid (fig. 11), a collar-canal which is cut near its dorsal side may appear as two separate parts. The inner part (*c.c.i.*) opens into the collar-cavity, while the two parts of the tube are connected by the strong collar-muscle. The epithelium of the canal is much thinner on the dorsal side than it is ventrally; and it is reasonable to suppose that it is more flexible there. The muscle would thus seem to have the function partly of dilating the cœlomic opening and partly of acting in antagonism to the prolongation of the principal muscular mass of the metasome; which, as shown in the sagittal section, fig. 16, *ms.*, ends in close relation with the collar-canal (*c.c.i.*). The *modus operandi* of the collar-canals has previously been discussed by both of us (HARMER, 05, pp. 41–46 ; RIDEWOOD, 07, pp. 41–43).

GILL-SLITS.

The gill-slits (Pl. II. figs. 5, 11, *g.s.*) agree closely with those of other species of the genus. In the individual represented in figs. 6–11, the external openings of the gill-slits are seen from the plasticine reconstruction to lie in strongly marked longitudinal grooves, each of which occurs nearer to the middle line of the anterior wall of the metasome than the external opening of the corresponding collar-canal. These grooves are, however, probably the result of contraction at the moment of death. They can be traced along the metasome for a considerable distance, in an aboral direction, beyond the collar-pores. The walls of the gill-slits are composed of vacuolated epithelium (MASTERMAN'S "pleurochords"), as in other species of *Cephalodiscus*.

ALIMENTARY CANAL AND NOTOCHORD.

The great length of the intestinal loop, which commences at the stomach and is situated in the cæcal end * of the metasome has been alluded to above in describing the distinctive features of this species. It is well seen in the dissected specimen, fig. 12, and in the sagittal section, fig. 16. In both figures the metasome is probably shortened by muscular contraction ; and in its full state of extension the folds seen in the figures would have probably disappeared. Owing to the length of this part of the alimentary canal, the stomach (*stom.*) is separated by a considerable interval from the cæcal end of the metasome—a character in which the present species resembles *C. levinseni*. In one individual which has been examined, the intestinal loop contains a number of Diatoms and other microscopic organisms, and many Sponge-spicules.

The notochord (*nch.*) is seen in sagittal section in fig. 15 ; and as shown by this figure, as well as by figs. 8–10, it has a well-developed lumen.

GONADS.

Every individual in which the gonads have been examined has proved to be of the male sex. Although the amount of material at our disposal has been large, it was all dredged at one time, and there is nothing to forbid the assumption that all the pieces brought back by the *Scotia* were parts of a single large male colony.

The testes vary a good deal in size in the different individuals examined. In their highest development (figs. 5, 12) they are elongated organs, which may be simple tubular structures, or may be marked by several constrictions extending traversely to

* ANDERSSON (07, p. 7) has pointed out, from observations on living zooids, that the "cæcal end" of the metasome disappears in fully extended zooids, where the stalk appears as a direct continuation of the body. The appearance of a cæcal end is none the less very characteristic of the majority of the contracted zooids.

their main axis. These are probably in part the result of the contraction of the zooid. The aboral end of the testis may extend at least as far as the origin of the stalk from the metasome.

In some cases, though not in all, we have noticed the appearance indicated at the aboral end of the testis in fig. 12. A tube, which seems to end blindly, extends into the cavity of the organ as an invagination of the aboral end. The most probable interpretation of this structure is that it is merely part of the wall of the testis which has been invaginated, and that it has no special morphological significance. Its walls are sometimes more pigmented than those of the rest of the testis, so that it may be a conspicuous structure in entire preparations.

When both testes are fully developed, as in fig. 5, *t.l.*, *t.r.*, they appear symmetrically disposed on either side of the median dorsal mesentery of the metasome. The central part of the testis is occupied by a mass of fully developed spermatozoa, while there is a peripheral zone, of varying width, which contains very numerous nuclei, indicating stages in spermatogenesis. In other cases, as in fig. 11, the two testes are very different in size; and in this particular case the left testis (*t.l.*) is fully developed, while the right testis (*t.r.*) has remained vestigial. The figure shows the two transverse genital mesenteries which run from the dorsal mesentery of the metasome, near the region where the testes open to the exterior, to the two gonads. These transverse mesenteries are no doubt the bearers of blood-vessels which pass from the dorsal vessel to the gonads.

Nervous System.

We have no new observations of importance with regard to this part of the anatomy, and it will be sufficient to note that the nervous system of *C. agglutinans* agrees in essential respects with that of other species of the genus.

Andersson has, however, stated (07, pp. 7, 8, 32) that while in the subgenus *Orthoëcus* the lateral nerves unite ventrally on the metasome to give rise to a nerve-tract which has a single median thickening, *Demiothecia* differs from it in having a subsidiary thickening on each side of this median one. The occurrence of the three nerve-tracts in the ventral region of the metasome and in the stalk was first pointed out by Masterman (98, p. 513) in *C. dodecalophus*; but it is not certain that the character in question can be used to discriminate the subgenera of *Cephalodiscus*. Thus in *C. levinseni* (Harmer, 05, p. 51, pl. xi. fig. 132), which belongs to *Idiothecia*, a single nerve-tract is present in the stalk, while in *C. nigrescens* (Ridewood, 07[1], p. 40, text-fig. 15), belonging to the same subgenus, there are three nerve-tracts. Andersson has, moreover, not sufficiently taken into account the fact that in *C. gracilis* and *C. sibogæ* (Harmer, 05, pp. 52, 53), which belong to *Demiothecia*, only a single nerve-tract is present; while, on the other hand, *C. dodecalophus*, *C. hodgsoni*, and *C. æquatus*, belonging to the same subgenus, have three nerve-tracts. *C. agglutinans* (fig. 13, *n.t.*) agrees with the species of *Orthoëcus* described by Andersson, and with *C.* (*Idiothecia*) *levinseni*, *C.* (*Demiothecia*) *gracilis*, and *C.* (*D.*) *sibogæ* in having a single nerve-tract in the stalk.

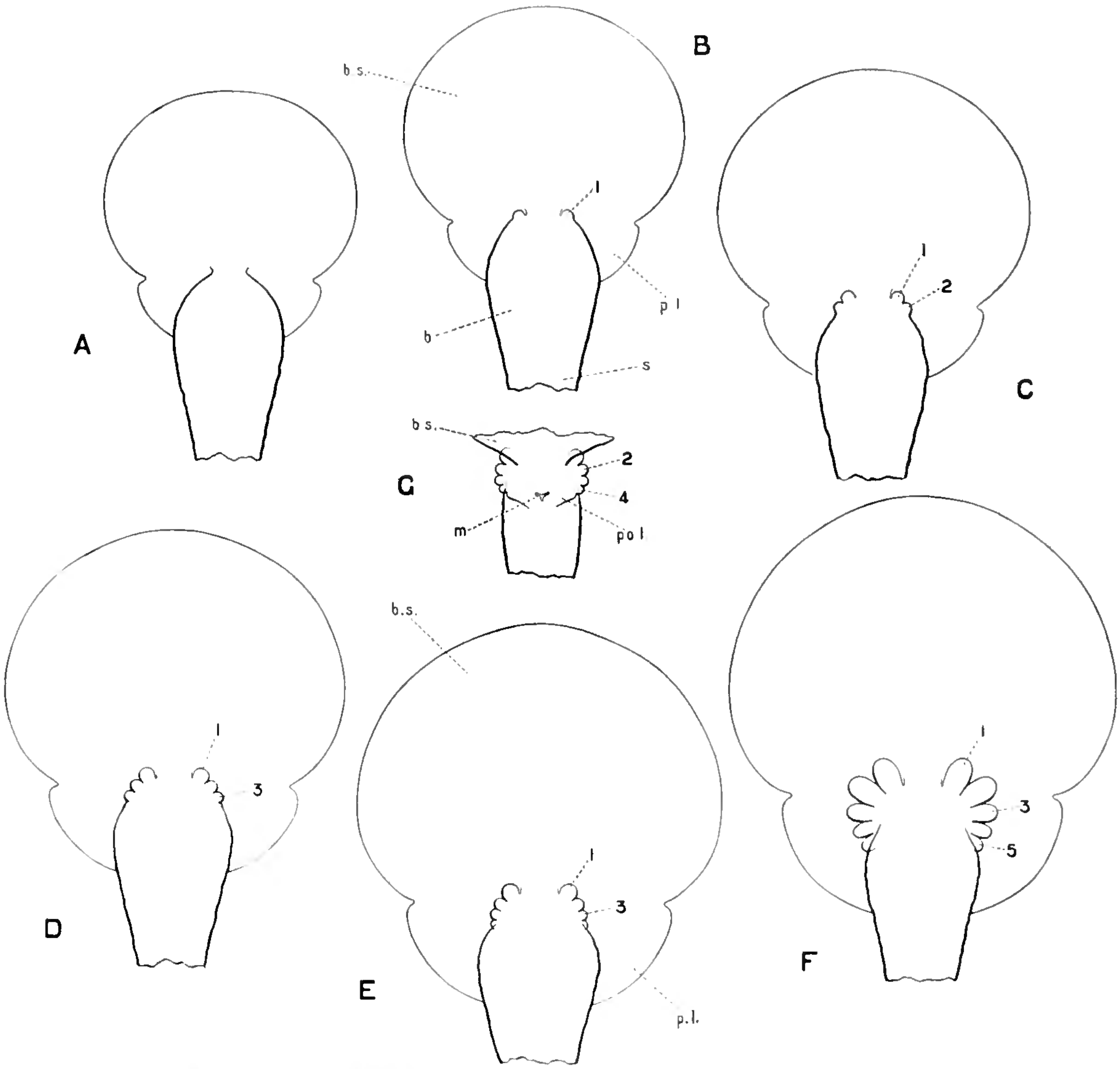
The number of the nerve-tracts in the region in question is no doubt correlated with the way in which the metasomatic muscles are arranged at the point where they pass into the stalk. In *C. agglutinans*, as in *C. levinseni*, *C. gracilis*, and *C. sibogæ*, the layer of metasomatic muscles forms a single fold extending deeply into the cavity of the stalk, round the single nerve-tract, in the region where the stalk is separating from the body. In *C. dodecalophus*, *C. hodgsoni*, and *C. æquatus*, in which three nerve-tracts are present, there is, in addition, a pair of muscular folds similarly related to the lateral nerve-tracts.

Buds.

The buds seem to be produced in exceptionally large numbers in the present species, and an examination of the budding disc at the end of the stalk of full-grown zooids shows that in some cases as many as seven pair of buds are present at the same time. As in other species, the free surface of the disc is of the nature of a sucker for adhering to foreign objects; the disc is wider than the end of the parental stalk, and the buds develop in pairs in the groove between the stalk and the disc. The youngest buds cannot be said to have any stalks; they are merely clavate or pyriform outgrowths, which soon show a transverse groove when the proboscis differentiates from the rest of the bud. The stalks of the other buds are remarkably long; that of one bud with two pairs of arms developing, of the stage shown in text-fig. 5, C, measured 3·9 mm.; another of the same stage of development measured 4·3 mm.

There is a remarkable uniformity to be noticed in the size of the stalked buds present. The proboscis of a bud in which the first pair of arms are just about to develop, such as is represented in text-fig. 5, A, is not very much smaller than that of a bud in which five pairs of arms can be recognised—and it is the proboscis which practically determines the size of the bud. Buds intermediate in size and development between minute stalkless buds just forming from the disc and buds like that shown in text-fig. 5, A, are scarce; and no buds have been found older than that shown in text-fig. 5, F. Indeed, only two buds of the latter stage were discovered. It would seem, therefore, that buds develop very rapidly up to the time when the first pair of arms make their appearance, and that their subsequent growth is slower. What happens after the stage with five pairs of arms it is impossible to say. The buds of this age seem to be too young to separate off as independent zooids and to leave the colony—their alimentary canal is still cæcal, and the ten arms have not yet produced any tentacles (text-fig. 5, F)—and in some other species of *Cephalodiscus* (e.g. *C. hodgsoni* and *C. nigrescens*, RIDEWOOD, 07[2]) buds may be found still attached by their stalk to the parent having the full number of arms characteristic of the adult zooids. The absence of old buds in the present material may perhaps be accounted for by some seasonal cause; or buds may only begin to be produced when the development of the gonads has reached a certain stage.

In text-fig. 5 are shown composite figures of buds based upon thirty-five *camera lucida* drawings. The proboscis is reproduced in the successive figures as gradually increasing in size; this is correct in the main, but buds with the same number of arms may have



TEXT-FIG. 5.—Figures illustrating the development of the arms or plumes in the buds of *Cephalodiscus agglutinans*, for comparison with the figures of *C. gilchristi* and *C. nigrescens* in RIDEWOOD, 07[2], pp. 243 and 236. The lettering is the same as before, namely:—1, 2, 3, 4, 5, the first, second, third, fourth, and fifth arms of the buds; *b*, the "body" or metasome of the bud; *b.s.*, main portion of the proboscis or buccal shield; *m*, mouth; *p.l.*, lower lobe of the proboscis; *po.l.*, operculum or postoral lamella; *s*, stalk of the bud.

A, aboral view of a bud in which no arms have yet developed; B, a bud with one pair of arms; C, a bud with two pairs; D, a bud with three pairs; E, a bud with four pairs; F, a bud with five pairs of arms; G, the oral surface of the body of a bud in which the lower lobe of the proboscis was turned well upward, and has been cut away. The operculum is seen to be continuous with the last developed (fourth) arm, and is as yet incomplete below the mouth. Approximately ×60.

the proboscis of different sizes, and there are many buds with three pairs of arms which have a smaller proboscis than others with two pairs or even one pair only. This irregularity may be partly accounted for by disparity in the rates of growth of the proboscis and the collar-region, but is to a large extent also to be explained by the fact that the proboscis is not only a very mobile organ, but is evidently also capable of considerable change in superficial extent; a large proboscis on a bud with three pairs of arms is thinner than a smaller proboscis on another bud with the same number of arms.

In buds with three, four, or five pairs of arms the first portion of the gut can be seen in the interior of the "body" in clarified preparations; it appears as a cæcal tube, connected with the mouth, and with a slender cord passing from the blind extremity towards the stalk. The state of preservation of the material is so poor that the study of the internal structure of the buds by means of serial sections did not seem advisable. The development of the internal organs in buds of *Cephalodiscus* is not likely to differ much among the various species, and any time and energy spent upon a study of these parts is most profitably expended by restricting oneself to material that is specially suited to the methods of microscopical technique.

On comparing the buds of *C. agglutinans* with those of other species of *Cephalodiscus*, one is struck by the fact that in the relatively late appearance of the arms this species more closely resembles *C. gilchristi*, a species of the subgenus *Idiothecia*, than it resembles species of the subgenus *Demiothecia*, such as *C. dodecalophus* and *C. hodgsoni* (RIDEWOOD, 07^2, pp. 231 and 225). Incidentally it may be mentioned that the buds of *C. æquatus* and *C. inæquatus*, examined by us in material collected on the Swedish South-Polar Expedition, agree very closely with those of *C. dodecalophus* and *C. hodgsoni*. In *C. dodecalophus*, *C. hodgsoni*, *C. inæquatus* (which we regard as synonymous with *C. hodgsoni*, see p. 436), and *C. æquatus* the first pair of arms reach the end of the proboscis at a stage when three pairs of arms are recognisable (07^2, p. 231, text-fig. 4, G and H, and p. 225, text-fig. 2, G); whereas in *C. agglutinans*, as also in *C. nigrescens* and *C. gilchristi* (07^2, pp. 236 and 243), the arms at the three-pair stage (text-fig. 5, D) are but insignificant bead-like outgrowths from the sides of the collar, and are very remote from the edge of the proboscis.

Systematic Position of C. agglutinans.

We have not found it an easy matter to come to a definite conclusion with regard to the affinities of the *Scotia* species of *Cephalodiscus*. In the present state of our knowledge it is probably best to accept provisionally the subdivision of the genus into the three subgenera mentioned on p. 408. We may remark, however, in passing that it is surprising that a crowd of independent zooids should be able to build up a cœnœcium, by their united efforts, which has a definite character of its own. But, on the other hand, there is sufficient resemblance between the cœnœcia of *C. levinseni*, *C. nigrescens*, and *C. gilchristi* to justify their inclusion in a single subgenus, *Idiothecia*; and this becomes the more significant when it is remembered that these species have been recorded from such widely distant localities as between Japan and Corea, the Antarctic Ocean, and South Africa respectively. There is, moreover, a considerable amount of resemblance in anatomical structure between the zooids of species which have been referred to *Demiothecia*, as well as between those which have been placed in *Orthoëcus*.

According to the subgeneric diagnoses which have previously been given, *C. agglutinans* should come in *Demiothecia*, since the cavity of the cœnœcium is continuous throughout (as distinguished from *Idiothecia*, in which each zooid inhabits a separate tube of its own), while the tubes are not in the main distinct from one another and with separate cavities, as in *Orthoëcus*. But in other respects the cœnœcium of *C. agglutinans* shows a greater resemblance to *Idiothecia*, to which we are inclined to refer it, in spite of the continuity of the cœnœcial cavity.

The cœnœcium of the known species of *Demiothecia* consists of a more or less branching system traversed by a continuous cavity, which is of such a kind that a transverse section of a branch shows a central cavity surrounded by a layer of the cœnœcial substance, irregularly thickened in various places. A transverse section of the cœnœcium of *C. agglutinans* does not show this simple arrangement: but it exhibits a massive cœnœcial substance, crammed with foreign inclusions, and traversed here and there by the relatively small tubes inhabited by the zooids. The arrangement of these tubes is shown diagrammatically in text-fig. 2, A, on p. 415. In its massive character and in the disposition of the outer parts of the tubes this has considerable resemblance to the cœnœcium of *C.* (*Idiothecia*) *nigrescens*, as figured by RIDEWOOD (07[1], pl. iv. fig. 10). It differs from it in the fact that the tubes which lead to the external ostia do not end blindly at their lower ends, but are connected together by a complicated system of branching tubes which occupy the axial part of the branch. But the fact must be emphasised that the arrangement of the outer parts of the tubes agrees substantially with that of the entire tubes of *C. nigrescens*, and that no species of *Demiothecia* yet described possesses a system of regularly arranged long tubes leading from the interior to the ostia. The ostia of *Demiothecia* are little more than perforations of the common cœnœcial wall, so that the central cavity may be described as opening directly to the exterior by means of the ostia. We think, therefore, that there is much to be said for the view that *C. agglutinans* may be regarded as an *Idiothecia* in which the inner parts of the tubes of the zooids are connected by a set of tubes, branching in the axial region of the cœnœcium and placing all the cavities in communication with one another.

A further argument in favour of this view may be obtained from a consideration of the mode of growth which appears to be indicated by a study of the cœnœcium (*cf.* p. 415). We have given reasons for believing that the growth of the branches is to a large extent apical, as appears to be the case in *C. nigrescens* and *C. levinseni*, both of which belong to *Idiothecia*. This may be inferred by the regular arrangement of the outer parts of the tubes, in all parts of the colony, as well as by the fact that the apical tubes are shorter than the others, and apparently younger.

The occasional occurrence of septa across the tubes of *C. agglutinans* (p. 414) may indicate some approach to the more typical species of *Idiothecia* in which each tube is completely cut off from its neighbours (compare the septa in *C. nigrescens*, RIDEWOOD, 07[1], pl. iv. fig. 10).

The single short spine or lip at the side of each ostium in *C. agglutinans* finds a parallel in *C.* (*I.*) *nigrescens*, *C.* (*I.*) *levinseni*, and *C.* (*O.*) *solidus*. In *C.* (*I.*) *gilchristi* there are long spines, about as numerous as the ostia, but not very distinctly related to them; whereas in *C.* (*I.*) *indicus*, *C.* (*O.*) *densus*, and *C.* (*O.*) *rarus* there are no lips to the tubes. In *C.* (*D.*) *dodecalophus*, *C.* (*D.*) *hodgsoni*, and *C.* (*D.*) *æquatus*, however, the spines are long and numerous, usually four or five to each ostium.

The study of the zooids may be held to give some support to the view that the nearest ally of *C. agglutinans* is to be found in the subgenus *Idiothecia*. There is considerable resemblance between the zooids of *C. agglutinans* and *C. nigrescens* in their relatively large size, in the general proportions of the body, in the large number of arms, and in the dense pigmentation of the skin. Too much weight, however, must not be attached to this last character, since the pigmentation may not really be an indication of affinity, but may be of a purely physiological nature, as seems to be the case in certain deep-water pelagic Fishes.* *C. sibogæ*, a species of *Demiothecia*, has, moreover, a deeply pigmented epidermis (HARMER, 05, p. 8).

In the absence of end-bulbs with refractive beads at the ends of the arms, *C. agglutinans* agrees with the species of *Idiothecia* and *Orthoëcus*, and differs from those of *Demiothecia*.

Attention has already been drawn (p. 432) to the fact that, in the relatively late appearance of the arms in the buds of *C. agglutinans*, this species more closely resembles *C. gilchristi* and *C. nigrescens* than species of *Demiothecia* such as *C. dodecalophus*, *C. hodgsoni*, and *C. æquatus*.

The special characters of the cœnœcium of *C. agglutinans* might be taken to justify the institution of a new subgenus for the reception of this species. We think it unnecessary to adopt this course; but it is obvious that, if the species is rightly referred to *Idiothecia*, the original diagnosis of that subgenus (RIDEWOOD, 07[1], p. 10) must be amended by adding to the statement, "tubular cavity . . . having no connection with the other cavities of the tubarium," some statement to the effect that the tubes may be connected with one another. The following amended diagnosis is suggested:—

Subgenus *Idiothecia*. Each ostium leading into a long tube lodged in a common cœnœcial substance; the tubes definitely arranged at a more or less constant angle to the surface, usually completely separated from one another, and each containing a single zooid with its buds, but sometimes connected with one another by an intercommunicating system of tubes.

It may be pointed out in conclusion that the name *Idiothecia* would not be less strictly applicable in consequence of the extension of the scope of the subgenus,

* *Cf.* Sir JOHN MURRAY and J. HJORT, *The Depths of the Ocean*, London (Macmillan & Co.), 1912, pp. 618, 624, 677, and elsewhere.

for the derivation of the word (*idios*, one's own, personal, private; and *theke*, a case, box, vault) refers to the zooids, with their buds, having each their own tubes; and this appears to be the case in *C. agglutinans*, in spite of the fact that the tubes communicate with one another in the axial part of the cœnœcium (see p. 416).

ADDENDUM ON THE SYNONYMY OF C. HODGSONI.

Through the kindness of Dr H. THÉEL, the British Museum has received from the Riksmuseum at Stockholm duplicate specimens of all the species of *Cephalodiscus* which were described by ANDERSSON in the report (07) on the Pterobranchia of the Swedish South-Polar Expedition. We have been much interested in comparing this material with the other specimens which have been available for study.

The species of *Cephalodiscus* which have previously been described from Southern localities are as follows:—*C. dodecalophus* (*Challenger* and Swedish Expedition); *C. æquatus* and *C. inæquatus* (Swedish Expedition); *C. nigrescens* and *C. hodgsoni* (*Discovery* Expedition); *C. gilchristi* (Cape Colony, Dr J. D. F. GILCHRIST); *C. densus*, *C. rarus*, and *C. solidus* (Swedish Expedition); and *C. anderssoni* (second French Antarctic Expedition). With the exception of the three Oriental species described in the "*Siboga*" report, and of *C. indicus*, from Ceylon, more recently described by SCHEPOTIEFF (09), this list accounts for all the species of *Cephalodiscus* hitherto recorded. ANDERSSON (07, p. 16) has stated that within the Antarctic area *Cephalodiscus* is one of the most characteristic members of the marine fauna, in the neighbourhood of Graham's Land at least; and that it occurs there, as a rule, in depths of 100 to 150 metres, wherever the bottom has a firm consistency and consists of gravel ("Kies") and small stones. We may agree with him, in view of these facts, in thinking that the headquarters of the genus lie in Antarctic and Subantarctic waters.

Of the species already mentioned, *C. densus*, *C. rarus*, and *C. solidus* were placed by ANDERSSON in his subgenus *Orthoëcus*; and *C. anderssoni*, more recently described by GRAVIER (12), clearly belongs to the same assemblage. None of these species have at present been found a second time, and we have no criticism to make with regard to them, except that *C. anderssoni* may perhaps prove to be a synonym of either *C. densus* or *C. rarus*.

C. nigrescens and *C. gilchristi* are two very distinct species of the subgenus *Idiothecia*.

The rest of the Antarctic or Subantarctic species, namely, *C. dodecalophus*, *C. æquatus*, *C. inæquatus*, and *C. hodgsoni*, belong to the subgenus *Demiothecia*, in which the cœnœcial cavity is continuous and is not represented by a number of distinct tubes, each belonging to one zooid. According to the diagnoses originally given, all these species are characterised by the possession of six pairs of arms in each sex, with the exception of *C. inæquatus*, in which ANDERSSON states that there are five pairs in the female and six pairs in the male. According to this observer (p. 8), *C. æquatus* is closely related to *C. hodgsoni*, but on p. 9 he says that it is nearly allied to *C. dodecalophus*.

At the first examination of the cœnœcium of the specimens obtained by the Swedish Expedition it appeared to us that there was an even closer resemblance—amounting, in fact, to a practical identity of characters—between *C. hodgsoni* and *C. inæquatus*. Since the latter is said to be characterised by a difference between the two sexes in respect of the number of arms (female five pairs, male six pairs), it became important to make a new examination of *C. hodgsoni* to ascertain whether any difference could be detected between the two sexes in that form. Although the number of male individuals examined was but small, the result of this inquiry was to confirm the conclusion, suggested by the appearance of the cœnœcium, that *C. inæquatus* is a synonym of *C. hodgsoni*. It may be noted in passing that although the memoirs containing the accounts of the two species in question were published in the same year (1907), the name *C. hodgsoni* has the priority, as is shown by the inclusion of the title of RIDEWOOD's paper in the bibliography given by ANDERSSON on p. 115.

In the original description of *C. hodgsoni* it is stated (RIDEWOOD, 07[1], p. 55) that "the normal number of plumes is twelve, but the sixth pair develop late, and a full-sized polypide, with buds of its own, and with well-developed ovaries, may have only ten fully-grown plumes." It is further remarked, however, that a vestigial sixth pair can "usually" be detected in such cases, but that no individual has more than six pairs. In his later paper (07[2], p. 230) the same author states that "some polypides of *Cephalodiscus hodgsoni* of full size and with mature gonads have five pairs of plumes only." He does not discuss, in either place, the possibility that the difference to which he alludes might be correlated with a difference in sex.

We are in a position to confirm the substantial accuracy of ANDERSSON's statement with regard to the number of arms or plumes in the specimens described by him as *C. inæquatus*, though we think he has gone rather too far in asserting (07, p. 6) that the number is invariable, in each sex, in the species examined by him. The following is the result of an examination of 38 zooids in which the arms were dissected from one another sufficiently to enable them to be counted when the zooid was mounted on a slide. There is no doubt some element of uncertainty in some of these estimations, particularly with regard to the presence or absence of vestigial sixth arms; but in the main the results can probably be accepted as trustworthy.

The material examined consisted principally of female zooids; since, when the gonads were sufficiently advanced in development to be recognisable as to their sex, 19 specimens were female and 3 were male. The remaining 16 specimens were mostly advanced buds or quite young zooids in which the sex was not certainly distinguishable.

The evidence as to the number of arms may be given in a tabular form, as follows:—

Sex.	Number of Arms.	Number of Individuals.			Remarks.
		Stat. 5.	Stat. 94.	Total.	
Female	10	13	2	15	
,,	11	3	...	3	In one of these cases the evidence for the occurrence of more than ten arms was not conclusive.
,,	9	1	...	1	
Unknown	10	5	9	14	
,,	11	...	1	1	Perhaps not more than ten arms.
,,	12	...	1	1	,, ,,
Male	12	...	2	2	
,,	11	...	1	1	
				38	

It is thus clear that the majority (29 out of 38) of the zooids examined have ten arms; that of this number 15 were proved to be female, while the remaining 14 may have belonged to that sex; and that no individual proved to be male has ten arms. It should be noted, however, that we are assuming, with ANDERSSON, that the specimens from Stations 5 and 94 belong to the same species. Of three zooids in which twelve arms are certainly or doubtfully present, two were ascertained to be male. There is evidence that the female may occasionally have eleven or nine arms instead of the normal number (ten), and that the male may have only eleven arms instead of the number (twelve) stated by ANDERSSON to be characteristic of that sex. The evidence of the occurrence of eleven arms in two female specimens appears to be quite satisfactory. In counting the arms, an arm-bud has been reckoned as an arm even though, as in one of these two, it is very small and but little developed.

Evidence of a similar nature was obtained from sections of the material received from Stockholm. In six series of sections of female zooids, five arms could be counted on one or both sides: while in a single series of sections through a male zooid twelve arms were ascertained to be present.

Turning to the *Discovery* specimens described by RIDEWOOD as *C. hodgsoni*, the number of the arms has been re-examined in eight series of sections, with the following result:—

Ten arms are present in 2 female zooids, and in 2 others in which the gonads are too minute to be certainly distinguishable as ovaries. Ten is probably the number of the arms in 1 other case in which the sex is not determinable. Three zooids are male; and of these 1 has twelve arms, 1 has not less than eleven arms, and 1 has not less than ten arms, while the possibility of the occurrence of twelve arms is not excluded.

In six individuals of *C. hodgsoni* which were partially dissected and in which ovaries could be identified with certainty the results were somewhat less uniform. Two of these zooids had ten arms each; 1 had eleven; and 3 had twelve arms. But even here there is a sufficient amount of correspondence with the results arrived at by ANDERSSON to give some support to the conclusion that *C. inæquatus* is synonymous with *C. hodgsoni*, on the assumption that the number of arms is not invariable.

Cœnœcium.

It can hardly be doubted, from the published figures, that there is at least a considerable resemblance between the cœnœcium of *C. hodgsoni* and that of *C. inæquatus*. ANDERSSON'S figure (07, pl. ii. fig. 1) of the latter closely resembles RIDEWOOD'S (07^1, pl. ii. fig. 1) of the former. It may be noted that both figures represent the natural size of the object. In both cases the general appearance of the cœnœcium and its mode of branching are substantially the same; and the same result is arrived at by a comparison of the actual specimens. RIDEWOOD states (p. 51) that the spines are simple, forked, or trifid, and that the length of their free part is variable, usually within the limits 5 to 15 mm. ANDERSSON states (p. 10) that the length of the "Ausläufer," by which we understand the free parts of the spines, may reach 20 mm.; and (p. 19) that they may be divided into two or three branches. Although this latter statement is made in a paragraph which refers to two other species as well as to *C. inæquatus*, an inspection of his figure shows that it really refers to the species under consideration.

We may add that the comparison of the actual specimens shows that *C. inæquatus* resembles *C. hodgsoni* in general size and proportions of the colony, in the colour of the cœnœcium, and in the length and thickness of the spines. In both forms the ostia are elliptical and their average long diameter is 3 mm.; while in both the number of spines associated with each ostium is about four or five.

Measurements of Zooids.

According to RIDEWOOD (07^1, p. 53), the zooids of *C. hodgsoni* measure about 2 mm. from the cæcal end of the body to the dorsal border of the proboscis. ANDERSSON (07, p. 10) gives the length of a zooid of *C. inæquatus* which is not too strongly contracted as about 3 mm. It must be remembered, however, that no special care had been taken, in preserving the *Discovery* material, to obtain well-extended zooids; and that ANDERSSON had the opportunity of examining the zooids of the form described by him in the living condition. It is, moreover, not quite clear how his measurement was taken.

We have ourselves measured several zooids of both forms in more or less median sagittal sections, the measurement being taken in each case from the extremity of the cæcal end of the metasome to the dorsal border of the proboscis. According to these measurements, four individuals of *C. hodgsoni*, of both sexes and in varying degrees of contraction, measured from 1·568 to 1·856 mm. Four individuals of *C. inæquatus*, similarly measured, fell within the limits 1·760 to 2·240 mm. The longest of these zooids in particular was obviously well extended. It may accordingly be concluded that while, on the whole, the zooids of the material collected by the Swedish Expedition are rather larger than those obtained by the *Discovery*, there is no essential difference in size between the zooids of the two forms under consideration.

Similar results were obtained by a study of the length and thickness of the notochord, the size of which ANDERSSON claims to be of some taxonomic value (07, p. 60). The measurements taken from sections of *C. inæquatus* are on the whole greater than those of *C. hodgsoni*, but the two series of measurements overlap.

The buds of *C. inæquatus* were examined to see if there is any appreciable difference between them and those of *C. hodgsoni* (RIDEWOOD, 07[2], p. 225), particularly in respect of the mode of development of the arms. In size and general proportions, and in the mode of development of the arms, the two sets of preparations are in very close agreement.

We are accordingly of opinion that *C. inæquatus* should be regarded as a synonym of *C. hodgsoni*.

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LIST OF REFERENCE-LETTERS.

an., anus.
b.c.[1], proboscis-cavity.
b.c.[2], collar-cavity.
b.c.[2]*a.*, anterior dorsal horn of collar-cavity.
b.c.[3], metasomatic cavity.
b.c.[3]*b.*, part of metasomatic cavity in loop of alimentary canal.
c.c., collar-canal.
c.c.i., internal opening of collar-canal.
c.n.s., central nervous system.
d.m.[2], dorsal mesentery of collar.
d.m.[3], dorsal mesentery of metasome.
g.s., gill-slit.
int., intestine.
L.[1]–L.[9], left arms.
l.n., lateral nerve.
m., mouth.
ms., longitudinal muscles of metasome.
nch., notochord.
n.t., nerve-tract.
op., operculum or postoral lamella.
op.l., left lobe of operculum.
op.r., right lobe of operculum.
op.rec., recess at base of operculum.
p., proboscis.
per., peristome.
ph., pharynx.
p.p., proboscis-pore.
r., rectum.
R.[1]–R.[9], right arms.
st., stalk.
stom., stomach.
t., testis.
t.l., left testis.
t.r., right testis.
v.m.[2], ventral mesentery of collar.

EXPLANATION OF PLATES.

Plate I.

Figs. 1–5. Selected pieces of colony of *Cephalodiscus agglutinans*, n. sp., drawn by Miss G. M. Woodward. Natural size. The specimen drawn in fig. 1 is selected as the type-specimen of the species.

Plate II.

Cephalodiscus agglutinans, n. sp.

The figures were drawn with the Zeiss objectives severally indicated, and were then reduced to two-fifths linear. The scale for the two objectives used in drawing the figures is given, in hundredths of a millimetre, at the bottom of the plate.

Fig. 1. A young bud. Obj. A.

Fig. 2. A slightly older bud. Obj. A.

Fig. 3. An older bud. Obj. A.

Fig 4. A still older bud. Obj. A.

Fig. 5. Obliquely frontal section, showing both testes (*t.l.*, *t.r.*), parts of both gill-slits (*g.s.*), and the left collar-canal (*c.c.*). Obj. C.

Figs. 6–11. Frontal sections of one zooid.

Fig. 6. Showing eight of the left arms (as numbered) and seven of the right arms. Obj. C.

Fig. 7. Showing the same fifteen arms, the anterior dorsal horns of the collar-cavities ($b.c.^2a.$), the pericardium (*per.*) enclosing the pericardial sinus or heart, and the internal openings of the proboscis-pores (*p.p.*). Obj. C.

Fig. 8. Showing the anterior end of the notochord (*nch.*) and of the right lobe (*op.r.*) of the operculum. Obj. C.

Fig. 9. Through the mouth (*m.*). The double appearance of the left lobe (*op.l.*) of the operculum is due to the fact that the organ in question is folded ventrally. To see the correspondence between the two sides of the section, the part of the left lobe which is nearer the proboscis (*p.*) must be imagined to have been folded dorsally. It would then not have appeared in the section, and the left lobe of the operculum would have had much the same appearance as the right lobe. Obj. C.

Fig. 10. The mouth (*m.*) is still visible. The reflected part of the left lobe (*op.l.*) of the operculum is almost separate from the rest of the organ. Obj. C.

Fig. 11. Through the region of the collar-canals (*c.c.*) and gill-slits (*g.s.*). The right testis (*t.r.*) is very small in this zooid. Two of the terminal lobes of the scalloped edge of the right half (*op.r.*) of the operculum are visible. Obj. C.

Fig. 12. Stomach (*stom.*), intestine (*int.*), rectum (*r.*), and one testis (*t.*) of an old zooid. Obj. A.

Fig. 13. Stalk, in transverse section. Obj. C.

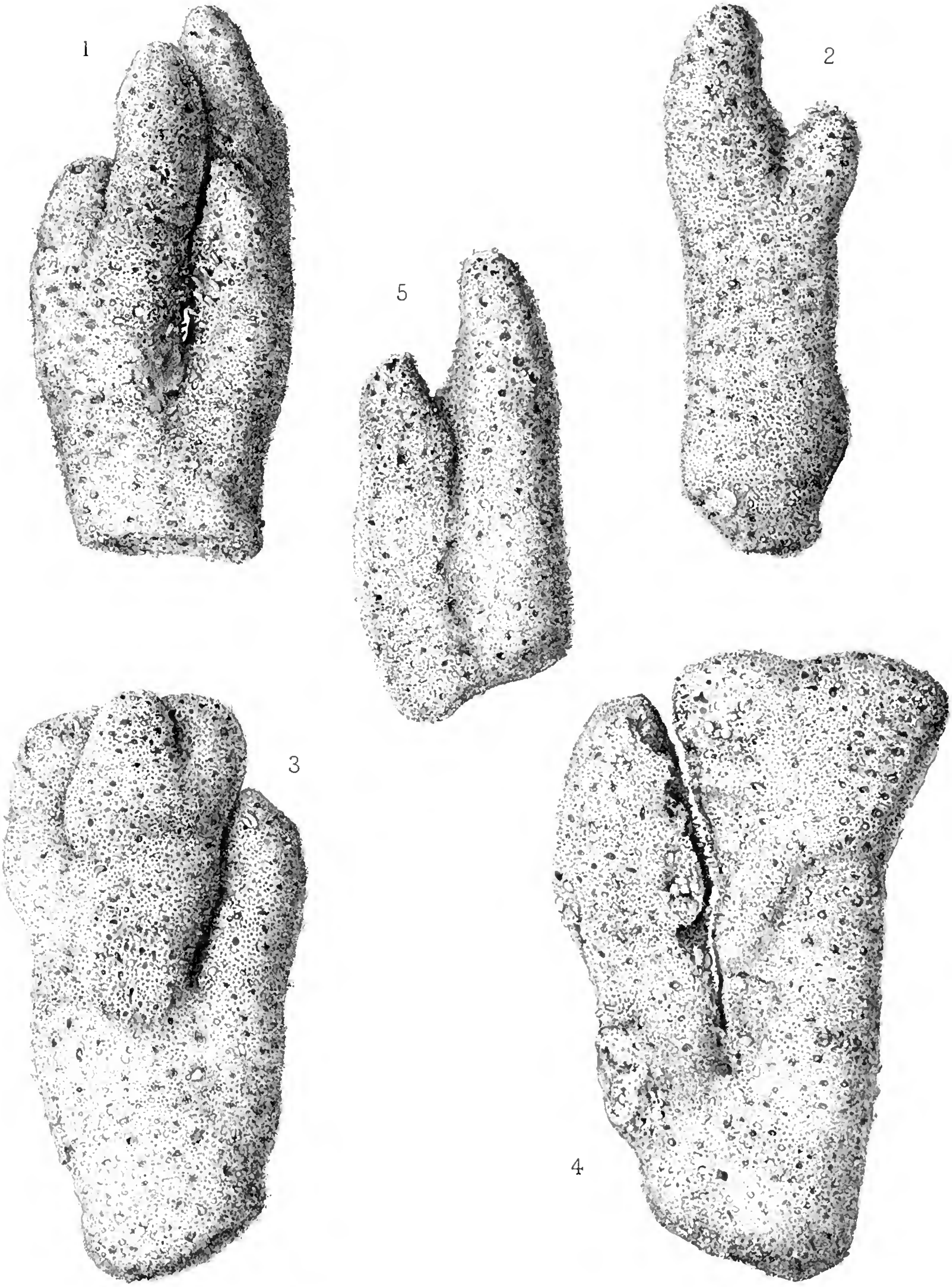
Fig. 14. Proboscis-stalk, in transverse section, showing both proboscis-pores (*p.p.*), the anterior dorsal horns ($b.c.^2a.$) of the collar-cavities, the anterior end of the central nervous system (*c.n.s.*), and the pericardium (*per.*) with the included pericardial sinus. Obj. C.

Fig. 15. Median sagittal section of the anterior end of a zooid, showing the notochord (*nch.*). Obj. C.

Fig. 16. Nearly median sagittal section of another zooid, showing the alimentary canal. Obj. C.

N.B.—In several of the sections, figured parts of the epithelia were somewhat macerated, as the result of imperfect preservation. The epithelium of the stomach in fig. 16, part of the anterior epidermis of the proboscis in figs. 6–9, and part of the epidermis containing the central nervous system in figs. 10 and 11 have accordingly been restored where necessary.

HARMER & RIDEWOOD: PTEROBRANCHIA.



G M Woodward del et lith. West, Newman imp

HARMER AND RIDEWOOD: "SCOTIA" PTEROBRANCHIA—PLATE II.

S.F.H. del.

M. Farlane & Erskine, Lith. Edin.

PART XVIII.

SEALS.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

XVIII.—SYSTEMATIC ANATOMY OF A FŒTAL SEA LEOPARD (*Stenorhynchus leptonyx*) AND MICROSCOPICAL ANATOMY OF SOME OF THE ORGANS.

By HAROLD AXEL HAIG, M.B., B.S., M.R.C.S.,

Late of University College, Cardiff; M'Robert Research Fellow, University of Aberdeen.

(*WITH FOUR PLATES AND THREE TEXT FIGURES.*)

XVIII.—**Scottish National Antarctic Expedition: A Description of the Systematic Anatomy of a Fœtal Sea-Leopard (Stenorhynchus leptonyx), with Remarks upon the Microscopical Anatomy of some of the Organs.** By **Harold Axel Haig,** M.B., B.S., M.R.C.S., late Lecturer in Histology and Embryology, University College, Cardiff; M'Robert Research Fellow, University of Aberdeen. *Communicated by* Professor ARTHUR ROBINSON, M.D. (With Four Plates and Three Text-figures.)

(MS. received January 26, 1914. Read February 16, 1914. Issued separately April 30, 1914.)

During the Scottish Antarctic Expedition of 1892–93 Dr W. S. BRUCE secured fœtuses of *Stenorhynchus leptonyx* and *Lobodon Carcinophaga*, and on his return passed them over, with other material, to Professor D'ARCY W. THOMPSON for the Zoological Museum of University College, Dundee. While some of the material has unfortunately been lost sight of during these twenty-one years, one specimen, viz. that of a fœtus of *Stenorhynchus leptonyx*, was still in existence, and was returned by Professor D'ARCY THOMPSON to Dr BRUCE, who in turn asked me to examine and report upon it. Furthermore, during the voyage of the *Scotia* embryos of *Leptonychotes weddelli* were obtained by the *Scotia* naturalists, and these were passed on for description to Professor WATERSTON, at that time in the University of Edinburgh. It is on this material that the present monograph is based.

PRELIMINARY CONSIDERATIONS.

The fœtus of *Stenoryhnchus leptonyx*, which is in a good state of preservation, measures 122 mm. from the tip of the tail to the most prominent part of the mid-brain; the greatest breadth is about 43 mm., and the greatest dorsi-ventral measurement is in the mid-dorsal region, measuring 35 mm. The umbilicus is situated 36 mm. from the cloacal aperture, the umbilical cord being relatively short, owing to the fact that the umbilical vessels soon undergo division into several large branches; a portion of the placenta with fragments of the fœtal membranes is still attached to the cord. The actual mode of placentation and the disposition of the fœtal membranes are points which will be discussed at a later stage (see *infra*, on the Placenta).

The skin is in many places thrown into folds, some of these being normal, but others undoubtedly due to shrinkage consequent upon the action of the preservative medium. The flippers are fully formed, nail rudiments being present upon the dorsal aspects of the distal phalanges.

The head is at this stage not large in proportion to the trunk; rudiments of the vibrissæ are to be seen at the sides of the snout, and the eyelids are formed although the palpebral fissure is not as yet open. The tongue is an elongated organ, with a cleft tip, the two divisions appearing between the lips in the middle line.

No sign of an external ear is present, nor is there any opening indicating the position of an auditory meatus.

The whole trunk is curved towards the ventral aspect, but some of the curvature is probably due to mechanical causes subsequent to removal of the fœtus from the uterus.

Reference to Pl. I. fig. 1 will render the above points clear.

SECTION I.

General Topography and Anatomy.

A. *Appearance of the Main Viscera* in situ, *from the Ventral Aspect.*

A median ventral incision was made, and flaps of skin and deeper tissues turned back to expose the structures in the neck, thorax, and abdomen; the sternum and ribs being also removed for the purpose of demonstrating the thoracic viscera, whilst the attachments of the diaphragm to the lower ribs were likewise severed. A separate flap was raised in the neck region to expose the larynx, trachea, thyroid, and parathyroids, and finally the parietal pericardium was cut away.

In the region of the umbilicus, care was taken not to sever the connection of the urinary bladder with the umbilical cord, and the umbilical vein passing from the cord to the liver was also kept intact; subsequently, however, these connections were severed for greater convenience of examination.

Reference to fig. 2, Plate I., will show that the *heart* is at this stage a large organ filling the greater part of the thoracic cavity; from the ventral aspect, the right ventricle appears larger than the left, and the right auricular appendix wider than the left; the right appendix has a deep notch in its lower border, whilst the left one possesses three such notches.

A portion of the aortic trunk shows above and dorsal to the right appendix.

The *thymus* is relatively large, and extends from the root of the neck, where it is bifurcated, towards the left of the middle line, until it reaches a point just anterior to the left auricular appendix: the main mass of the thymus is subdivided into a number of lobes and lobules, and there are a few small isolated masses situated at the sides of the trachea just anterior to the upper bifurcated extremity.*

The *lungs* lie compressed against the walls of the thorax, and are not very obvious from the ventral aspect, the right upper lobe being most prominent, and below

* Microscopical examination showed that these isolated masses possessed a typical thymus structure.

this a small portion of the middle lobe, whilst none of the lower lobe is visible; both lobes of the left lung show, the anterior edges and portions of the lateral surfaces being seen. In the neck region the *larynx* and *trachea* form prominent features, whilst at the sides of the trachea the lateral lobes of the thyroid gland with the lower parathyroids are to be seen; no thyroid isthmus is, however, to be detected, a point which is noteworthy.

The *abdominal viscera* from the ventral aspect (Pl. I. fig. 2):—The *liver* forms the most prominent organ in the abdomen, its right and left lobes, together with certain accessory lobes, occupying about one-half the available space; the right lobe appears to be larger than the left, but in reality this is not the case, since, when viewed from the dorsal aspect (see Pl. III. fig. 5), the left lobe is seen to be much the bulkier of the two. A fissure passes obliquely downwards and inwards from the middle of the lateral aspect of the right lobe, and effects a partial subdivision of this lobe into two, but the cleft does not extend deeply into its substance; whilst a small flap of the upper of the two subdivisions is seen a short distance internal to the right lateral margin, and partly conceals an aperture in the lobe in which the fundus of the *gall-bladder* appears (Pl. I. fig. 2[15]).

Between the right and left lobes there is a fairly wide cleft, in which may be seen the umbilical vein passing from the umbilicus towards the ductus venosus.

Coils of *small intestine* are seen lying caudal to the liver, but the stomach is not visible, being largely hidden by the left hepatic lobe.

The *urinary bladder* is a very elongated structure, and is attached ventrally to the umbilicus: it opens caudally into the cloaca. The umbilical arteries pass along the lateral aspects of the viscus towards their destination in the placenta, and are well seen in transverse sections. (See Pl. III. fig. 4.)

The chief points of interest in connection with the above description of the ventral aspect of the viscera are:—

(i.) The relative size of the *thymus*, which, although as a rule large at this stage of development, appears in the present case to be markedly so; the left lateral deviation of its caudal extremity is also a point worthy of note. The presence of isolated lobules of this gland suggests a possible origin of these from some of the higher branchial clefts.

(ii.) The deep notching of the auricular appendices in the heart is a feature which seems very striking upon opening the pericardial cavity. One other point also, viz. the well-marked interventricular furrow, is a characteristic which becomes more marked as development proceeds, the external subdivision of the ventricular portion of the heart giving it in the full-grown seal an almost bifid appearance.

(iii.) The great longitudinal extent of the liver, an organ occupying at this stage of development a relatively large proportion of the abdominal cavity.

(iv.) The peculiar shape of the urinary bladder. According to HEPBURN,* the bladder in the adult seal is represented by the whole length of the fœtal organ, since no shrinkage takes place in the cephalic portion to form a definite urachus.

B. *General Topographical Anatomy of the Head.*

I. The oral, nasal, and cranial cavities, with their contents (Pl. II.).

A median sagittal section of the head was made, so that the oral, nasal, and cranial cavities were laid bare; whilst, in order to expose the contents of the nasal fossæ, the nasal septum was subsequently removed.

Rudiments of the incisor milk-teeth were cut through in the upper and lower jaws, and the surface of the mesial section of the hypophysis cerebri exposed, the hypophysis lying in the sella turcica of the developing sphenoid bone at the base of the skull (Pl. II. fig. 3^3).

Other points worthy of note in such a hemisection of the head are :—

(*a*) The elongated tongue (Pl. II. fig. 3^2).

(*b*) The falx cerebri, covering the mesial surface of the right cerebral hemisphere (Pl. II. fig. 3^9); about the middle of the concave edge of the falx the corpus callosum is seen in section (Pl. II. fig. $3^{9'}$.)

(*c*) The optic thalamus (Pl. II. fig. 3^8) continued posteriorly into the mesencephalon and pons; dorsal to these latter, the Sylvian aqueduct with its roof, in which the rudiments of the corpora quadrigemina (fig. 3^7) are to be made out; posterior to these are seen the mesial section of the cerebellar vermis, and, ventral to this, the 4th ventricle and medulla oblongata (Pl. II. fig. $3^{3,6,5,4}$).

(*d*) The cavity of the 3rd ventricle, with its extension into the infundibulum of the hypophysis.

After the removal of the falx cerebri and nasal septum, the following additional structures come into view :—

In the cranial cavity (Pl. II. fig. 5) :—

(*e*) The mesial surface of the cerebral hemisphere (*h.*).

(*f*) The olfactory lobe (*olf. l.*), lying between the fore-brain and the anterior boundary of the cranial cavity: the lobe is not a large one, and does not appear to give off many nerve-filaments to the ethmoidal region of the nasal fossa.

In the region of the nasal fossæ :—

(*g*) The rudiment of the ethmo-turbinal bone (*eth. t.*) lying at the superior angle; this rudiment, which at the present stage is cartilaginous, shows three ridges

* *Trans. Roy. Soc. Edin.*, vol. xlviii. part i., No. 3, 1913.

with two intervening depressions, and represents the olfactory region of the nasal fossa.

(*h*) The large maxillo-turbinal rudiment (*mx. t.*), presenting upon its mesial surface a number of narrow lamellæ with intervening sulci: it is cartilaginous and is covered by a mucous membrane lined by ciliated epithelium. Anteriorly the maxillo-turbinal bone is attached to the outer wall of the fossa, whilst posteriorly it fuses by an elongated pedicle with the periosteum of the base of the skull.

The buccal cavity is lined by a mucous membrane covered by stratified epithelium with but few cell-layers. At the present stage of development, the membrane bones of the cranial vault are partially ossified, but the bones of the base of the skull (basi-sphenoid, basi-occipital) are still partly cartilaginous; the sphenoid bone (see text-fig. 3, *b*) is in the "irruption"-stage of endochondral ossification, the process being seemingly delayed by the rather late persistence of the epithelial connection between the hypophysis cerebri and the buccal epithelium.*

The brain.—General superficial anatomy (Pl. II. figs. 1 and 2). The brain of the present specimen shows some very well-defined characters, and on the whole may be said to conform to the mammalian type: viewed from the dorsal aspect (Pl. II. fig. 1), the following features are obvious:—

(i.) The large cerebral hemispheres separated by the longitudinal sulcus in which the falx cerebri is normally lodged.

(ii.) Behind the hemispheres, the crura cerebri and region of the mesencephalon, covered by fragments of torn pia mater.

(iii.) The cerebellum, consisting of the mesially situated rudiment of the vermis, and on either side of this the cerebellar hemisphere: the latter already present a number of flattened laminæ with intervening sulci.

(iv.) The 4th ventricle in its lower half, with the restiform bodies bounding it on either side; the floor of the ventricle is seen owing to previous removal of the roof of pia mater.

The surface of each cerebral hemisphere is quite smooth upon its superior aspect, and shows no indications as yet of any convolutions.

Viewed from the side, several additional features become apparent, viz. (Pl. II. fig. 2):—

(v.) The olfactory lobe, and its connection with the ventral part of the fore-brain.

(vi.) A wide shallow depression passing from the lower aspect of the fore-brain upwards and backwards towards the hind-brain (future occipital lobe): this depression indicates the position of the future Sylvian fissure (Pl. II. fig. 2[2]), and ventral to its posterior extremity a forward extension of the hemisphere represents the rudimentary temporo-sphenoidal lobe.

* See also P. T. Herring on "Development of Mammalian Pituitary Body," *Journ. Exper. Physiol.*, 1909.

Upon the ventral aspect, at the base of the brain, the infundibulum forms a downward projection from the floor of the 3rd ventricle (Pl. II. fig. 2[3]), whilst half way between the infundibulum and a projection which marks the position of the ventral part of the pons the 3rd nerve forms a noticeable feature (Pl. II. fig. 2[4]).

Additional features to be made out in a sagittal section taken through a cerebral hemisphere, the optic thalamus and mid- and hind-brain (Pl. II. fig. 4):—In such a section the general relations of the various regions of the brain may be studied to a certain extent, and, moreover, by staining with hæmatoxylin and eosin the main distribution of grey and white matter at this stage of development may be made out. The cortex cerebri (Pl. II. fig. 4[4, 5]) is made up of two parts, viz.:—

(i.) A superficial layer of white fibres and neuroglia, forming a very narrow zone (Pl. II. fig. 4[5]).

(ii.) A deeper layer of deeply-staining nerve-cells, with neuroglia, of somewhat wider extent than (i.).

Deep to the cortex comes the white matter of the hemisphere, which is at this stage not very thick. A section taken so as to pass completely through the cavity of the prosencephalon shows in addition an inner layer, somewhat deeply stained, which later on will form the ependymal lining of the lateral ventricle.

Below the main mass of the hemisphere, part of the descending horn of the lateral ventricle is seen (Pl. II. fig. 4[ii]), and this becomes continuous anteriorly with the rhinencephalon, passing into the olfactory lobe. The anterior boundary of the descending horn is formed by a layer of grey matter, which above takes the form of radiating streaks, alternating with white matter.

In the region of the optic thalamus, small isolated patches of grey substance appear near the dorsal surface, but in the region of the corpora quadrigemina white matter seems as yet to predominate.

The grey matter of the cerebellar hemisphere appears to lie chiefly on the surface, but there is a deeper zone of small nerve-cells, the two layers being separated by a clear zone of white matter: the cells of Purkinje do not as yet appear to have become differentiated as a distinct line of neuroblasts. In the region of the medulla oblongata, the nuclei of the 10th and 12th cranial nerves form a series of groups of rather large nerve-cells (Pl. II. fig. 4[1]); whilst the pyramidal tract appears as a well-defined longitudinal set of fibres.

The infundibulum, with a small portion of the cavity of the 3rd ventricle, has been already noted; the ventral mass of the pons is a very obvious feature lying just anterior to the medulla (Pl. II. fig. 4).

A fold of pia mater (Pl. II. fig. 4[3]) shows between the overhanging posterior extremity of the cerebral hemisphere and the mesencephalon, whilst in the deep fissure anterior to the optic thalamus a small piece of choroid plexus appears.

Points for comparison with the brains of other carnivora are the following:—

(*a*) The relative shortness of the corpus callosum, a structure which, for instance, in the cat, at a corresponding stage of development has assumed a much longer antero-posterior measurement; moreover, it would seem that in this Seal embryo the corpus callosum is taking a more vertical course than is usual.

(*b*) Altogether the general appearance and stage of development of the brain under discussion corresponds very closely with one figured by His * of a three-months human fœtus, with the exceptions that the hypophysis cerebri is much further advanced (see *infra*) and the cerebellum has assumed greater complexity.

C. *Anatomical Details of the Remaining Viscera.*

The thyroid and parathyroids, the thymus, pancreas, and tongue, will be described under the histological section of this pamphlet; in the present instance the following organs will be considered, and comparisons made with other types, where this is possible:—

(i.) The lungs.
(ii.) The heart.
(iii.) The liver, stomach, and intestines.
(iv.) The spleen.
(v.) The kidneys and adrenal bodies.
(vi.) The genital glands and ducts: the urinary bladder.

The histology of some of these will be dealt with later.

(i.) *The lungs* (Pl. III. fig. 3).—Both lungs are somewhat compressed against the thoracic walls, owing to the large size of the heart, and it is only upon removing the latter organ that a good view can be obtained of the roots of the lungs and their ventral aspect; posteriorly the inner margins of the upper and lower lobes of both lungs are grooved longitudinally by the vertebral column, whilst laterally the surfaces of all the lobes are grooved by the ribs.

In the right lung, three lobes, upper, middle, and lower, can be distinguished †; the middle lobe is peculiar in that at the root it gives off two caudally directed subdivisions, the largest of which is almost a separate lobe, and presents dorsal, right lateral, and anterior surfaces (Pl. III. fig. 3 *a*). The cranial and caudal lobes of both lungs are somewhat similar in shape, the caudal lobes being the larger, being not unlike the corresponding lobes of a human lung. Marked trabeculæ of connective tissue are to be seen upon the surfaces of all lobes, with finer strands passing off in all directions, and these subdivide the surface into polygonal areas, the bases, as it were, of the superficial lobules; on being placed in water the lungs sink.

At the root of the lung the bronchi and pulmonary vessels are seen entering (or

* HERTWIG, *Handbuch der Entwickelungslehre der Wirbeltiere.*

† The terms "upper," etc., are here used with reference to the vertical position of the trunk, and not the natural position of the adult animal.

emerging from) the upper lobes, the bronchi being dorsal to the pulmonary arteries, although the left bronchus is much closer to the artery than the left.

(ii.) *The heart* (Pl. II. fig. 2 and text-fig. 1).—All four cavities of the heart contain firm clot, which extends into the auricular appendices; on section in the coronal plane, the cavities of the auricles appear to be larger than those of the ventricles, whilst the auricular appendices add considerably to the auricular capacity. Moreover, although from the ventral aspect the right ventricle appear larger than the left, there is not the same relative difference between the capacities of the ventricles, both appearing to possess much the same size in median coronal section; the thickness of the myocardium is rather greater in the left than in the right ventricle, that of the auricles being about equal on both sides. The aortic bulb is

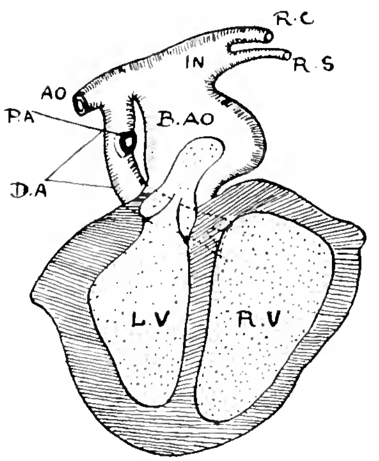


Fig. 1.—Dissection to show the relations of the aortic trunk, pulmonary trunk, and ductus arteriosus.

L.V. Left ventricle in section.
R.V. Right ventricle in section.
B.AO. Aortic trunk and bulb.
IN. Innominate trunk.
R.C. Right common carotid.
R.S. Right subclavian.
AO. Aorta.
P.A. Pulmonary artery.
D.A. Ductus arteriosus.

The dotted lines show the connection of the pulmonary trunk with the right ventricle; the lumen of the aortic bulb is opened, and two semilunar valves are seen.

full of firm clot, and passes at once into a relatively short but thick aortic arch; the pulmonary trunk shows the same relations to the aortic trunk as it does in the case of the human fœtus of a corresponding stage of development, whilst the ductus arteriosus is relatively wide and is a continuation of the main pulmonary trunk after the latter has given off the two branches to the lungs (see fig. 2). The ductus joins the arch of the aorta close to the origin of the latter from the bulbus aortæ.

The cardiac valves are well developed, the semilunar valves consisting of thin plates of fibrous tissue, the free edges of which project into the aortic and pulmonary trunks, whilst the mitral and tricuspid valves have their free edges projecting into the ventricular cavities. The columnæ carnæ are not marked features, nor do the chordæ tendinæ appear to be strongly developed at this stage.

Serial sections taken coronally through the heart show that the foramen ovale is a feature at this phase, but the aperture is a very narrow one, and will not admit a glass seeker of more than 1 mm. diameter.

From the above description it will be seen that the heart of *Stenorhynchus* during early fœtal life corresponds more or less closely with the typical mammalian organ in its developmental aspects; the interventricular furrow, however, is a marked external feature, and during development, at least in the Weddell Seal, it becomes deeper, so that the full-grown heart possesses a bifid apex, the tips of the two ventricles being separated by a deep notch.*

(iii.) *The liver, stomach, and intestines* (Pl. III. figs. 1 and 5).—In some respects the liver of this specimen shows characters similar to those of the human fœtal organ, but the accessory lobes, and the clefts which produce these, are to a certain extent atypical; thus the right lobe shows from the ventral aspect a fissure which passes obliquely inwards from the lateral surface, but this fissure is not seen from behind, as it extends for only a short distance into the substance of the lobe.

From the dorsal aspect (Pl. III. fig. 5) it appears that the left lobe is the bulkier of the two, and the inner surface of this lobe shows depressions corresponding to the ventral surface of the stomach, a small area of the spleen, and anteriorly the œsophagus and vena cava; the inner surface of the right lobe shows dorsally depressions corresponding to the numerous subdivisions of the right kidney, whilst the lateral aspects of both lobes are grooved by five or six of the posterior ribs. In the middle line ventrally the umbilical vein (Pl. III. fig. 5, *l.v.*) forms a thick cord, passing towards the ductus venosus.

The gall-bladder is not seen from the dorsal aspect except when the lobes are widely separated, when it appears as an elongated sac, deeply embedded in the deep surface of the right lobe, the fundus presenting ventrally in the small opening noted in the topographical description (see *supra*).

Certain accessory lobes show up when the two main lobes are separated from one another: these may possibly be the homologues of the Spigelian and quadrate lobes of the human organ, but their relations are somewhat different.

The main points for comparison to be noted in this organ are:—

(i.) The relative longitudinal extent of both lobes, this being distinctly greater than is the case with most other carnivora.

(ii.) The small accessory flap guarding the aperture in which, ventrally, the fundus of the gall-bladder is to be seen.

(iii.) The large volume of the abdominal cavity, occupied by the whole liver, at a stage when other abdominal viscera have assumed a relative importance in size.

The *stomach* and *intestines* (Pl. III. fig. 1) are seen from the ventral aspect, after

* See HEPBURN, *Trans. Roy. Soc. Edin.*, vol. xlviii., 1913.

removal of the liver, by which organ they are largely concealed; the stomach is placed with its long axis nearly parallel to the long axis of the fœtus, and possesses a well-marked cardiac extremity lying with its fundus pressed against the diaphragm, and a pyloric end which is narrow and passes by a sharply curved portion into the first part of the small intestine. The lesser curvature of the stomach looks towards the ventral aspect, the greater curvature and fundus are dorsally situated, whilst a peritoneal fold, the representative of a great omentum, is attached to the whole length of the larger curvature; the lesser curvature and the duodenum have passing between them a narrow peritoneal sheet, which holds up the duodenum so that its first part runs parallel with the stomach.

The stomach is an inch and a half in length, and at its cardiac end is joined by the œsophagus, the latter being a somewhat wide tube, two inches long and quarter of an inch in diameter.

The first part of the small intestine (duodenum) makes three bends, and possesses four distinct portions, the first of which is parallel with the smaller curvature of the stomach, whilst the second, third, and fourth divisions enclose a portion of peritoneum, between the layers of which the pancreas is held in position. The coils of small intestine proper are already many in number, and their general arrangement may be made out by reference to Pl. III. fig. 1.

With regard to the large intestine, the position of the cæcal pouch is noteworthy: this pouch is placed opposite the level of the third bend of the duodenum, being connected with the latter by a short fold of peritoneum. No sign of a vermiform appendix is to be made out; as a matter of fact, this organ is not seen in the full-grown animal.*

(iv.) *The spleen* (Pl. III. fig. 6) has a situation upon the left side of the abdomen, parallel to the greater curvature of the stomach and attached to this by a fold of peritoneum; in thickness this organ does not measure more than one-eighth of an inch, but in length exceeds two inches. There are no notches in either its ventral or its dorsal edge, and the hilus occupies a large proportion of a ridge forming its inner margin which lies close to the stomach; the outer surface of the spleen is grooved by two or three of the posterior ribs.

(v.) *The kidneys* (Pl. III. fig. 4).—These organs are somewhat elongated oval bodies lying low down at the back of the abdominal cavity and close to the middle line; each kidney belongs to the type common to the Pinnipedia, viz. the permanently subdivided type, where the organ is made up of a large number of anatomically distinct renal pyramids,† the secreting tubules of which open into a common pelvis, from which latter a ureter conducts the secretion to the urinary bladder.

In this specimen there are in each kidney about two hundred and forty small

* HEPBURN (*Trans. Roy. Soc. Edin.*, vol. xlviii. part i., No. 3, 1913) regards the cæcal diverticulum as a combined cæcum and vermiform appendix.

† "Renculi" of German authors.

raised areas, circular in contour, representing the bases of the renal pyramids: these are mostly uniform in size, but some, smaller than the majority, lie rather below the general surface. A mesial coronal section of the kidney passes through many of the pyramids and also opens up the calyces and pelvis; according to CHIEVITZ,* a certain amount of reduction takes place during development, so that whereas in certain instances about two hundred calyces may be present, in the full-grown animal only one hundred and forty remain, the reduction apparently commencing in those of the 6th and 7th order of origin.

The ureter emerges from about the middle of the inner and dorsal margin of the kidney, and passes down parallel to the mid-line, crossing the Müllerian ducts dorsally at right angles, and finally opens dorsally into the lower segment of the bladder; the hilus of the kidney from which the ureter emerges and into which the renal vessels pass is not a marked feature. The "pelvis" mentioned above is also but little developed, since the ureter divides almost at once into two main branches, the latter undergoing further subdivision in the kidney until the final divisions are reached close to the surface of the organ in the cortical zone of each renal pyramid. Each kidney measures about one inch by half an inch. The *adrenal bodies* (Pl. III. fig. 4) are small reniform structures lying one on each side just anterior to the kidney; there is a loose connection with the latter organ by means of a peritoneal band. In actual shape the adrenal is a flattened pyramid with a convex base facing outwards and ventralwards, whilst the hilus is placed at about the middle of the inner, or rather dorsal, edge, close to the vertebral column; the length of each gland is half an inch, and the breadth one quarter inch. Some points in the histology of both the kidney and the adrenal gland will be described later.

(vi.) *The genital glands* with their ducts (Pl. III. fig. 4) are in the present specimen already sufficiently established to be able to determine the sex of the animal —*i.e.* they are ovaries, and the Fallopian tubes pass from the outer ends of the glands to fuse in the middle line dorsal to the bladder and ventral to the rectum, and from the rudimentary uterus; the outer ends of the Fallopian tubes are dilated to form large ampullæ for the reception of the ova, and these ampullæ lie ventral to the outer pole of each ovary.

Each gland is an ovoid body lying obliquely from without backwards and inwards just behind the posterior pole of the kidney; from its anterior extremity an elongated narrow muscular band, the diaphragmatic ligament of the mesonephros, passes towards the diaphragm and becomes attached to the dorsal wall of the abdomen.

The *urinary bladder* (Pl. III. fig. 4^3) is an elongated organ attached above by a patent allantoic duct to the umbilicus; on transverse section, three apertures are seen —a median one, the bladder, and two lateral, the lumina of the umbilical arteries. The latter are passing to the umbilicus from their origin in the aorta.

The bladder opens into the cloaca by a transversely elongated slit-like aperture,

* *Archiv Anat. u. Embryol.*, Supplement, 1897.

and the ureters are to be seen opening into the bladder laterally upon its dorsal aspect; it is noteworthy that in the seals the bladder is represented by the entire intra-abdominal extent of the allantois.*

Summary of the Anatomical Features.

From the foregoing description it will be readily gathered that the Sea-Leopard Seal, during the middle phase of fœtal life, presents fairly typical embryological features; the age of the present specimen can hardly be worked out with any approach to accuracy, but it may be stated that the stage of development of most of the organs would place the fœtus at about the end of the first third of intra-uterine life. The exact period of gestation of seals is, however, somewhat difficult to determine owing to the peculiar habits of mating which these animals have, so that the above estimate should be accepted with some reservation.

In summarising the main anatomical features, it is possible to pick out the following more obvious characters:—

(*a*) In the *brain*: firstly, the relatively advanced stage of the cerebellum, the hemispheres of this portion showing distinct evidence of folds and sulci which are not to be made out in a three-months human fœtus; secondly, the comparatively advanced development of the pituitary body, a feature which will be more readily appreciated when the histology of the hypophysis is considered (see *infra*).

(*b*) In the *heart*: the most prominent feature is the late persistence of the bulbus aortæ, whilst the peculiar shape of the auricular appendices is also worthy of note.

(*c*) In the *lungs*: the possession of an accessory lobe by the right lung, and the relative size of these organs, which are certainly large, are points of comparative value.

(*d*) Other points which may be emphasised are the large size of the thymus and the left-sided deviation of this organ, the apparent absence of a thyroid isthmus, and the large size of the lowest parathyroids; in connection with the alimentary tract, the forward position of the cæcal diverticulum and the great length of the lobes of the liver. The kidneys are noteworthy on account of their surface lobulation into numerous renal pyramids, whilst the adrenal bodies do not lie directly upon the anterior poles of the kidneys. Moreover, the adrenals are relatively much smaller than is the case with these bodies in the human fœtus at a corresponding stage of development.

Lastly, certain external characters, such as the absence of an external ear and the protruding bifid tip of the tongue, are features so obvious as to need no further comment.

* HEPBURN, *Trans. Roy. Soc. Edin.*, vol. xlviii. part i., No. 3, 1913.

SECTION II.

An Outline of the Microscopical Anatomy of some of the Organs.

The histological characters of certain of the viscera were examined in this fœtus, and in a few instances, viz. kidney and pituitary body, were found interesting from the point of view of the histogenesis of their essential secreting portions. The following account must, however, be looked upon as purely descriptive in character, since from the mere observation of features presented by a single specimen at one stage of development it is hardly possible to formulate a complete account of the histogenesis of any one organ.

(i.) *The thyroid and parathyroids* (see Pl. III. fig. 2).—The lateral lobes of the thyroid gland are situated rather far forward in the neck region, reaching the level of the lower border of the cricoid cartilage; each lobe measures about half an inch in length. The largest parathyroid is the posterior one, and is placed upon the mesial surface of the thyroid at the ventral and posterior angle of the lobe. The anterior parathyroid is quite small, and is found about the middle of the dorsal margin of the lateral lobe.

In minute structure the thyroid is seen to be made up of a large number of small vesicles, some of them showing evidence of recent origin from branched tubular columns of cells, and in some of them colloid is already to be detected; the vesicles are lined by a cubical epithelium, and there is a small amount of interstitial connective tissue, but no sign of a basement membrane outside the epithelium. The whole lobe is subdivided into relatively few rather large lobules by coarser trabeculæ of connective tissue which are given off from the inner surface of a rudimentary capsule which surrounds the lobes. Blood-vessels are fairly numerous, the larger branches being supported by the coarser trabeculæ of connective tissue lying between the lobules.

The parathyroid (Pl. III. fig. 2, *p.th.*) shows a quite typical structure: it is enclosed by a capsule of somewhat open connective tissue, which gives off trabeculæ passing into the interior of the gland. The essential secreting cells occur in the form of folded columns of cuboidal or polyhedral cells, whilst these columns are in close apposition to the blood-channels, the latter being at this stage lined by a definite endothelium; the latter, however, is not so marked a feature as it is in the blood-channels occurring in the pars anterior of the pituitary body of this fœtus.

(ii.) The *thymus* shows on section and microscopical examination a number of lobulated masses of lymphoid tissue supported by a framework of open connective tissue in which run a few rather large blood-vessels; here and there in the actual substance of the lymphoid masses there occur a few areas which appear clearer and which probably represent the remains of the original lumina of the epithelial tubules from which the gland arises.

The accessory portions of the thymus, noted in the general description of the viscera as being isolated from the main mass, are in all probability derived from the 2nd branchial cleft, and do not fuse with the portions derived from the 3rd and 4th clefts.

GROSCHUFF and VERDUN state that the thymus in carnivora arises invariably from the 3rd and 4th clefts, but in the rabbit, according to VERDUN, additional parts may arise from the 2nd cleft.* In the present instance, paired accessory portions were found lying dorsal to the sterno-mastoid muscle on either side of the trachea, and these on examination showed a typical thymus structure.

The lymphoid nodules of the thymus present a more or less uniform density with the exception of the occurrence of the above-mentioned clearer areas, and no subdivision into cortex and medulla is as yet obvious; nor are any corpuscles of Hassall to be observed.

(iii.) The *lungs* (Pl. IV. fig. 3).—Microscopical examination reveals in these organs a structure entirely comparable to that of a compound tubular gland, the branching tubules of which lie embedded in connective tissue; the latter exists in large amount and is of a fibro-cellular character. The epithelium lining all of the ramifications of the bronchi is of the high columnar type, with the nuclei lying next the basement membrane, whilst immediately outside the latter there is seen a fairly wide zone of tissue, more densely cellular than the true interstitial connective tissue; this denser zone is the anlage of the fibro-muscular and elastic coats of the bronchioles.

The epithelium of the branching tubules is ciliated, and it is only during later stages that the cilia disappear in those portions of the bronchioles where the latter expand into the infundibula and alveoli; at the present stage, although in some places the tubules appear to widen out into sac-like expansions, the epithelium remains of the ciliated variety, since no true alveoli with air-sacs are as yet developed. The interstitial connective tissue, which during later stages becomes compressed and relatively diminished in amount by the preponderating development of the alveoli, contains some large blood-vessels, but these are as yet relatively few in number.

(iv.) The *pancreas* (Pl. IV. fig. 5).—The histological features presented by this gland are quite typical: branching tubules supported by a fine meshwork of connective tissue, the whole enclosed by a capsule of somewhat open character, from which trabeculæ pass into the substance of the gland. The tubules are lined by columnar epithelium, but there is as yet no definite basement membrane;† the lumina of the developing alveoli are quite small. The blood-vessels are quite small and apparently not very numerous at this stage; no signs of any cell-groups comparable to islets of Langerhans are to be detected, but probably it is too early for

* See HERTWIG, *Handbuch der Entwickelungslehre der Wirbeltiere*, 1906.

† The connective tissue appeared to have shrunken away from the tubules, leaving a considerable space between the two (see fig. 5).

these to have been formed. When a section of the pancreas stained with hæmatoxylin is examined, it appears that the cells lining the alveoli are not characterised by the deeply-staining outer zone which is so marked a feature in the pancreas of the armadillo; moreover, the nuclei lie at the outer or attached borders of the cells.

(v.) *The spleen.*—In minute structure, the spleen presents the following features :—

(*a*) Externally, a somewhat dense fibrous capsule, in which also unstriped muscle cells are undergoing development.

(*b*) Trabeculæ passing from the capsule into the substance of the gland, and forming a network in the interior: near the surface some large arteries may be seen passing in, more especially in the vicinity of the hilus, and corresponding venous branches are emerging.

(*c*) The bulk of the organ is made up of a mass of erythrocytes, erythroblasts, and lymphocytes; here and there cells suggesting the splenic cells of the adult organ may be seen, but giant-cells are apparently not present. A section taken through the splenic artery and vein with the blood contents of these vessels shows quite clearly that the vein contains many more lymphocytes than the artery, a feature which indicates that the lymphoid function of the spleen is already established; whilst the presence of erythroblasts in fairly large numbers in the spleen-pulp leads to the inference that hæmogenesis is also a splenic function at this stage—a point which is well established in the case of the rabbit and some other mammals.

No Malpighian corpuscles are to be seen in a section of the organ, but in some places the lymphocytes seem to be more densely aggregated than in others, with an indication of a small artery in their neighbourhood: these masses are not, however, well defined.

(vi.) *The kidneys and adrenal bodies* (Pl. IV. figs. 1 and 2).—At this stage the kidney presents histogenetic features which correspond fairly closely with those seen in the kidney of a four-months human fœtus; that is to say, each renal pyramid when sectioned in a plane passing through the cortex and the apex of the papilla is seen to be made up of the following parts :—

(*a*) A cortical zone, in the outermost layer of which are to be seen the dichotomously branched endings of the tubules derived from the ingrowth into the metanephros of the diverticulum from the Wolffian duct; in many of them the ampullary portions are continued into a coiled tubule—cut across many times and in various planes—the first or proximal convoluted tubule. At a somewhat deeper region of the cortex, the first set of Malpighian capsules are to be seen, these being relatively large as compared with those arising later: no sign of Henle's tube is as yet evident, since no downgrowth has occurred from the convoluted tubule to form the loop.*

(*b*) A deep zone, in which as yet connective tissue preponderates, and through which course the branching tubes derived from the Wolffian diverticulum; these tubules possess wide lumina, and are lined by a clear cubical epithelium. They represent the rudiments of the straight and collecting tubules, those nearest the papilla becoming later on the ducts of Bellini; in the Phocidæ, according to CHIEVITZ,† many of the secondary and tertiary branches of the Wolffian diverticulum disappear during development.

The epithelium lining the convoluted tubules of the cortical zone is clear and cubical, the nuclei staining but feebly with basic stains: the portion of the tubule, however, which joins the ampulla is lined by smaller cells, the nuclei of which stain deeply. The glomerulus in each Malpighian capsule is a well-developed capillary tuft with already an indication of lobulation.

Between the renal pyramids and supporting them there is a certain amount of connective tissue (columns of Bertini) in which small blood-vessels are seen cut across (capsular vessels of later stages).

The *adrenal bodies* (Pl. IV. fig. 2).—Relatively speaking, the adrenals are much smaller than one would expect at this phase of development, but their histogenetic features are none the less instructive: each gland is enclosed in a capsule of connective tissue in which course branches of the adrenal artery and vein, whilst smaller vessels (arterial) pass at right angles to the surface into the gland, being supported by the fine septa which are given off from the inner aspect of the capsule.

The substance of the adrenal is made up of the following parts:—

(*a*) An outer zone, the commencing zona glomerulosa, composed of folded columns of small cuboidal cells.

(*b*) A wide intermediate zone composed of anastomosing broad columns of large polyhedral cells: this is the developing zona fasciculata, amongst the columns of which ramify the small vessels noted above as passing in from the capsule. The cells of this zone are characterised by their small clear nuclei, and their deeply-staining cytoplasm, which takes up eosin very readily.

Throughout this zone are scattered small masses of rounded cells, with deeply-staining nuclei, the sympathetic ganglion rudiments. These are aggregated in larger masses in the central region of the gland, where they form the anlage of the medulla. In the medullary region the blood-channels are wide, and as yet are lined by a well-defined endothelium.

* CHIEVITZ (*Archiv Anat. u. Embryol.*, Supplement, 1897) found Henle's tubule present in an embryo of Phoca, 145 mm. in length. The present fœtus is only 122 mm. in length.

† *Op. cit.*

Compared with mammals, such as the pig, the adrenal of this Seal appears to be somewhat behindhand in the relative rate of its development; thus, in a pig embryo of 119 mm. the medulla is well defined, and most of the sympathetic derivatives are confined to it alone; but in a pig embryo of 70 mm. the histology of the gland is much as has been described above.*

(vii.) *The genital glands* (Pl. IV. fig. 4).—As has been noted, the genital glands in the present instance are ovaries; each ovary has a well-defined histological appearance, and it is possible to recognise—

(*a*) An outer layer of rather high cubical epithelium.

(*b*) A wide cortical zone composed of masses of rounded cells or primordial ova (some of these being considerably larger than others, and forming potential ova which will later become surrounded by a follicle of smaller cells to form the commencing Graafian follicles). Between the ova a good deal of fibro-cellular connective tissue is to be seen, and this forms a dense interlacing network supporting the egg-cells.

(*c*) Deep to the above cortical zone comes a layer of fibro-cellular stroma, comparable to the tunica albuginea of the testicle, but having a relatively different position in the gland.

(*d*) A central portion, composed for the most part of dense stroma, with here and there masses of ova, which are the remains of the so-called medullary cords of somewhat earlier stages.

In the mesovarium, which forms a wide peritoneal band of attachment, there are to be seen mesonephric tubules and glomeruli, whilst at the point of attachment of this band to the ovary there are some tubules, supported by stroma, forming the rete ovarii.

The above histological appearances correspond closely with those to be seen in the ovary of a cat embryo of 94 mm.; † no signs of developing Graafian follicles are to be seen, as the follicular epithelium has not as yet been formed round any of the larger ova.

(viii.) *The placenta* (Text-fig. 2).—The details of the placenta and placentation have been acquired in the present instance from the study of a specimen lent to the author by Professor WATERSTON of King's College, London; this specimen shows a fœtus of the Weddell Seal, a closely allied species, *in situ* in the uterus, with the membranes in their proper relative position with regard to fœtus and placenta.‡ The relations of the amniotic sac to the fœtus and umbilical cord are such that the former appears to be enclosed in a small complete sac, which is quite closed towards the ventral aspect of the embryo, the umbilical cord upon reaching the line of closure dividing up into a number of branches each containing twigs from the

* See HERTWIG, *op. cit.* † Figured by COERT, Inaug. Dissert., Leiden, 1898.

‡ Figured in Sir WILLIAM TURNER's *Catalogue of Marine Mammals.*

arteries and vein. The amnion then spreads out on either side of the line of closure, the resulting folds passing anteriorly, posteriorly, and laterally to the margins of the placenta, over which it then spreads, covering the fœtal surface of that structure. The branches of the umbilical arteries and vein are conducted by the above-mentioned folds to the margins of the placenta, and finally divide up into numerous twigs which enter the substance of the chorion.

The placenta itself is of the zonary type, occupying a median zone of the uterus: its histology corresponds very closely with the descriptions of GROSSER * and DUVAL for the zonary placentæ of the cat and bitch, with the exception of certain minor

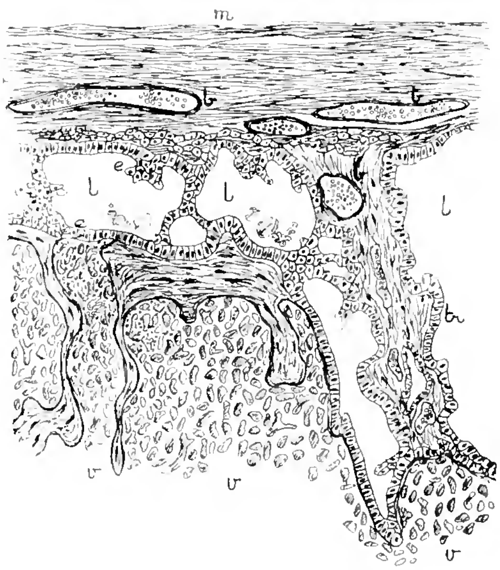


FIG. 2.—A portion of a transverse section of the uterine wall and placenta of the Weddell Seal. (Semi-diagrammatic.)

m. Muscle layers of uterine wall.
b. Maternal blood-vessels.
e. Epithelium lining uterine glands.
l. Lumina of glands containing secretion (embryotrophe of Grosser).
tr. Interglandular fastening septum.
v. Villi of placental labyrinth.

The fœtal blood-vessels exist in considerable numbers in the villi, but are not represented in the figure; the fœtus contained in the above uterus had undergone about one-third of its development.

details. Thus we find that a vertical section taken through the placenta and uterine wall presents the following main features (fig. 2):—

(*a*) A sheet of amnion (not shown in the figure) covering the fœtal surface of the numerous "cotyledons" of the placenta.

(*b*) The fœtal portion of the placenta, composed of the rather wide laminæ of the so-called "placental labyrinth" † between which mesodermic tissue lies; the sheets of this labyrinth are made up of a syncytium (derived from the trophoblast of earlier stages) which encloses and surrounds large

* *Vergleichende Anat. und Entwickelungsgesch. der Eihaute u. Placenta*, 1909.

† See GROSSER, *op. cit.*

numbers of fœtal capillaries, whilst maternal vessels of rather wider calibre lie in the mesodermic septa and become at times surrounded by portions of the syncytium.

(c) A zone in which an invasion of the superficial gland-layer of the uterine mucosa has taken place, the syncytium of the villi having at an earlier phase converted the uterine epithelium into what GROSSER terms a "symplasma," and becoming as it were welded with the mucosa at numerous points; the partitions between the glands become also fixed to other villous tufts.

(d) A deeper layer which comprises the bases of the uterine glands, and lies next the uterine muscle. The muscular coat, which is in the present case thin, contains large branches of the maternal blood-vessels, and these, where the interglandular septa pass to become fixed to the syncytium of the villi, pass into the mesoderm lying between the lamellæ of the placental labyrinth.

It appears that zone *c* noted above (so-called "umlagerungszone" of STRAHL and GROSSER) is, during the earlier phases, of the greatest importance in establishing the connection between the uterine epithelium and the syncytium of the villi; a further action of the syncytium is to convert some of the decidual cells lying between the uterine glands into trophoblastic masses not unlike the invading syncytium itself.

During earlier stages, stress is also to be laid upon the probability that the secretion of the uterine glands serves as an additional source of nutriment ("embryotrophe") to the fœtus.

From the above account it will be seen that there is a considerable histological similarity between the zonary placentæ of the cat and Seal: one notable difference is to be seen in the relatively narrow extent of the gland-layer in the uterus of the Seal, and another in the greater width of the laminæ of the placental labyrinth.

(ix.) *The internal ear* (Pl. IV. fig. 6).—The semicircular canals, utricle, ampullæ, and cochlea are well advanced in development, and lie in the cartilaginous rudiment of the osseous labyrinth; the membranous labyrinth is represented by a somewhat thick connective tissue with a certain amount of elastic tissue entering into its composition.

A transverse section across one of the semicircular canals *in situ* shows that the canal is placed very excentrically, lying against one side of the cartilaginous labyrinth, to which the connective tissue fixes it quite firmly. From the projecting part of the canal, strands or bundles of fibres pass to the opposite circumference of the cartilaginous tube, and, joining here a continuation of the membrane, help to fix the canal, so that practically no contraction of the lumen is possible. The spaces between the fixing strands are filled with perilymph, whilst the canal itself is lined by a somewhat flattened epithelium, which later on secretes endolymph. In the utricle and ampullæ small elevations or "cristae" project into the lumen, and are lined by a much higher type of epithelium than that found in the canals; but as yet there is no evidence of hair-like structures upon the free internal borders of the component cells.

The cochlea is rather more advanced in development than would be the case in a three-months human fœtus; according to KRAUSE,* the organ of Corti in the human fœtus at birth shows that the membrana tectoria is only commencing to form, whilst the sensory epithelium lying upon the basilar membrane shows only a larger and a smaller group of columnar cells. The author's preparations of the cochlea of a three-months human fœtus show the sensory epithelium as a group of columnar cells higher than the remainder in the tube, but no sign of the membrana tectoria. The scala tympani is present, but no membrane of Reissner as yet divides the upper cavity into scalæ media and vestibuli, whilst the rudiments of the spiral ganglion and cochlear nerve are certainly to be made out, but are not at all advanced.

In the Seal embryo under discussion, all three scalæ are present, the spiral ganglion is a marked feature, the membrane of Reissner is well defined, and the epithelium of the organ of Corti is becoming differentiated, the component cells being higher upon the outer side, and their free borders showing a well-defined clear zone.

(x.) *The pituitary body* (see text-fig. 3).—A specimen of the pituitary gland of an adult Weddell Seal (*Leptonychotes weddelli*) was examined histologically by the author some time since,† and found to possess all three portions, viz. pars anterior, pars intermedia, and pars nervosa, highly differentiated. The Sea-Leopard Seal in its earlier phases of development possesses a very interesting hypophysis, which moreover sheds some light upon the origin of the pars intermedia. Although a complete account of the histogenesis of this structure is not possible in the present instance, there are certain points in its development which are worthy of somewhat detailed description, and for purposes of comparison the developing hypophyses of the rabbit (at the twelfth, fourteenth, and nineteenth days) and of the three-months human fœtus were submitted to microscopical examination.

A nearly median sagittal section taken through the pituitary of this Seal embryo (the gland being *in situ* in the sella turcica of the ossifying sphenoid bone) shows the following features:—

(i.) *The anterior lobe* (pars anterior), consisting of irregular columns of rather large polyhedral cells, separated by wide blood-channels, the latter possessing a well-marked endothelial lining; at the posterior extremity of the lobe the blood-channels are observed to open into large venous tributaries, which ultimately join up and communicate with the cavernous sinus, the latter being seen in section lying just anterior to the dorsum sellæ of the sphenoid bone (fig. 3, *g*).

* See HERTWIG, *op. cit.*

† *Trans. Roy. Soc. Edin.*, vol. xlviii. part iv., No. 31, 1913.

(ii.) An *intermediate cleft* lying dorsal to the pars anterior, which is the remaining evidence of Rathke's pouch; this cleft is towards its lateral aspects (not shown in the figure) partially filled by proliferating columns of epithelial cells, some of which are to be seen in the mesial section at the anterior extremity of the cleft.

(iii.) The *pars nervosa*, or posterior lobe, lying dorsal to the cleft, and connected with the floor of the 3rd ventricle by the infundibulum; part of the cavity of the ventricle is seen extending into the infundibulum, but this feature disappears during later stages to a large extent.

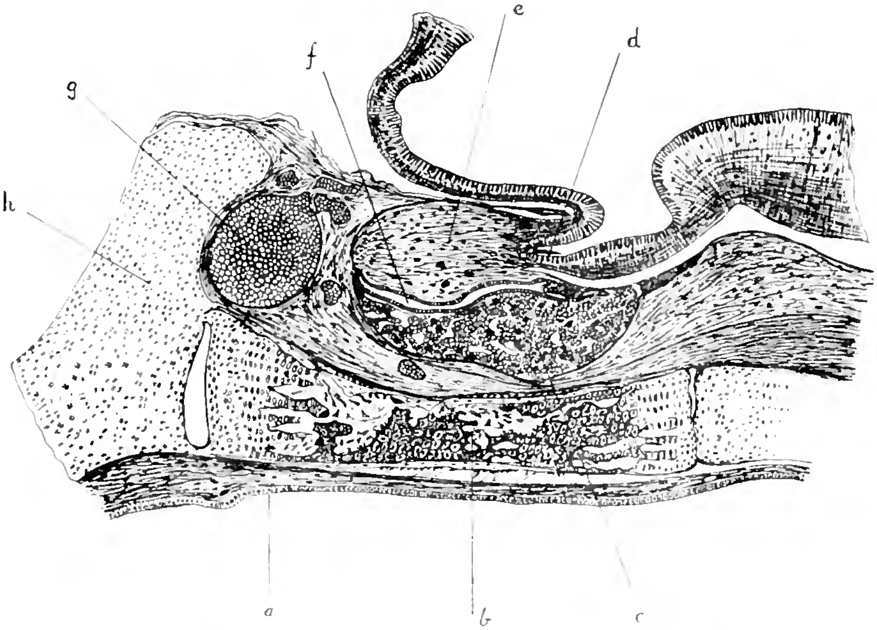


FIG. 3.—A vertical section through the base of the skull to show the hypophysis cerebri *in situ*, lying in the sella turcica of the sphenoid bone. (Semi-diagrammatic.)

a. Epithelium of the roof of the nasal cavity.
b. Developing basi sphenoid bone; the "irruption"-stage of ossification in cartilage is represented.
c. Large anterior lobe of hypophysis showing cell-columns and intervening blood-vessels; the dark masses are cells staining more deeply with eosin.
d. Infundibulum, showing communication with the 3rd ventricle of brain.
e. Posterior lobe (*pars nervosa*) of hypophysis.
f. Cleft between the anterior and posterior lobes; at the anterior end of this is seen a mass of cells, derived by an infolding from the anterior lobe, which will ultimately give rise to the *pars intermedia*.
g. Cavernous sinus.
h. Dorsum sellæ of sella turcica.

In connection with the pars intermedia, it appears that the columns of cells found partially filling the above-mentioned cleft are derived by a proliferation of cells at the upper and anterior angle of the pars anterior. HERRING * describes (in the cat) the pars intermedia as an epithelial investment of the posterior lobe, but in the Seal, at least during later stages, the intermediate mass is a well-defined strip of closely

* *Journ. of Exper. Physiol.*, 1909.

packed cells, which curves round the ventral aspect of the posterior lobe and appears to end abruptly in a broad club-shaped extremity at the posterior and ventral margiu of that lobe. The dorsal portion, however, passes over the upper surface of the pars anterior and seems to fuse with the anterior and dorsal margin of that lobe. No remnant of Rathke's pouch is to be seen in the fully formed pituitary of the Seal, whereas in the rabbit, cat, and man the pouch persists as a distinct cleft between the pars anterior and the pars intermedia.

In the present instance the roof of Rathke's pouch is lined by a columnar epithelium, which at the anterior extremity merges into the cell-columns which later on fill up the pouch. Upon the dorsal aspect of the posterior lobe no epithelial investment is to be seen, whilst the floor of Rathke's pouch is formed by the superficial cells of the pars anterior, which are arranged in the form of an epithelium.

The very close union maintained between the buccal and cerebral portions of the pituitary from the earliest stages is commented upon by HERRING * and emphasised as having a direct bearing upon the functional importance of the gland. In the Seal, at the stage of development now under discussion, the union between the two portions is very intimate, but becomes even more marked as development proceeds.

Compared with the hypophysis of a three-months human fœtus, that of this Seal is a good deal in advance. In the human fœtus at three months the connecting strand passing between the pars anterior and the buccal epithelium is still present, whilst the posterior lobe is only represented by a very narrow diverticulum from the floor of the 3rd ventricle.

Again, sections taken sagittally through the pituitary of the rabbit three days before birth show that the size of the posterior lobe is small as compared with the anterior, and the cavity in the infundibulum is represented by a mere cleft lined by ependyma. During earlier phases in this animal (twelfth and fourteenth days) the relation between the size of the lobes is such that the posterior lobe is proportionately larger than during later stages. In the Seal, at the stage under discussion, the posterior lobe is at least one-half the size of the pars anterior; but this relation does not hold in the full-grown animal, where the anterior lobe is five or six times as large as the pars nervosa.

More detailed histological examination of the pituitary of the present fœtus shows certain characters which differ from those observed in similar anatomical regions during later stages; in the first place, the blood-channels in the pars anterior still retain their endothelial lining, a feature which disappears during development to a large extent, although in some parts of the full-grown anterior lobe endothelial cells are to be seen forming at least a partial lining to the blood-vessels. The cell-columns of the anterior lobe are composed of closely packed polyhedral cells, which, when stained with an acid stain such as eosin, may be differentiated into two

* *Op. cit.*

varieties, viz. a majority which stain lightly, and here and there isolated cells staining intensely; the cytoplasm of the latter cells is also more granular in appearance. In the fully formed gland these deeply staining cells are more numerous, and collected into small groups instead of being isolated cells. The proliferating columns seen in Rathke's pouch are composed of rather cuboidal, or in some cases columnar, cells, which do not possess any special affinity for eosin, but the nuclei of which stain deeply with basic dyes; no evidence of the syncytial structure seen in the pars intermedia of later stages is to be made out, nor does any colloid appear to have been formed as yet. The pars nervosa appears to possess much the same minute structure as does that part of the adult gland; for the most part, neuroglia cells and fibres predominate, some of the former being spindle-shaped and occurring in that portion of the lobe which lies next the epithelium forming the roof of Rathke's pouch, their long axes being at right angles to the ventral surface of the lobe. The portion of the cavity of the 3rd ventricle which passes into the infundibulum is lined by an ependyma of the usual type, viz. rather high columnar epithelium, the component cells being ciliated, whilst the basal portions of these cells are continued as neuroglia fibres into the substance of the pars nervosa. There is no colloid to be detected as yet in this part of the pituitary, although in the fully formed gland small particles of colloidal material derived from the pars intermedia are to be seen scattered throughout the posterior lobe. Lying just dorsal to the infundibulum is a folded portion of the floor of the 3rd ventricle, which encloses a small fold of pia mater; this portion later on becomes modified to form a small ovoid mass lying on the dorsal aspect of the posterior lobe, and contains syncytial strands of nucleated cytoplasm more fully described by the author in a previous communication.* When fully formed it is very vascular, but its functional significance is not at all obvious. The above somewhat brief description of some of the developmental aspects of the pituitary of the Sea-Leopard Seal are, of necessity, incomplete, on account of the fact that only a single specimen was available for investigation. It would be interesting to follow some of the earlier phases, inasmuch as the gland appears in this animal to have a high functional significance—quite as much so, in fact, as in some higher types.†

General Comparative Conclusions in connection with the Anatomical and Histological Features presented by the Fœtus of Stenorhynchus.

(i.) The fœtus, in the light of the above considerations, shows many points in common with the human fœtus at the beginning of the fourth month of intra-uterine development. If the relative rates of growths during the earlier developmental

* *Op. cit.*

† For further details of the cytological characters of the various regions of the mammalian pituitary, see Schafer, "Text-Book of Microscopic Anatomy" (*Quain's Anatomy*, vol. ii. part i.).

phases are at all comparable in the two cases, then the present fœtus should have completed about one-third of its development. In many respects, however, this fœtus shows an advance upon the three-months human embryo, notably in connection with the pituitary gland, the cerebellum, and the internal ear.

(ii.) The other mammals (rabbit, cat, and pig) with which incidentally the fœtus has been compared show on the whole a fairly close agreement, both anatomically and histologically; one marked exception, from the anatomical point of view, is in connection with the kidney, which places the Seals in a small sub-group of the carnivora, to which the bear also belongs.

(iii.) The developmental features of the pituitary, kidney, and brain are sufficiently instructive to necessitate, when possible, investigation of the earlier phases of development of these organs; the acquisition of early Seal embryos is, however, a difficult matter, but they might with advantage be sought for, as large numbers of Seals are killed annually.

In conclusion, the author wishes to thank Dr. W. S. Bruce and Professor Waterston for their courtesy in lending *Scotia* specimens of fœtal Seals for investigation; also Professor Hepburn for many valuable suggestions in connection with anatomical details, and Mr. T. H. Burlend, of University College, Cardiff, for much useful criticism concerning the arrangement of the above report.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. Fœtus of the Sea-Leopard Seal:—

a.f. Anterior flipper.
p.f. Posterior flipper.
t. Tail.
cl.a. Cloacal aperture.
u. Umbilicus.
u.c. Umbilical cord.
am. Amnion.
p. Placenta.
b. Tongue: the bifid extremity showing between lips.
pal.f. Palpebral fissure.

Fig. 2. Dissection of the Sea-Leopard Seal, to show the principal viscera *in situ* (ventral aspect):—

1. Thyroid and lowest parathyroid.
2. Trachea.
3. Thymus.
4. Left lung (upper lobe).
5. Left auricular appendix.
5*a*. Left lung (lower lobe).
6. Ventricular portion of heart.
7. Diaphragm.
8. Left lobe of liver.
9. Umbilical cord.
10. Patent allantoic duct.
11. Urinary bladder.
12. Coils of small intestine.
13. Umbilical vein.
14. Right lobe of liver.
15. Gall bladder.
15*a*. Right lung (middle lobe).
16. Right auricular appendix.
17. Right lung (upper lobe).
18. Arch of aorta.

Plate II.

Anatomical details of the brain and cranial and nasal fossæ.

Fig. 1. The brain from the dorsal aspect :—

1. 4th ventricle (floor).
2. Lamellæ of cerebellar hemisphere.
3. Superior surface of cerebral hemisphere.
4. Crura cerebri.

Fig. 2. The brain from the side :—

1. Olfactory lobe.
2. Fissure of Sylvius.
3. Infundibulum.
4. 3rd nerve.
5. Medulla oblongata.
6. Cerebellum.
7 Cerebral hemisphere.

Fig. 3. Mesial surface of a median sagittal section of head :—

1. Lower jaw.
2. Tongue.
2[1]. Lamina terminalis.
3. Hypophysis cerebri.
4. Medulla oblongata.
5. 4th ventricle.
6. Cerebellum.
7. Corpora quadrigemina.
8. Optic thalamus.
9. Falx cerebri.
9[1]. Corpus callosum.
10. Nasal fossa (lower).
11. Nasal septum.
12. Buccal cavity.

Fig. 4. Nearly mesial sagittal section of brain to show distribution of grey and white matter, and general relations of parts :—

1. Nuclei of vagus and hypoglossal nerves.
2. Grey matter of cerebellar hemisphere.
3. Pia mater.
4. Grey matter of cortex cerebri.
5. Superficial white matter of cortex.
6. Grey matter lining cavity of prosencephalon, just showing.
7. Portion of choroid plexus.
8. Portion of 3rd ventricle in infundibulum.
9. Grey matter in optic thalamus.

ii. Part of prosencephalon communicating with lateral ventricle.
iv. 4th ventricle.

Fig. 5. Mesial surface of sagittal section of head, the nasal septum and falx having been removed :—

t. Tongue.
hy. Hypophysis.
m.o. Medulla oblongata.
cb. Cerebellum.
p. Pons.
op. Optic thalamus.
h. Cerebral hemisphere.
olf.l. Olfactory lobe.
eth.t. Ethmo-turbinal bone.
mx.t. Maxillo-turbinal bone.

Plate III.

Anatomical features of some of the viscera.

Fig. 1. The stomach and intestines from the ventral aspect:—

1. Coils of small intestine.
2. Peritoneal fold attached to greater curvature of stomach.
3. Pyloric end of stomach.
4. Cardiac end of stomach.
5. Œsophagus.
6. First bend of duodenum.
7. Pancreas.
8. Part of transverse colon.

Fig. 2. A coronal section of the thyroid and lowest parathyroid:—

th. Lobules of the lateral lobe.
p.th. Parathyroid, showing arrangement of cell-columns with intervening blood-channels and connective tissue.
v. Vein in capsule, with a small nerve-trunk.

Fig. 3. The lungs from the ventral aspect:—

a. Part of right middle lobe.
b. Upper and lower lobes of left lung.
c. Bronchi entering root of lung.
d. Pulmonary vein emerging from right lung.
e. The three lobes of right lung.

Fig. 4. The retroperitoneal and pelvic viscera:—

1. Cloacal aperture.
2. Severed allantoic duct.
3. Urinary bladder.
4. Ureter (cut across).
5. Genital duct.
6. Left kidney.
7. Adrenal gland.
8. Diaphragmatic ligament of mesonephros.
9. Genital gland.
10. Rectum, with rudimentary uterus just ventral to it.

Fig. 5. The liver from dorsal aspect:—

r.l. Right lobe.
k. Surface of right lobe which lies over kidney.
l.l. Left lobe
l.v. Umbilical vein (= ligamentum teres of later stages.)

Fig. 6. Deep surface of the spleen:—

a. Elongated hilus with blood-vessels.
b. and *c.* Dorsal and ventral margins.

Plate IV.

Figures (semi-diagrammatic) illustrating the histological features of some of the viscera.

Fig. 1. Portion of a longitudinal coronal section of a kidney showing a quadrant of one renal pyramid and some intervening connective tissue:—

a. Ampullæ of terminal branches of Wolffian diverticulum.
con.t. Convoluted tubule seen cut across several times.
m.c. Malpighian capsules.
w. Secondary, tertiary, etc., branches of Wolffian diverticulum.
i. Intervening connective tissue between neighbouring pyramids.

Fig. 2. Part of a longitudinal coronal section of an adrenal body:—

c. Capsule.
z.g. Zona glomerulosa.
z.f. Zona fasciculata.
m. Medulla.
s. Sympathetic ganglion cell masses.
b. Blood-channels in medulla between large groups of sympathetic cell-masses.

Fig. 3. Part of a section of lung, showing the branching tubules embedded in discrete masses of condensed connective tissue with rudiments of muscular and elastic layers lying next the tubules. The interstitial connective tissue is also present in large relative amount.

Fig. 4. Portion of a longitudinal section of the ovary :—

ep. Surface epithelium (germinal epithelium).

c. Cortical zone with primitive ova and some stroma.

s. Dense stroma forming a kind of tunica albuginea.

m. Medulla with a few masses of ova and much stroma separating them.

Fig. 5. Part of a section of the pancreas, showing typical arrangement of branching tubular acini, with but little interstitial connective tissue.

Fig. 6. Portion of a vertical section through the developing cochlea showing one turn of the spiral in section :—

s.v. Scala vestibuli.

R. Membrane of Reissner.

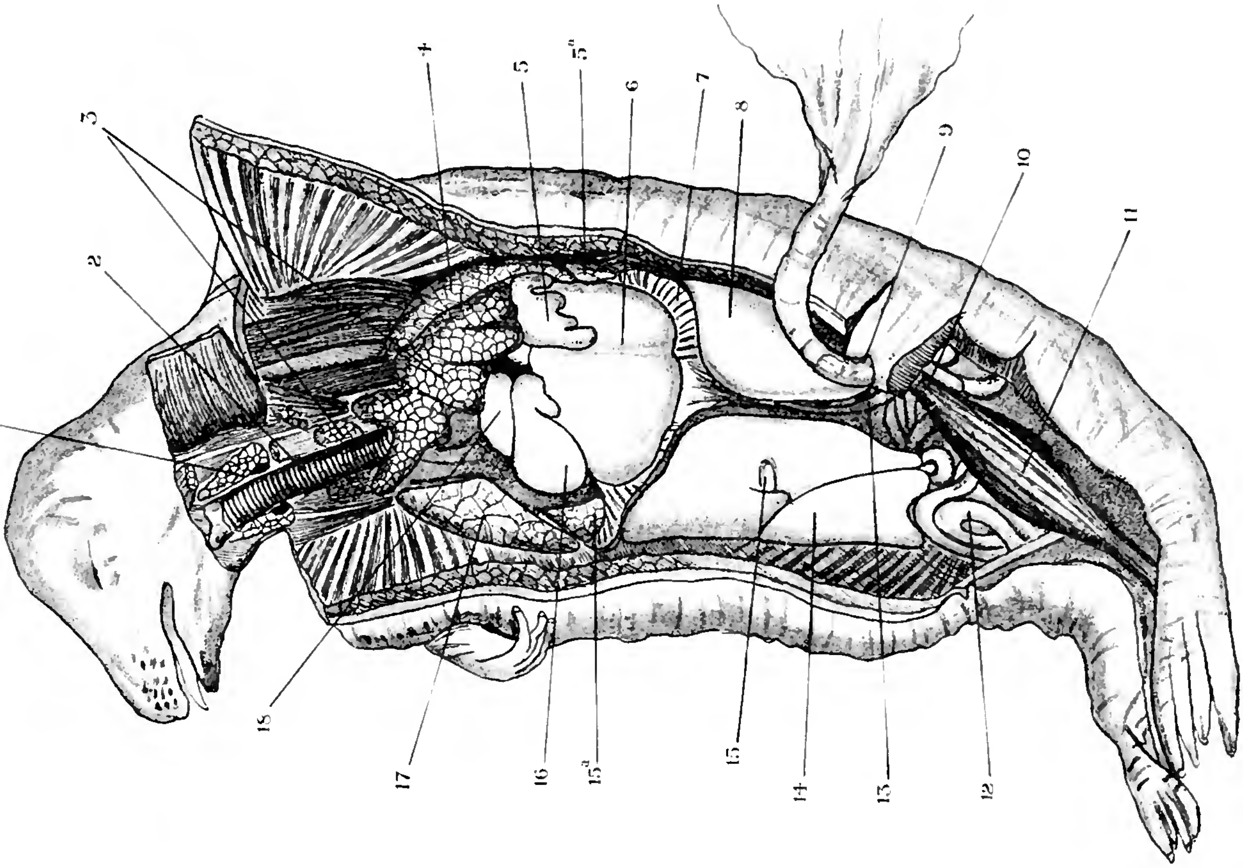
c.c. Canal of the cochlea.

B. Basilar membrane, with rudimentary organ of corti resting upon it.

S.T. Scala tympani.

G. Spiral ganglion.

HAIG: SYSTEMATIC ANATOMY OF A FOETAL SEA-LEOPARD.



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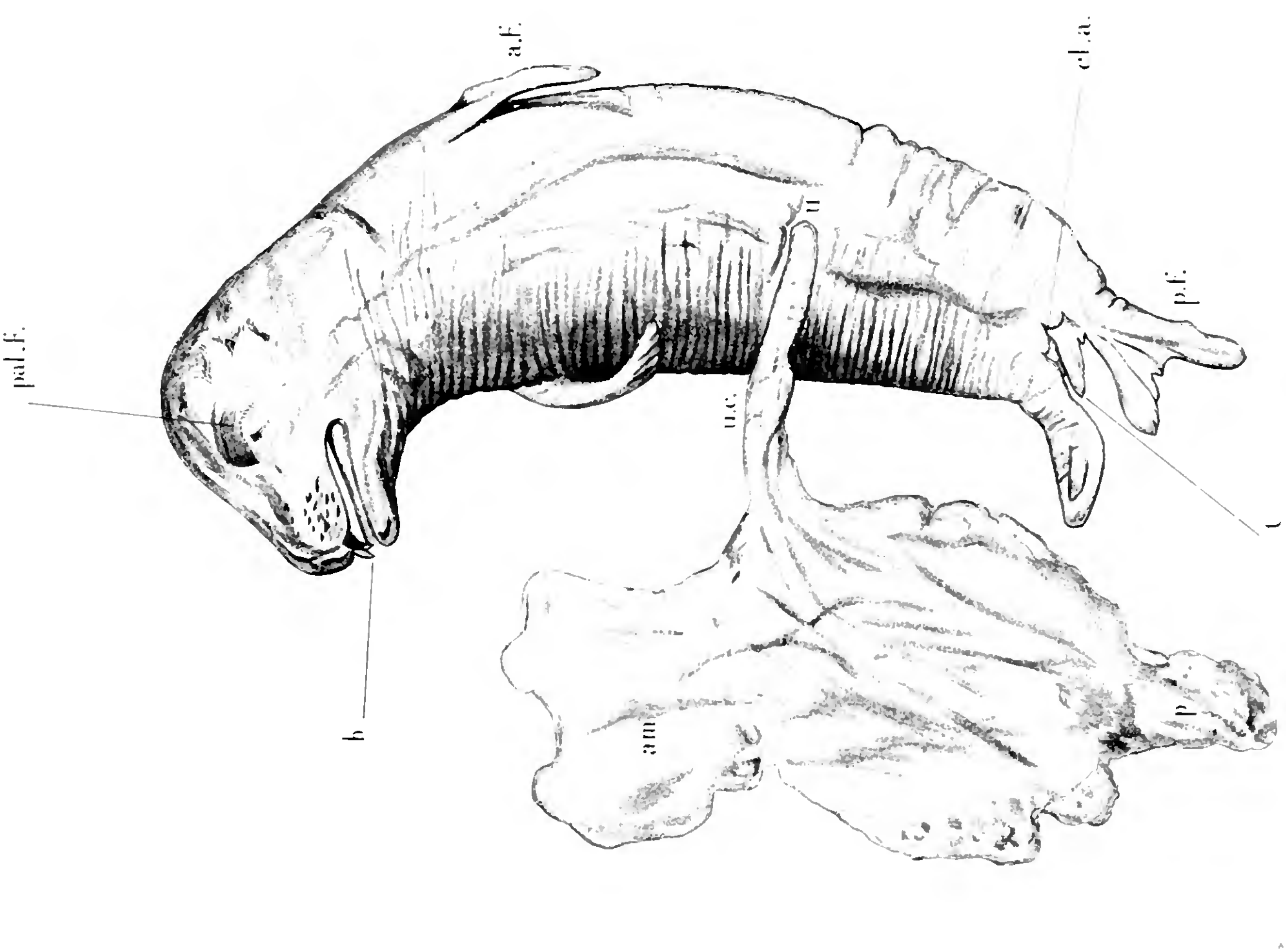

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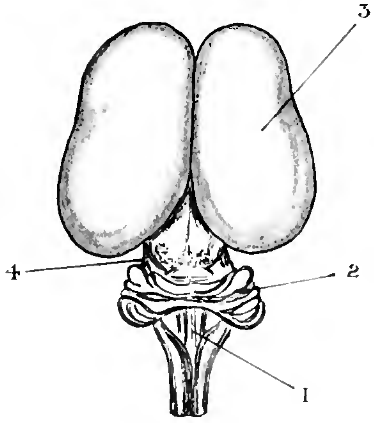
Haig: Systematic Anatomy of a Foetal Sea-Leopard.



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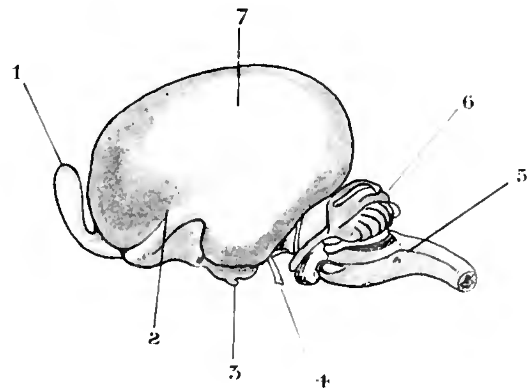

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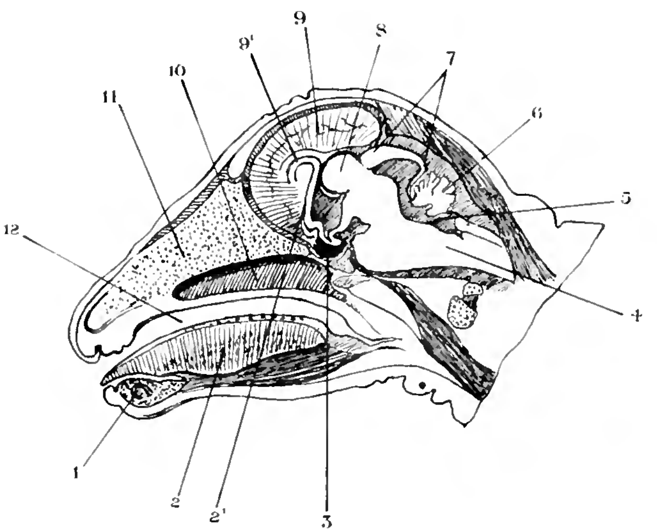

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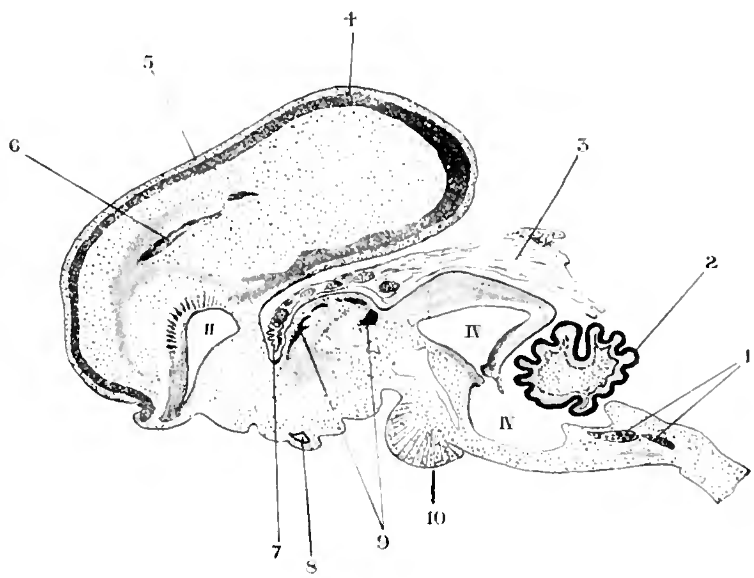

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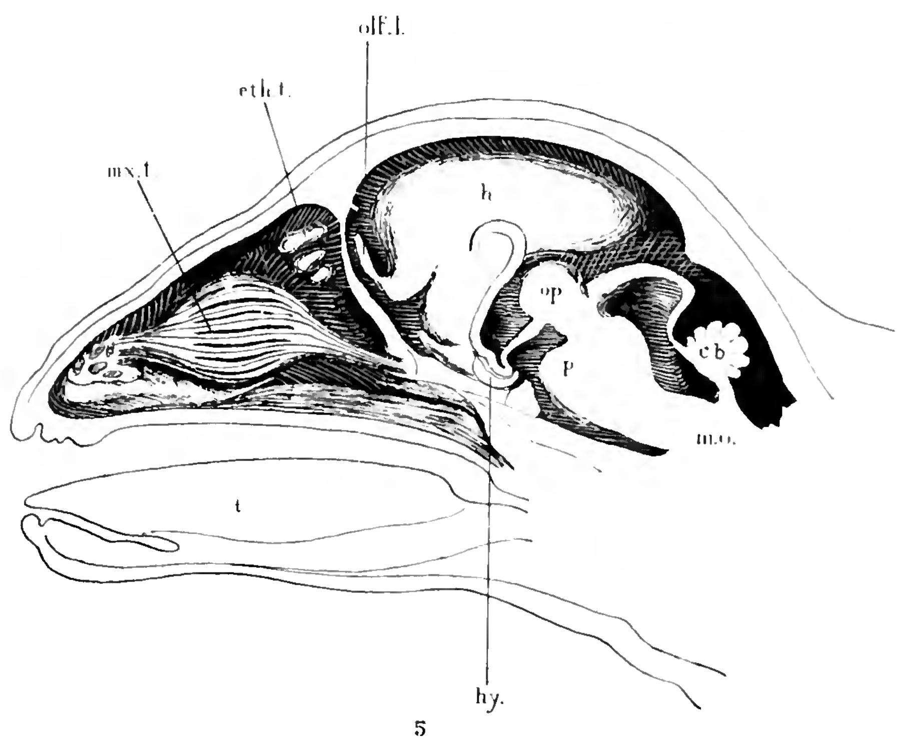

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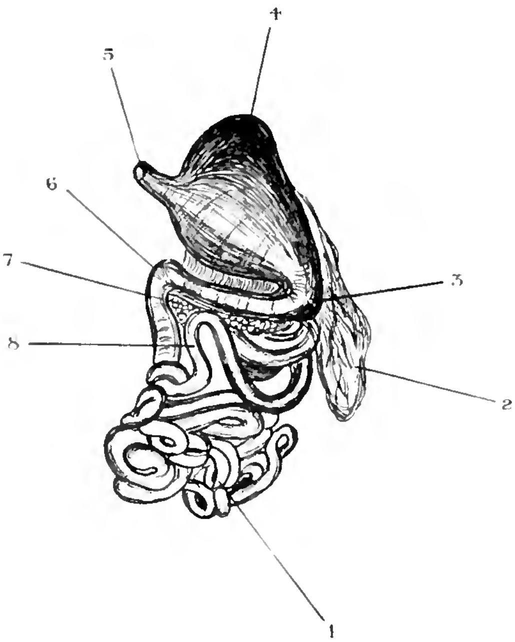
Haig: Systematic Anatomy of a Foetal Sea-Leopard.



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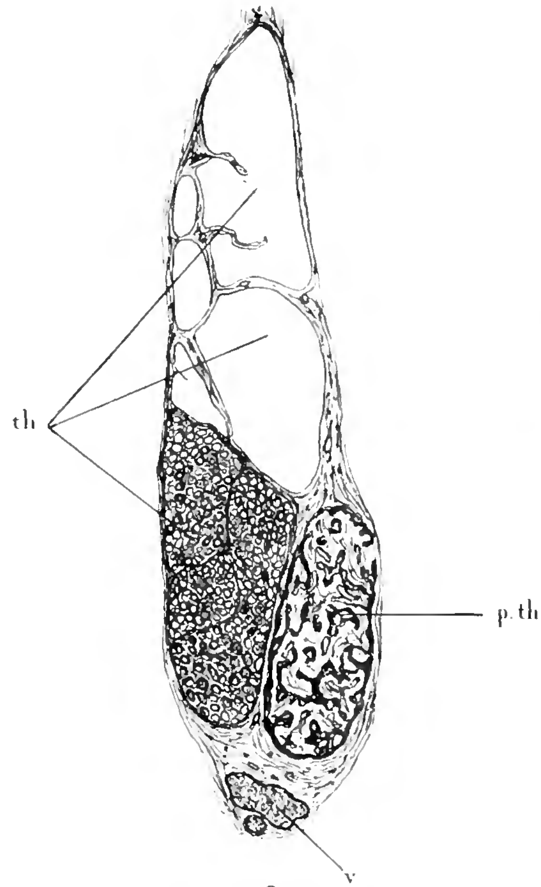

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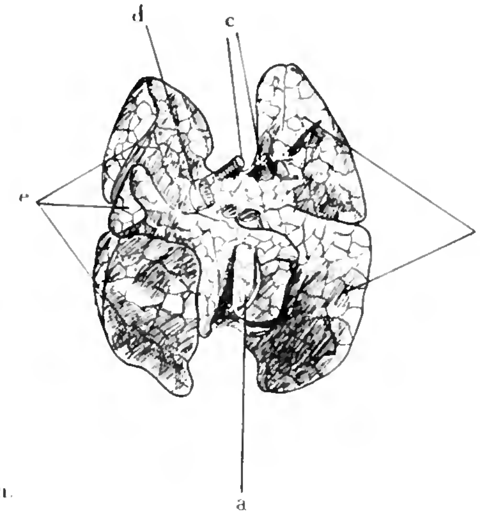

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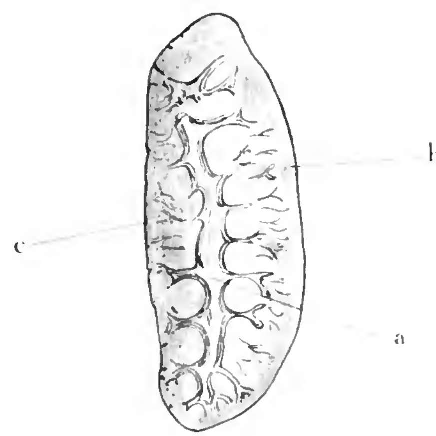

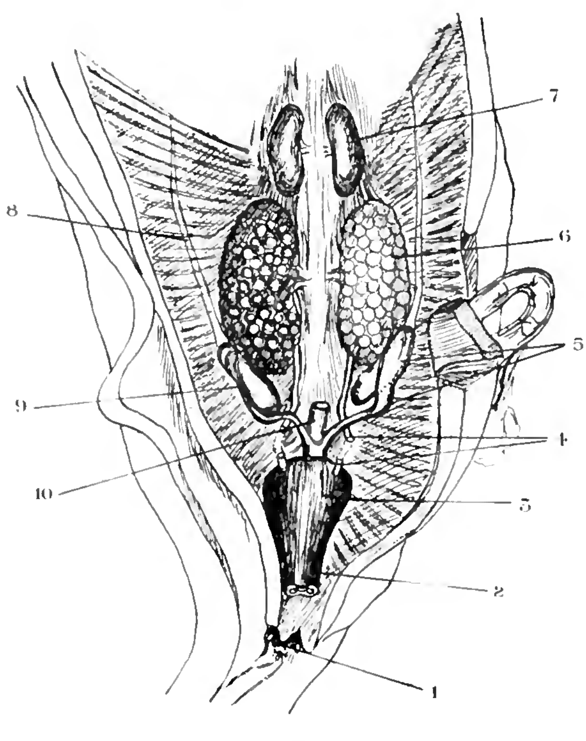

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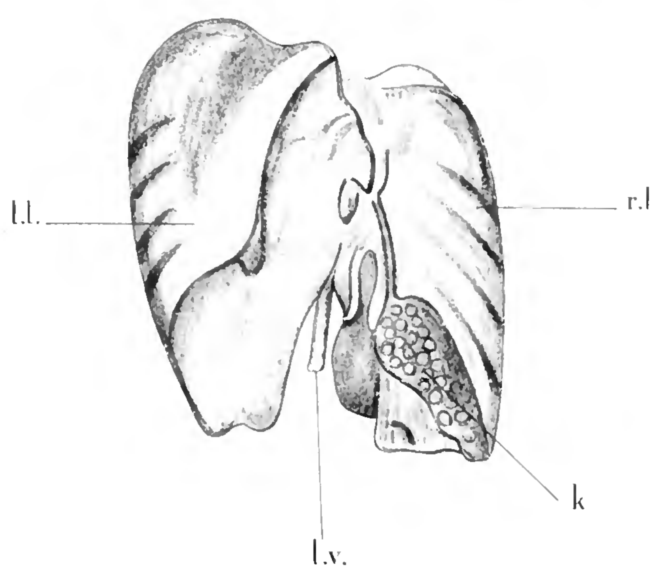

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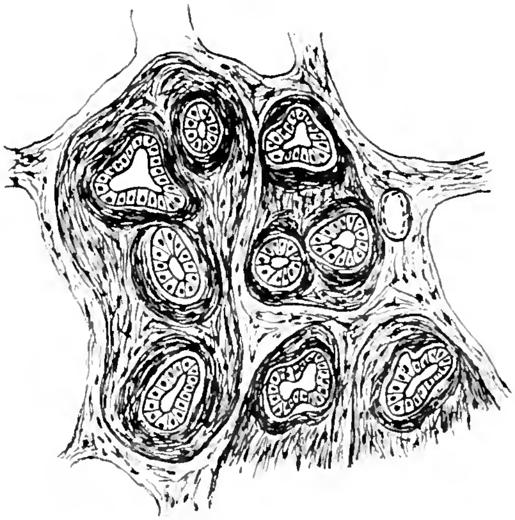

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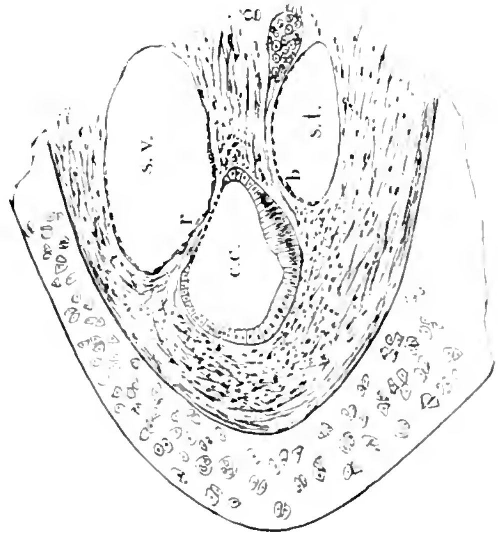

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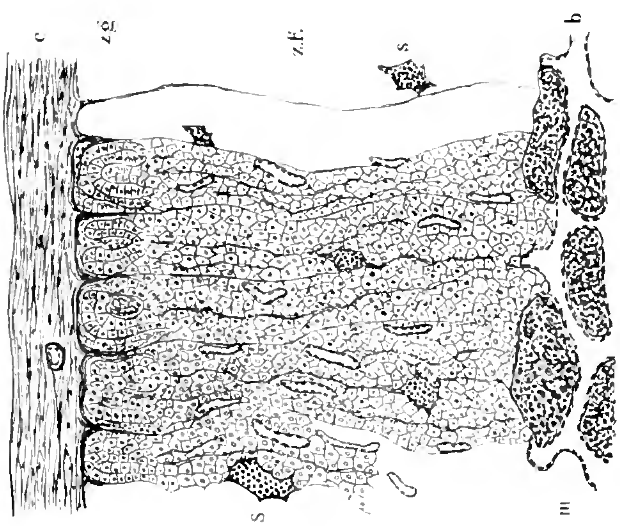

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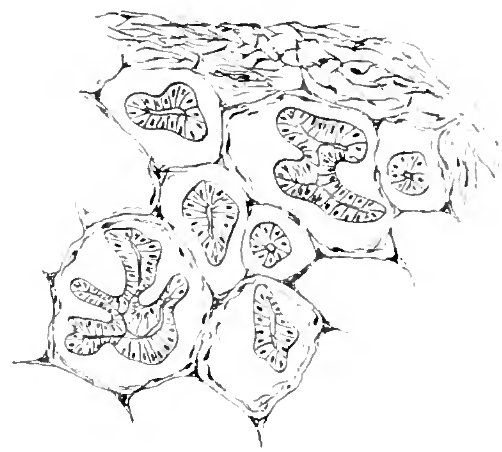

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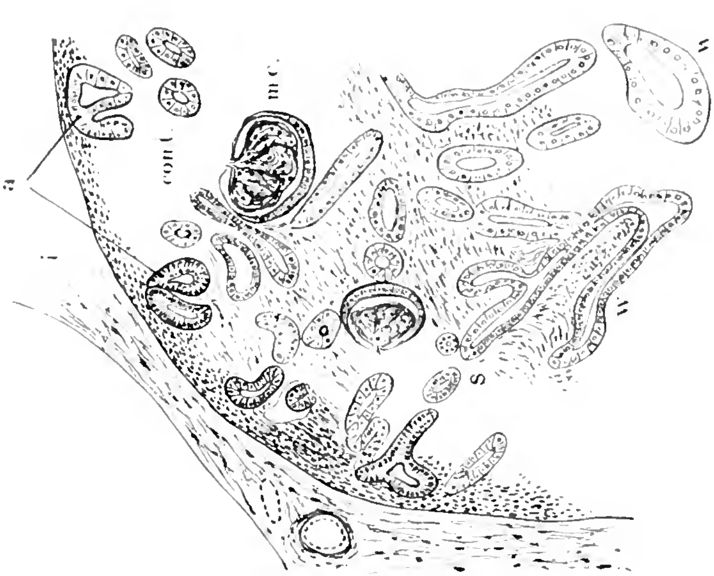

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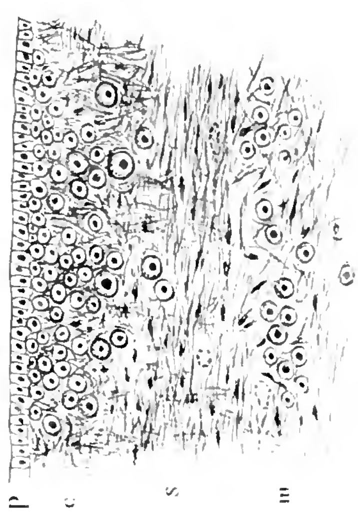

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PART XIX.

WHALE FISHERIES.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

XIX.—THE WHALE FISHERIES OF THE FALKLAND ISLANDS AND DEPENDENCIES.

By THEODORE E. SALVESEN, F.R.S.E., Leith.

(*WITH TEN PLATES.*)

XIX.—The Whale Fisheries of the Falkland Islands and Dependencies. By Theodore E. Salvesen, F.R.S.E., Leith. (With Ten Plates.)

(MS. received December 9, 1913. Issued separately May 12, 1914.)

Time was, and not long ago, when the only human enemies of the Cachalot or Sperm whale (*Physeter macrocephalus*), and of the southern Right whale (*Balæna australis*) in the South Atlantic and Antarctic oceans, were the crews of British and American whaling ships. The whales of the Finner species, such as the Blue whale (*Balænoptera sibbaldii*), the Finner whale (*Balænoptera musculus* or *physalus*), and the Humpback whale (*Megaptera boops*), were left entirely unmolested, the reason being that the method of capture was unsuitable. Rowing boats were employed, where the harpooner stationed in the bow threw by hand or shot from a gun a harpoon, with or without a bomb, and attached to a whaling line. The Cachalot and Right whales generally remain some time on the surface, thereby enabling a rowing boat to approach them; whereas the Finner species are much more active in their movements, and are only awash for a very short time when breathing. However, there might now and again be opportunities for even a rowing boat to approach and kill a Finner whale, but it would not be possible to bring the dead whale to the surface. This is simply owing to the fact that the Finner whales sink after being killed, whereas the Cachalot and Right whales float when dead. The weight of the carcase of the dead Finner whale is very much greater than the buoyancy of an ordinary whale boat, and if an attempt were made to lift the dead whale to the surface the whale boat would naturally be drawn under.

These whalers were wooden sailing vessels of about 150 to 450 tons register, and carried on pelagic whaling, touching only at ports in order to refit. They were complete in themselves, inasmuch as they carried not only their whale boats and gear, but also the products of the catch, the blubber being rendered into oil on board.

The industry was commenced in the beginning of the eighteenth century, the first British whaling fleet of 12 vessels sailing in 1725 for the southern seas. In the first half of the nineteenth century as many as 500 to 600 vessels were employed in the southern hemisphere hunting Cachalot and southern Right whales. Since then the number of vessels has been very greatly reduced owing to the fall in value of the products, viz. oil and baleen, combined with increased working expenses and smaller catches. At present this class of whaler is practically unknown in the Antarctic Regions.

The existence of enormous quantities of whales of the Finner tribe in the southern seas was well known in whaling circles, and by members of Antarctic scientific expeditions. Various attempts had been made to form companies for the purpose of prosecuting whaling operations in the south by the same methods as employed by the Norwegians in the north, but these efforts were unsuccessful until the year 1903.

Captain C. A. Larsen of Sandefjord had noticed the enormous numbers of Finner whales when, in command of the sealer *Jason*, he visited the Antarctic in 1892 and 1893 in search of seals and Right whales, and also about ten years later, as master of the *Antarctic*, he accompanied Nordenskiöld's scientific expedition to the Antarctic regions. His efforts to form a company in his native land to start whaling operations met with no success, but having friends in Buenos Aires, he succeeded in raising sufficient capital there, and the Compania Argentina de Pesca of Buenos Aires was founded, with Captain Larsen as manager.

He fitted out his expedition in Sandefjord, Norway, and arrived in Cumberland Bay, South Georgia, in December 1904, with one modern steam whaler and two small sailing vessels as transports, and immediately started building a whaling factory in King Edward's Cove, on the same site as had been used for trying-in plant for seal blubber in the early part of the preceding century. The satisfactory results obtained led to the formation of a large number of companies, which now carry on in the dependencies of the Falkland Islands the largest whaling business in the world.

Methods.

Before enumerating in detail the various companies presently operating, it may be of interest to have the method of pursuit and capture carried on by the whalers fully explained, as it differs in every essential from that practised by the men who hunted whales in the South Atlantic and Antarctic oceans up to the last decade.

The successful pursuit and capture of the Finner whales was inaugurated in 1866 by a Norwegian, Captain Svend Foyn, who noticed the large numbers of this species when passing the northern coast of Norway on his way to the Arctic ocean in search of seals. After three years of arduous labour he at last solved the difficulties, and the methods introduced by him, with considerable improvements, are those now in use by all the modern whaling companies the world over.

In order to be able to pursue the active Finner whales and get within striking distance, Captain Foyn substituted steam propulsion instead of men rowing the whale boats, and he overcame the buoyancy question by increasing the size of the vessel. The most approved type of a modern steam whale-catcher (Pls. I. and II. fig. 1) has a length of from 98 to 115 feet over all, with a beam of 18 to 22 feet, and a moulded depth of from 11 feet to 12 feet 9 inches, flush-decked, and cut away at both bow and stern in order to make the vessel answer her helm very quickly. The lines of the hull are designed for a speed of from 11 to 12 knots, and the engines are from 350 to 650 effective horse-power. Steam steering-gear is provided in order to operate the rudder to most advantage, and a powerful double whaling-winch of two cylinders each is fitted on the deck abaft the foremast. In the bow a glycerine recoil muzzle-loading cannon is fixed on a swivel, and so delicately balanced that, when loaded with powder and harpoon, it can be raised and lowered and turned from side to side by the harpooner without apparent exertion. The bore of the cannon varies from 3 to $3\frac{1}{2}$ inches, and its length is about 45 inches. The harpoon is made of the finest tempered Swedish steel, and is about 6 feet in length, weighing slightly over 1 cwt. It has four prongs, which spring out to an angle of about 45° on tightening the line after the harpoon is lodged in the whale's body. The point of the harpoon consists of a cast-iron head or shell of conical shape, about 14 inches in length and weighing from 10 to 12 lbs. This shell is charged with gunpowder, which is fired by a time-fuse about three seconds after the harpoon has been shot from the cannon. A foregoer of 60 fathoms in length and from $3\frac{3}{4}$ to $4\frac{1}{4}$ inches in circumference, made of the finest Italian hemp, is attached to a ring in the shank of the harpoon. To the other end of the foregoer a 5-inch to $5\frac{1}{2}$-inch whale line of 120 fathoms is spliced on. The length may be increased by adding additional lines as may be required. The bow of the vessel is fitted with a double set of rollers over which the lines run, and along the keelson, from the collision bulkhead forward to the stokehold bulkhead, are arranged double rows of powerful spiral steel springs, connected to two snatch-blocks above the shrouds of the foremast by strong flexible wire ropes.

The usual charge for a whaling gun is about 14 ounces of powder, and the range is only 25 yards. If a whale be struck in a vulnerable part, death will usually be instantaneous. The animal will then immediately sink, drawing with it the whale line. The steamer is brought to a standstill, and when the rope hangs vertically it is stoppered in the bow, and slack is given inboard to allow it to be passed over the snatch-block at the shrouds, from whence it goes to the winch, which raises the whale to the surface.

The snatch-block is, as stated above, attached to powerful steel springs, and the object of this arrangement is to compensate for the rise and fall of the whaler caused by wave motion, and to effect this these steel springs should be compressible to an extent equal to the difference of level between the top and the bottom of the waves. The elasticity of the whale line itself is not sufficient, and were no accumulators, as these springs are called, fitted, the strain on the rope when heaving in the whale, caused by the rise and fall of the steamer, would be greater than the strength of the line.

If the whale be not shot dead on the spot, the gunner has to play it in a very similar manner to that of the angler who has hooked a salmon. In both cases the line is much weaker than the weight exercised at its extremity, and the most experienced skill and careful handling have to be exercised. The whaling steamer plays the whale by manipulating the steam-winch, and also by moving ahead and astern, but it often happens that the rope will be snapped, caused by a sudden jerk.

The animal having been raised to the surface, a chain is passed round the tail and made fast at the bow of the ship, the foregoer is cut off at the harpoon, and the whale is towed at the side of the vessel tail foremost. In order to make the carcase float and thus lessen its towing weight, a hole is pierced through the body into the lungs or the stomach, and the whale is inflated with air by means of a steam air-pipe in the engine-room of the whaler.

Species.

The following are the only species of whales which are hunted in the South Atlantic:—

The southern Right whale (*Balæna australis*) (Pl. II. fig. 2) is a sub-antarctic species, and has a length of about 45 to 50 feet, the baleen measuring up to 7 feet in length and weighing from 4 to 5 cwts. A full-grown specimen in good condition will yield from 60 to 70 barrels of oil. The price of baleen being now so low, no special efforts are made to kill it, and the annual catch varies from ten to fifteen only.

The Blue whale (*Balænoptera sibbaldii*) is the largest living animal in the world, and may attain a length of 100 feet, and yields on an average 70 to 80 barrels of oil.

The Finner whale (*Balænoptera musculus* or *physalus*) (Pls. III. figs. 1, 2, IV. fig. 1) has a length from 50 to 70 feet, and its yield of oil averages 35 to 50 barrels.

The Fish whale or Seihval (*Balænoptera borealis*) is the smallest of the whales killed in the south, measuring only from 25 to 40 feet, and yielding 10 to 15 barrels. It is thus of very small value, and is only pursued when there is a scarcity of the larger kinds.

The Humpback whale (*Megaptera boops*) (Pls. IV. fig. 2, V. fig. 1) varies in length from 40 to 50 feet. Its oil contents may be reckoned from 25 to 35 barrels.

The Cachalot or Sperm whale (*Physeter macrocephalus*) has a length of from 50 to 60 feet. It has no baleen or finners, but from 58 to 64 teeth in its lower jaw. Its head constitutes about one-third of the whole animal, and contains about 30 barrels of spermaceti and sperm oil, the body yielding a similar quantity of oil. This whale is seldom met with in the waters round the Falkland Islands and dependencies, as its natural habitat is in warmer zones.

Reduction.

With whaling by the method just described, a separate factory for the reduction of the whale carcase is a necessity. The whaling steamers have no reducing plant on board, and tow the carcases to the harbour where the company's factory is situated. These factories are of two kinds—the shore factory and the floating factory.

When the whale is towed to a fully equipped shore factory (Pls. V. fig. 2, VI. figs. 1, 2) it is hauled up a slip on to the flenching platform (Pl. III. fig. 1). The baleen or whale bone is first removed, after which the whale is flenched by cutting off the blubber in strips, which are passed through a cutting machine and then conveyed by elevator to large open iron vats, where the oil is extracted by means of steam. The tongue and kidney fat are dealt with in a similar way, but the flenched carcase has to be chopped and sawn into suitable pieces before being conveyed and stowed into large boilers, where the contents are subjected to a steam pressure of 60 lbs. per square inch for 12 to 15 hours continuously. During this period the oil contained in the bones and flesh is run off into clearing tanks. The digesters thereafter are emptied of their contents, which are passed into drying kilns fired by coke, and finally the dried residue is run through a disintegrator, then sifted, and ultimately bagged as a powder or meal and ready for the market.

A floating whaling factory (Pls. VII. figs. 1, 2, VIII. figs. 1, 2) consists of a steamer or sailing ship up to 7000 tons burden, fitted with all the necessary reducing plant and with accommodation for storing the oil. These vessels must be moored in a harbour, as smooth water is required to enable the whales being flenched alongside the vessel. The blubber and carcase are cut up and hoisted on board, where the treatment is very similar to that adopted at the shore stations. A few steamers have been fitted with drying kilns for the manufacture of guano, but so far the results have not been quite satisfactory, and it is open to doubt whether the expenses of manufacturing and marketing guano manufactured on board are covered by the prices realised.

Products.

Three products may be obtained from the dried meat and bones. Firstly, whale meat meal, manufactured exclusively from absolutely fresh whale flesh. This is a most nutritious and wholesome foodstuff, containing $17\frac{1}{2}$ per cent. proteid, and is largely used for feeding cattle. Secondly, whale guano, made from the remaining flesh and about one-third of bones. The analysis shows about 8·50 per cent. ammonia and about 21 per cent. tribasic phosphates. Thirdly, bone meal, made exclusively from bones, and analysing about 4 per cent. ammonia and about 50 per cent. phosphates. The whole of the dried carcase may also be made into one product, forming a rich guano and containing from 10 per cent. to 12 per cent. ammonia and 17 per cent. to 24 per cent. phosphates.

The present value is about 13s. 6d. per unit of ammonia and 6d. per unit of phosphates per ton delivered at a European port.

The value of whalebone, baleen, or finners, as the whalebone of the Finner species of the whales is commonly called, is now very small compared to the prices formerly obtained. The baleen of the southern Right whale is at present only worth about £750 per ton, and the finners of the Fish whale fetch about £85 per ton, of the Blue and Finner whales only about £30, and of the Humpback whale about £10 per ton. These prices are so low that it is questionable whether the expenses of marketing are not heavier than the value realised. There can be no doubt that it does not pay to ship Humpback finners at the prices mentioned.

Whale oil is usually graded into four qualities, Nos. I., II., III., and IV., although some companies add a fifth—No. 0. Nos. 0 and I. are made entirely from blubber, No. II. from the tongues and kidney fat and from the residue of the blubber boilings, No. III. from the flesh and bones, and No. IV. from refuse.

The present value of Nos. 0 and I. is about £24 per ton net weight, No. II. £22, No. III. £20, and No. IV. £18 per ton, all delivered U.K. or Continental port, barrels included, or proportionate reduction if delivered naked.

Whaling Companies.

Undernoted is a list of the Companies presently operating:—

South Georgia.

1. Compania Argentina de Pesca of Buenos Aires, started in 1904; shore station in King Edward's Cove, Cumberland Bay (Pl. VIII. fig. 2); licensed for 4 steam whalers. With this concern is affiliated a floating factory sailing vessel for the reduction of flenched carcases.
2. Sandefjord Whaling Co. of Sandefjord, Norway, started in 1907; shore station in Stromness Bay; also floating factory steamer and 3 steam whalers. This Company was founded in 1906, but the floating factory steamer was totally wrecked outside of Stromness Bay on an uncharted rock.
3. Toensberg Whaling Co. of Toensberg, Norway, started in 1907; shore station in Husvik Harbour, Stromness Bay. Three steam whalers.
4. Bryde & Dahl's Whaling Co. of Sandefjord, started in 1908; floating factory steamer in St George's Bay. Three steam whalers.
5. The South Georgia Co. Ltd. of Leith, started in 1909; shore station in Leith Harbour, Stromness Bay (Pls. V. fig. 2, VI. fig. 1, IX. fig. 1). Operates 4 steam whalers.
6. The Ocean Whaling Co. of Larvik, Norway, started in 1909; shore station in New Fortune Bay (Pl. IX. fig. 2). Two steam whalers.
7. The Southern Whaling and Sealing Co., Ltd., of North Shields, started in 1911; floating factory steamer in Possession Bay (Pl. VIII. fig. 1). Two steam whalers.

South Shetlands and Graham Land.

1. Oernen Whaling Co. of Sandefjord, Norway, started January 1906. Two floating factory steamers and 6 steam whalers.
3. Sydhavet Whaling Co. of Sandefjord, started 1908. Floating factory steamer and 3 whalers.
4. Sociedad Ballenera de Magallanes, Punta Arenas, started in 1908. Floating factory steamer and 3 whalers.
5. Laboremus Whaling Co.
6. Hvalen Whaling Co.
7. Odd Whaling Co.

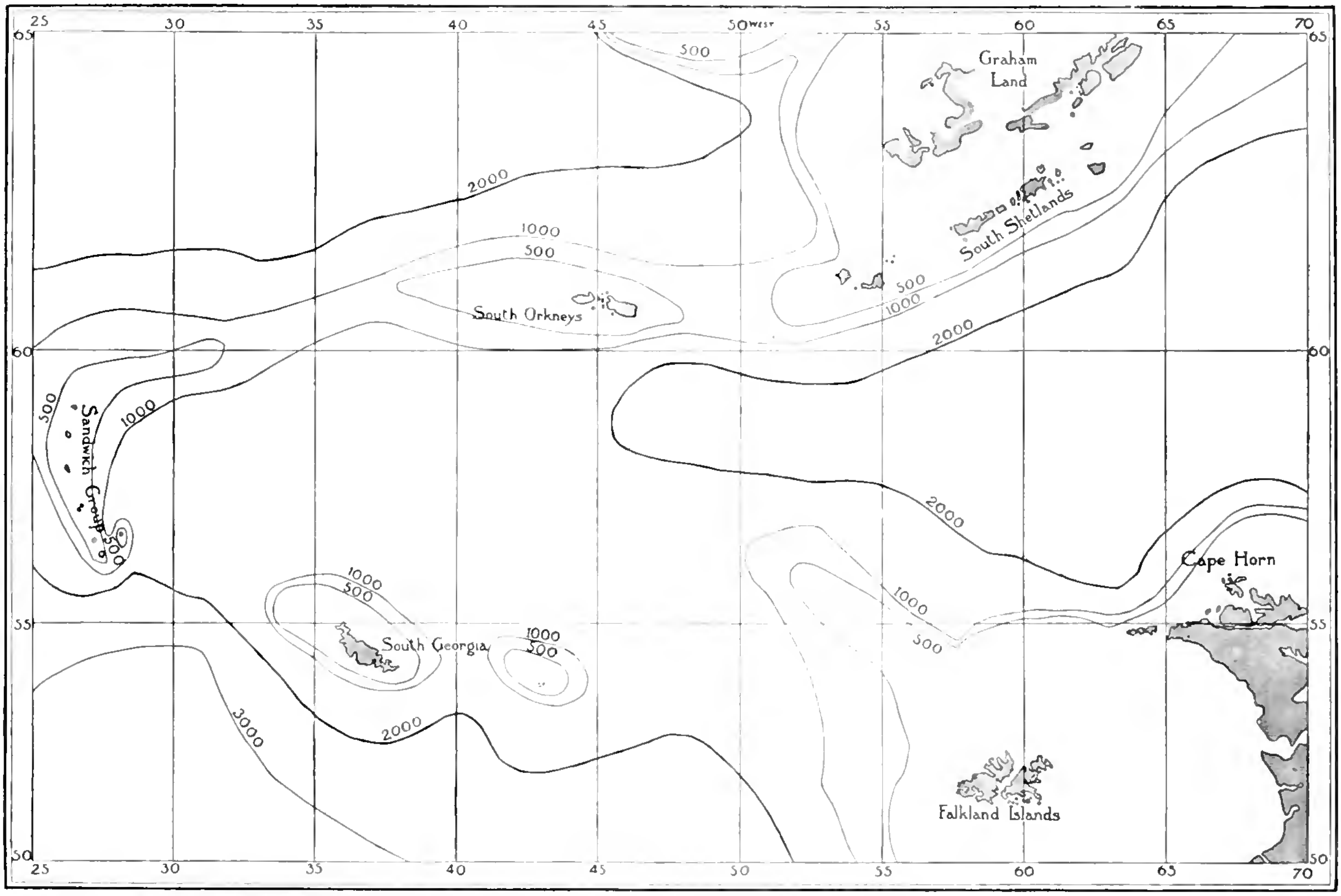
   } All of Sandefjord, Norway, and started in 1910. Floating factories and 3 whalers each.
8. Hektor Whaling Co. of Toensberg, Norway, started in 1910. Operates 2 floating factories, a factory ashore on Deception Island, and 5 steam whalers.
9. Norge Whaling Co. of Larvik, Norway, started in 1910. Floating factory steamer and 3 steam whalers.
10. Chr. Salvesen & Co. of Leith, started in 1911. Two floating factory steamers and 3 whalers.

Falkland Islands.

1. New Whaling Co. of Leith, started in 1908; shore station on New Island (Pl. VI. fig. 2). Operates 3 whalers.

South Orkneys.

1. Whaling Companies, Rethval & Thule of Christiania, Norway, started in January 1912. Operate 2 floating factory steamers and 4 whalers.
2. Normanna Whaling Co. of Sandefjord, Norway, started in 1912. One floating factory and 2 whalers.
3. Corral Whaling Co. of Bergen, Norway, started in 1912, with 1 floating factory steamer and 2 steam whalers. The floating factory steamer was lost in the ice in the spring of 1913.



John Mathieson, del.

The Falkland Islands and Dependencies.

Production.

During last season, from say 1st November 1912 till the end of April 1913, the catch of the 21 steam whalers operating at South Georgia was about 5000 whales, of which about 52 per cent. were Humpbacks, about 42 per cent. Finners, and about 6 per cent. Blue whales. This catch yielded about 200,000 barrels of whale oil, and about 8000 tons of whale guano.

The season at the South Shetlands and Graham Land is much shorter, and it is seldom that there is open water for more than four and a half months. The 32 whalers working in these waters killed also about 5000 whales, yielding about 200,000 barrels of oil, and about 100 tons of guano at the only shore station there, on Deception Island. The percentage of the whales caught was as follows: about 43 per cent. Finners, about 35 per cent. Blue, and only about 22 per cent. Humpback whales.

At the South Orkneys the season is still shorter, open water being seldom met with before the end of December, and ice setting in again about the middle or end of March. The 6 steam whalers at work from these Islands caught about 800 whales, yielding about 27,000 barrels of oil. The proportion of the various species is much the same as for the South Shetlands and Graham Land.

At the Falkland Islands the 3 whalers operating brought in only 87 whales, composed of 43 Fish whales, 36 Finners, and 8 Humpbacks, yielding 2128 barrels of oil and 275 tons guano.

The total production in the Falkland Islands and dependencies is thus about 430,000 barrels of oil—which is more than half of the world's output during last season—and 8375 tons of guano, the gross value of which is about £1,350,000 sterling. The industry gives employment to about 3500 men composing the crews of the whaling and transport vessels and working at the factories ashore and afloat.

EXPLANATION OF PLATES.

Plate I.

Steam whaler *Sedna* of Leith.

Plate II.

Fig. 1. Steam whaler *Ramna* of Leith.
Fig. 2. Southern Right whale (*Balæna australis*).

Plate III.

Fig. 1. Finner whale (*Balænoptera musculus*).
Fig. 2. Finner whale (*Balænoptera musculus*).

Plate IV.

Fig. 1. Finner whale (*Balænoptera musculus*).
Fig. 2. Humpback whale (*Megaptera boops*).

Plate V.

Fig. 1. Humpback whale (*Megaptera boops*).
Fig. 2. Whale factory, Leith Harbour, South Georgia.

Plate VI.

Fig. 1. Whale factory, Leith Harbour, South Georgia.
Fig. 2. Whale factory, New Island, Falkland Islands.

Plate VII.

Fig. 1. Whale factory, New Fortune Bay, South Georgia.
Fig. 2. Floating whale factory, s.s. *Neko* of Leith.

Plate VIII.

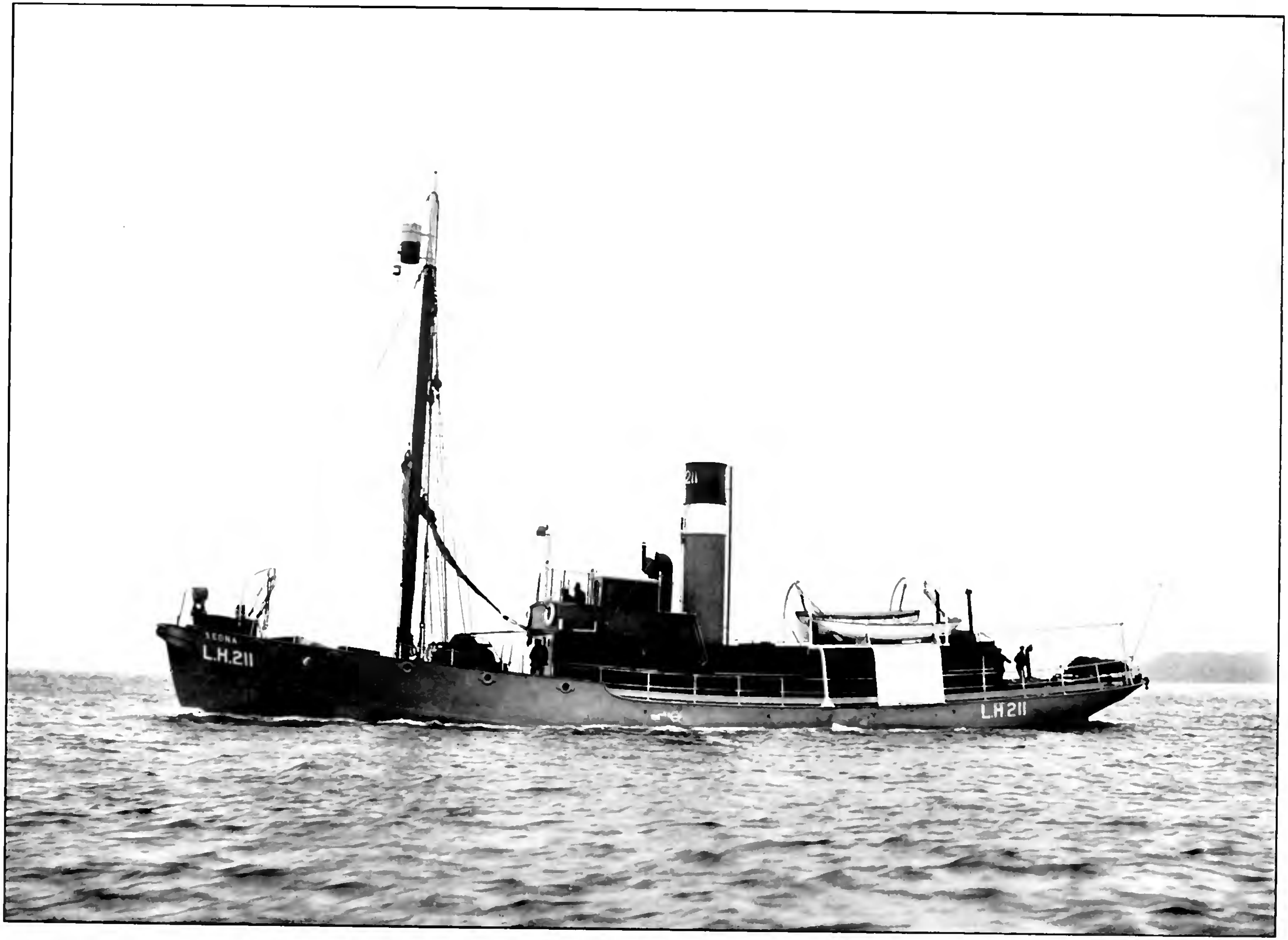
Fig. 1. Floating whale factory, s.s. *Horatio* of Leith.
Fig. 2. Floating factory, s.s. *Restitution* of North Shields, Possession Bay, South Georgia.

Plate IX.

Fig. 1. Floating factory, ship *Nor* of Sandefjord, King Edward's Cove, South Georgia.
Fig. 2. S.S. *Coronda* of Leith, discharging stores at Leith Harbour, South Georgia.

Plate X.

Female Cachalot or Sperm whale (*Physeter macrocephalus*), captured 1913, on flenching platform, Leith Harbour, South Georgia.



Steam Whaler *Sedna* of Leith.

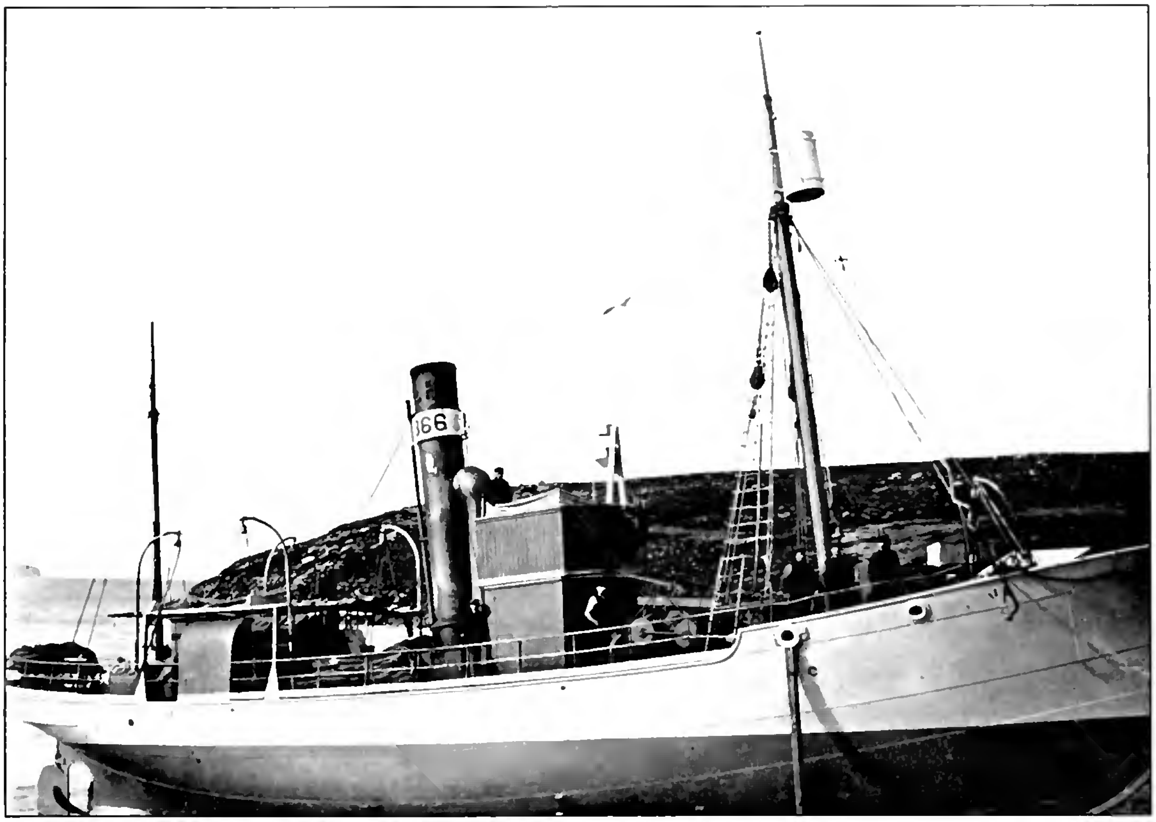


Fig. 1.—Steam Whaler *Romna* of Leith.

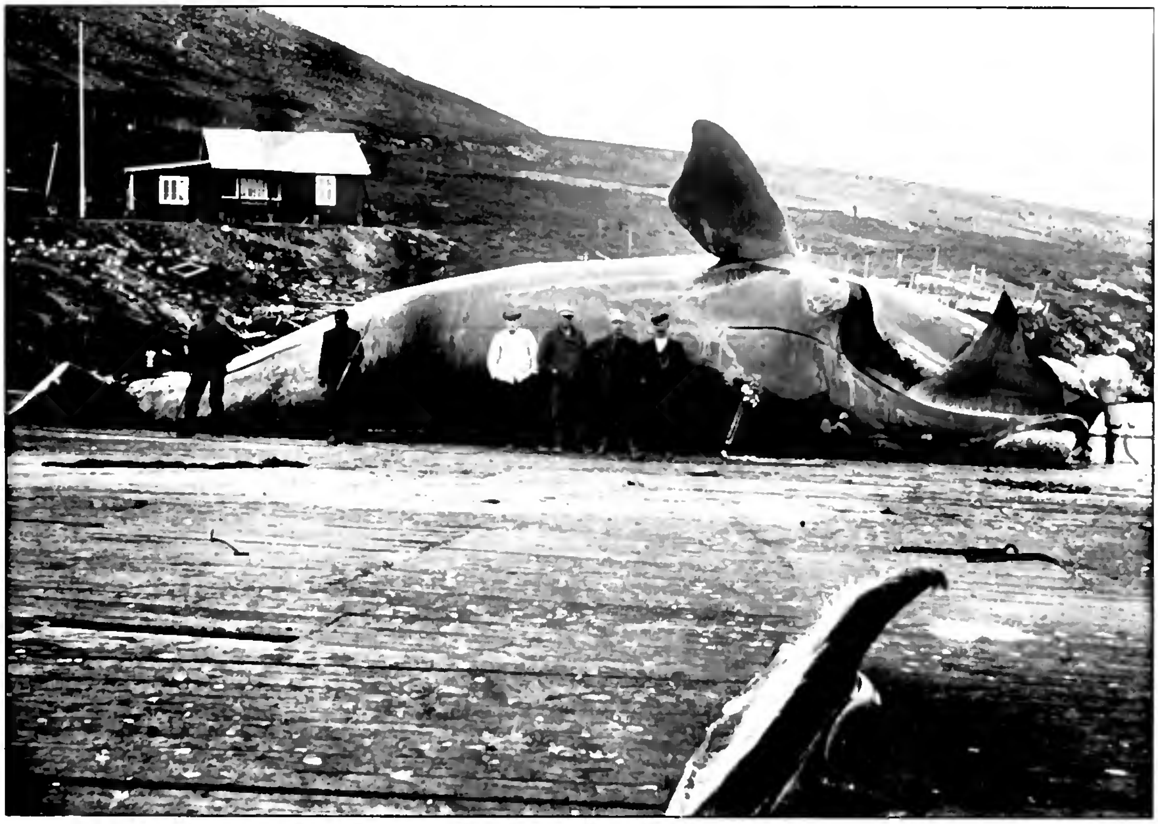


Fig. 2.—Southern Right Whale (*Balæna australis*).

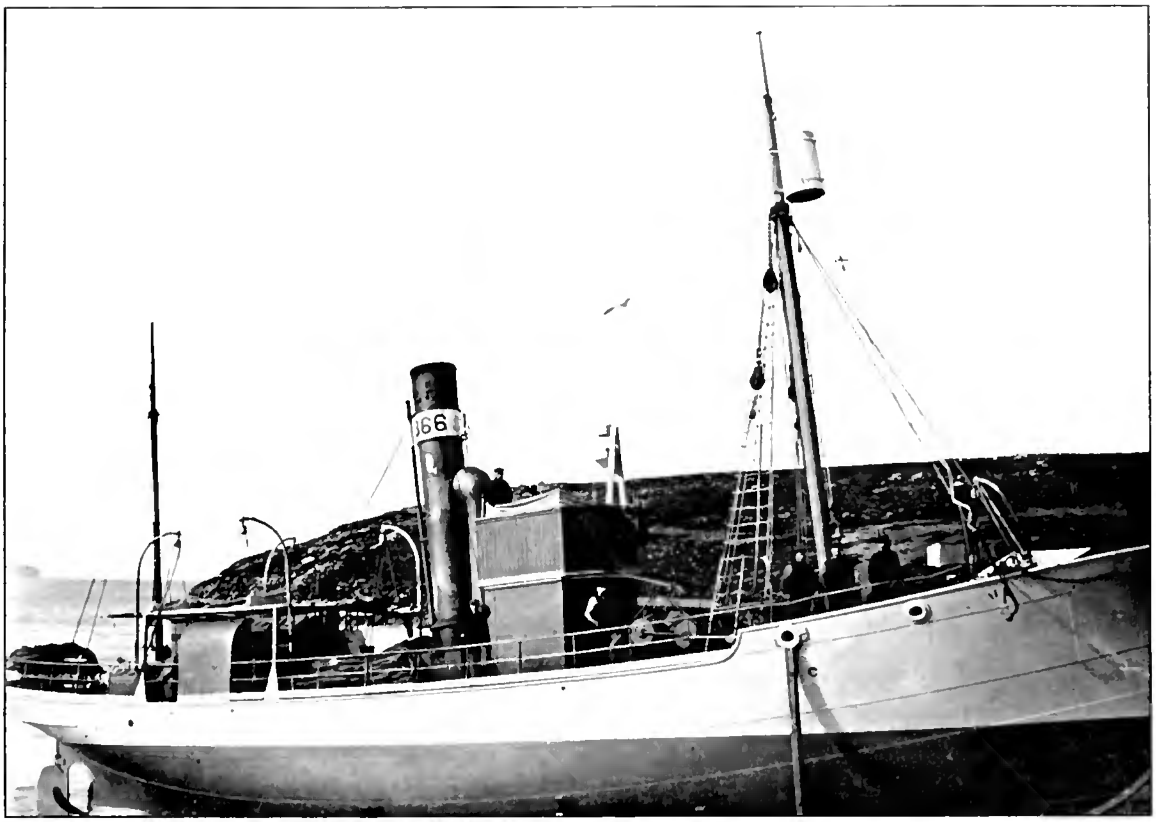


Fig. 1.—Steam Whaler *Romna* of Leith.

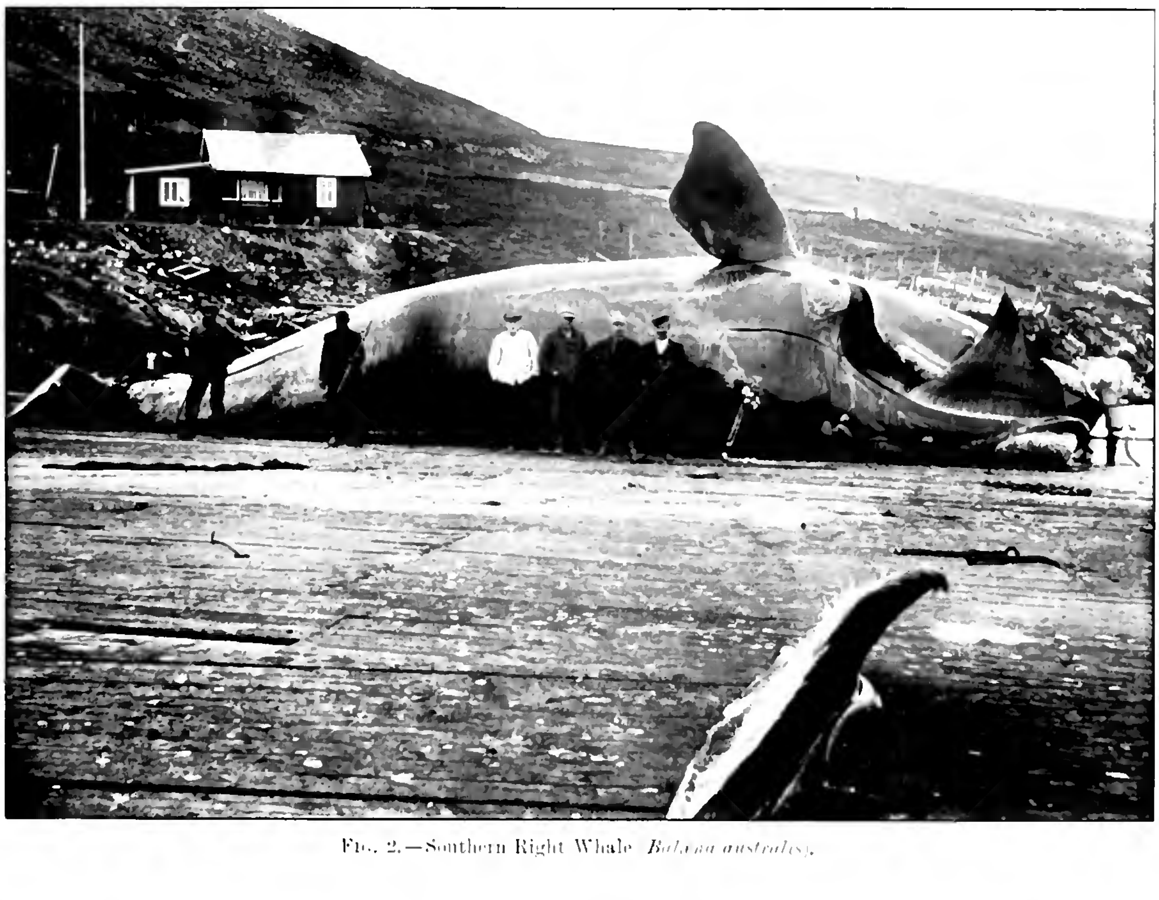


Fig. 2.—Southern Right Whale (*Balæna australis*).

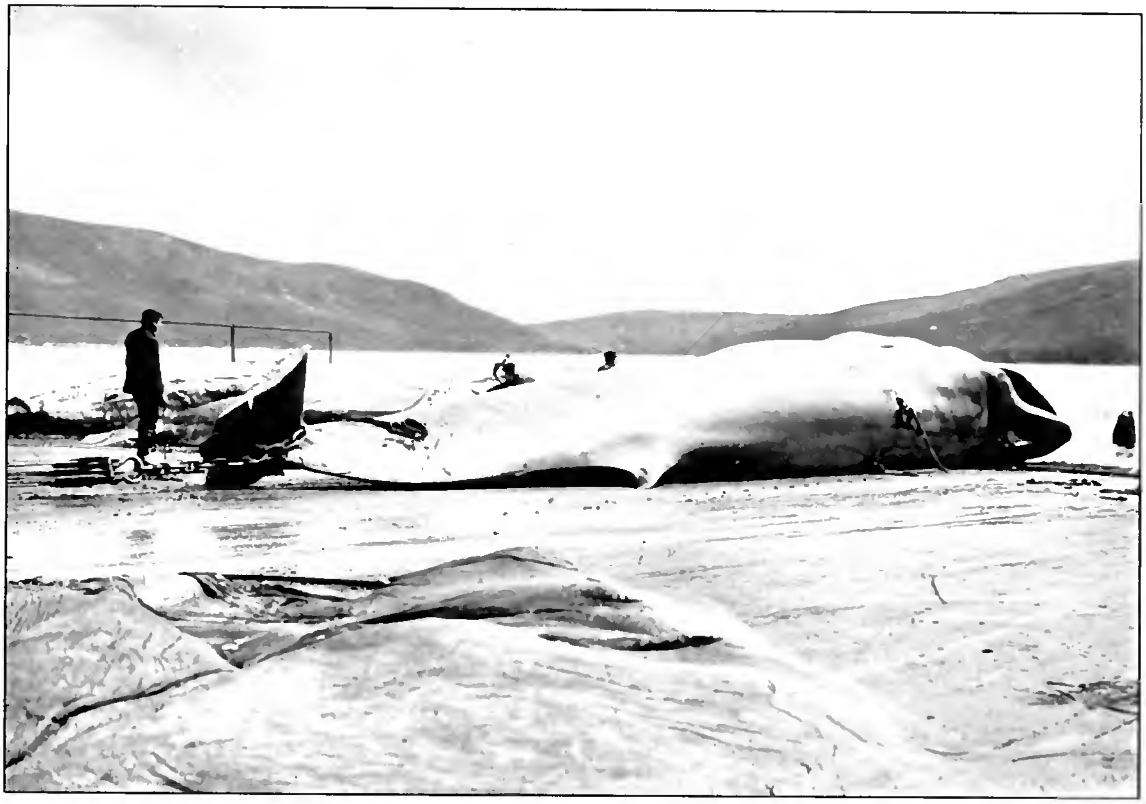


FIG. 1.—Finner Whale (*Balænoptera musculus*).

FIG. 2.—Finner Whale (*Balænoptera musculus*).

Fig. 1.—Finner Whale (*Balænoptera musculus*).

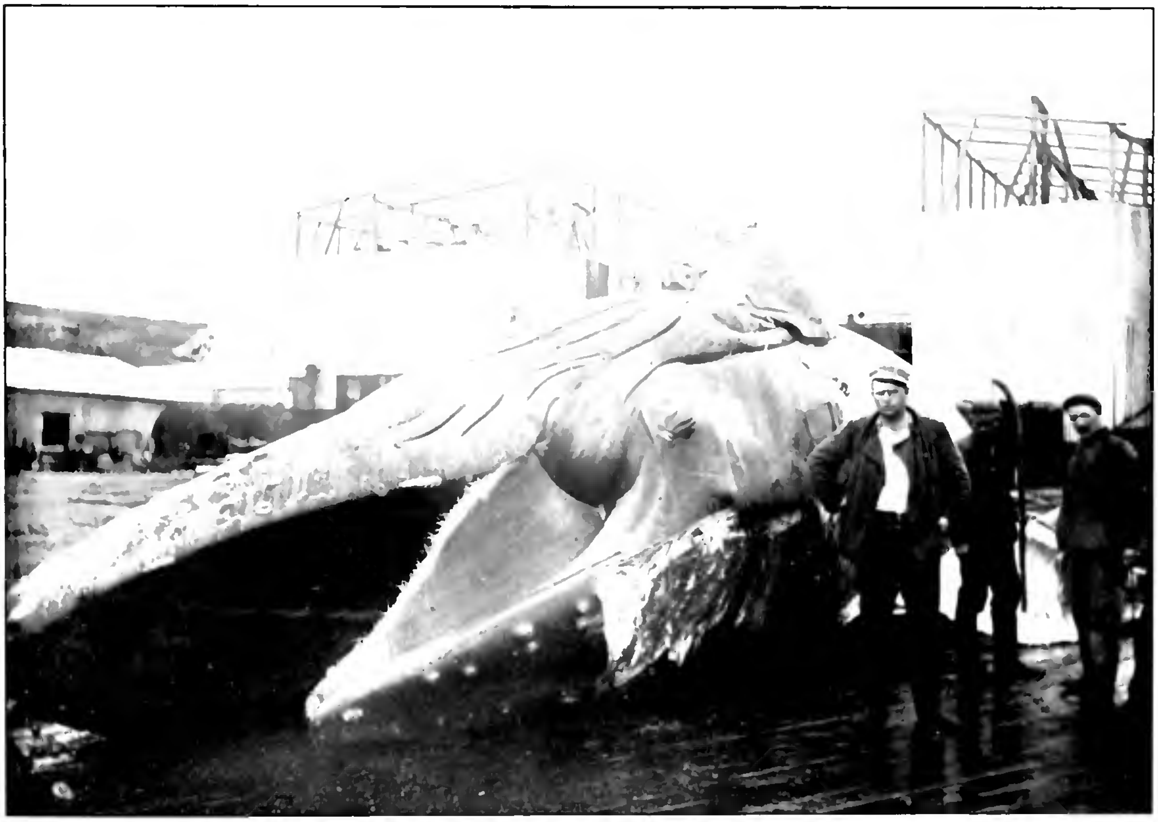


Fig. 2.—Humpback Whale (*Megaptera boops*).

FIG. 1.—Humpback Whale (*Megaptera boops*).

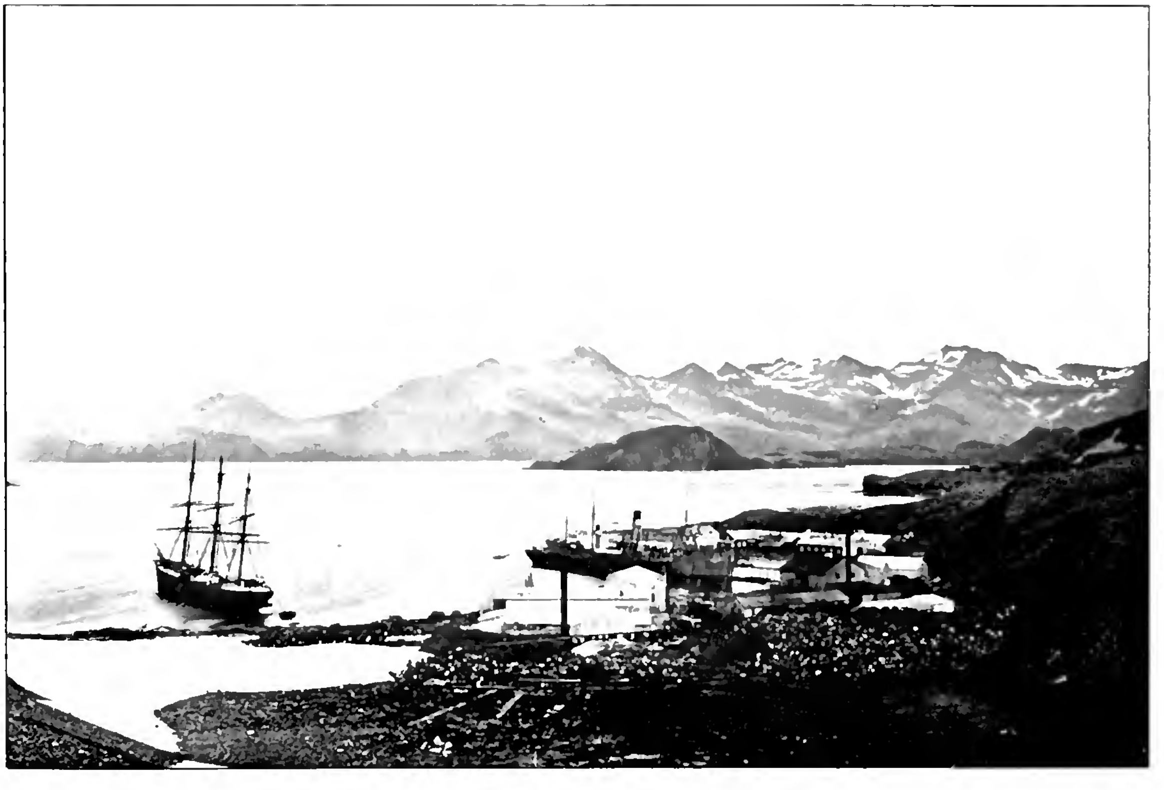


FIG. 2.—Whale Factory, Leith Harbour, South Georgia.

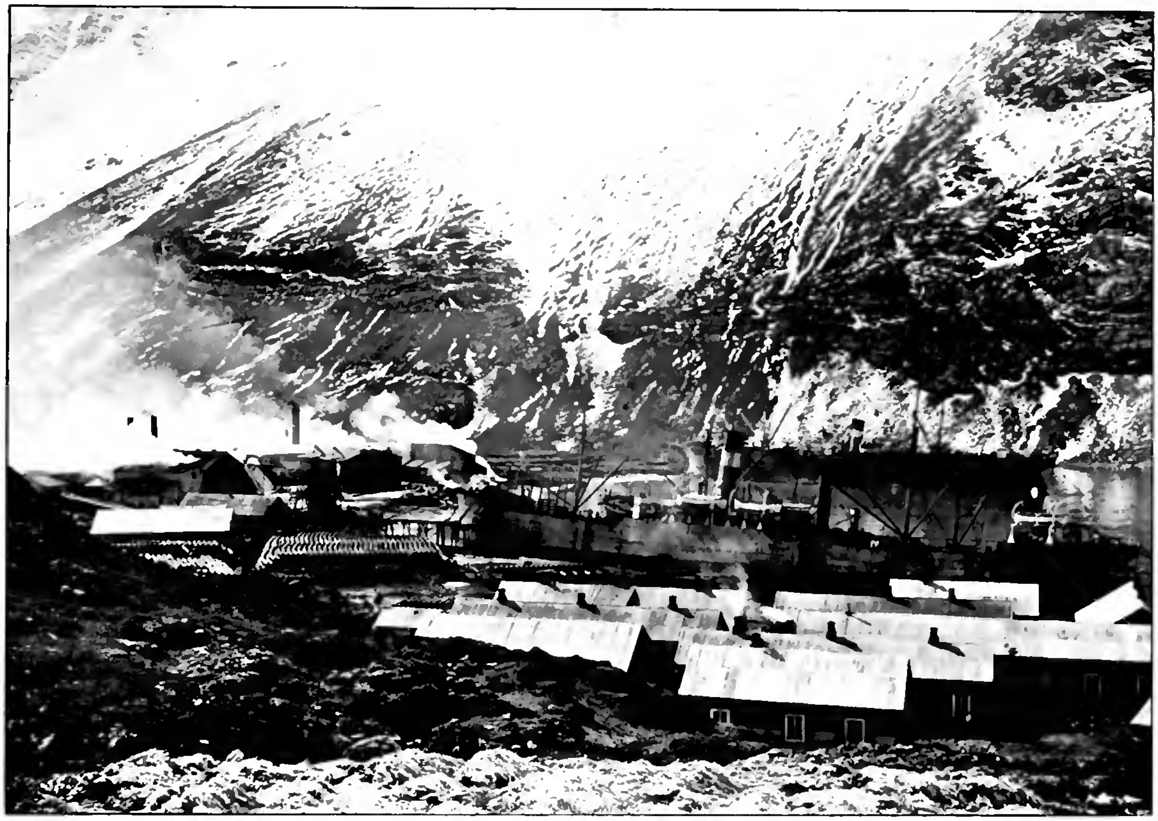


FIG. 1.—Whale Factory, Leith Harbour, South Georgia.

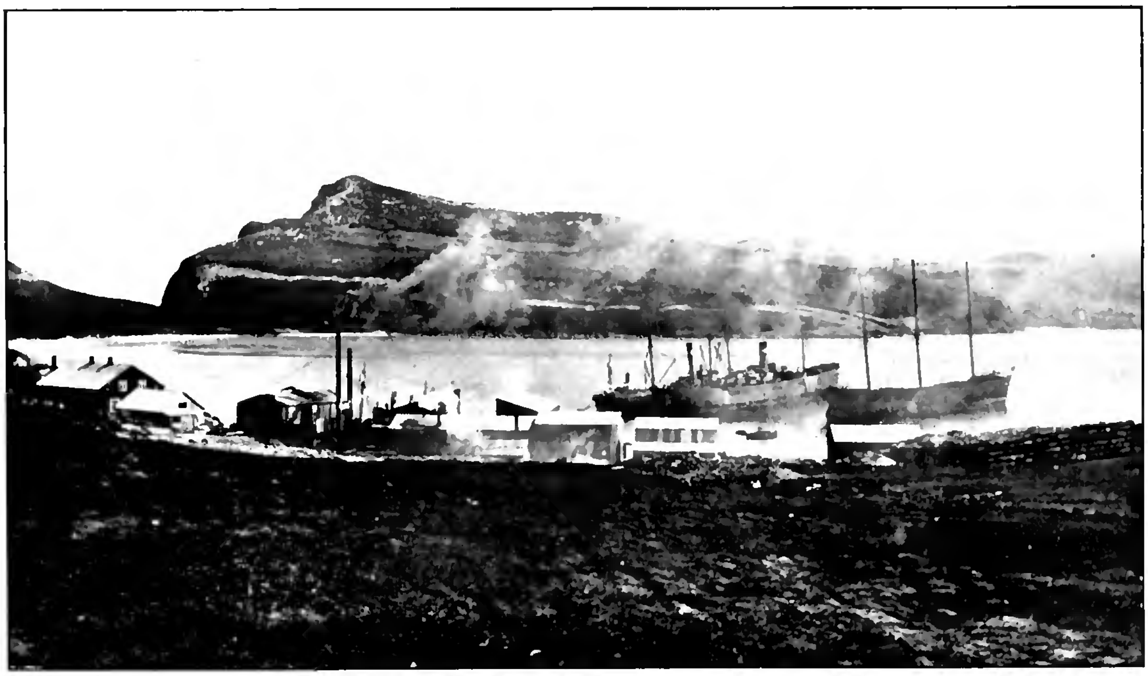


FIG. 2.—Whale Factory, New Island, Falkland Islands.

FIG. 1.—Whale Factory, New Fortune Bay, South Georgia.

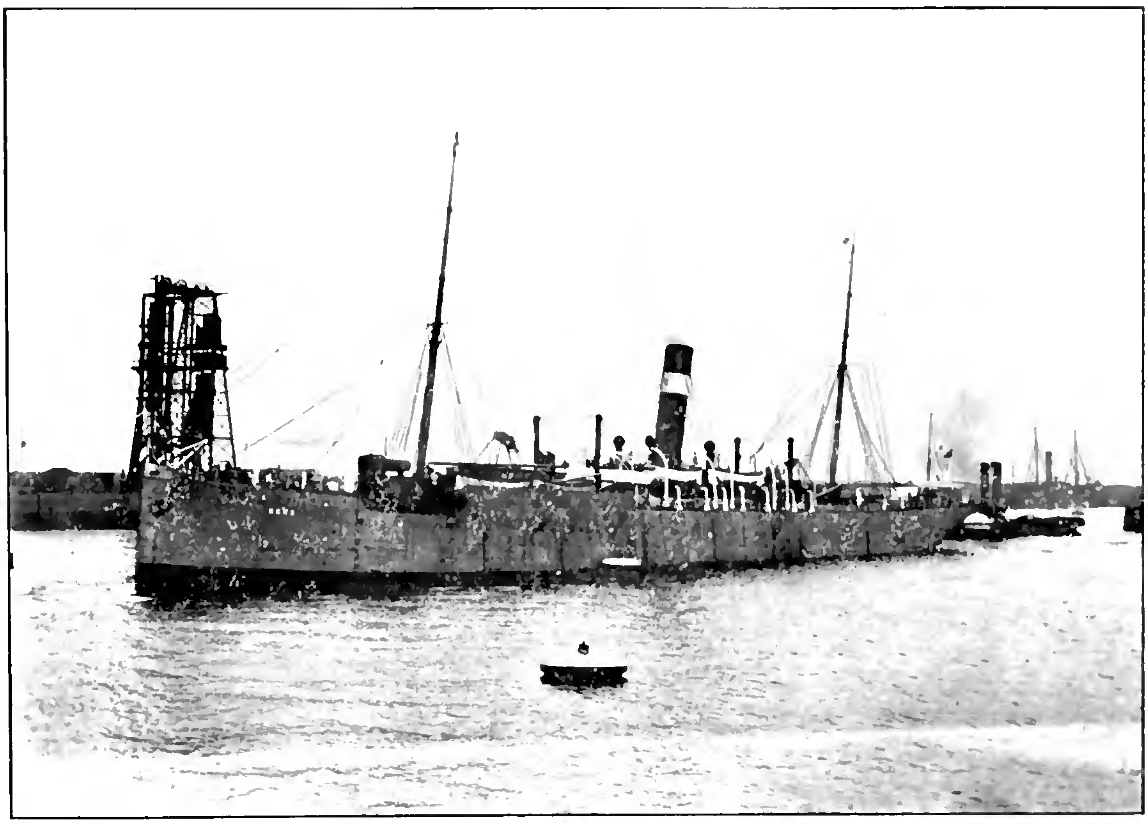


FIG. 2.—Floating Whale Factory, s.s. *Neko* of Leith.

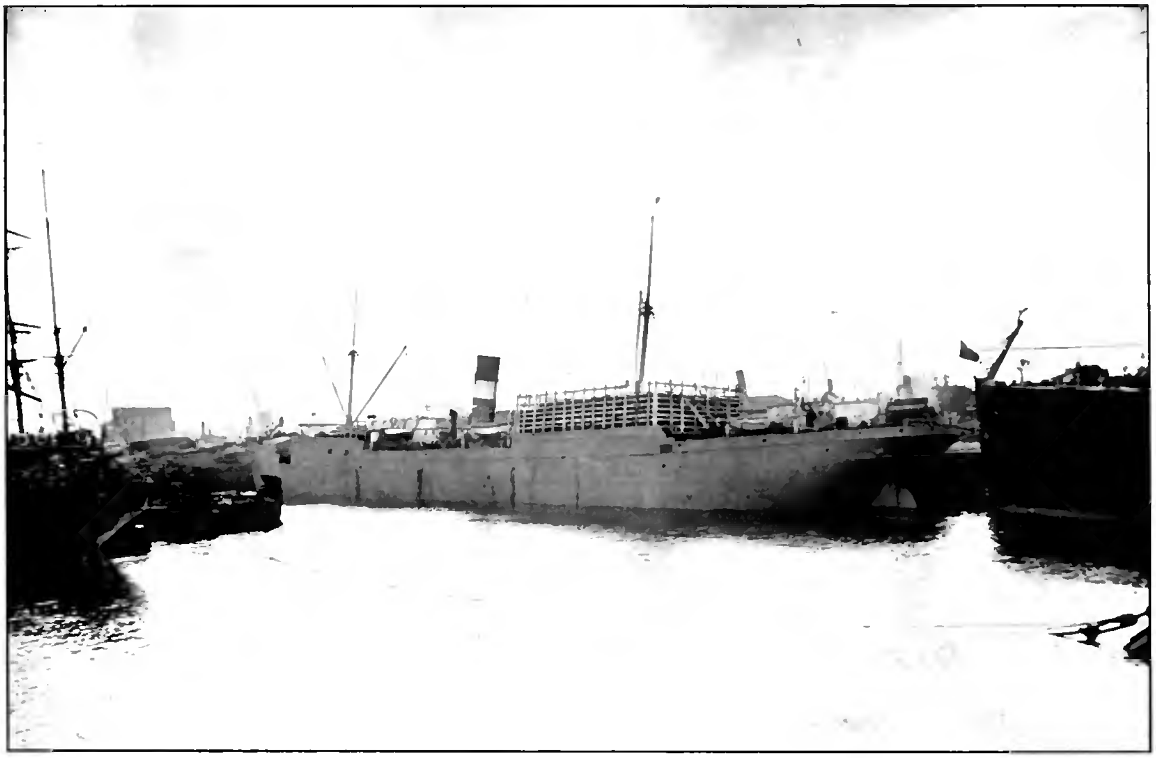


FIG. 1.—Floating Whale Factory, s.s. *Horatio* of Leith.

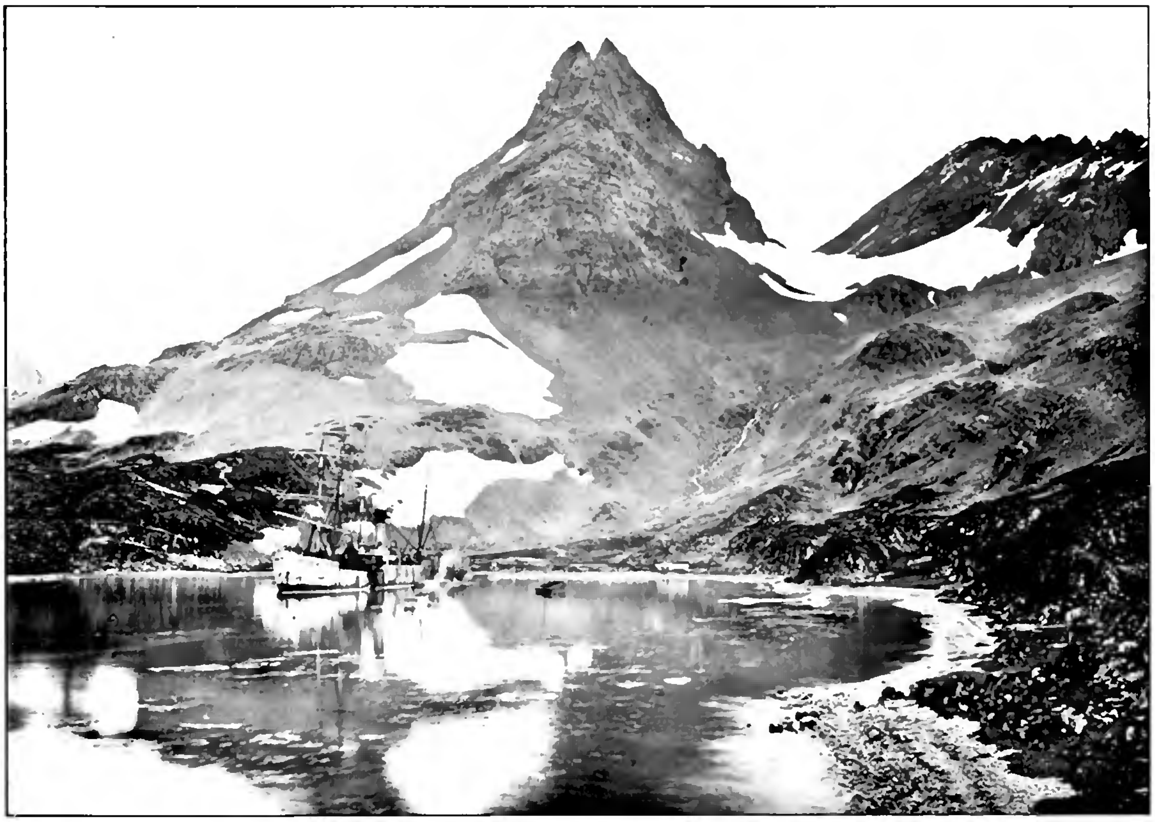


FIG. 2.—Floating Factory, s.s. *Restitution* of North Shields, Possession Bay, South Georgia.

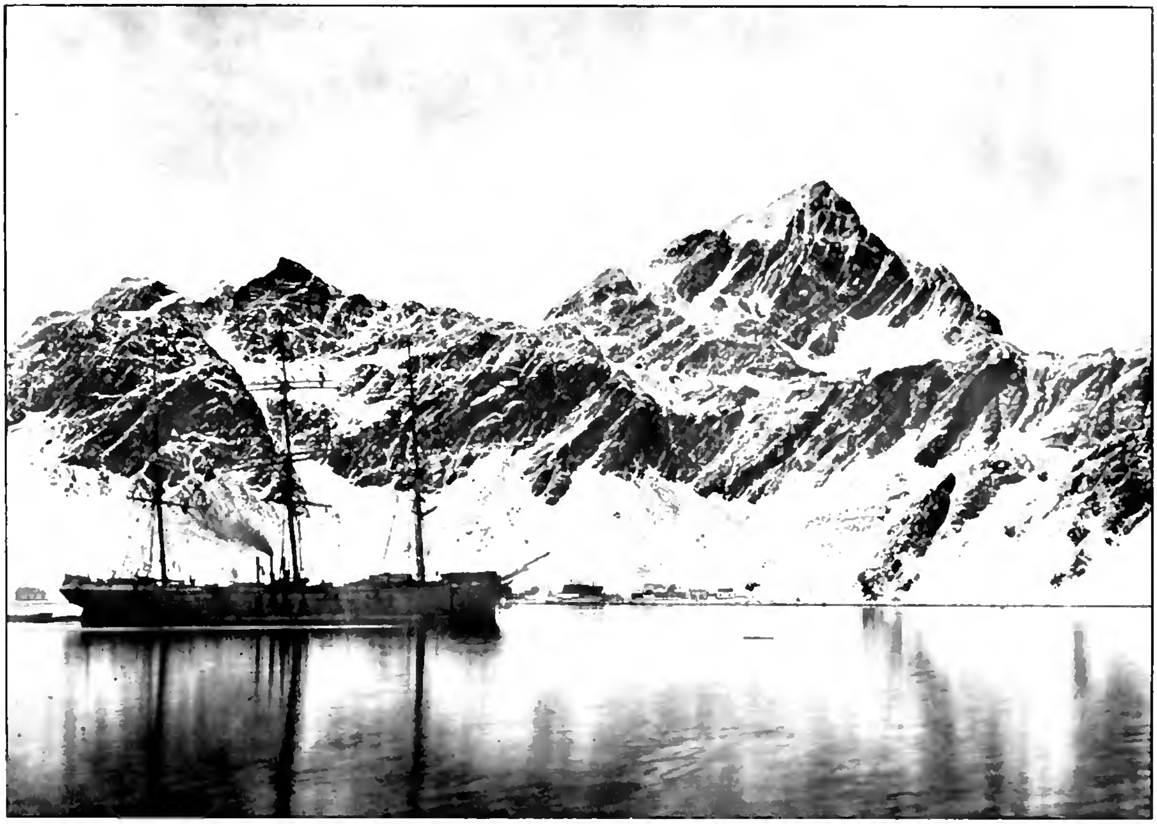


FIG. 1.—Floating Factory, ship *Nor* of Sandefjord, King Edward's Cove, South Georgia.

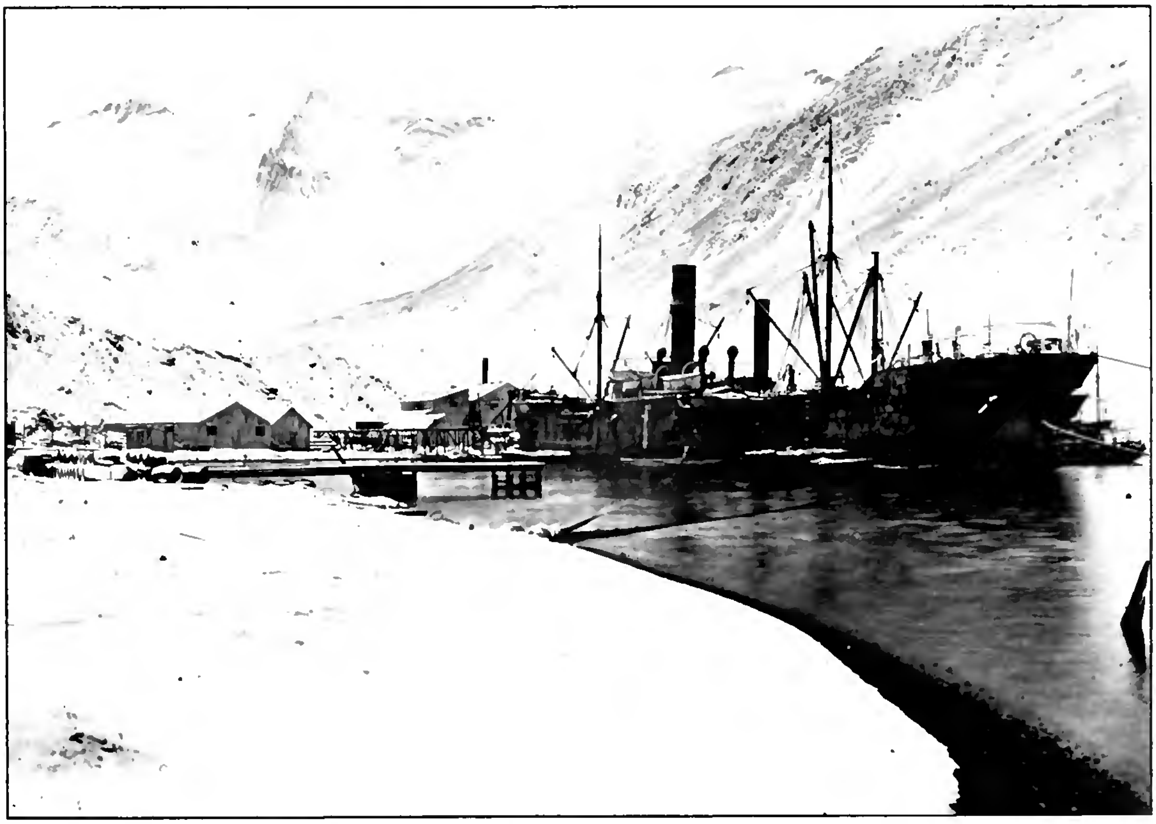


FIG. 2.—S.S. *Coronda* of Leith, discharging stores at Leith Harbour, South Georgia.

Female Cachalot or Sperm Whale (*Physeter macrocephalus*), captured 1913, on Flenching Platform, Leith Harbour Station, South Georgia.

PART XX.

CETACEA.

SCOTTISH NATIONAL ANTARCTIC EXPEDITION.

XX.—SOME OBSERVATIONS ON ANTARCTIC CETACEA.

By WM. S. BRUCE, LL.D., F.R.S.E.,
Director of the Scottish Oceanographical Laboratory.

(WITH TWO PLATES AND ONE TEXT FIGURE.)

Some Observations on Antarctic Cetacea: Scottish National Antarctic Expedition. By William S. Bruce, LL.D., F.R.S.E. (With Two Plates and One Text-figure.)

(Handed in October 21, 1914. Issued separately March 31, 1915.)

The study of the Cetacea forms one of the most interesting and most difficult problems for zoologists, and at the same time one of the most important from the industrial standpoint.

The main difficulty encountered is the costliness of the investigation, both on account of the size of the animals, the difficulty of following out their migrations, and the great commercial value of the products of the carcase: the financial resources of zoologists have so far proved entirely inadequate to meet the amount of money required to make whalers devote sufficient time towards assisting them in these important researches. Because, while attending to the requirements of zoologists in handling the animals for anatomical investigation, they would be losing the chance of catching many other whales each of great commercial value.

Even an institution like the Natural History Museum (British Museum), though receiving a large annual Government grant, has never been able to offer sufficient money to Dundee whalers for the skeleton of a Greenland whale, and is in consequence without an example of it, in spite of the enormous number that have been killed, ever since the foundation of the Museum, by Scottish and other whalers. The offer of £100 for the skeleton of *Balæna mysticetus*, when the whalebone in its mouth alone was worth £2700, only produced a smile on the faces of those hardy Arctic skippers and owners. Even now, with much reduced prices, which have for the time killed the Dundee whaling trade on account of severe competition by Norwegian methods,* a sum many times greater than that would not induce any owner, skipper, or crew to consider the proposal.

The new Norwegian methods,† however, of fishing whales other than the Greenland or Bowhead whale in almost all seas outside the limits of, but close up to, the compact pack ice of Arctic and Antarctic seas, which entails hauling the carcases of the whales up on landing slips ashore or alongside large tank ships anchored in a sheltered harbour, have enabled closer investigation to be made during recent years by trained naturalists; and in view of the fact that detailed investigations of these southern whales has thus been more possible during the last few years, and that a special effort has recently been made in this direction by the despatch to

* "The Whale Fisheries of the Falkland Islands and Dependencies," by Theodore E. Salvesen, F.R.S.E. (with ten plates), *vide* Part XIX. pp. 475–486.

† On the return of Mr Burn Murdoch and myself from the Antarctic voyage of 1892–93, in conjunction with Captain Larsen and Mr H. J. Bull, we endeavoured to raise interest in Britain to develop whale fisheries in connection with the Falkland Islands and Dependencies. Our project, however, was not supported by business men, or by the Colonial Office. Ten years later Captain Larsen induced Argentine capitalists to form the "Compañia Argentina de Pesca" of Buenos Aires, and erected a whaling station at South Georgia, with four whalers, which has yielded, and is still yielding, magnificent returns.

South Georgia of Major BARRETT HAMILTON, whose untimely death zoologists so deeply deplore, I have thought it well to publish for what they are worth, without alteration by an outsider and with my own interpretation, the brief notes I made over twenty years ago, answering criticism only when it is misleading and not merely derisive.

In his "Cétacés" in the *Résultats du voyage du S.Y. "Belgica,"* published in 1903, Mr E. G. RACOVITZA passes criticism on certain notes made by myself and others on board the Dundee whalers in 1892–93. The criticism is so wild as to be worthless, and for that reason has been ignored.

I recorded Cetacea south of latitude 50° S. on board the *Balæna*,* on 29 † days out of 85 days, viz. from 11th December 1892 to 23rd March 1893; and the naturalists of the *Scotia* recorded Cetacea south of latitude 50° S. on 38 days out of 82 days, viz. from 7th January 1903 to 23rd March 1903, 27th November 1903 to 3rd December 1903, as well as on 31 days out of 56 days, viz. from 11th February 1904 to 7th April 1904.

On some days when Cetacea might have been in the vicinity of the *Balæna*, I was unable to record their presence on account of heavy ship's duties which were not those of a naturalist,‡ but which by contract I had agreed to undertake and accordingly fulfilled.

The species of whales,§ as far as they are known, were :—

1. BALÆNA AUSTRALIS :

    Balæna australis, Desmoulins.

    (The Southern Right Whale.)

2. BALÆNOPTERA MUSCULUS :

    Balæna musculus, Linn.

    Balæna tripinnis, R. Sibbald.

    Balænoptera musculus, Van Beneden and Gervais.

    Balænoptera physalus, True.

    (The Finner, the Common Rorqual, Fin Whale, or Razor Back.)

3. BALÆNOPTERA SIBBALDI :

    Balænoptera sibbaldii, Flower.

    Balæna tripinnis, R. Sibbald.

    Balæna maximus borealis, Knox.

    Physalus sibbaldii, Gray.

    Balænoptera musculus (Sulphur Bottom), True.

    (The Blue Whale, Sibbald's Rorqual, or the Sulphur Bottom.)

* *From Edinburgh to the Antarctic*, by W. G. BURN MURDOCH, with chapter by W. S. BRUCE. Longmans, Green & Co., 1894.

† Not 7 days, as recorded by Mr RACOVITZA.

‡ Mr RACOVITZA sailed as official naturalist on board a scientific ship. I signed articles on board a whaler. Those early observations, however, taken under highly disadvantageous circumstances by my scientific colleagues and myself, stimulated the despatch of the *Belgica*, on which Mr RACOVITZA sailed, and in turn all the many scientific expeditions sent out from Europe during the past twenty years.

§ The classification is according to that of Sir WILLIAM TURNER in his Catalogue entitled *The Marine Mammals in the Anatomical Museum of the University of Edinburgh*, 1912.

4. BALÆNOPTERA BOREALIS :
Balænoptera borealis, Lesson.
Balænoptera laticeps, Gray.
(The Seihval, or Rudolphi's Rorqual.)

5. MEGAPTERA BOOPS :
Balæna boops, Linn.
Balæna longimana, Rudolphi.
Megaptera boops, Van Beneden and Gervais.
(The Humpback, the Hunchback, or Long-armed Whale.)

6. HYPEROODON ROSTRATUS :
Balæna rostrata, O. H. Müller.
Hyperoodon Butskopf, Lacépède.
Hyperoodon bidens, Fleming.
(The Bottlenose Whale.)

7. ORCA GLADIATOR :
Delphinus orca, Linn.
Orca gladiator, Gray.
(The Grampus, Killer Whale, or Sword Fish.*)

The Sperm Whale or Cachalot (*Physeter macrocephalus*), though captured more recently at South Georgia, was not seen either by the *Balæna* or the *Scotia* south of the fiftieth parallel of latitude. It is interesting to note that all the sperm whales captured at South Georgia have been males except one (*vide* SALVESEN, "The Whale Fisheries of the Falkland Islands and Dependencies," Pl. X., Vol. IV., Part XIX.). Besides whales, black fish and porpoises of doubtful species were recorded, and one especially, seen frequently in the vicinity of the Falkland Islands and in Stanley Harbour, appears to be of considerable interest.

Cetacea observed South of 50° Latitude on board the "Balæna."

Date.	Locality.	Temp.	Colour.		
1892.					
Dec. 11	51° 49′ S., 57° 35′ W., 3 miles off Cape Pembroke.	40·7° F.	...	Piebald porpoises	Lagenorhynchus cruciger?
,, 12	53° 38′ S., 55° 17′ W.	40·6° F.	...	Two large finners	Balænoptera musculus.
,, 16	59° 24′ S., 51° 01′ W.	34·8° F.	...	Great numbers of finners	,, ,,
,, 17	61° 06′ S., 50° 03′ W.	31·8° F.	...	Finners; but none resembling the Bowhead whale. *First ice.*	,, ,,

* The term "sword fish," though confusing, is the usual name given to the northern grampus by British and, I believe, American whalers.

Cetacea observed South of 50° Latitude on board the "Balæna"—continued.

Date.	Locality.	Temp.	Colour.		
1892.					
Dec. 21	62° 21′ S., 54° 03′ W.	31·5° F.	Dirty green	Many finners	Balænoptera musculus.
,, 22	63° 02′ S., 54° 31′ W.	32·0° F.	...	Many whales	,, sp.?
,, 24	64° 10′ S., 55° 40′ W.	32.2° F.	...	Many whales and grampuses	,, ,, and Orca gladiator.
,, 30	In the vicinity of Erebus and Terror Gulf, Graham Land	...	Dirty dark green	Finners	Balænoptera musculus.
,, 31	,, ,,	...	...	Blue whales	,, sibbaldi.
1893.					
Jan. 4	,, ,,	...	...	Finners	,, musculus.
,, 6	,, ,,	...	...	Many finners	,, ,,
,, 7	,, ,,	...	Dark blue	Finners	,, ,,
,, 8	,, ,,	...	Green	Whales	,, sp.?
,, 12	64° 40′ S., 56° 10′ W.	...	Olive green	Finners	,, musculus.
,, 13	In the vicinity of Erebus and Terror Gulf, Graham Land	...	Green and dark blue	A humpback	Megaptera boops.
,, 14	,, ,,	...	...	Whales	Balænoptera sp.?
,, 15	,, ,,	32·0° F.	Blue	Finners	,, musculus.
,, 20	,, ,,	31·5° F.	...	Finners	,, ,,
,, 25	,, ,,	...	...	Finners	,, ,,
,, 26	,, ,,	...	...	Finners, including a white finner	,, ,,
,, 27	,, ,,	...	...	Finners	,, ,,
,, 28	,, ,,	...	...	Finners	,, ,,
Feb. 2	,, ,,	30·8° F.	...	Finners	,, ,,
,, 6	,, ,,	...	Blue and clear	Finners	,, ,,
,, 7	,, ,,	...	,,	Finners	,, ,,
,, 17	62° 33′ S., 54° 35′ W., Joinville Land, S. × W. ½ W.	...	,,	Finners	,, ,,
Mar. 6	50° 35′ S., 53° 53′ W.	...	,,	Finners and Porpoises (piebald?)	,, ,, and (Lagenorhynchus cruciger?).

Observations on board the "Scotia," First Voyage.

Date.	Locality.	Temp.	Colour.		
1903.					
Jan. 7–25	Port Stanley, 51° 41′ S., 57° 51′ W.	53·1° F.	...	Piebald porpoises seen several times	Lagenorhynchus cruciger?
,, 27	52° 55′ S., 55° 00′ W.	44·6° F.	Light greenish blue	Several piebald porpoises seen	,, ,,
,, 31	58° 14′ S., 45° 15′ W.	35·4° F.	Blue	Finners and bottlenoses plentiful	Balænoptera musculus and Hyperoodon rostratus.

Observations on board the "Scotia," First Voyage—continued.

Date.		Locality.	Temp.	Colour.		
1903.						
Feb.	1	59° 32′ S., 43° 10′ W.	34·0° F.	,,	Finners were seen in great numbers	Balænoptera musculus.
,,	4	60° 47′ S., 44° 00′ W.	29·9° F.	,,	Finners	,, ,,
,,	5	61° 06′ S., 43° 40′ W.	29·8° F.	,,	Finner whales very conspicuous	,, ,,
,,	6	60° 10′ S., 42° 35′ W.	33·6° F.	,,	Several finners	,, ,,
,,	8	59° 14′ S., 36° 10′ W.	31·0° F.	,,	Finners conspicuous	,, ,,
,,	9	59° 42′ S., 34° 13′ W.	30·0° F.	,,	Finners with calves	,, ,,
,,	10	60° 05′ S., 32° 10′ W.	30·2° F.	,,	Two bottlenoses	Hyperoodon rostratus.
,,	11	60° 03′ S., 32° 31′ W.	30·0° F.	,,	Two small whales about 20 feet long, head and back resembling finner, probably the fish whale.	Balænoptera (borealis?).
,,	12	59° 19′ S., 31° 32′ W.	29·9° F.	,,	A large finner	,, musculus.
,,	13	59° 43′ S., 30° 44′ W.	30·0° F.	,,	Two finners	,, ,,
,,	14	59° 33′ S., 27° 37′ W.	30·8° F.	,,	Several finners	,, ,,
,,	15	61° 37′ S., 26° 10′ W.	31·0° F.	,,	Several finners	,, ,,
,,	16	62° 52′ S., 25° 00′ W.	30·9° F.	,,	Plenty of finners all day, especially in the morning	,, ,,
,,	17	64° 18′ S., 23° 09′ W.	31·7° F.	...	Finners seen in afternoon	,, ,,
,,	20	69° 39′ S., 22° 58′ W.	29·0° F.	Dark slatey blue	Finners	,, ,,
,,	21	69° 46′ S., 19° 10′ W.	29·8° F.	,,	Finners and bottlenoses have been observed, the former scarce	,, ,, and Hyperoodon boops.
,,	22	70° 21′ S., 17° 00′ W.	29·0° F.	Blue	Whale heard blowing about 6 p.m.	Balænoptera sp.?
,,	25	69° 44′ S., 18° 02′ W.	29·2° F.	Very dull blue	Two grampuses	Orca gladiator.
,,	26	69° 36′ S., 20° 20′ W.	29·1° F.	Light dull blue	A "spout" of a whale seen	Balænoptera sp.?
,,	27	69° 32′ S., 24° 00′ W.	29·2° F.	Dull blue	A grampus	Orca gladiator.
,,	28	69° 22′ S., 26° 36′ W.	29·4° F.	Light blue	A few grampuses	,, ,,
Mar.	1	69° 03′ S., 28° 02′ W.	29·2° F.	Dull blue	Grampuses numerous	,, ,,
,,	3	68° 35′ S., 31° 56′ W.	29·4° F.	. .	Three grampuses	,, ,,
,,	5	68° 11′ S., 34° 17′ W.	29·0° F.	Turquoise	A few grampuses, one with its dorsal fin broken	,, ,,
,,	6	67° 39′ S., 36° 10′ W.	31·4° F.	Blue	A school of grampuses	,, ,,

Observations on board the "Scotia," First Voyage—continued.

Date.	Locality.	Temp.	Colour.		
1903.					
Mar. 12	65° 29′ S., 44° 06′ W.	29·0 F.	Light blue	Bottlenoses seen twice	Hyperoodon rostratus.
,, 13	64° 48′ S., 44° 26′ W.	29·4° F.	Blue	Grampuses	Orca gladiator.
,, 14	64° 30′ S., 43° 45′ W.	29·0° F.	,,	A finner's blast seen	Balænoptera musculus.
,, 16	63° 51′ S., 40° 50′ W.	29·9° F.	,,	Grampuses seen	Orca gladiator.
,, 21	Leathwaite Strait, S.O.	...	...	Several finners	Balænoptera musculus.
,, 22	Between Saddle Island and Cape Bennett	30·0° F.	Blue	Finners	,, ,,
,, 23	Leathwaite Strait, S.O.	29·8° F.	,,	Grampuses and finners	Orca gladiator and Balænoptera musculus.
Nov. 27	Off north coast of Coronation Island	29·0° F.	...	A few grampuses were sighted	Orca gladiator.
,, 28	59° 43′ S., 48° 10′ W.	32·7° F.	Blue	Bottlenoses and finners were conspicuous during the day	Balænoptera musculus and Hyperoodon boops.
,, 29	58° 28′ S., 51° 56′ W.	33·3° F.	Pale blue	Many finners were seen early this morning	Balænoptera musculus.

Second Voyage of the "Scotia."

Date.	Locality.	Temp.	Colour.		
1904.					
Feb. 11	55° 47′ S., 54° 19′ W.	39·8° F.	Blue	A school of porpoises seen in the evening	...
,, 13	59° 56′ S., 49° 30′ W.	36·0° F.	,,	A large whale seen	Balænoptera (sibbaldi ?).
,, 23	61° 28′ S., 41° 55′ W.	33·3° F.	,,	Several finners	,, musculus.
,, 24	62° 49′ S., 38° 12′ W.	31·6° F.	,,	Several finners	,, ,,
,, 25	64° 29′ S., 35° 29′ W.	31·0° F.	,,	Several finners	,, ,,
,, 26	65° 59′ S., 33° 06′ W.	30·2° F.	,,	Some finners	,, ,,
,, 29	68° 08′ S., 27° 10′ W.	29·2° F.	,,	Many grampuses and the blast of a whale	Orca gladiator and Balænoptera sp. ?
Mar. 1	68° 43′ S., 24° 15′ W.	31·0° F.	,,	Some grampuses	Orca gladiator.
,, 2	71° 04′ S., 23° 10′ W., off Coats Land	30·8° F.	,,	Grampuses	,, ,,
,, 3	72° 18′ S., 17° 59′ W., off Coats Land	30·9° F.	,,	Many grampuses and whales	,, ,, and Balænoptera sp. ?
,, 4	72° 22′ S., 18° 13′ W., off Coats Land	30·9° F.	,,	Some whales were seen in the evening; Captain Robertson considered their blast resembled that of the Bowhead. A few grampuses were also sighted	Balæna (australis ?).

Second Voyage of the "Scotia"—continued.

Date.		Locality.	Temp.	Colour.		
1904.						
Mar.	5	72° 31′ S., 19° 00′ W., off Coats Land	29·2° F.	Indigo blue	Grampuses and whales	Orca gladiator and Balænoptera sp.?
,,	12	74° 01′ S., 22° 00′ W., off Coats Land	...	...	A grampus	Orca gladiator.
,,	13	74° 01′ S., 22° 00′ W., off Coats Land	...	...	Several bottle-noses and two grampuses	Hyperoodon rostratus and Orca gladiator.
,,	14	73° 11′ S., 23° 53′ W.	28·9° F.	Indigo	Two grampuses seen and finner heard blowing	Orca gladiator and Balænoptera musculus.
,,	15	71° 50′ S., 23° 30′ W.	29·1° F.	Bright indigo	A finner	Balænoptera musculus.
,,	16	71° 28′ S., 22° 32′ W.	29·0° F.	Indigo	Many finners and grampuses	Balænoptera musculus and Orca gladiator.
,,	17	71° 22′ S., 18° 15′ W.	29·6° F.	Blue	Many grampuses and finners	,, ,, ,,
,,	18	71° 22′ S., 16° 34′ W.	29·9° F.	,,	Grampuses	Orca gladiator.
,,	19	71° 32′ S., 17° 15′ W.	29·8° F.	,,	Grampuses and finners	Balænoptera musculus and Orca gladiator.
,,	20	71° 17′ S., 18° 50′ W.	30·4° F.	Antwerp blue	Numerous grampuses and a few finners	,, ,, ,,
,,	21	69° 33′ S., 15° 19′ W.	31·0° F.	,,	Some finners	Balænoptera musculus.
,,	22	68° 32′ S., 10° 52′ W.	31·8° F.	Cobalt	One or two finners	,, ,,
,,	23	68° 32′ S., 12° 49′ W.	31·1° F.	Indigo	Many grampuses and finners	,, ,, and Orca gladiator.
,,	24	68° 41′ S., 12° 36′ W.	...	...	Finners	Balænoptera musculus.
,,	25	68° 26′ S., 11° 11′ W.	31·3° F.	Antwerp blue	A few finners	,, ,,
,,	27	66° 57′ S., 11° 13′ W.	30·5° F.	Blue	Some grampuses and finners	Balænoptera musculus and Orca gladiator.
,,	28	65° 58′ S., 11° 24′ W.	31·2° F.	,,	Some grampuses and finners	,, ,, ,,
Apr.	3	56° 55′ S., 10° 00′ W.	32·9° F.	,,	Many whales all day, mostly humpbacks	Megaptera boops and Balænoptera sp.?
,,	6	54° 33′ S., 11° 47′ W.	...	,,	Whales were seen	Balænoptera sp.?
,,	7	53° 58′ S., 10° 10′ W.	...	Dull Antwerp blue	A whale and three or four grampuses	Balænoptera sp. and Orca gladiator?
					No whales seen between this position and Gough Island, but porpoises seen in 46° 31′ S., 10° 10′ W. and 43° 21′ S., 8° 30′ W.	

If reference be made to the Zoological Log of the *Scotia* (Vol. IV. Part I.), it will be found that the plentiful appearance of whales is almost always associated with the presence of large numbers of birds of different species and with phosphorescence of the sea. The presence of *Euphausia*, which are themselves phosphorescent, is also a sign that general conditions are favourable to the presence of whales; in short, any sign, direct or indirect, of a plentiful food supply both for whales and birds is significant. Mr RACOVITZA throws doubt on my statement that myriads of Cape pigeons and thousands of finners were seen on December 16, 1892, in latitude 59° 24′ S., longitude 50° 01′ W. Twenty years later this statement is more than vindicated by Mr THEODORE E. SALVESEN* reporting that nearly eleven thousand whales were killed and captured in that same region from "1st November 1912 till the end of April 1913," even after several years' hunting. The previous season seven thousand whales were taken at South Georgia alone. The sight of these whales and birds in December 1892 will for ever remain one of the most vivid of my Antarctic recollections. Whales' backs and blasts were seen at close intervals quite near to the ship, and from horizon to horizon, while Cape pigeons were tumbling over each other after small pieces of fat thrown over the ship's side, just as do fulmar petrels after scraps of whale fat in the northern hemisphere. These Cape pigeons were captured with an ordinary hand landing-net over the side of the ship in such numbers that our crew of forty-seven hands were furnished with a very full supply of "scouce."† The sea was swarming with *Euphausia*. This host of animal life in Antarctic seas is surely no more impossible than a swarm of locusts, an army of lemmings, or a flock of owls.

It will be noted that on January 26, 1893, I recorded seeing a white finner (*Balænoptera musculus*). Doubt has been thrown on this observation of mine, but I have recently seen a photograph of a piebald humpback whale that was landed in South Georgia, and am told that this is not a solitary example, and that white humpbacks have also been taken there. I now have the additional satisfaction of presenting herewith an excellent photograph (Plate II.) of a piebald Nordkapper (*Balæna biscayensis*) which was taken, and lent to me for reproduction, by the well-known author Mr J. J. BELL. Mr BELL tells me that out of a dozen whales he saw captured in the Atlantic, near St Kilda, about seven years ago, "several were piebald."

Globiocephalus species?

On the 22nd November 1892, on board the *Balæna* in 40° 01′ S., 48° 55′ W., I record: "Very green sea. Whales and seaweed. Globiocephalus." These are also recorded by BURN MURDOCH,‡ with the accompanying black-and-white sketch. On November 24 he describes them thus: "We saw many hundreds of small whales or porpoises the night before this last gale. They came up from the N.W., and

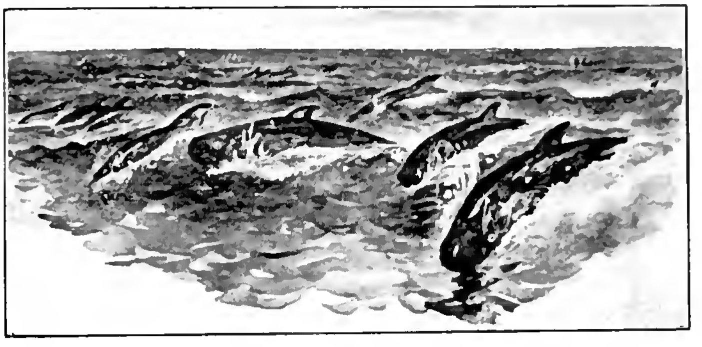
* *Vide* Vol. IV., Part XIX. Special reference should also be made, not only to Mr THEODORE E. SALVESEN's account of "The Whale Fisheries of the Falkland Islands and their Dependencies" in this volume, but also to his article entitled "The Whaling Industry of To-day," in *The Scottish Bankers' Magazine*, vol. iv., No. 14, July 1912, pp. 109–119.

† A whaler's term for a thick stew resembling jugged hare, made of guillemots, penguins, etc.

‡ *From Edinburgh to the Antarctic*, by W. G. BURN MURDOCH, pp. 141–142.

passed us swimming S.E., travelling in companies of seven or eight, plunging half out of the seas, and tossing up spirts of white water. They were about seven feet in length, with black round heads and a white patch over the eye. Some had patches of grey-white on their backs. They resembled the American drawings (True) of the pigmy sperm, but had a large dorsal fin."

BURN MURDOCH'S sketch and my remembrance of these animals incline me to the belief that they were *Globiocephalus*, and that they were *Globiocephalus melas* (Traill). BURN MURDOCH'S estimate of their length, the estimate of an extremely accurate field naturalist, is, however, small, being only a little more than half the length given by TRUE; moreover, the white patch over the eye and some grey-white



Globiocephalus. By W. G. Burn Murdoch.

on their backs do not tally with the white markings recorded by TRUE, but these may be variable. The dorsal fin, however, appears to agree with that of *Globiocephalus*. MURIE'S figure of the head closely resembles that of BURN MURDOCH, except in regard to the upper lip, the shape of which in the case of a swiftly moving animal may easily have been missed. The shape and position of the dorsal fin in both are practically identical, as well as the general contour of the body.* It may be useful to give TRUE'S description † of the genus and species *Globiocephalus melas*:—

" *Globiocephalus*, Gray.

" Rostrum short and very broad. Rostral portion of intermaxillæ flat and very broad (sometimes covering the entire anterior half of the rostrum). Symphysis of mandible short. Pterygoid bones large and in contact. Teeth few and large, 7 to 11, confined to the anterior half of the rostrum. Vertebræ, 57 to 60.

" Head globular, with a rounded protuberance on the lip; beak wanting; mouth oblique. Dorsal fin very long, low, and thick. Pectoral fins narrow and very long. Colour black.

* MURIE, *Trans. of the Zool. Soc. of London*, viii., 1873, pl. xxx. fig. 1.

† "Contributions to the Natural History of the Cetaceans: a Review of the Family Delphinidæ," by FREDERICK W. TRUE, *Bulletin of the United States National Museum*, No. 36, pp. 183, 184, pl. xl. fig. 1.

"*Globiocephalus melas*, Traill. (Pl. xl. figs. 1 and 2.)

"Size large; form stout. Head globose; forehead protuberant, overhanging the lip in adult individuals; body especially deep opposite the dorsal fin. Pectoral fins very long, slender, and pointed; length about one-fifth the total length of the body. Dorsal fin on a long base and strongly recumbent, situated anterior to the middle of the length of the body. Caudal ridges prominent, extending respectively to the dorsal fin and to the vent. Flukes large and broad. Mouth oblique.

"General colour uniform black; a large hastate white area on the breast, extending from the line of the corners of the mouth to the base of the pectoral fins; from behind this area a white band, which is much the broadest in the posterior half, extends backwards along the median line to the vent; the whole white area has the general form of an arrow with its head, shaft, and feathers.

"Teeth $\frac{10}{10}$. Vertebræ: C. 7; D. 11; L. 13(–14); Ca. 27(–29) = 58–60. Skull large and massive. Rostrum longer than broad at the base; its breadth at the base slightly less than three-fourths its length. Intermaxillæ large and flat; not greatly broader anteriorly than posteriorly; rugose in front; their outer margins not coinciding with the margins of the maxillæ, except at the extremity of the rostrum; separated in the median line throughout. Superior nares broad transversely, and bordered by narrow plates of the intermaxillæ. Vomer extending nearly to the extremity of the rostrum. Pterygoid bones large, obtusely keeled, and closely approximated in the median line. Temporal fossæ moderate, oval.

"*Measurements of the Exterior* (from Bell).—Total length, 182 inches (462·3 cm.); extremity of snout to corner of mouth, 14·5 inches (36·8 cm.); to dorsal fin, 55 inches (139·7 cm.); length of pectoral fin along anterior edge, 50 inches (127 cm.); greatest breadth of pectoral fin, 11 inches (27·9 cm.).

"*Measurements of the Skull* (U.S. National Museum, No. 12,100, Cape Cod, Massachusetts).—Total length, 655 cm.; length of rostrum, 33·4 cm.; breadth of rostrum at base, 24·1 cm.; at its middle, 19·4 cm.; breadth of intermaxillæ at same point, 15·4 cm.; breadth between orbits, 42·3 cm.; length of temporal fossa, 17·3 cm.

"*Habitat.*—Atlantic coast of North America to New Jersey; coast of Europe; Cape of Good Hope; New Zealand."

THE PIEBALD PORPOISE (*Lagenorhynchus cruciger?*).

Considerable interest attaches to the porpoise* seen several times by myself on board the *Balæna* in 1892 and 1893 in the vicinity of the Falkland Islands, and seen again in 1903 and 1904 by the other naturalists of the *Scotia* and myself in this locality, the same probably as a school of porpoises that the *Scotia* fell in with

* This porpoise was called a "ground porpoise" by the crew of the *Balæna*.

to the south of Gough Island. For convenience, I have called this animal the "Piebald Porpoise," on account of its special markings, which are here specially considered.

I here tabulate the results of those observations in the same way as I have the larger Cetacea.

The Piebald Porpoise (Lagenorhynchus cruciger?).

Date.	Locality.	Temp.	Colour.	
1892.				
Dec. 4	46° 41′ S., 51° 40′ W.	55·3° F.	...	Porpoises.
,, 11	Port William, Falkland Islands, 51° 40′ S.	40·7° F.	...	Piebald porpoises.
1893.				
Mar. 3	Port Stanley, 51° 42′ S., 57° 51′ W.	...	...	Piebald porpoise captured in fisherman's net. Skeleton taken and afterwards presented to University College, Dundee.
,, 6	50° 35′ S., 53° 53′ W.	...	...	Porpoises (piebald?).
,, 9	47° 45′ S., 47° 52′ W.	56·7° F.	...	Porpoises.
,, 10	46° 31′ S., 45° 30′ W.	56·8° F.	...	Porpoises.
,, 12	43° 51′ S., 40° 47′ W.	57·3° F.	...	Porpoises.
,, 16	39° 28′ S., 36° 18′ W.	65·7° F.	...	Porpoises (piebald?).
1903.				
Jan. 4	47° 37′ S., 57° 25′ W.	49·2° F.	Very dark green	The following note is from the Zoological Log of the *Scotia*, Vol. IV. Part I. p. 6: "A large school of porpoises, black on the back and white on the belly, probably the same species as those seen by Mr Bruce in 1892 in about the same latitude and at Port Stanley, were seen playing under the bows of the ship at 8.45 p.m."
,, 7–25	Port Stanley, 51° 42′ S., 57° 51′ W.	53·1° F.	Turbid	Piebald porpoises were seen several times.
,, 27	52° 55′ S., 55° 00′ W.	44·6° F.	Light greenish blue	Several piebald porpoises seen.
1904.				
Feb. 11	55° 47′ S., 54° 19′ W.	39·8° F.	Blue	A school of porpoises (probably piebald) seen in the evening.
Apr. 14	46° 35′ S., 10° 10′ W.	42·9° F.	Light cobalt	Porpoises (probably piebald).
,, 18	43° 21′ S., 8° 30′ W.	52·0° F.	Cobalt	White, piebald, and black porpoises.

On 3rd March 1893, at Port Stanley, Falkland Islands, I purchased one of these porpoises from a fisherman. It had been drowned by being entangled in one of his nets in the harbour. This fresh specimen measured 4 feet 4 inches in length, and before dissecting it for skeletal purposes it was fortunate that the well-known artist, Mr W. G. Burn Murdoch, who was my companion on that voyage, was able to make a series of faithful studies of the animal as it lay on the deck of the *Balæna*. These studies are now reproduced *fac-simile* (*vide* Plate). After discussion with Mr Burn

MURDOCH we have both come to the conclusion that it was better to reproduce faithfully the drawings of twenty-two years ago rather than to court even slight errors by redrawing them in finished diagrammatic form. The drawings are a very faithful representation of the freshly killed specimen.

On my return to Dundee I entrusted the skeleton to Professor D'ARCY W. THOMPSON, C.B., who accepted it for his excellent Museum at University College, Dundee. Professor D'ARCY THOMPSON has recently looked through the Museum, but has failed to find the specimen. He suggests that "during a long period some years ago when the Museum was not well served, possibly this small skeleton, which had got somewhat injured by rats, was either thrown out or was made use of for class purposes, in the belief that it was only a common porpoise." The loss of this skeleton removes the only concrete facts beyond Mr BURN MURDOCH's drawings and my measurement, and with Professor D'ARCY THOMPSON I can only regret its loss.

Consulting with Dr S. F. HARMER, inquiries have been made at Cambridge, but no trace of the animal is at this time to be found. Neither does any other specimen appear to exist in British or foreign museums. In his report on the seals of the *Discovery* the late Dr WILSON * describes a porpoise which he frequently saw in subantarctic seas; but its length, to my mind, precludes the probability of it being the same species. Dr JACQUES LIOUVILLE † describes a school of eight brown-and-white "Delphinidés," the colour and position of the markings of which appeared to him to be characteristic.

Dr LIOUVILLE gives the length of those animals seen by him as 1·10 metres, *i.e.* about 44 inches, but presumably this was estimated and not actually measured. It may be noticed that this compares somewhat with the size of my Falkland Islands specimen, which had a measured length of 52 inches. Dr WILSON's specimens were estimated at 8 to 10 feet long, *i.e.* 96 to 120 inches, or fully double the length of my specimen. Dr LIOUVILLE is of opinion that the animals seen by himself and Dr WILSON are of the same species but different ages. But in shape as well as in size my specimen resembles Dr LIOUVILLE's rather than Dr WILSON's. The snout is more truncated than beaked, though it is somewhat depressed above, as can be seen in Mr BURN MURDOCH's outline sketch, as well as by the shading in his other drawings. The pectoral and dorsal fins are more like those in Dr LIOUVILLE's sketch, and indeed, considering that the latter was drawn from a distant and active specimen, they may well prove to be in reality identical. The main difference is in the dorsal fin, which Dr LIOUVILLE has shown to have a sharp point, whereas Mr BURN MURDOCH indicates a blunt termination. The characters of the tail in the two drawings are almost identical. In size and shape, therefore, making allowance for drawings made from

* *(British) National Antarctic Expedition*, ii. 1907.

† "Sur le polymorphisme d'un Delphinidé des mers australes: *Delphinus cruciger*, Quoy et Gaymard": Note de M. JACQUES LIOUVILLE, *Comptes rendus*, t. 156, p. 90, séance du janvier 1913 de l'Acad. des Sciences.

a quickly moving animal in the case of Dr LIOUVILLE, the two animals closely resemble one another in form if they are not actually identical.*

The markings, however, of Dr LIOUVILLE's animal and mine are decidedly different. The *Balæna* specimen is mainly white, and its markings are black rather than brown. The whole head, dorsally as far as the line of the base of the pectoral fins, laterally less far back, thence just past the axilla, and extending back in a central ventral line as far back as the extremity of the pectoral fin, is black, with the exception of the throat. The snout is black, not white, as in Dr LIOUVILLE's drawing, and so are both upper and lower lips. The tail is entirely black: ventrally this black extends forward to half way between the root of the tail and the vent; dorsally forward of the dorsal fin, which is itself black, to the middle of the back. All the rest of the body is white. There is no lateral stripe as in the case of Dr LIOUVILLE's drawing. I am inclined, however, to think that this is a polymorphic form of the same animal, especially as His Excellency W. L. ALLARDYCE, formerly Governor of the Falkland Islands, tells me that his impression of the Falkland Islands porpoise is that it is somewhat striped. Mr LYDEKKER is of similar opinion to myself that the *Balæna* specimen is like Dr LIOUVILLE's *Lagenorhynchus cruciger*, Q. and G.; but in the absence of the skeleton this determination cannot be absolutely relied on.

The following is TRUE's description † of the genus *Lagenorhynchus* and of *Lagenorhynchus cruciger* :—

"7. *Lagenorhynchus*, Gray.

"Rostrum large and broad. Rostral portion of intermaxillæ flat (somewhat convex in obliquidens and electra). Pterygoid bones in contact or separate. Symphysis of mandible short. Teeth variable in size, 22 to 45. Vertebræ, 73 to 92.

"Head with a short, ploughshare-like beak (not distinctly marked off from the forehead in obscurus). Dorsal and pectoral fins moderate, falcate. Caudal ridges very prominent. Sides with two areas of light colour separated by irregular, oblique dark bands.

"*Lagenorhynchus cruciger* (D'Orbigny and Gervais). (Pl. xxv. figs. 1 and 2.)

"Beak short, only slightly marked off from the convexity of the forehead. Muzzle to the corner of the mouth, forehead, back, dorsal fin, tail, and pectoral fins black. On the sides, from the eye and base of the pectoral fins to the tail, a broad black band. This band is broadest above the base of the pectoral fin, and decreases in

* "Cétacés de l'Antarctique," par le Dr J. LIOUVILLE (*Deuxième Expédition Antarctique Française*, Paris, 1913), pp. 165–179.

† "Contributions to the Natural History of the Cetaceans: a Review of the Family Delphinidæ," by FREDERICK W. TRUE, *Bulletin of the United States National Museum*, No. 36, pp. 168, 170, 171, Washington, 1889.

width posteriorly until a point about opposite the anus is reached, after which it again increases in width and joins the black of the tail. Between the median and lateral black bands and on the belly the colour is white, more or less pure. (D'Orbigny and Gervais.)

"Teeth $\frac{28}{28}$; skull smaller than that of *L. acutus*, but similar in proportions. Rostral portion of premaxillæ flat, not twisted into a vertical position at the distal extremity; their outer margins straight; triangular area high, flat, and smooth; temporal fossæ moderate, oval directed backwards; pterygoid bones in contact in the median line, moderate, very short antero-posteriorly, not keeled laterally; the conjoint postero-internal free margin transverse, as in *L. acutus*; vomer extending along three-fourths of the rostrum, appearing on the palate as a narrow ridge.

"*Measurements of the Skull* (Mus. d'Hist. Nat., Paris, No. *a* 3045, type).—Total length, 34·9 cm.; length of rostrum, 17·8 cm.; breadth of rostrum at the base, 10·7 cm.; at its middle, 6·6 cm.; breadth of intermaxillæ at same point, 4·1 cm.; breadth between orbits, 17·1 cm.; length of temporal fossa, 6·9 cm.; depth of temporal fossa, 4·1 cm.

"*Habitat.*—Seas south of Cape Horn; Pacific Ocean."

In the museums of Britain and of the Continent there is great lack of material for the comparative study of the larger forms of Cetaceans.

Through the general interest of some owners, however, front fins of many of the species and other parts have recently enriched collections, and have enabled the comparative anatomist to arrange phalanges, carpals, and other bones in their skeletons and make models in a manner truer to their actual disposition in the living animal.

What is really required are several scientific Cetacean expeditions with different classes of ships: (1) one a well-protected ice ship, such as the *Scotia*, adequately fitted with all the usual equipment for the fishing of *Balæna mysticetus* within the limits of the polar pack; (2) another a thoroughly modern whaler of the Norwegian type, for securing different species of whales outside the ice limit, and the free use of a whaling-station ship for a definite time; (3) a third ship especially fitted out for the hunting of smaller Cetacea; (4) and, fourth, a vessel that will devote itself to following the tracks of whales, to give us definite information regarding migration and breeding habits. There should be no question of making these ships pay by hunting for other than scientific purposes, although other scientific observations and collections should be made, such as temperature, salinity, and plankton as far as they are definitely associated with the food supply and life of the whale.

The question of migration is of very special interest. Unlike almost all other marine animals, there are indications that whales, if not the smaller Cetacea as well, are not so dependent on the temperature of the water remaining moderately constant, but are capable of withstanding very great variations in temperature. There are indications, for instance, that whales migrate from polar to tropical seas, and that in consequence northern and southern species are probably in many cases identical, as has been urged by Sir WILLIAM TURNER and others.*

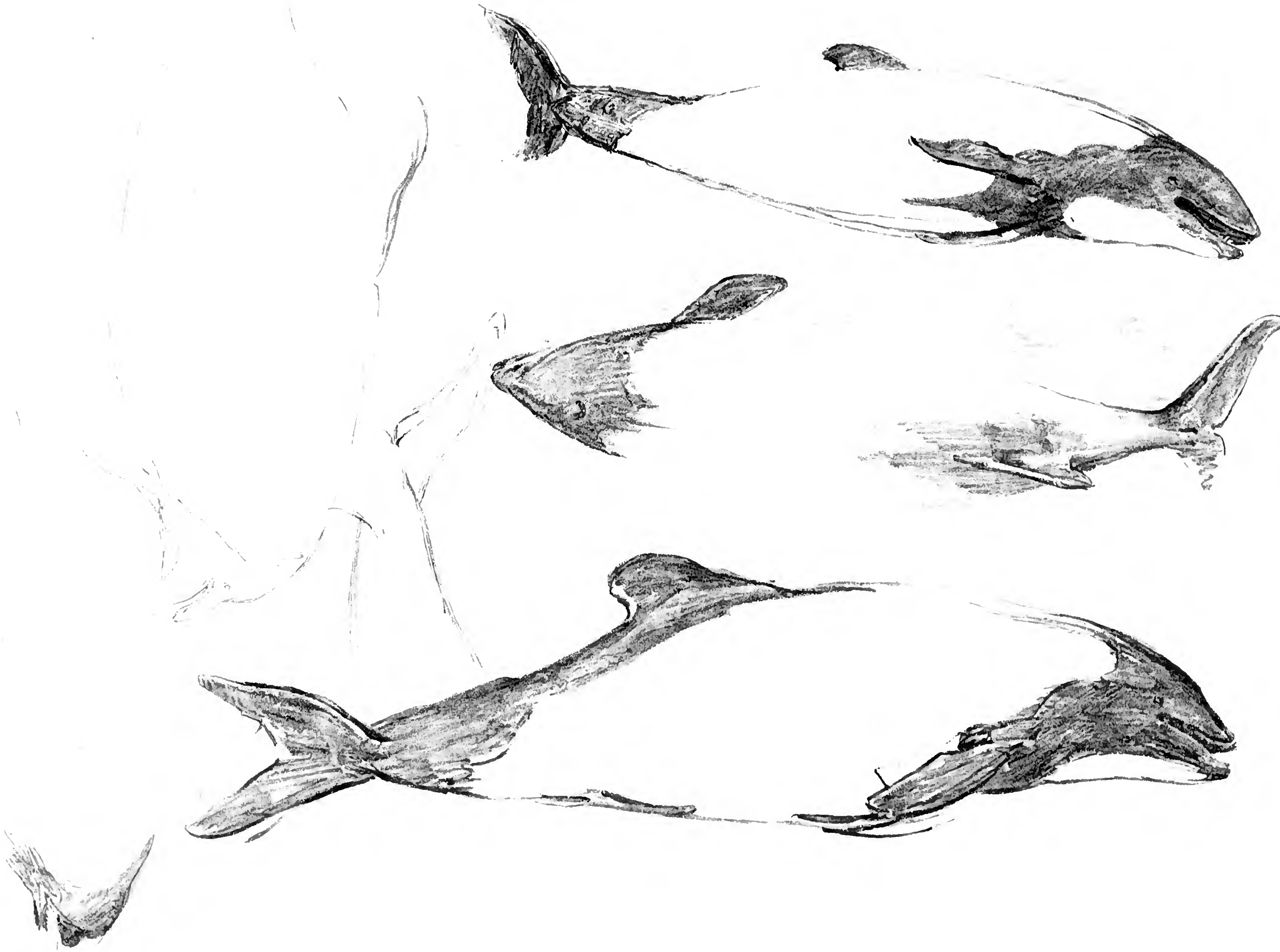
* "The Right Whale of the North Atlantic, *Balæna biscayensis*, etc.," by Principal Sir WILLIAM TURNER, K.C.B., F.R.S., D.C.L., *Trans. Roy. Soc. Edinburgh*, vol. xlviii. pt. iv., 1913.

"The Baleen Whales of the South Atlantic," by Principal Sir WILLIAM TURNER, K.C.B., F.R.S., D.C.L., *Proc. Roy. Soc. Edinburgh*, vol. xxxv. part i. No. 2, 1914.

EXPLANATION OF PLATES.

Plate I. Facsimile drawings by Mr W. G. BURN MURDOCH of a piebald porpoise (*Lagenorhynchus cruciger?*) taken at the Falkland Islands.

Plate II. Photograph of Nordkapper (*Balæna biscayensis*), by Mr J. J. BELL.



W. G. Burn Murdoch, del.

M'Farlane & Erskine, Lith. Edin.

Dr W. S. BRUCE: "Some Observations on Antarctic Cetacea."—PLATE II.

Photo by J. J. BELL.

Piebald Nordkapper (*Balæna biscayensis*) taken at Bunaveneader (Hebrides) Station, June 1907.