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AUSTRALASIAN ANTARCTIC EXPEDITION

1911–14.

UNDER THE LEADERSHIP OF SIR DOUGLAS MAWSON, D.Sc., B.E.

SCIENTIFIC REPORTS.

SERIES C.—ZOOLOGY AND BOTANY.

VOL. IV. PART 3.

BRACHIOPODA

BY

J. ALLAN THOMSON, M.A., D.Sc.,
DIRECTOR DOMINION MUSEUM, WELLINGTON, NEW ZEALAND.

WITH FOUR PLATES AND ONE MAP.

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Plates and Map.

BRACHIOPODA.

By J. Allan Thomson, M.A., D.Sc., F.G.S., Director, Dominion Museum, Wellington, New Zealand.

INTRODUCTION AND ACKNOWLEDGMENTS.

The Brachiopoda of the Australian Antarctic Expedition, 1911–1914, are not many in number, but are relatively rich in species, and add considerably to a knowledge of the faunas of the Antarctic coast-line, Macquarie Island, and Tasmania.

In the description by Eichler (1911) of the Brachiopods obtained by the German Antarctic Expedition, 1901–1903, a resumé of the known Antarctic fauna has been given. It is now a quarter of a century since an account of the distribution of the class in the southern hemisphere was given by Fischer and Oehlert (1892), and since that time a considerable number of new species have been described and many previous identifications have been corrected. Much also has been learnt with respect to the southern Tertiary faunas, from which these recent faunas have in great part descended. The present seems a fitting opportunity to bring together these new facts, and to show their bearing on the theories of southern land connections which it is one of the aims of Antarctic expeditions to prove or disprove. The first part of this report, therefore, will be devoted to a systematic description and comparison of the new material, and the second to an account of the geographical distribution of the Brachiopoda in the south temperate and Antarctic seas. To render the latter more complete, descriptions of two new and significant species from New Zealand have been included.

My warmest thanks are due to Mr. C. Hedley, of Sydney, for generously assenting to the present arrangement for the description of these specimens after they had been already allocated to him, and also for his kindly encouragement and assistance. Professor H. B. Kirk, of Victoria College, Wellington, has given freely of his time in overcoming difficulties in the study of the spicules and of the shell structure. The photographs from which the plates were prepared were taken mainly by myself, but I have to thank Messrs. J. McDonald and F. E. Tomlinson of the Dominion Museum, Wellington, for much assistance in this branch of the work, and especially in the preparation of the prints from the negatives. Mr. G. E. Harris, draughtsman to the Geological Survey of New Zealand, kindly undertook the lettering of the accompanying map.

PART I.

Systematic Description.

PRELIMINARY REMARKS ON SPICULES AND SHELL STRUCTURE.

Before discussing the species in detail, it is desirable to give an account of the calcareous spicules contained in the soft parts of certain brachiopods, since no good presentation of the existing state of knowledge as to these bodies has yet appeared in any English publication.

The spicules generally consist of nearly flat plates of calcite, and each one is composed of a single crystal of the mineral, so oriented that the plane of flattening is parallel to the basal plane (111). The plates therefore give good uniaxial interference figures in convergent polarised light. They are frequently perforated by a number of holes, which I have termed "windows," and generally give off a number of angular lateral processes, so that some are almost stellate in form. The upper and lower surfaces of the plates are not infrequently adorned with numerous small spines. In other cases the spicules form linear, rod-like bodies, of less regular crystallographic orientiation.

In such species as bear them the spicules may be found in the body walls, the mantles or only the sinuses thereof, around the mouth, in the walls of the arms and in the cirri of the arms. They lie, according to van Benmelen (1882) below the epithelium in the connective tissue, and are surrounded each by a membrane, of which they are the product. The genera in which they are known are *Thecidea*, *Liothyrina*, *Liothyrella*, *Terebratulina*, *Chlidonophora*, *Eucalathis*, *Dyscolia*, *Argyrotheca*,* *Platidia*, *Kraussina*, *Megerlina*, *Mühlfeldtia* and *Laqueus*.

The functions of the spicules are not yet well known. Occasionally adjacent spicules are united by their lateral process, and they may thus serve to act as an internal skeleton and strengthen the parts of the animal in which they lie. Deslongchamps (1884, p. 206) states that in *Kraussina rubra* the mantle is furnished with very small and thin spicules which serve to protect the circulatory organs, there being one system for the venous sinuses and another of different shape for the arterial organs. It may be supposed that in the short looped forms (*Terebratulidæ*) the presence of spicules in the free arms tends to give rigidity to these organs, which are unsupported by a calcareous loop.† The spicules are, however, relatively much more massive in the arms of the smaller species than in those of the larger, and if they performed a useful function of such a nature, it is difficult to see why they should not be found better developed in the larger species.

Deslongchamps (1860, 1865, and 1884) was the first to make a study of brachiopod spicules and to employ them in classification. In 1884 he divided the Terebratulidae into two groups, the first, which included *Liothyris* (now *Liothyrina*),

* Blochmann does not recognise this genus as possessing spicules, but Dall (1871, p. 24) mentions that a few were observed in the pallial sinuses of *Cistella lutea*=*Argyrotheca*.

† Twelvetrees and Petterd (1900) consider that this is the function of the spicules of *Megerlina lamarckiana*.

Terebratulina, *Disculina*, *Megerlia*, (now *Mühlfeldtia*), *Megerlina*, *Kraussina*, and *Platidia*, being characterised by the absence of profound metamorphoses in the development of the loop and by the presence of spicules, the second group which included *Terebratula*, *Macandrevia*, *Waldheimia*, *Neothyris*, *Terebratella*, &c., being characterised by the presence of profound metamorphoses in the development of the loop and by the absence of spicules. This classification has not been sustained, being replaced by that of Beecher (1895) in which the family and sub-family characters are drawn from considerations of loop development only, based on a much more extensive knowledge of the latter than Deslongchamps possessed. It is worthy of enquiry whether the presence or absence of spicules cannot be brought into line with Beecher's classification.

The spicules are not preserved in fossil forms, and it was quite an arbitrary assumption on Deslongchamps' part that *Terebratula* possessed no spicules. All the recent genera of the *Terebratulidae* (as now restricted) of which the bodies are known are possessed of spicules, viz., *Liothyrina*, *Liothyrella*, *Terebratulina*, *Chlidonophora*, *Eucalathis* and *Dyscolia*, the only genus of which the body is unknown being *Murravia*, (Thomson, 1916, No. 1). It may therefore be assumed with some degree of assurance that spicules were also present in *Terebratula* and the other extinct genera of the family and that the presence of spicules is a constant character of the *Terebratulidae*.

The genera of the *Terebratellidae* which are known to possess spicules are distributed at present in the sub-families as follows :—

Dallininae : Platidia, *Laqueus*.
Magellaninae : Kraussina, *Megerlina*, and *Mühlfeldtia*.
Megathyrinae : Argyrotheca (some species only).

I have recently (1916, No. 2) given reasons for doubting whether *Kraussina*, *Megerlina* and *Mühlfeldtia* are correctly placed within the *Magellaninae*, and suggested that they may prove to form a separate sub-family, which may also include *Aldingia*, *Kingena* and *Laqueus*. The bodies of *Aldingia* and *Kingena* are not yet known, but the remainder of these genera all possess spicules, and if their separation into a sub-family is sustained by a further study of the loop development of the higher forms, the presence of spicules in the *Terebratellidae* will then be confined to this sub-family alone, so far as present knowledge goes, with the exceptions only of *Argyrotheca* and *Platidia*. As will be seen below,* there are other grounds for doubting whether *Platidia* belongs to the *Dallininae*, and it is suggested that it belongs to still another sub-family.

Besides Deslongchamps, Fischer and Oehlert (1891 and 1892) have also paid some attention to spicules, and have sought to use them as specific characters, but it is to Blochmann (1906, 1908, 1912) that we owe our fullest knowledge of their usefulness in this respect. He has pointed out that within the same individual the spicules vary in shape from point to point, and that the figuring of isolated spicules is of little value for specific comparison. The shape and mode of arrangement of the spicules of any given part of the body, however, are within limits recognisably similar for different

* Page 21.

individuals of the same species and different for different species. These characters are difficult to define in words and recourse is therefore had to figures of definite districts of the body, of which the most useful for comparison are the ventral body wall and the side arms. All the figures are reproduced with the magnification of 45, in order to facilitate comparisons.

The technique of preparing the spicules for microscopic examination recommended by Blochmann is as follows :—by utilising the natural gape of the shell the desired parts of the body wall or of the arms may be cut away by suitable instruments without further damaging the specimen. Dried material is first soaked for some time away from air in old turpentine, and the mounting is done with gum damar. The arms of the larger specimens are best not mounted, but examined while immersed in turpentine, cedar oil, or fluid paraffine, as they can then be moved into any desired position.

As material for the study of the spicules of brachiopods is not readily available for practice in acquiring the technique, I venture to give in greater detail the procedure finally adopted by Professor Kirk and myself. The part which it is desired to mount is first cut away, and if dried, is soaked for some time in water, and all air-bubbles removed under an air-pump. The specimen is then, while still under water, placed between two stout cover glasses in the position in which it is desired to mount it. It is then transferred to alcohol to remove the water, two lots of alcohol being used, and then to clove oil. The upper cover glass may now be removed as the clove oil renders the object rigid in the desired position. If any air-bubbles still remain they are removed at this stage by the air-pump. The cover-glass and object are then lifted out of the oil and partially drained, and the object is then slid into the desired position on a slide on which a bed of canada balsam and xylol has been placed, and is covered in the usual manner.

There is no difficulty in mounting portions of the body wall or of the mantle unless these are so old as to have become very brittle, but the suitable mounting of the side arms of *Liothyrina* and *Liothyrella* is not always easy, owing to the shape of these organs and the position of the spicules. It is best to spread the arms out so that the dorsal and ventral parts of the arms are separated, keeping a note of which is the dorsal and which the ventral side, but that sometimes proves impossible, and it is then necessary to rely on an optical section to separate the spicules of the dorsal and ventral sides of the arms. In either case the side folds of the arms which often bear spicules are folded against the arms, and an optical section has to be relied upon. This militates against clear photographic representation of the spicules.

The punctation and shell structure of brachiopods has received renewed attention in recent years, particularly with a view to the use of these characters in classification, and rather divergent opinions have been expressed. The prisms of the prismatic layer of the shell meet the inner surface obliquely, and trace upon it a "mosaic," which varies in pattern in different species. For purposes of comparing

different species, Blochmann (1908), who has called attention to this character, figures the middle part of the ventral valve in front of the muscular impressions. It seems probable from the differences displayed by his figures that a study of the mosaic may prove of considerable value in distinguishing species which are similar in external form. Unfortunately this character can seldom be observed in fossils. The pores or tubules which penetrate the shells of many species also show considerable differences in certain cases. Blochmann makes measurements of the outer and inner diameter of the pores, and of the number per square millimetre, and recommends that the same district of the shell as mentioned above, viz., the middle of the ventral valve in front of the muscular impressions, be selected for comparison, and also that all figures be reproduced with a magnification of 100 diameters. For portraying the shell mosaic he has unfortunately chosen a magnification of 175, and in this has been followed by Eichler (1911) and Jackson (1912). As a figure of the mosaic of a punctate shell serves also as a figure of the pores, it is here recommended that a magnification of 100 be adopted for the figures of both structures.

Blochmann was able to show from a study of the pores that the specimens from Kerguelen Islands formerly identified as *Terebratella dorsata* belonged to a distinct species. In other cases, such as the genus *Liothyrina*, the differences between the species are so slight that a study of the pores does not assist in identification.

Percival (1916) has made a study of the punctation of certain English fossils, and especially the " density " or number of the pores per square millimetre, and finds that the range in the two species selected for close study is so great that this feature can have little value for specific distinction. He has certainly proved his case for the species studied, *Terebratula biplicata* and *T. punctata*, but it does not follow that species of other genera will show a similar behaviour. In the present collection the large and distinctive pores of *Magellania joubini* enable the young of this species to be easily distinguished from the young of other species of *Magellania* and *Macandrevia*, the latter having always relatively small pores, and it appears probable that a fuller use of these characters may prove of considerable value in other cases. Meanwhile it is desirable to have figures of both pores and mosaic of as many species as possible.

For counting the number of pores, Blochmann uses a netz-mikrometer. Percival adopts a camera giving a magnification of fourteen times, and isolates an area of 14 sq. mm. on the screen by cutting a hole of this size in a sheet of paper. In the absence of an ocular micrometer I have found the following a convenient procedure. A Dick-Swift petrological microscope is used, the tube and the eye-piece of which are slotted to receive certain accessory plates. In this slot is inserted a piece of Bristol board with a square cut out of it of such a size that it gives an area of 1 sq. mm. on the object with a given objective (1 inch). The size of the square is determined experimentally, using an ordinary stage micrometer for calibration. The data obtained by this method are lower in the same species than those obtained by Blochmann, but I have checked its accuracy by the camera method of Percival.

Superfamily CRANIACEA *Waagen.*

Genus Crania *Retzius*, 1781.

Genotype Anomia craniolaris *L.*

Crania joubini *sp. nov.*

(Plate XVI, figs. 18, 19.)

Habitat.—Station 9; lat. 65° 20′ S., long. 95° 27′ E. (Davis Sea), 240 fathoms, 24th January, 1914. Sea bottom, small rocks.

A single specimen of a dorsal valve of a species of *Crania* was dredged from Station 9. The shell was without any trace of the animal, and had evidently been dead for some time, as it contained the tube of a calcareous annelid on its inner side. In shape it is somewhat irregular, owing to a feeble development of the left posterior corner in the latest stages of growth, but the course of the growth lines shows that it has developed from a roundly rectangular shape, broader than long. The convexity is very slight, and the margins of the valves are not in one plane. The blunt apex is situated very close to the posterior border, where the steepest slopes exist. The shell also slopes more steeply to the right than to the left side, which is arched about halfway between the apex and the left anterior corner. Growth lines are not prominent except in the outer third of the shell. There is no trace of radial costation or striation. A light brown epidermis covers the greater part of the surface, but where this is removed, as on the apex and round the anterior margin, the shell is white.

In the interior there is a narrow, finely-granulated rim, limited by an indistinct shoulder. The muscular impressions are not strongly marked, and only the posterior and anterior adductors and one of the dorsal protractors can be distinguished under favourable conditions of lighting. The pallial sinuses have left no impressions. The fine punctation can be easily distinguished on the interior by the aid of a lens.

The dimensions of the specimen are—length 7·8 mm., breadth 9·2 mm., height 2 mm.

The shape and ornament of this specimen are approached more nearly by northern than by southern recent forms. The only species of the genus hitherto described from Antarctic waters, *Crania lecointei* Joubin, possesses a nearly central apex and growth lines which develop from rounded through elliptical to roundly ovate. These differences in shape and in development seem sufficient to prevent the association of the present specimen with that species.

The other forms from the southern seas, *Crania patagonica* Dall, from the west coast of Patagonia, *C. Suessi* Reeve, from East Australia, and *C. huttoni* Thomson, from New Zealand, have all a radiating ornament, and are thus clearly distinct. *Crania joubini* differs from *C. anomala* and other northern forms by its feeble convexity and the poor development of the muscular impressions.

The only known Tertiary fossil form of the genus from the Southern Hemisphere is the Australian *Crania quadrangularis* Tate, which is similar in form to the present species, but has fine radial striæ and strong muscular impressions.

Superfamily RHYNCONELLACEA Schuchert.

Genus Hemithyris *d'Orbingy*, 1847.

Genotype Anomia psittacea *Gmelin.*

Hemithyris striata *sp. nov.*

(Plate XVI, figs. 30, 31, 32, 45.)

Habitat.—Station 11, off Shackleton Glacier (Davis Sea), 358 fathoms, 31st January, 1914. Sea bottom, ooze.

There is from Station 11 a single ventral valve of a *Hemithyris* which must be referred to a new species. All trace of the animal had disappeared. The shell is of a dull white colour with a nacreous interior. It is roundly triangular in shape, with an acute apex, is lightly and regularly convex without fold or sinus, and the margins of the valves are in one plane. The surface is ornamented with a few strongly-marked lines of growth and very numerous fine radial striæ of somewhat uneven breadth, increasing in number towards the margin chiefly by intercalation, but occasionally by bifurcation. The beak is quite short, sub-erect, and possesses distinct beak ridges. The foramen may be described as hypothyrid, but a ventralwards movement has commenced and has just destroyed the apex, about 1 mm. of which has been removed. The narrow delthyrium is partially closed by lateral deltidial plates which pass ventrally into a short anteriorly excavate pedicle collar. The hinge teeth are close, and are supported by dental plates, which incline towards one another in the ventral direction and the free margins of which are arcuate anteriorly. Muscular impressions a dull white, small, not extending far forward. There is no trace of a median septum in the beak. Shell substance imperforate; the imbricated structure is easily visible on the interior by means of a lens. The shell is very thin, and the radial striation shows on the interior by transparence. The dimensions of the valve are—length 17·5 mm., breadth 18 mm., thickness 4·75 mm.

Three species of rhynconellids are known from Antarctic waters, viz., *Rhynconella racovitzae* Joubin (1901), *R. gerlachei* Joubin and *Hemithyris* sp. Jackson (1912). The first of these, *Rhynconella racovitzae*, was compared by Joubin to *R. cornea* Fischer, but it does not seem probable that these species are closely related. Joubin pointed out a difference in the course of the anterior commissure, viz., that the re-entrant angle is on the ventral valve in *R. cornea*, and on the dorsal valve in *R. racovitzae*, or in other words that *R. cornea* is incipiently ventrally uniplicate and *R. racovitzae* dorsally uniplicate.* Fischer and Oehlert's figures (1891) seem to show, however, that *R. cornea* possesses a faint sinus in each valve, and that the folding is really of the *Cincta* type. This suggests the possibility that *R. cornea* may belong to the genus *Frieleia*, in which a similar tendency to a folding of the *Cincta* type is evident,† and the cardinalia certainly seem to show an approach to the type described by Dall in *Frieleia halli*, although the hinge plates do not quite unite above the septum. *Hemithyris craneana* Dall is another

* Cf. Thomson, 1915, No. 1 for terminology. † Cf. Thomson, 1915, No. 3.

recent rhynconellid which shows a tendency to folding of the *Cincta* type, but which also differs from *Frieleia halli* by a separation of the crura or hinge-plates clear to the cardinal margin. The differences separating these two species from *Hemithyris* seem as important as those separating them from *Frieleia*, and they may be provisionally referred to as the *Rhynconella cornea* series. With this series *R. racovitzae* can have little relationship, and its dorsal uniplication is in accord with its reference to *Hemithyris*.

Rhynconella gerlachei is a shell in the lenticular stage, so that its type of folding gives no clue to its generic position. The cardinalia, however, are not of the Hemithyrid pattern, but present considerable resemblance to those of *Frieleia*, to which genus it may be provisionally referred until adult examples are discovered.

The fragments described by Jackson under the heading of *Hemithyris* sp. consist only of the posterior parts of valves, and consequently the type of folding is not known. From the other characters it seems probable that they belong to a new species of *Hemithyris* with the long beak which separates the *H. psittacea* series from the short-beaked *H. nigricans* series. A fossil member of the *H. psittacea* series, *H. antarctica*, has been described by Buckman (1910) from the Post-Tertiary Pecten Conglomerate of Cockburn Island, off Graham Land, and Jackson states that his specimens present some points of resemblance to this species.

The present species, *Hemithyris striata*, is an adult shell in the lenticular stage, and, as the dorsal valve is unknown, some uncertainty as to whether it belongs to *Hemithyris* or *Frieleia* must remain. It is not impossible, as far as shape and ornament are concerned, that it is the adult form of *Frieleia gerlachei*. It possesses the short beak of the *Hemithyris nigricans* series, but differs from these species (*H. nigricans*, *H. pyxidata*, *H. doederleini*) by the fineness of the radial ornament, as well as by the lack of folding. It is easily distinguished from *Hemithyris racovitzae* by its rounder shape and relatively lesser convexity as well as by the absence of folding. The only other southern species of rhynconellid not discussed above is the Australian form, *Hemithyris colurnus* Hedley, which, from characters of beak and cardinalia, must be referred to *Aetheia*, and therefore need not be further compared with our species.

Superfamily TEREBRATULACEA *Waagen*.

Family Terebratulidae *Gray*.

Genus Liothyrella *Thomson*, 1916.

Genotype Terebratula uva *Broderip*.

Liothyrella was founded to include a series of finely punctate recent and Tertiary terebratulids distinguished from *Liothyrina* and *Terebratula* by the possession of a low but sharp median septum in the dorsal valve, accompanied in many cases by an irregularly distributed fine radial ornament. All the known species, *L. uva*, *L. notor-*

cadensis (Jackson), *L. antarctica* (Blochmann), *L. fulva* (Blochmann), *L. blochmanni* (Jackson), *L. concentrica* (Hutton), *L. tateana* (Tenison-Woods), and the new species described below have a southern distribution and include Oligocene–Miocene southern fossils. Whether the other known southern recent species, *Terebratula moseleyi* Davidson, *Terebratula vitrea* var *minor* Davidson (not of Philippi), Cape of Good Hope, *Terebratula uva* Davidson (? of Broderip), Heard Island, and *Liothyrina winteri* Blochmann, belong also to this genus or to *Liothyrina* must remain uncertain until the presence or absence of the median septum has been ascertained.

From a study of the spicules occurring in the arms, Blochmann (1906 and 1908) divided the species then considered as *Liothyrina* into two groups, distinguished by the presence or absence of a row of spicules as the base of the cirri (Cirrensockel), which may conveniently be termed cirri socles. The group in which they are absent, which includes *Liothyrina vitrea*, occurs chiefly in the Atlantic Ocean and the Mediterranean sea, with the exception of one species in Japan and one off Madagascar, to which must now be added a species in Australia. The group in which they are present, which includes *Liothyrella uva*, embraces the majority of southern forms, and also one species each in the Arctic, the Mediterranean and the Panamic regions, while *L. uva* itself ranges from southern American waters as far north on the west coast as the gulf of Tehuantepec in Mexico. Blochmann's conception of the relationship of the various species with the latter group is of interest. From the fact that each of them has its peculiar district and does not transgress into the district of another, and from the further fact that these various districts hang together, he concludes that the smaller species, such as *artica*, *affinis*, *clarkeana*, *antarctica*, *davidsoni*, *winteri*, and perhaps *moseleyi* have arisen as local forms of a species which has gradually extended its distribution, each form corresponding to a new district which has been occupied. The occurrence of *arctica* between Iceland and Greenland and of *affinis* in the Mediterranean is difficult to account for on this theory, for the districts of these species do not join up to those of the southern forms. In any case such a theory of the relationship of the species of so old a genus seems much too simple to be credible, and takes no account of the extinct Terebratulids of the Tertiary.

From a study of the spicules in a series of *Liothyrella antarctica* in different stages of growth Eichler suggests the possibility that cirri socles may be present in the young stages of *Liothyrina vitrea* and other forms, their absence in adolescence being due to a later resorption.

Liothyrella fulva (Blochmann) furnishes a critical case for determining the value of Blochmann's two divisions. The similarity in shape of this species to *Liothyrella uva* caused Davidson to unite it with the latter. If the specimen described below is correctly assigned to *L. fulva*, the latter species agrees further with *L. uva* in the presence of a fine radial ornament, and is without doubt a species of *Liothyrella*. Nevertheless in *L. uva*, which is a smaller species, cirri socles are present, while in *L. fulva* they are absent. Blochmann's division, therefore, conflicts with a division of the species based

on shell characters; the latter are, in my opinion, more entitled to consideration in classification, more especially as they have been shown to exist also in Middle or Early Tertiary shells alike in the Antarctic, New Zealand and Australia, and are thus apparently characters of considerable permanence. The truth seems to be that the absence of cirri socles can be correlated with the size of the species whether it be referable to *Liothyrina* or *Liothyrella*.

Liothyrella fulva *Blochmann*.

(Plate XV, figs. 20, 21, 22; plate XVII, fig. 53).

1880. *Terebratula uva* (in part) Davidson, Voy. Challenger, Zool., vol. 1, Brachiopoda, pp. 31–32, plate II, figs. 3, 4 (not of Broderip).

1886. *Liothyris uva* (in part) Davidson, Trans. Linn. Soc., Zool., vol. 4, pt. 1, pp. 10–11.

1906. *Liothyrina fulva* Blochmann, Zool. Anz., Bd. XXX, p. 698.

1908. *Liothyrina fulva* Blochmann, Zeits. f. wissensch. Zool., Bd. XC, pp. 617–618, Taf. XXXVIII, fig. 22, a–b, Taf. XXXIX, fig. 26.

1914. *Liothyrina fulva* Blochmann, Pap. & Proc. Roy. Soc. Tasm. for 1913, pp. 112–114, plate X, figs. 1–6, plate XII, figs. 12a, 12b.

Habitat.—Off Maria Island, Tasmania, 12th December, 1912, 65 fathoms. Collected by Mr. T. T. Flynn. A single specimen.

The shell is white in colour, fairly large, elongate ovate with the greatest width about the middle, the sides obtusely angled, the front truncate and gently rounded. Both valves are convex, the ventral strongly so, and show neither fold nor sinus. The anterior commissures are straight. The hinge line is short and curved. The beak is moderately produced, erect, truncated by a fairly large foramen which is epithyrid and labiate, but does not entirely hide the narrow concave pseudodeltidium. The beak ridges are not prominent. The surface of the valves show numerous fairly prominent growth lines and a very fine radial ornament, only visible under favourable conditions of lighting.

The loop is short, extending only one-third the length of the dorsal valve, and is relatively narrow. The transverse band is composed of a broad ribbon, sharply arched in the middle to form a ventrally directed ridge. The crura are very short, but the crural bases relatively long and with broad triangular discrete hinge plates separating them from the widely diverging socket ridges. The cardinal process is lamellar and fairly high. The muscular impressions are fairly strong, those of the abductors being separated by a low but sharp median ridge running nearly to the umbo and showing clearly on the exterior of the shell.

The mantle has four sinuses in each valve but the middle pair are much more prominent, and corresponding to them are internal grooves in the shell. The sinuses

throw out several branches on each side, and the middle pair in each valve bifurcate broadly near the anterior margin, the outer branches again branching repeatedly. Spicules occur in the sinuses and all the branches, as well as in the body wall, around the mouth, and in the arms. The latter are short, with relatively short cirri which contain slender, elongate, overlapping rod-like spicules. The body wall is stiffened with interlocking stellate spicules containing each only a few " windows " in the central part, and the surfaces of these spicules are finely spinose. Those of the ventral body wall are stouter than those of the dorsal. The body having been dried and the cirri curled in before examination of the spicules of the arms, the latter could not be satisfactorily exposed, but the absence of cirri socles and the presence of numerous branch-like main plates below was determined and agrees with the account given by Blochmann for the specimens from Schouten Island. Length, 33 mm., breadth 23 mm., thickness 19 mm.

The specimen described above differs considerably both in size and beak characters from the type as figured by Davidson and by Blochmann. There are so many points of agreement, however, between it and the larger, more elongate, specimen described by Blochmann (1914) from Schouten Island, especially in the shape of the dorsal valve and the loop, and the spicules, that there can be little doubt that these are the same species. The more advanced beak characters of the present specimen, together with its larger size, may probably be correlated with its greater age.

Mr. C. Hedley has kindly lent me for comparison a specimen from Cape Byron determined by him in 1908 as *Liothyrina uva*. This consists of a ventral valve 16·5 mm. in length, and agrees closely in shape and beak characters with the present specimen, and like it possess a fine radial striation. It is also doubtless to be referred to *Lithyrella fulva*.

Liothyrella ovata *sp. nov.*

(Plate XVI, fig. 42; plate XVII, figs. 54, 55, 56; plate XVIII, fig. 63.)

Habitat.—Station 10; off Shackleton Glacier (Davis Sea), 325 fathoms, 29th January, 1914. Sea-bottom, ooze ; temperature 1·65° C. A single shell.

The shell is white in colour, ovate, with a blunt beak and a truncate front, the sides being rounded and passing gradually into the gently rounded front. The greatest width is very slightly in front of the middle. The hinge line is of moderate width and obtusely angled. Both valves are convex, the ventral more so than the latter. There is no marked sinus or fold on either valve, but a very faint indication of dorsal biplication. The lateral commissures are practically straight while the anterior commissure shows a very light ventral median depression corresponding to the median sinus of the dorsal biplication. The beak is short, sub-erect, without pronounced beak ridges, and is truncated by a fairly large epithyrid foramen, which is marginate and possesses a small pedicle collar within. The surface ornament consists of numerous not very pronounced growth lines, crossed by a rather widely spaced faint radial striation. Dimensions—Length 23 mm., breadth 19 mm., thickness 13 mm.

The loop unfortunately was broken before examination, but appears to have been short and moderately broad. The crura are very short, and the crural bases of moderate length, diverging rather rapidly, their free edges not raised above (ventrally of) the hinge plates, which are narrow. The cardinal process is small, low and transverse. The median septum is very slender, but is well defined and shows clearly on the exterior of the shell.

The mantle and the body walls appear to be free of spicules, while those in the arms are slender but exceedingly numerous. The long cirri of both inner and outer rows contain rather short and very irregularly bounded spicules in great numbers. The place of the cirri socles is taken by small crowded spicules of very irregular shape which penetrate into the bases of the cirri of the outer row, but not into those of the inner row. The main plates are slender and very irregularly branched, and are confined to the dorsal side of the arms.

Spicules are recorded as being absent from the cirri of *Liothyrina arctica*, *Liothyrella uva*, and *L. blochmanni*, and present in *Liothyrina vitrea*, *L. affinis*, *L. stearnsi*, *L. moseleyi* and *Liothyrella fulva*. In other respects the spicules of the arms of the present species differ widely from those of the five last named species, being perhaps most like those of *L. moseleyi*, but differing in that the main plates are confined to the dorsal sides of the arms. The shell resembles in beak characters the type of *Liothyrella fulva*, but is broader than that species, and also differs in its truncate front margin. In this respect it resembles *Terebratula moseleyi* Davidson, but it is less broad than that species. It approaches in shape very closely some examples of *Liothyrella tateana* (Tenison-Woods) from the Tertiary of Table Cape, Tasmania, but has a less advanced beak, the foramen being labiate in the latter species. *L. tateana*, moreover, attains a more pronounced biplication in many specimens, while in the uniplicate stage it is more strongly folded.

Liothyrella antarctica (*Blochmann.*)

(Plate XV, figs. 8, 9, plate XVIII, figs. 65, 66.)

1906. *Liothyrina antarctica* Blochmann, Zool. Anz., Bd. XXX, pp. 692–693, fig. 1.

1911. *Liothyrina antarctica* Eichler, Deutsche Südpolar-Exped., Zool., Bd. IV, Heft. IV, pp. 386–388, 397–400, Taf. XLII, figs. 1–4, Taf. XLIII, figs. 13, 19, 20, Taf. XLIV, figs. 25–34.

Habitat.—Station 2 ; lat. 66° 55′ S., long. 145° 21′ E. (off Adelie Land), 288–300 fathoms, 28th December, 1913. Sea-bottom, ooze; temperature 1·8° C.

A small series of specimens from Station 2 is ascribed to this species with some confidence, not only because of the general agreement in shell characters, but also on account of the close resemblance of the spicules to those of *L. antarctica* described by Eichler. The following description applies to the largest specimen of the series.

The shell is broadly ovate with rounded sides passing gradually into a rounded front. The greatest breadth is a little in front of the middle. The hinge line is of moderate breadth and obtusely angled. The convexity, in which the ventral valve assumes a slightly larger share, is only moderate. There is a slight tendency to dorsal uniplication, revealed chiefly by the arching of the anterior commissure, but also by a slight flattening towards the sides of the dorsal valve. The beak is rather short, suberect, without pronounced beak ridges, and is truncated by a fairly large epithyrid foramen, which is marginate with a well developed pedicle collar within. The growth lines are not well marked, and there is an almost obsolete faint radial striation only to be discerned with a magnifying lens.

In the dorsal valve the septum is not conspicuous, but may be clearly seen by holding the shell up against a strong light. The loop is short, extending forward only two-sevenths the length of the valve. The transverse band is relatively broad and presents two folds directed ventrally with a groove between them. The crural bases are longer than the sides of the loop, and the crural processes occur right at the end of the hinge plates. The crural bases diverge rather rapidly and are raised above (ventrally of) the hinge plates anteriorly and gradually descend to their level about halfway to the umbo. The hinge plates are concave ventrally. The cardinal process is low and very broad.

No spicules were observed in the sinuses of the mantle, or in the cirri, and they occur only sporadically in the body walls. In the arms they are well developed, consisting of a row of massive stellate main plates on both dorsal and ventral sides of the arms, and a row of pyramidal cirri socles at the base of the cirri on the dorsal side only. Both rows of plates vary considerably from place to place, the cirri socles in places losing their pyramidal shape by the development of a large spine in place of the base of the pyramid, and take the appearance of a cross. The main plates are roughly stellate with a small central disc, which is occasionally perforated by small " windows," while the rays have a tendency to bifurcate. The lateral branches in both series overlap one another. The general shape and the relationships of both rows of spicules agree with those described for *L. antarctica* by Eichler, though not so well in the shape of the main plates with the figure given by Blochmann. In a young specimen of 6 mm. the cirri socles continue from the dorsal side right to the proximal end of the ventral side of the side arms, *i.e.*, somewhat further than in the cases studied by Eichler.

The discovery of this species off Adelie Land represents a considerable extension of its range, the previous specimens being all obtained from the Winter Station of the " Gauss " in 385 metres depth (210 fathoms).

Liothyrella neozelanica *sp. nov.*

(Plate XVI, figs. 36, 37, 38; plate XVII, figs. 51, 52; plate XVIII, figs. 61, 62, 64.)

Habitat.—On a flat stone entangled on a fishing line of 200 fathoms length, Cook Strait, off Wellington, New Zealand.

About forty large and several minute shells belonging to a new species of *Liothyrella* were found on a large flat stone brought up on a fishing line, in Cook Strait. The depth cannot have exceeded 200 fathoms and may have been much less. Mr. T. Iredale, who kindly examined the associated molluscs, states that they are distinctly of shallow water facies, and probably from not more than 50 fathoms in depth. The specimens had been rotting for a fortnight before they were obtained by the Dominion Museum.

The shell is large, pale horn-coloured to white, and broadly ovate in shape with a blunt beak and a slightly truncate but gently rounded front. The hinge line is moderately broad and strongly angled at the dorsal umbo. The convexity is considerable, the greater share being assumed by the ventral valve. There is an obscure broad median fold in the dorsal valve, flattened on top anteriorly, and a corresponding very shallow anterior sinus in the ventral valve giving rise to a flattened dorsally directed arch in the anterior commissure. The beak is short, sub-erect, with blunt beak ridges and a large epithyrid foramen which is labiate with a well developed pedicle collar within. The pseudodeltidium is not entirely concealed by the labiate foramen, and is of one piece, rather low, moderately broad and concave dorsally. The umbo of the dorsal valve is considerably incurved, and is hidden by the pseudodeltidium. The surface of the shell show numerous fairly strong growth lines, and a very fine wavy radial striation, only clearly visible in a favourable light by the aid of a lens, but occasionally distinguishable by the naked eye. The dimensions of the specimen chosen as holotype, are—Length 47 mm., breadth 42 mm., thickness 29 mm.

The loop is short, extending forward little more than one-quarter the length of the dorsal valve. The crural bases are relatively long and project above the narrow hinge plates for nearly their whole length, being inclined slightly towards one another. The crural processes occur at the anterior ends of the hinge plates, and are long and pointed. The remainder of the primary lamellæ are very short. The transverse band is of only moderate length with a ribbon narrow at the points of origin and in the middle, but swelling out anteriorly on each side. It is strongly arched ventrally, the top of the arch being flattened for a short distance. The cardinal process is moderately developed, but appears prominent owing to the incurving of the dorsal umbo. The thread-like posterior dorsal septum is clearly marked, but does not show through the shell, which is moderately thick, and not markedly grooved internally for the reception of the pallial sinuses.

The sinuses of the mantle are narrow and not conspicuous in the dried shell. They send out many branches on each side alternately, and bifurcate repeatedly near the front margin, the branches uniting near the margin with those of the adjoining sinuses. Spicules are present both in the sinuses and in the branches. The body walls are braced with large interlocking spicules, which are more massive in the dorsal than the ventral portion; those of the dorsal body wall consist in the middle of large plates with dorso-ventral elongation of their rays and with few "windows," passing out on

the sides into stellate plates with spiny rays and large central discs presenting many "windows," and finally into more slender, much branched, irregularly shaped, plates resembling the latter, but with the "windows" so developed as to destroy the appearance of the central disc. The plates of the ventral body wall agree with the second and third types above described for the dorsal body wall.

The spicules of the arms and cirri, on the other hand, are relatively very slender. The row of main plates is stoutest on the dorsal side at the proximal end, and these consist of irregularly stellate plates of three or four primary rays, which quickly branch and bear spines, the branches having a tendency to curve to assume a dorso-ventral direction. These main plates have at first a small central disc with occasional small "windows," and when followed distally are seen to become more and more slender, common forms near the end of the arm being four-rayed stars like a Southern Cross or three-pronged spines of swastika shape. Similar forms but of decreasing size persist on the ventral sides of the arm and in the spiral arm, where still simpler forms with assegai or boomerang shapes occur.

The cirri of the inner row bear no spicules, while those of the outer row possess small, distantly-spaced, spindle-shaped rods. Into the base of the latter row of cirri there project small irregularly pointed but frequently pyramidal plates in a fairly definite row, which fails on the ventral side, except quite sporadically. It is separated from the row of main plates by an intermediate series of larger, similarly shaped plates, often resembling a twice-barbed arrow head with the points directed towards the cirri. This intermediate series, which is almost but not quite referable to a single row, persists on the ventral side almost to the proximal end.

The row of plates at the base of the cirri appears to be homologous with the more massive cirri socles of smaller shells. In the presence of the intermediate row, however, the arrangement of the spicules presents more resemblance to that shown by *Liothyrina vitrea* than by *Liothyrella uva*. The shell characters, however, and particularly the presence of the dorsal median septum and of the fine radial ornament prove the closer relationship of the species with the latter. The slender development of the spicules of the arms seems in this species and *Liothyrella fulva* to be a function of size.

The species is distinguished from other recent *Liothyrellæ* by its great size, and is to be compared with fossil forms in the Oamaruian of New Zealand, such as *L. gravida* (Suess) and *L. oamarutica* (Boehm). With the former it agrees in length, but is not quite so broad and not so angled at the sides. It agrees more nearly in shape with the latter, but is slightly broader, with broader youthful growth lines, and has a labiate instead of a marginate foramen. *L. oamarutica* in addition is frequently more strongly folded than any examples of the present species.

The young shell from Foveaux Strait, described by me in 1915 as *Liothyrina sp.*, possesses stout cirri socles, and much more massive spicules in the cirri, and is quite probably not the young of the present species.

Family Terebratellidæ *King.*

Subfamily Megathyrinæ *Dall.*

Amphithyris *genus nov.*

Genotype Amphithyris buckmani *sp. nov.*

Shell plano-convex, with beak characters similar to those of *Platidia*, viz., ventral valve with sharp beak ridges meeting in an apex dorsally of which there is an open triangular delthyrium; dorsal valve with a semi-circular foramen replacing the umbo. The pedicle opening consists of a triangular delthyrium behind and a semicircular foramen in front, and the very short pedicle issues perpendicularly to the flat dorsal valve, enabling the shell to lie close against its support with the convex limpet-like ventral valve uppermost. Buckman (1916) has shown that the foramen in terebratuloids may shift ventralwards of the beak ridges from the hypothyrid to the epithyrid position. In this and other similar cases the foramen has moved dorsally, resorbing the dorsal umbo. The name of the genus is intended to indicate the position of the foramen in respect of the valves, and this type may be called *amphithyrid*.

The genus is distinguished from *Platidia* by its more primitive lophophore and brachial support. The lophophore is in the stage termed by Beecher (1897) the schizolophous, with inwardly directed cirri, *i.e.*, the lophophore is relatively large and reniform, with a simple invagination in front dividing it into two lobes as in *Argyrotheca*. The lophophore of *Platidia* is much more complex, consisting of a small median posterior lobe or disc around the mouth with the cirri directed ventrally and outwards, and two larger symmetrical anterior lobes with the cirri directed dorsally and outwards. The lophophore in passing from the posterior into the two anterior lobes becomes twisted on itself. For a more detailed account the description of Fischer and Oehlert (1891) should be consulted. Beecher has cited *Platidia* as possessing the zugolophous type of lophophore, which is an intermediate stage between the schizolophous and the plectolophous, the latter being the final stage in the *Terebratulacea* with a well-developed median dorso-ventrally rolled spiral arm. The lophophore of *Platidia*, however, departs widely from the zugolophous stage as represented in young examples of the *Dallininæ* in the so-called Platidiform loop stage, and represents a special type of its own. Fischer and Oehlert (1891) have pointed out that a dorso-ventral rolling of a spiral arm is precluded in this genus by the restriction of the visceral cavity imposed by the flattening of the dorsal valve, and that the lophophore has had to develop in the plane of the commissures.

Amphithyris differs further both from *Argyrotheca* and *Platidia* in its brachial support, which consists solely of a centrally situated, fairly high, median septum, with no trace of descending or ascending branches of a loop. For the rest the lophophore is supported by spicules. In *Argyrotheca* there is a calcareous band roughly parallel to the sides of the shell, corresponding to the primary loop of higher forms. In *Platidia* the septum is placed more posteriorly, and has in consequence a shorter primary loop, and in addition a pair of prongs at the top of the septum.

Amphithyris is thus comparable to *Argyrotheca* in its type of lophophore, but has a more primitive type of brachidium, and in addition differs in beak characters, *Argyrotheca* having a hypothyrid foramen. It is comparable in shape and beak characters to *Platidia*, but has a more primitive type of lophophore and brachidium. The only other genus in which amphithyrid beak characters are attained is *Mühlfeldtia*. In *M. truncata* the dorsal umbo is only slightly notched, the dorsal valve is still convex and the lophophore is plectolophous. In *M. monstruosa* and *M. echinata* the dorsal umbo is deeply notched and the dorsal valve is flat or even slightly concave, while nothing is known of the lophophore. The loop of *Mühlfeldtia* is, of course, much more advanced.

Amphithyris must be placed at present in the subfamily *Megathyrinæ*, which includes those members of the *Terebratellidæ* which have not advanced beyond the schizolophous stage of lophophore, together with *Megathyris* itself in which the lophophore is pytcholophous, *i.e.*, with additional lateral lobation. It may be questioned, however, whether *Platidia* is correctly placed in the *Dallininæ*, and should not be regarded as the final member of a subfamily which should include *Amphithyris* and *Argyrotheca* (in part). *Platidia* differs from all other members of the *Dallininæ* in its loop, lophophore and beak characters and in the possession of spicules. *Argyrotheca australis* (Blochmann) has prongs rising from the septum very similar to those displayed by *Platidia*, and differs in its brachidium only in possessing short crura and long and strongly curved primary lamellæ. The lophophore, which is unknown, may confidently be expected to be intermediate between the simple schizolophous type and the type displayed by *Platidia*. *Magasella incerta*, Davidson, which Fischer and Oehlert refer with doubt to *Platidia*, has hypothyrid beak characters, and its loop resembles that of *Platidia* but lacks the prongs on the septum. If adult, it appears to constitute a new genus in the above series.

The only other species at present referable to *Amphithyris* is *Terebratula seminulum* Philippi, which was considered by Davidson (1887) as a synonym of *Platidia anomioides*, but which Fischer and Oehlert (1891) recognise as generically distinct, and perhaps a species of *Cistella* (*Argyrotheca*). This species has amphithyrid beak characters, a schizolophous lophophore, and apparently no primary loop lamellæ. It was placed by Davidson in 1852 in his new genus *Morrisia*, the type of which was left ambiguous. Davidson's first gave a diagnosis and figure of the shell now known as *Platidia anomioides* but gave no name, and then added as belonging to the genus *Morrisia seminula* Philippi. It was, therefore, a case of a genus with two genosyntypes, *Platidia anomioides* indicated by the diagnosis and figure, and *Morrisia seminula* indicated by name, but not definitely stated to be the type. Later in the same year Davidson recognised the ambiguity, and definitely selected *Platidia anomioides* as the type of *Morrisia*, which thus became an absolute synonym of *Platidia*, founded earlier in the same year. But for this unfortunate choice of Davidson's it would have been possible to employ *Morrisia* for the new genus here described and to avoid the introduction of a new name.

Amphithyris buckmani *sp. nov.*

(Plate XV, fig. 29; plate XVI, fig. 35)

Habitat.—With *Liothyrella neozelanica* on a stone entangled on a fishing line of 200 fathoms length, Cook Strait, off Wellington, New Zealand.

The shell is broadly sub-orbicular or roundly sub-rectangular, with an obtusely angled beak and a broad, nearly straight hinge-line, the greatest breadth being about the middle of the shell. The ventral valve is feebly convex, and the dorsal valve nearly flat, the commissures being straight. The beak ridges are sharp, and meet in an obtuse apex, which has not been notched by the foramen. The pedicle issues through an opening composed partly of a large open triangular delthyrium in the ventral valve, and partly of a large semicircular notch in the cardinal edge of the dorsal valve replacing the dorsal umbo. The surface of the ventral valve is ornamented with fine raised radial lines. The punctation of the shell is fine, and the pore density in the ventral valve 160. The dimensions of the shell are :—Length 5 mm., breadth 5 mm., thickness 1·25 mm.

The hinge teeth are situated at the anterior edges of the delthyrium and are small, and not supported by dental plates. There are a few spicules in the sinuses of the ventral valve.

The cardinal border of the dorsal valve is notched by a semicircular foramen between one-third and one quarter the total width of the valve. At the posterior corners of the foramen two short socket ridges project slightly beyond the cardinal border, leaving two small semicircular hinge sockets at their outer sides. There is no sign of crura or primary loop lamellæ. A simple thin septum, highest at its posterior end arises from the median line a little in front of the middle of the valve. The lophophore is reniform in shape, occupying five-eighths the length of the valve and seven-tenths of its width and has a slight forward indentation near the foramen, and a deep posterior invagination in front where it passes behind the septum. It contains a single row of cirri, which were strongly coiled towards the interior in the dead shell, and give a serrate appearance to the outer border of the lophophore. The cirri are apparently divided by numerous transverse partitions. The lophophore is supported by a row of spicules rising obliquely outwards from the floor of the valve and from the top of the septum. These spicules continue all the way around the lophophore and are most crowded behind the mouth, but in front of it there is a space free from them, bounded on each side by two large spicules which pass back from the posterior base of the septum like two large prongs.

Further material is necessary for a better knowledge of the viscera and the muscles. The single specimen had been dead and rotting for a fortnight before it came into my hands.

The species differs from *Amphithyris seminula* (Philippi) in the presence of the radial ornament in the ventral valve. That species has moreover a smaller dorsal foramen and a smaller and less invaginated lophophore according to Philippi's figures as reproduced by Davidson.

Subfamily Magellaninæ *Beecher.*

The subfamily *Magellaninæ* includes a number of genera with loops of a pre-Magadiniform, a Magadiniform, a Magelliform, a Terebratelliform, or a Magellaniform pattern, or of a pattern derived from one of these, each genus attaining its final loop form by a series of metamorphoses corresponding to all of the above patterns which precede it in the order above stated. Thus the genus *Terebratella* passes through pre-Magadiniform, Magadiniform, and Magelliform loop stages during development. There are, however, a number of different stocks which have by similar but independent series of loop metamorphoses attained Terebratelliform or Magellaniform loop characters, and it has been found that some of these stocks can be satisfactorily distinguished by characters of the beak and cardinalia. A study of the fossil forms of New Zealand and Australia with regard to these latter characters indicates that there are other forms with Terebratelliform or Magellaniform loops which cannot be placed in any of the known genera, and the same is probably true of some of the recent species that have been placed under *Terebratella* and *Magellania*. Comparisons of the fossil or of the existing faunas of the various southern lands and seas cannot possess much weight until these different stocks have been distinguished.

In the present collection there are two species for which new genera become necessary. These I propose as follows :—

Gyrothyris, genotype *Gyrothyris mawsoni* sp. nov., Macquarie Island, loop terebratelliform.

Stethothyris, genotype *Stethothyris uttleyi* sp. nov., Ototaran, New Zealand, loop magellaniform.

Gyrothyris stands in most of its characters between *Pachymagas* and *Terebratella*, but in beak characters it differs from both. These two last genera have a mesothyrid foramen with fairly well-marked beak ridges, whereas in *Gyrothyris* beak ridges are practically absent. There is a difference between the hinge teeth of *Terebratella* and *Magellania* on the one hand and *Pachymagas* and *Neothyris* on the other, to which attention has not previously been called. In the former pair the hinge teeth are rather slender and spring from the overhanging dorsal sides of the posterior part of the ventral valve. Their bases are not greatly swollen and do not interrupt the internal curvature of the valve at the points of origin, the inner and outer surfaces being approximately parallel. In *Pachymagas* and *Neothyris* the hinge teeth are larger and spring from swollen bases which depart greatly from parallelism to the outer surface and considerably restrict the beak cavity. In *Gyrothyris* the teeth resemble those of *Pachymagas* in these respects.

In *Terebratella* the septum joins the cardinalia without bifurcation and the hinge trough is enclosed by two flatly inclined and excavate hinge plates. The cardinal process is confined to the umbonal region and is transverse. The cavities between the hinge plates and the floor of the valve also penetrate to some extent under the floor of the hinge sockets. In *Pachymagas* no such cavities exist, and there are no excavate hinge plates. The floor of the hinge sockets is a raised solid platform at the posterior end of the valve. The septum bifurcates before reaching the cardinalia, the socket ridges are swollen and firmly united with the crural bases, and the hinge trough lying between them is more or less completely occupied posteriorly by a prominent cardinal process. In *Gyrothyris* there is no cavity below the hinge trough or the base of the hinge sockets, both being floored by a solid platform. The septum bifurcates narrowly on top just before reaching the cardinalia, but the hinge trough is shallow and obtuse. The cardinal process is confined to the umbonal region and is transverse as in *Terebratella*.

Gyrothyris resembles *Pachymagas* more than *Terebratella* but differs from the former in the absence of beak ridges, the shallowness of the hinge trough, and the transverse nature of the cardinal process. Further, *Gyrothyris mawsoni* possesses a radial ornament which has never been observed on any species of *Pachymagas*. The genus is probably of similar antiquity, for in the uppermost Mount Brown limestone of the Weka Pass district, Canterbury, New Zealand, there is an unnamed species with exactly similar shape and beak characters, although larger in size and without radial ornament. The age of the rock in which it occurs is Awamoan, probably Upper Miocene.

All the other recent species with Terebratelliform loop from the southern seas appear with one exception to be correctly referred to *Terebratella*, viz., *T. dorsata* (genotype), *T. dorsata submutica* Fischer and Oehlert, *T. sanguinea* Leach, *T. sanguinea* var. Thomson, *T. rubicunda* Sow., *T.* cf. *Magella carinata*, Thomson, and *T. mayi* Blochmann. The above list omits the doubtful *Terebratella rubiginosa* Dall,* concerning which very little is known. The exception referred to is *Terebratella* sp. Jackson (1912) from the Burdwood Bank, in which Jackson states that the " well-developed cardinal plateau is fixed to the bottom of the valve, and depressed longitudinally in the form of a trough." The cardinal process is Terebratelliform, the foramen apparently submesothyrid with discrete deltidal plates and with well-marked beak ridges. This species appears to belong to a new genus.

Stethothyris approaches *Neothyris* most nearly in its beak and hinge characters, but it appears to belong to an older stock which attained Magellaniform loop characters independently. There can be little doubt that the various species of *Neothyris* have developed from species of *Pachymagas* of the type of *P. parki* (Hutton). The earliest known species of *Neothyris*, *N. novara* von Ihering, appears in the Awamoan of New Zealand. The *Pachymagas parki* group flourished in the preceding stage, the Hutchinsonian, although their range is somewhat greater, while *Stetothyris uttleyi* is confined, so

* Dr. Dall has kindly re-examined the cardinalia of this species and states *in litteris* that they are Terebratelliform, and not Terebratiform.

far as present knowledge goes, to the Ototaran, which is a still earlier stage. The ventral valve of *Stethothyris uttleyi* shows no great difference from that of *Neothyris*, the foramen being rather small, mesothyrid, attrite, with fairly well marked beak ridges. The hinge teeth are rather small and the bases not greatly swollen, except in old shells, but the beak cavity is considerably restricted by a general posterior thickening of the shell. The muscular impressions are well marked, as in *Neothyris*, with a raised median ridge between the adductor impressions.

In the dorsal valve (Plate XV, fig. 26) the septum bifurcates narrowly before joining the cardinalia. There is a solid raised platform at the posterior end of the shell above which the cardinalia rise and below the surface of which the hinge sockets are slightly countersunk. There are no excavate hinge plates. The crural bases are considerably swollen, lying within the diverging socket ridges, and they nearly unite posteriorly, leaving between them a hinge trough which is long, narrow and shallow. The cardinal process consists of three parts, a slightly raised central boss similar to that of primitive *Pachymagas* (cf. Thomson, 1915, No. 1, fig. 2a) and two lateral swellings which project on each side of the umbo and at first sight seem to be backward continuations of the socket ridges.

The principal differences between the cardinalia of *Stethothyris* and *Neothyris* may be summed up by stating that in the former the hinge trough is shallower and longer and the cardinal process less advanced, not filling the hinge trough.

In the only example of *Stethothyris pectoralis* (Tate) in which I have been able to expose the cardinalia, there is a similar arrangement of the parts (Plate XVII, fig. 60), but the hinge trough is almost non-existent apparently owing to abnormal growth. Neither the crural bases nor the lateral parts of the cardinal process are so swollen.

In *Stethothyris antarctica* sp. nov. the cardinalia almost exactly reproduce those of *S. pectoralis*, with the difference that the hinge trough is well defined and the cardinal process a little less advanced, being transverse and little different from that of *Terebratella*.

By the recognition of this genus it now becomes possible to obtain a clearer idea of the history of the forms previously placed under *Magellania*. *Rhizothyris*, so far as is at present known, is confined to the Oamaruian of New Zealand, [*R. rhizoida* (Hutt.), *R. curiosa* Thomson] and the older Tertiary of Australia [*R. corioensis* (McCoy)], and did not survive into the Wanganuian of New Zealand, although possibly, as is suggested below, it may have survived to a later date in other areas. *Stethothyris* occurs in the Ototaran (middle Oamaruian) of New Zealand (*S. uttleyi* Thomson) and the older Tertiary of Australia [*S. pectoralis* (Tate)], and still survives in the Antarctic seas (*S. antarctica*). *Neothyris* first appeared in the Awamoan (Upper Oamaruian) of New Zealand [*N. novara* (von Ihering)], was abundant in the Wanganuian of that country [*N. ovalis* (Hutton), *N. campbellica* (Filhol) and other unnamed species], and still lives in the New Zealand seas (*N. ovalis*, *N lenticularis* (Desh)]. *Magellania* is not found

either fossil or recent in New Zealand, but occurs in the seas of Australia [*M. flavescens* (Val.)], the Macquarie Islands (see postea), and the Antarctic (*M. joubini* Blochmann), and in South America. How far back into the Tertiary of Australia it extends is not yet exactly known, but some of the Table Cape fossils are undoubtedly true *Magellaniae*. There are still other stocks as yet undifferentiated in the older Tertiary of South America and Australia.

The position of many recent species commonly ascribed to *Magellania* is difficult to decide from the published descriptions and figures, because at the time these were made the characters of the beak and cardinalia were not considered of such importance as those of the general shape, the terminology employed in description did not lend itself to exactitude, and no great care was employed in depicting these characters.

In *Magellania*, *Stethothyris*, and *Neothyris* the foramen is mesothyrid, while in *Rhizothyris* it is permesothyrid. The chief difference in beak characters between *Magellania* and *Neothyris* lies in the sharpness of the beak ridges, which are always more obtuse and less pronounced in *Magellania*. *Anomia venosa* Solander is a species with beak characters more like those of *Neothyris* than *Magellania*. The cardinalia depicted by Davidson (1886, plate VIII, fig. 5) seem to be Magellaniform, but the description and figures of Fischer and Oehlert (1892, plate XI, fig. 16) indicate rather a Neothyroid type, although the cardinal process recalls that of *Rhizothyris*. Until the cardinalia have been redescribed from a modern standpoint, this species is best left in *Magellania sensu lato*.* *Terebratula fontainei* d'Orbingy has much external resemblance to *Neothyris ovalis*, but I have been unable to glean anything about its type of cardinalia in the literature available to me. As it is regarded by some as a synonym of *Magellania venosa*, it is also temporarily placed in *Magellania sensu lato*.

Waldheimia kerguelensis Davidson possesses cardinalia which from Davidson's figures (1880, plate III, figs. 8, 9; 1886, plate X, figs. 16, 17) are neither Magellaniform nor Neothyroid, but recall in the simple unbifurcated septum those of *Rhizothyris*. The figures for the most part indicate a mesothyrid foramen, but in one (1886, plate X, fig. 8) the foramen appears to be permesothyrid. There is thus uncertainty as to whether this species is referable to *Rhizothyris* or belongs to a distinct stock. The Kerguelen specimen figured by Eichler (1911, Taf. XLII, figs. 7, a, b, c; Taf. XLIII, fig. 16) has a submesothyrid foramen and apparently Magellaniform cardinalia, and appears to be the young of a quite distinct species, probably a true *Magellania*. Until a better specimen is forthcoming to serve as a type, it is not desirable to rename it. The cardinalia of *Magellania fragilis* Smith have not been described or figured, so that it is impossible to place the species. In general, however, the shell of Magellania is more fragile than that of *Neothyris* or *Rhizothyris*. Finally *Waldheimia wyvillei* Davidson is a species whose cardinalia as figured by Davidson (1880, plate III, fig. 13b; 1886, plate X, fig. 6) do not agree with any of the known types.

* The examination of specimens recently received indicates that the cardinalia are Magellaniform, but the foramen is becoming permesothyrid (January, 1918).

Genus STETHOTHYRIS *Thomson*, 1918.

STETHOTHYRIS UTTLEYI *sp. nov.*

(Plate XV, figs. 27, 28.)

In order to base a new genus on this species, it is necessary to give here a brief diagnosis. The internal parts have already been described. The shell is of moderate size, elliptical, with gently rounded sides and a truncate front. The hinge line is of moderate breadth and obtusely angled. The lateral commissures are nearly straight, but the anterior commissure shows a flat-bottomed ventral depression of moderate width, corresponding to which there is a shallow anterior median sinus in the dorsal valve and an obscure median fold in the ventral valve, flattened anteriorly. The valves are moderately and nearly equally convex, the greatest thickness of the ventral valve being about the middle, and of the dorsal a little anterior to the middle of that valve. The beak is of moderate length, sub-erect, with fairly prominent beak ridges and a rather small mesothyrid foramen. The deltidial plates are fairly high and are transversely striated, often with a prominent median cord. The species differs from *S. pectoralis* (Tate) in its much shorter median dorsal sinus, its less incurved beak and correspondingly less convex pseudodeltidium, and its broader hinge line.

Type locality.—Tuff band, Weston's Quarry, Weston, near Oamaru, New Zealand. Horizon Ototaran, probably Lower Miocene. The species was discovered by Mr. G. Uttley, after whom it is named.

The holotype is not the specimen here figured, and is in the Dominion Museum, Wellington.

STETHOTHYRIS ANTARCTICA *sp. nov.*

(Plate XV, figs. 24, 25, 26; plate XVI, fig. 39.)

Habitat.—Station 10; off Shackleton Glacier (Davis Sea), 325 fathoms, 29th January, 1914. Sea-bottom, ooze; temperature 1·65° C.

The material consists of the united posterior end of both valves, and a separate fragment apparently of the anterior and left side of the ventral valve of the same specimen. The shell was evidently larger in size than any known Antarctic species, and must have been 50 mm. or more in length. The ventral valve is strongly convex, and the dorsal much less so. The beak has only moderately pronounced beak ridges and a fairly large mesothyrid foramen. The dorsal view of the united parts strongly recalls that of *Magellania venosa* as figured by Fischer and Oehlert (1891, plate XI, figs. 12, 13), but the characters of the cardinalia of the dorsal valve prevent an association with that species or with *Waldheimia kerguelensis* Davidson. The septum bifurcates narrowly before joining the cardinalia, and the two branches, instead of uniting with the crural bases, as in *Neothyris*, run backwards towards the cardinal process, which is small and transverse as in *Magellania*. The socket ridges are very massive and broad posteriorly. The branches of the bifurcating septum overhang somewhat on each side,

as if in process of evolution to hinge plates of the Magellaniform type, but the process is not far advanced. The shell substance is thick, and the pores rather large and circular, with a density of only 60 to 70 on the fragment of the anterior border.

The type of cardinalia above described agrees so nearly with that of *Stethothyris pectoralis* Tate (plate II, fig. 2) that there can be little doubt the two species are congeneric. Although the material is fragmentary the characters of the cardinalia render the identification of more perfect examples easy, and for the purposes of convenient reference I venture to give the species a name.

Genus GYROTHYRIS *Thomson*, 1918.

GYROTHYRIS MAWSONI *sp. nov.*

(Plate XV, Figs. 1, 2, 3, 4, 5.)

Habitat.—One mile off south end of Macquarie Island.

Shell ovato-triangular, with a narrow beak and rounded sides and front, the latter slightly produced. The hinge line is narrow and strongly curved. The dorsal valve is only moderately convex, with steep slopes near the umbo, and an indistinct frontal sinuation. The ventral valve is strongly convex posteriorly, becoming flatter in front, and has an indistinct median fold. The commissure is straight on the sides and shows a broad, shallow ventral depression in front. The beak is of moderate length, narrow but swollen, erect, and without pronounced beak ridges. It is truncated by a foramen of moderate size, apparently mesothyrid in position and attrite in condition. The pseudodeltidium is almost hidden, and is low, narrow, and concave. The surface of the single specimen is much obscured by encrusting bryozoans, but shows fairly strong growth lines, and an obsolete radial costation a little more prominent than that present in *Terebratella rubicunda* and of similar fineness. This radial ornament is not brought out in the illustration owing to lighting of the specimen from both sides. Owing to the encrusting organisms, the pores could not be counted.

The characters of the interior and the relationships of the species have been described above.

Genus MAGELLANIA *Bayle*, 1880.

Genotype TEREBRATULA FLAVESCENS *Val.*

MAGELLANIA JOUBINI *Blochmann.*

(Plate XV, figs. 6, 7; plate XVI, figs. 33, 34, 41.)

1906. *Magellania joubini* Blochmann, Zool. Anz., Bd. XXX, p. 697.

1907. *Magellania sulcata* Smith, National Antarctic Expedition, 1901–1904. Natural History, Zoology, vol. 11, Brachiopoda, pp. 1, 2, figs. 3, 4.

1908. *Magellania joubini* Blochmann, Zeitschr. f. wissensch. Zool., Bd. XC, p. 609.

1911. *Magellania joubini* Eichler, Deutsche Südpolar-Exped. 1901–1903, Bd. XII (Zool. Bd. IV), Heft. IV, pp. 388–390, Taf. XLII, figs. 5a–c, 6a, b, Taf. XLIII, figs. 17, 18, Taf. XLIV, figs. 23, 24.

1911. *Campages joubini* Hedley, Commonwealth of Australia. Fisheries. Zool. Res. F.I.S. "Endeavour," 1909–1910. Part 1, p. 114.

Habitat.—Station 2, lat. 66° 56′ S., long. 145° 21′ E. (off Adelie Land), 288–300 fathoms, 28th December, 1913. Sea-bottom, ooze ; temperature 1·8° C.

Station 3, lat. 66° 32′ S., long. 141° 39′ E. (off Adelie Land), 157 fathoms, 31st December, 1913. Sea-bottom, ooze ; temperature 1·62° C.

Station 8, lat. 66° 8′ S., long. 94° 17′ E. (Davis Sea), 60 fathoms, 27th January 1914. Sea-bottom, red algæ and small rocks.

The only adult shell of this species from Station 3 may be described as follows :— Shell in shape resembling a lozenge with rounded edges, considerably longer than broad, greatest breadth slightly posterior to the middle, rapidly tapering to a narrow, nearly straight front, the sides uniting with the front in marked angles. Hinge line rather broad and very obtusely angled. Dorsal valves lightly convex, flattened on top, ventral valve strongly convex with a broad median fold. Anterior commissure, with a shallow, broad ventral sinuation. Beak of moderate length, erect, beak ridges rounded but distinct, foramen of moderate size, mesothyrid, attrite ; pseudodeltidium rather narrow and low, concave. Surface of valves marked with numerous strong growth-lines crowded anteriorly, giving rise to a lamellar structure. Shell substance thin, pores very large, 96 to 108 to the square mm.

The loop is relatively as fragile as the shell, and parted entirely from the crura in an effort to remove the arms and other soft parts, but it was observed to be of typical Magellaniform pattern, with a very slender ribbon. The septum extends barely to the middle of the valve. The excavate hinge plates are narrow and steeply inclined, and the cardinal process is small.

The above specimen differs somewhat in outline from the forms of *Magellania joubini* previously described, but it possesses the chief distinguishing characteristics of that species, viz., the thin shell with large pores and the strong concentric "sulcations." These features thus appear to mark off from other species of *Magellania* a series of shells exhibiting considerable variety of form, and it seems best to group them together under one species.

The other examples from Stations 2, 3, and 8 are all young or half-grown shells, but they are all easily distinguished from the other associated species by the coarse punctation of their tests. One of 9 mm. in length from Station 8 has a pore density of 124. Some of these specimens enable the younger stages of the loop to be observed,

the youngest being in the Magelliform stage. The chief peculiarity of the series lies in the obliquity of the attachment of the jugal band in the Terebratelliform stage, and of the remnants of this band in the early Magellaniform stages, one of which is shown on plate XV, fig. 6.

Magellania macquariensis *sp. nov.*

(Plate XV, figs. 13, 14, 15, 16, 17; plate XVI, fig. 40.)

Habitat.—"On beach above present high-water level, Wireless Cove, north-west end of Macquarie Island, over an extent of $\frac{1}{4}$ mile."—H. Hamilton.

Some thirty specimens of this polymorphic species were obtained above the normal high-water on the beach of Wireless Cove, but as several of them contain the dried animal it is evident that they were recently cast there by a high sea, probably during a storm.

There is considerable diversity in shape, between the extremes shown in plate XV, figs. 13 and 15, but roundly ovate shells with a broad hinge line and a slightly produced front predominate. The growth lines in all cases indicate development from a roundly ovate form, but in a few cases the adults are much longer than broad. The specimen chosen as holotype has the following dimensions:—Length 26 mm., breadth 24 mm., thickness 15 mm. The shell figured in plate XV, fig. 15, is the only one showing a truncate front margin, which is due to a sudden reduction anteriorly of the broad ventral fold. The diversity in form, taken together with the frequency of unsymmetrical and distorted shells, may probably be correlated with diversity of environment such as is to be found in a shallow and stony bottom within range of current action.*

The dorsal valve is only moderately convex, but the slopes leading to the umbo are steep. There is a median sinus which is generally rather narrow and shallow, giving rise to a simply curved ventral sinuation of the anterior commissure. In a few cases it is narrow, but fairly deep, and again in others it is broad and shallow, causing a nearly flat-bottomed ventral sinuation in the anterior commissure. The ventral valve is more convex than the dorsal, and presents an obscure median fold. The lateral commissures are straight.

The beak is of moderate length, is sub-erect to erect, and bears fairly strong but blunt beak ridges. The large rounded foramen is mesothyrid in position and attrite in condition, but it is not completed dorsally by the deltidial plates, which are discrete in every case, allowing the dorsal umbo to project into the foramen.

The test is moderately thick, and is generally in a rough condition exteriorly. The growth lines are prominent, and there is no trace of radial ornament. The pores are of moderate size and number 108 to the square millimetre.

* Distortion of brachiopods is frequently caused by the fry settling in the mouth of a boring, the diameter of which is too small to accommodate the adult shell. This is well exhibited in the series of *Liothyrella neozelanica*, described above.

In the ventral valve the hinge teeth spring from the sides of the valve, and are not supported by dental plates. The cardinalia, septum and loop of the dorsal valve are all typically Magellaniform. Compared with *Magellania flavescens*, the septum is short, the hinge plates broader and less pointed in front, the cardinal process broader, and the loop more delicate. In the fully grown specimen no trace of the connecting band with the septum remains, not even in the form of a projection on the dorsal side of the primary lamellæ, but in a specimen of 13 mm. in length, the connecting bands almost reach the septum as two needle like spurs. A young individual of 6 mm. in length is in the Magadiniform loop stage.

The species with which *Magellania macquariensis* is to be compared is undoubtedly *Waldheimia smithi* Pfeffer from South Georgia, known from a single individual. Some of the Macquarie Island specimens agree in many respects with Pfeffer's figure, but they lack the anterior indentation of that species, and the youthful growth lines are sub-orbicular instead of being elongated ovate with a straight front. Further study will probably reveal other differences between the species, the internal characters of *Waldheimia smithi* being as yet unknown.

Genus Terebratella *d'Orbigny*, 1847.

Genotype Anomia dorsata *Gmelin.*

Terebratella sanguinea (*Leach.*)

1814. *Terebratula sanguinea* Leach, Zool. Misc., p. 76, tab. XXXIII.

1817. *Terebratula cruenta* Dillwyn, Descript. Cat. Recent Shells, vol. 2, p. 295.

1841. *Terebratula zelandica* Deshayes, Revue Zool. Soc. Cuv., p. 359.

1846. *Terebratula rubra* Sowerby, Thes. Conch., vol. 1, p. 345, plate LXVIII, figs. 9–11 (not of Pallas).

1852. *Terebratella Evansii* Davidson, Proc. Zool. Soc., p. 77, plate XIV, figs. 7–9.

1905. *Terebratella sanguinea* Hutton, Trans. N.Z. Inst., vol. 37, p. 447.

(For fuller synonymy consult Davidson, Trans. Linn. Soc., vol. 4, pt. 2, p. 87, 1887 and Suter, Man. N.Z. Moll., p. 1074, 1913.)

A single specimen of 7 mm. length dredged in 40 fathoms from the east of Enderby Island, Auckland Islands, by Mr. Edgar Waite, agrees well with young examples of the common New Zealand species *Terebratella sanguinea*. It has not before been recorded from the outlying islands of New Zealand.

Terebratella vel Magellania *sp.*

(Plate XV, figs. 11, 12.)

Habitat.—Station 10; off Shackleton Glacier (Davis Sea), 325 fathoms, 29th January, 1914. Sea-bottom ooze, temperature 1·65° C.

The single specimen is small, translucent white, broadly ovate to lozenge-shaped in shape with a broad obtusely angled hinge line. The sides are rounded, passing without a marked angle into the slightly truncate but gently rounded front. The convexity is moderate, the ventral valve taking the larger share. There is a faint anterior median sinus in the dorsal valve producing a ventrally directed sinuation in the anterior commissure. The beak is blunt, short, sub-erect without marked beak ridges, truncated by a submesothyrid foramen which opens into a delthyrium only partially closed by lateral deltidial plates. The surface of the shell is smooth, with feebly developed growth lines, not crowded anteriorly, indicating a youthful shell. The pores are moderately large, but not so large as in *M. joubini*, the pore density being low, only 70 per sp. mm.

The loop is in a late Terebratelliform stage and extends forward to three-quarters the length of the dorsal valve; the ascending branches are broader than the descending, and occupy only one-third the breadth of the valve. The septum and cardinalia are of the Magellaniform pattern with narrow and short hinge plates.

As the specimen is apparently not fully grown, it is uncertain whether it should be referred to *Terebratella* or *Magellania*. In shape it lies between *Magellania joubini* and *M. fragilis* Smith, and is broader than specimens of the former of the same length, and narrower than growth lines of the latter at the same length. From *M. joubini* it is further distinguished by the absence of the strong growth lines of that species and by the smaller pores. Although the less developed beak characters, as compared with *M. fragilis*, might be considered as due merely to its youth, the more advanced folding in so much smaller a shell shows that it cannot be the young of this species. It is probably the young of a new species.

Dimensions—Length 13 mm., breadth 11·5 mm., thickness 6·5 mm.

Magellania (?) *sp.*

(Plate XV, fig. 23.)

Habitat.—Station 2, lat. 66° 55′ S., long. 145° 21′ E. (off Adelie Land), 288–300 fathoms, 28th December, 1913. Sea-bottom, ooze; temperature 1·80° C.

A series of small specimens, from 6 mm. to 12 mm. in length, and all obviously young shells, must apparently be referred to a new species. As in the case of the last described specimen, the generic position must remain uncertain until adult shells have been examined. None of the present series have passed the Magelliform stage, and they may be referable to *Magella*, *Terebratella* or *Magellania*.

The largest specimen (length 12 mm., breadth 10 mm., thickness 5 mm.) is regularly ovate with a hinge line moderately broad and obtusely angled. The convexity is slight, the greater part being taken by the ventral valve. There is no marked sinus in the dorsal valve, but a gentle and broad ventral sinuation in the anterior commissure. The beak is short, sub-erect, with moderate beak ridges and a relatively

large mesothyrid foramen not separated from the dorsal umbo by the deltidial plates, which are small and discrete. There are rather prominent growth lines in the first half of the shell, and again at three-quarters, the remainder of the shell being smooth. The pore density is 80 per sq. mm.

The septum is long and junctions behind with cardinalia of the Magellaniform pattern. The loop is in the Magelliform stage.

The other specimens agree nearly enough in all essential characters but are on the whole broader. They show a pore density of 70 to 87.

The smallest specimen of 6 mm. in length deserves special mention. It was at first thought to be a specimen of *Macandrevia* in the Platidiform loop stage, but it does not possess dental plates which were observed in an undoubted *Macandrevia* of the same length in the present collection (see below), and moreover it possesses Magellaniform hinge plates. It must be regarded as in an abnormal Magadiniform loop stage in which the primitive hood has not yet been converted into a ring while the attachment of the primary lamellæ has become very oblique and nearly reached the position usually attained in the Magelliform stage. This specimen shows a tendency to a straight front and is perhaps a different species from the others.

Subfamily Dalliniae *Beecher.*

Genus Macandrevia *King*, 1859.

Genotype Terebratula cranium *Müller.*

Macandrevia lata *sp. nov.*

(Plate XVI, fig. 44; plate XVII, figs. 46, 47, 48, 49, 50.)

Habitat.—Station 10; off Shackleton Glacier (Davis Sea), 325 fathoms, 29th January, 1914. Sea-bottom, ooze; temperature, 1·65° C.

Material : one fragment of a dead shell and eight specimens taken alive, of which only four are fully adult.

The shell is broadly ovate, as broad as long, and in shape most resembles *Macandrevia americana* Dall (1895) and *M. vanhoffeni* Blochmann (1906) but is even broader than these species, and differs from both in possessing a straight instead of a rounded front. The hinge line is rather short and obtusely angled. The ventral valve is moderately convex and the dorsal valve flatter, the species repeating in these respects the proportions of *M. americana* and differing from *M. vanhoffeni*. There is no marked fold or sinus on either valve, and the commissures are practically plane, but a tendency to anterior retardation of the *Cincta* type is perhaps evidenced by a slight anterior flattening along the middle line of each valve, giving rise to the straight front. This flattening is, however, rather more pronounced on the dorsal valve. A similar

phenomenon has been described in *M. cranium* by Fischer and Oehlert (1891, p. 72), while a straight front is also exhibited by *M. craniella* Dall (1895). On the other hand *M. diamantina* Dall has a well-marked ventral uniplication.

The beak is short, and sub-erect to erect, as is usual in species of this genus. Beak ridges are not well-defined, but appear to point dorsally of the foramen, which is thus permesothyrid in position. The foramen, however, merges dorsally into an open delthyrium, with only very feebly developed lateral deltidial plates. Within the beak there is a deposit of callus, resembling a pedicle collar, but closely applied to the bottom of the valve, passing up in front laterally into the dental plates, which support small teeth. A similar deposit of callus is described by Dall in *M. americana*, while in *M. cranium* it is figured, although not described, by Fischer and Oehlert (1891, plate V, fig. 10 f.). The deltidial plates are very feebly developed and less prominent than in *M. americana*.

In the dorsal valve, the loop is long, extending forwards three quarters the length of the valve, when it is sharply recurved and gives off a few spinules on each side. The transverse band is narrow, its greatest width of the loop occupying only about a third of the breadth of the valve. The average breadth of the ribbon does not exceed one millimetre, except in the neighbourhood of the crural processes, which point ventrally inwards and are approximate. The crura are very short and spring from crural bases which are fused laterally on their outer margins with the short, widely diverging socket ridges. There is no median septum in the adult shell, while the hinge plate is represented by two lamellae which descend steeply from the inner sides of the crural bases to the floor of the valve a little more than one mm. on each side of the middle line, and are excavate anteriorly on their outer sides. These lamellae appear to be continuous across the floor of the valve along the middle line of the valve, closely applied to the bottom, extending back right to the neighbourhood of the umbo, and forward beyond their lateral free anterior edges for a slightly greater distance. In front of them there are three raised thread-like lines extending forward a short distance.

The surface of the shell is smooth, with only occasional traces of a radial ornament such as is described in the next species. The lines of growth are mostly very fine, but a few well-marked growth pauses may be seen on all the specimens. The shell substance is delicate. There are 80–112 pores per sq. mm., the pore density being somewhat variable on the same specimen, but a little lower than in *M. vanhoffeni* (120–132) though in view of the variability in this respect displayed by species of *Macandrevia*, too much importance must not be attached to such differences.

The above described peculiarities in the beak characters, dental plates and cardinalia seems to be common to all species of *Macandrevia*,* and are alone sufficient to establish the generic position of any shell. The direct evidence of the Macandrevian type of loop development is, however, forthcoming in the present species, a specimen of

* Cf. Thomson, 1916, No. 2, pp. 502–503, and the figures of *M. vanhoffeni* by Eichler (1911, Taf. XLII, fig. 9, d; Taf. XLIII, fig. 14,

6 mm. length being in the Platidiform stage. In this specimen the dental plates are already developed and there is no anterior median ridge in the ventral valve such as occurs in young stages of species of the *Magellaninae*. In the dorsal valve the elevated septum does not reach as far back as the cardinalia, and the hinge plates descend steeply from the socket ridges to the floor of the valve much as in early stages of *Terebratella rubicunda* (Thomson, 1915, No. 2). The next smallest specimen of 11 mm. length has just passed the Terebrataliform stage and shows no trace of the septum.

The dimensions of the specimen chosen as the holotype are :—length 24 mm., breadth 22 mm., thickness 11 mm. A tendency to a straight front is noticeable on specimens as small as 13 mm. in length, but the specimen of 6 mm. is regularly rounded, with a dorsal valve slightly broader than long.

Macandrevia vanhoffeni *Blochmann.*

(Plate XV, fig. 10; plate XVI, fig. 43; plate XVII, figs. 57, 58, 59.)

1906. *Macandrevia vanhoffeni* Blochmann, Zool. Anz., Bd. XXX, pp. 696–697.

1911. *Macandrevia vanhoffeni* Eichler, Deutsche Südpolar Exped., 1901–1903. Zool., Bd. IV, Heft. IV, pp. 391–392, Taf. XLII, figs. 8*a-b*, 9 *a-d*, Taf, XLIII, figs. 14, 15, 21.

Habitat.—Station 11, off Shackleton Glacier (Davis Sea), 358 fathoms, 31st January, 1914. Sea-bottom, ooze.

The single adult shell is of moderate size, white in colour, and is rather broadly ovate with rounded sides and a slightly truncate front which is gently rounded. It is not so broad as *Macandrevia lata* and differs fron that species in the narrower and rounded front. The hinge line is broad and curved without a marked angle at the dorsal umbo· The convexity is moderate, the ventral valve assuming a slightly larger share. The folding is similar to that described above for *M. lata*, except that the anterior flattening of the valves is not so pronounced. The beak characters and dental plates do not differ from those of *M. lata*, and the cardinalia are of the same pattern, but the hinge plates are more approximate at their base and there is a small swelling just in front of the dorsal umbo which seems to represent a feeble cardinal process. The loop extends to three-fifths the length of the dorsal valve. The descending branches describe gentle outward curves from the middle line, making a total width of about one-third the width of the valve. The ascending branches are missing. The shell substance is thin, and the interior has a nacreous appearance. The growth lines are fairly prominent, and there is in addition a fine but irregular radial ornament which in the interior takes the form of faintly impressed radial grooves, most noticeable at a short distance on each side of the flattened middle longitudinal part of the dorsal valve. A fine radial ornament has been described by Dall in *M. craniella*, from which the present species differs by its greater breadth and less truncate front. No such radial ornament has been described for *M. vanhoffeni*, but it is possible that it has been overlooked. It seems safest meanwhile to

ascribe the present specimen to that species, as the general shape is the same, and it was obtained from a neighbouring locality. The pore density varies from 115–120 mm. near the middle of the ventral valve, a valve differing but slightly from that observed for *M. vanhoffeni*, viz., 120–132.

The dimensions of the specimen are :—length 20 mm., breadth 17 mm., thickness 9 mm.

From the same locality there is an immature specimen of 11 mm. in length which also shows the radial grooves on one side of the interior of the dorsal valve. It is relatively broader than the adult, and is a little broader than the growth lines of the latter at the same length, but is doubtless to be referred to the same species.

Similarly a fragment of a dorsal valve, 4 mm. in length, from the same locality also shows the internal radial grooves. The loop and one side of the hinge are broken off, but there are the remains of a septum placed posteriorly but not reaching to the umbo. Obviously this fragment belongs to a young stage of the same species in the Platidiform loop stage.

Macandrevia vanhoffeni differs from *M. americana* in being slightly narrower and less convex, and also, if the present species is correctly identified, in possessing a fine radial ornament.

Habitat.—Station 10 off Shackleton Glacier (Davis Sea), 325 fathoms, 29th January, 1914. Sea-bottom, ooze. Temperature, 1·65° C.

From this locality there are four adolescent shells differing from the specimens of *M. lata* occurring at the same locality in a less amount of frontal truncation combined with a more marked radial ornament. Three of them agree nearly enough in shape with *M. vanhoffeni*, but the fourth (length 9 mm. breadth 17 mm.) is relatively nearly as broad as *M. lata*, although without the straight front of that species. It may be regarded as a broad example of the present species.

Habitat.—Station 2; lat. 66·55 S. long. 145·21 E. (off Adelie Land), 288–300 fathoms, 28th December, 1913. Sea-bottom, ooze. Temperature, 1·8° C.

From this locality there is a small specimen (length 13·5 mm., breadth 13 mm.), of broadly ovate shape with a rounded front, which also displayes the internal radial grooves in the dorsal valve. Its pore density is 103 per sq. mm. A still smaller specimen of 8 mm. in length is rather narrower and also displays the radial ornament.

Both contain dental plates, the larger being in the Macandreviform loop stage without a septum, and the smaller in what must at present (though incorrectly) be termed the Terebrataliform stage with a septum which does not unite with the cardinalia.

These specimens must be tentatively referred to as *M. vanhoffeni* in the absence of adult shells from this locality, and greatly extend the range of the species to the East.

PART II.

Geographical Distribution of the Brachiopods in the Southern Seas.

PREVIOUS DISCUSSIONS.

The geographical distribution of recent Brachiopods throughout the whole world has been stated and briefly discussed by Suess, Davidson, Oehlert, and Hall and Clarke, but at the time these discussions were attempted (1852 to 1892) many cases of discontinuous distribution, which have since proved to be cases of erroneous determinations, were believed to exist, and the conclusions reached were thus lessened in value. Many of the errors in previous determinations were corrected by Blochmann (1908), who at the same time gave a most useful statement of the significance of the general facts of distribution.

In 1892 Fischer and Oehlert gave an excellent summary of the then known distribution of the Brachiopoda of the southern seas, pointing out the unity of the faunas of the Arctic and neighbouring coasts as opposed to the diversity of the southern faunas. They grouped the latter into the following zoological provinces :— Magellan or Antarctic, New Zealand, Tasmania and Southern Australia, Cape of Good Hope, and the Kerguelen Islands. The similarities existing between the Magellan, Kerguelen, and New Zealand faunas on the one hand, and the differences from these displayed by the Australian and South African faunas on the other were sought to be explained solely by considerations of latitude and temperature.

Dall (1894) in describing *Macandrevia americana* pointed out the possibility of a migration of Brachiopods and other marine organisms along the western coast of America. "It may be observed that there is nothing to prevent the free migration of northern forms into the South Pacific along the coast of the Americas. The writer has already the evidence to show that several species in deep water do extend from Behring Sea south to the vicinity of the Galapagos Islands, and, in the case of one species, *Solemya johnsoni* Dall, more than a thousand miles further south. With the known great range of many Brachiopods, there would be no apparent reason why species of the Panamic region, for instance, belonging to the northern type of development, should not extend their range southward, if opportunity arose."

As Jackson (1912) has remarked, the prescience of this eminent American author has been amply justified by the subsequent discovery of a Panamic species of Brachiopod, *Macandrevia diamantina* Dall, off Coats' Land, Antarctic.

Von Ihering in 1903 discussed the history of the fauna of the Magellan region, and gave lists of the species from Chili, Brazil, and New Zealand. He pointed out that the Tertiary Brachiopod fauna of Patagonia agreed more closely with that of New Zealand than with that of Chili, and argued that the Patagonian and New Zealand regions were each united to an Antarctic continent at that time, but that

Patagonia was separated from Chili by a strait of considerable breadth. The present Magellan fauna was considered to consist in part of forms derived from the Tertiary fauna of that district and in part of recent immigrants from the north along the Pacific coast of America, and from the south (Kerguelen district) along the coast of the Antarctic Continent. Von Ihering recognised that the climate of the early Tertiary in Patagonia was warmer than that of the present day.

Blochmann (1908) discussed the possibilities of migration possessed by Brachiopods and their larvæ, and arrived at most interesting conclusions, which appear well founded. In the adult stage the animals are fixed to some object by their peduncle and locomotion is precluded. They are frequently swallowed by fish, and may be subsequently disgorged alive, but the chances of their living in the stomach of a fish while being carried any great distance, and the further chance of both male and female individual being thus planted close to one another, are so small as to render such a method of transference quite negligible. There remains only the distribution effected during the free swimming larval stage. In this respect a distinction must be drawn between *Lingula* and *Discina* (sensu lato) on the one hand and the rest of the class on the other.

Lingula and *Discina* have pelagic larvæ furnished with a mouth and a functioning stomach. Nevertheless only one species, the deep-sea form *Pelagodiscus atlanticus*, is cosmopolitan in its distribution. The narrower distribution of other species is probably conditioned by the fact that they are adapted to shallow bottoms in warm waters. *Discinisca lamellosa* is frequently found in great groups, which seems to show that the larvæ have not swum far, and the young of *Discinisca lævis* frequently also rest on adult shells.

So far as is known, the larvæ of other Brachiopods are not pelagic, and have not been found in the plankton of higher levels of the sea. Blochmann has himself repeatedly searched for them at the season of reproduction without success around the Norwegian coasts where Brachiopods are common, and he concludes that they remain near the bottom and settle down not far from their mother. This must especially be the case for the deeper forms which are below the effective action of currents.

The organisation of the larvæ of the species in question precludes a long duration of the free-swimming stage. With the exception of *Lingula* and *Discina** they are all, as far as known, without a mouth and functioning stomach during this stage, and must consequently soon come to rest. Actual observations on two species of *Terebratulina* show that the larvæ settle after ten to twelve days.

From these facts Blochmann concludes that the power of distribution of Brachiopods is very limited, and that the larvæ are unable to cross the oceans from one coast to another. Only a few species live in depths of over 2,000 metres (roughly

* Little is known of the larvæ of *Crania*.

1,000 fathoms) and a gradual migration across the deep oceans along the bottom is impossible for other species. The majority of the Brachiopods are found on the submarine slopes of the continents and the neighbouring islands, and the deep oceans are barriers which they cannot cross.

Cases of discontinuous distribution of the shallower water forms have therefore a profound significance. Thus the occurrence of *Dyscolia wyvillei*, *Lacazella mediterranea*, *Platidia anomioides*, and *Eucalathis ergastica* in the Antilles and on the corresponding coasts east of the Atlantic, together with the occurrence of other closely allied species on these opposite coasts and of two Antillean species on Ascension Island, can have only one explanation, viz., the occurrence of land connections or at least shallow submarine ridges across the Atlantic in an earlier geological period.

In the case of the discontinuous distribution of the deep water species *Dyscolia wyvillei* in the north Indian Ocean and east and west of the Atlantic, together with the restriction of *Chlidonophora* to these two regions, Blochmann seeks a similar geological explanation, viz., that in Tertiary times there was an open seaway between the Atlantic and the Indian Ocean through the earlier greatly extended Mediterranean Sea. The occurrence of *Kingena alcocki* Joubin in the Indian Ocean is similarly correlated with the fossil occurrence of this genus in Europe.

Before these conclusions can be regarded as definitely established, Blochmann points out that more must be learnt of the structure of the larvæ and of the duration of the free-swimming period in a larger and more varied series of genera. Meanwhile they possess a high degree of probability, and they suggest that a study of the distribution of southern Brachiopods may be a useful contribution to the larger problem of the former land connections of the southern hemisphere.

Schuchert (1911), in discussing the palæographic and geological significance of recent Brachiopoda, has analysed and discussed the bathymetric and geographical distribution of the recent genera. The districts recognised are a deep-water realm and four shallow-water geographical regions as follows :—Boreal, Austral, Oceanica, and Gondwana. The analysis contains several minor inaccuracies, but these do not greatly affect the main conclusions. A more serious defect is the apparent assumption that the origin of nearly all the southern forms must be sought in the north, but that none of the northern forms originated in the south. Yet the southern Tertiary faunas were at least as rich and varied as those of the north, and there is little reason to assume that such was not also the case in earlier times.

Schuchert follows Blochmann in postulating a former land connection across the Atlantic, the northern shore of ancient Gondwana and the southern strand of the extensive Mediterranean Tethys which reached from Central America to India. This shore was broken up in the present south Atlantic region during the early Eocene, but in the early Tertiary there was an open seaway between the Panama and Caribbean regions and also free communication with the Indian Ocean. The genera of the northern

Atlantic distributed themselves not only around the Atlantic coasts but also eastwards into the Indian Ocean, but the principal drift was westward by way of the Antillean region into the Pacific, and thence in the main down the west coast of South America into the Antarctic realm, whose waters were then much warmer than they are now.

Hemithyris is regarded as originating in the Boreal region, where the family *Rhynconellidae* is best developed since the Silurian. The four species of the Austral region seem to have spread from Japan south through Oceanica, and thence by way of New Zealand into Antarctica. This conclusion seems based mainly on the occurrence of the species *Rhynconella grayi* Woodward in the Fiji Islands, but it cannot be regarded as yet established that this species is correctly assigned to *Hemithyris*.

There are six genera restricted to the Austral region, viz., *Agulhasia*, *Kraussina*, *Bouchardia*, *Magellania*, *Terebratella* and *Megerlina*. This region is faunally connected directly with Oceanica. The other genera in these waters are regarded as immigrants from Gondwana. Schuchert has not discussed the different districts of the Austral region or the former land connections which have been suggested between them.

As regards the deep-sea realm, Schuchert concludes from a consideration of the deeper-seated forms whose geological history is known that the present deep-sea forms as a rule did not begin to migrate to this habitat earlier than the middle Mesozoic, and further, that this adaption is still going on. The truly abyssal forms, as *Basiliola*, *Chlidonophora*, *Frieleia* and *Pelagodiscus*, are probably of stocks even older than the middle Mesozoic, and these genera may have begun their abyssal march as early as the beginning of the Mesozoic, the period at which the oceans began to get exceedingly deep.

In the subsequent discussion it will be convenient first to consider the abyssal fauna, and then to state in detail the distribution of the coastal forms according to geographical districts, before discussing fully the significance of the similarities and differences that these various districts exhibit.

THE ABYSSAL FAUNA.

A distinction must be drawn, as Schuchert has pointed out, between deep-water forms which frequent the margins of the continents, and typical abyssal forms which occur in the middle parts of the great oceans as well. Of the latter there are only five species known, two of which *Chlidonophora incerta* (Dav.) and *Chlidonophora chuni* Blochmann do not occur in the southern hemisphere. *Neorhynchia strebeli* (Dall) has been reported only from the " Albatross " station, 4721, in mid-Pacific, in 2,084 fathoms, globigerina ooze, and from Station 4709 southwest of the Galapagos group, in 2,035 fathoms, ooze. The other two species, *Pelagodiscus atlanticus* (King) and *Terebratula* (Abyssothyris) *Wyvillei* Dav., have a wide distribution in both hemispheres. The former occurs in

the north and Mid-Atlantic, off Coats Land, Antarctic, and in the Pacific Ocean at various stations around the enclosing coasts and near the middle, at depths of from 200 to 2,645 fathoms. This great geographic range is no doubt due to the pelagic life of the larvae in the free-swimming stage. *Terebratula wyvillei*, which most probably does not possess a surface-living larvae, is found at depths of from 1,035 to 2,900 fathoms off South Australia and North Queensland, in the north-west Pacific, south-west of the Galapagos Islands, off Valparaiso and the west coast of Patagonia, and near the Falkland Islands. It is thus almost restricted to the Pacific, but appears to have spread eastwards into the South Atlantic, as Blochmann observed, and westward to the Southern Ocean south of Australia. This circum-Pacific distribution is in marked contrast to the more limited range of other Pacific species inhabiting shallower waters, and helps to support Blochmann's contention that for the coastal species the deep waters form impassable barriers.

There are a number of other southern forms inhabiting depths greater than 1,000 fathoms in one or the other hemisphere, but which nevertheless are not found far away from the continental margins. Most of these occur on the Pacific coast of America, viz. :—

Liothyrina clarkeana Dall, 1,175 fathoms, Gulf of Panama, and 2,035 fathoms, south-west of the Galapagos Islands.

Macandrevia americana Dall, 1,672 fathoms, Gulf of Panama, and 122 fathoms, off the west coast of Patagonia.

Macandrevia diamantina Dall, 1,175 fathoms, Gulf of Panama, 2,222 fathoms off Peru, and 1,410 fathoms off Coats Land, Antarctica.

Waldheimia wyvillei Davidson, 2,160 fathoms off Valparaiso.

Besides *Macondrevia diamantina* and *Pelagodiscus atlanticus*, two other deep-sea forms are recorded from the Antarctic Coast, viz., *Liothyrella blochmanni* (Jackson), and *Hemithyris sp.* Jackson, 1,410 fathoms off Coats Land.

SOUTHERN GEOGRAPHICAL DISTRICTS.

The map accompanying this report is designed to throw into relief the areas of sea-bottom above 1,000 fathoms, which may be taken as the approximate depth limiting the seaward extension of the coastal species. The map is based on Stieler's Hand-atlas, which includes the results of the Valdivia and Gauss Expeditions, the map of the Antarctic published in "The Sub-Antarctic Islands of New Zealand," and the maps published by the various Antarctic expeditions including that by which the specimens here described were obtained. The Australian Antarctic Expedition made a very valuable series of soundings and has greatly modified previous views as to the contour of the sea bottom south of Australia. Very many more soundings are necessary

in all parts of the southern seas before a map claiming any great degree of accuracy can be prepared. At present it seems possible to recognise the following geographical districts of sea-bottom above the 1,000-fathom line separated from all other districts by seas of greater depth. Those from which brachiopods are known are marked with an asterisk.

*Australia including Tasmania.

*New Zealand, including Chatham, Bounty, Antipodes, Campbell, Auckland, Lord Howe, and Norfolk Islands.

Kermadec Islands.

*Macquarie Island.

Juan Fernandez and S. Felix Islands.

*South America, including the Falkland Islands.

*South Georgia.

Sandwich Islands.

Tristan da Cunha.

Gough Island.

Bouvet Island.

*South Africa.

Madagascar.

*Marion, Prince Edward, and Crozet Islands.

*Kerguelen and Heard Islands.

*St. Paul and New Amsterdam Islands.

Balleny Islands.

Peter Island.

*The Antarctic, including the South Shetland and South Orkney Islands.

Numerous other small reefs and submarine ridges.

The number of southern districts from which brachiopods have not yet been obtained is thus shown to be large, and the attention of future exploring expeditions may be directed to the desirability of obtaining dredgings in these areas. From a scientific point of view more is to be gained by an expedition exploring the little known submarine banks of the Southern and the Pacific ocean bottoms than from a further Antarctic expedition. If these banks have arisen by subsidence of previous lands, remains of coastal faunas such as brachiopods are to be expected. If, on the other hand, they represent recent diastrophic uplifts of formerly deeper portions of the ocean floor, no such faunas can occur, and they can be inhabited only by species with abyssal range or modifications of such species. There is thus a practical method of testing the theory of the permanence of ocean basins.

THE AUSTRALIAN DISTRICT.

The following species are found off the Australian and Tasmanian Coasts :—

Crania Suessi Reeve.—Off Sydney (types); Mast Head Reef, Queensland, 17–20 fathoms.

Lingula rostrum (Shaw).—Moreton Bay (cf. Hedley, 1917). Indian Ocean to Japan.

Lingula hirundo Reeve.—Port Curtis, Queensland (type).

Lingula hians Swainson.—Port Jackson (Brazier). China Seas (type).

Lingula tumidula Reeve.—Moreton Bay (Strange). Philippine Islands (type).

Lingula murphiana King.—Moreton Bay (type).

Lingula exusta Reeve.—Moreton Bay (type).

Cryptopora brazieri (Davidson).—Cabbage Tree Island, Port Stephens, N.S.W., 25 fathoms (type); Mast Head Reef, Queensland, 17–22 fathoms; east of Cape Pillar, Tasmania, 100 fathoms; off Ninety-mile Beach, Victoria, 40 fathoms.

Aetheia colurna (Hedley).—East of Wollongong, 100 fathoms (type); 3 miles east of Sydney, 250 fathoms; east of Cape Byron, N.S.W., 111 fathoms.

Terebratulina cancellata (Koch).—Western Australia (type); off South Australia, 12–200 fathoms; Bass Strait; east of Cape Pillar, Tasmania, 100 fathoms; near Port Jackson, 3–7 fathoms.

Terebratulina cavata (Verco).—Off Cape Jaffa, South Australia, 130 and 300 fathoms (type); Port Phillip Heads.

Terebratulina radula (Hedley).—East of Wollongong, 100 fathoms (type); off Narrabeen, 80 fathoms; east of Cape Pillar, Tasmania, 100 fathoms; off Wilson's Promontary, Victoria.

Terebratulina radiata Alexander (? of Reeve).—Western Australia.

Murravia exarata (Verco).—Off Cape Jaffa, South Australia, 150 fathoms (type), 49 fathoms and 40 fathoms.

Liothyrella fulva (Blochmann).—Twofold Bay, N.S.W., 600 fathoms (type); east of Cape Byron, N.S.W., 111 fathoms; 3 miles east of Schouten Island, east coast of Tasmania, 65 fathoms; off Maria Island, Tasmania, 65 fathoms.

Argyrotheca australis (Blochmann).—Cape Willoughby, Kangaroo Island, South Australia (type).

Argyrotheca mayi (Blochmann).—10 miles east of Schouten Island, Tasmaina, 50 fathoms (type).

Kraussina atkinsoni (Tenison-Woods).—Long Bay, Tasmania, 10 fathoms (type); Shoreham and San Remo, Victoria.

Megerlina lamarckiana (Davidson).—Double Bay, Port Jackson, Sydney (type); under stones at low water, Tamar Head, Tasmania (Tenison-Woods) and Williamstown, Victoria (Lucas); Frankston, Port Phillip, Portland, and Western Port, Victoria; on the beach at Robe, and at Venus Bay, South Australia (Verco).

Aldingia willemoesi (Davidson).—Twofold Bay, N.S.W., 120 fathoms (type); east of Cape Byron, N.S.W., 111 fathoms (Hedley); off Port Phillip Heads (Wilson).

Magadina cumingi (Davidson).—Type locality uncertain; Port Jackson; Bass Strait; east of Cape Pillar, Tasmania, 100 fathoms; off South Australia, 12–200 fathoms.

Magasella vercoi Blochmann.—Backstairs Passage, near Adelaide (type), 16–22 fathoms; other South Australian localities, 40–200 fathoms; Port Phillip Heads.

Campages furcifera (Hedley).—East of Cape Byron, N.S.W., 111 fathoms (type).

Campages jaffaensis (Blochmann).—Cape Jaffa, South Australia, 90 fathoms (type); north of Cape Borda, South Australia, 40 fathoms; east of Cape Pillar, Tasmania, 100 fathoms; outside Sydney, 250 fathoms; off Narrabeen, 80 fathoms.

Terebratella mayi (Blochmann).—East of Cape Pillar, Tasmania, 180 fathoms (type).

Magellania flavescens (Val.).—Type locality unknown. Port Jackson, under stones at low spring tides (Brazier), 14 fathoms; Bass Strait; in bunches, Western Port, Victoria, 6–8 fathoms; north coast of Tasmania; South Australia, 6–100 fathoms (Verco).

Frenulina sanguinolenta (Gmelin).—Port Jackson (Brazier); Mast Head Reef, Queensland, 17–20 fathoms; Bird Island, Coral Sea (Davidson).

In order to compare the Australian Fauna with that of the Pacific Islands, it is desirable to give a list of the few species known from that region.

Discinisca stella Gould.—Singapore and Philippines; also China, Japan and Korea.

Lingula rostrum (Shaw).—Philippines and Moluccas; also Indian Ocean and Japan.

Lingula tumidula Reeve.—Philippines and Australia.

Lingula reevei Davidson.—Hawaiian Islands.

Thecidellina maxilla (Hedley).—Funafuti and New Hebrides.

Rhynconella grayi Woodward.—Fiji.

Eucalathis murrayi (Davidson).—Between Kermadec Islands and Fiji, 600 fathoms.

Frenulina sanguinolenta (Gmelin).—New Caledonia, Tonga, Tahiti, Honolulu, Philippines, also Australia and Japan.

Terebratella (?) *frielei* Davidson (?).—Philippines. The type is from Halifax.

Schuchert considers that the Austral Region is closely connected faunally with Oceanica, but although the long eastern coast-line of Australia offers a favourable means of communication, the above lists do not bear out his contention. The presence of shallow water species of *Lingula* from Sydney northward certainly supports a former land connection through the Indo-Malayan Archipelago with the Philippine Islands and Eastern Asia. Similarly the presence of *Frenulina sanguinolenta*, which is also a species frequenting warm and shallow waters, suggests former land connections between North Australia and the Pacific Islands. These two elements, however, do not belong to the Southern Australian fauna developed between Sydney and South Australia, which is a typical southern fauna with peculiarities of its own, and with little if any relationship to the present fauna of Oceanica. *Crania*, *Terebratulina*, *Liothyrella*, *Terebratella*, and *Magellania*, are, as we shall presently find, genera which are widespread in the southern seas. *Kraussina* occurs also at South Africa and *Megerlina* at the Island of St. Paul. *Cryptopora* and *Argyrotheca* are not represented elsewhere in the southern seas, but occur in the Atlantic-Mediterranean districts, and with *Kraussina* and *Megerlina* point to an old Gondwana land element which did not reach the American and Antarctic coasts, and is absent from the Pacific Islands. *Aetheia*, *Murravia*, *Magadina*, *Campages*, and *Aldingia* are not as yet known outside Australian seas, but the first three occur in the Oamaruian of New Zealand, and *Aetheia* also in the Patagonian of South America.

THE NEW ZEALAND DISTRICT.

The following species are found off the New Zealand coasts :—

Crania huttoni Thomson.—Cook Strait.

Hemithyris nigricans (Sowerby).—Foveaux Strait to Cook Strait, 19–30 fathoms, Whangaroa Harbour (Murdoch), Chatham Islands (Hutton).

Liothyrella neozelanica Thomson.—Cook Strait, 50 fathoms or more.

Liothyrella sp. Thomson.—Foveaux Strait.

Amphithyris buckmani Thomson.—Cook Strait, 50 fathoms or more.

Neothyris lenticularis (Deshayes).—Foveaux Strait, 15 fathoms; off Oamaru, 35–43 fathoms (Suter); on cable, Cook Strait, 90 fathoms (young).

Neothyris ovalis (Hutton).—Farewell Spit.

Terebratella rubicunda (Sowerby).—Foveaux Strait to Whangaroa Harbour, 5–50 fathoms; under stones at low-water, Rangitoto Island (Cheeseman); Chatham Islands; Auckland Island.

Terebratella sanguinea (Leach).—Stewart Island to Cook Strait, 5-30 fathoms; Auckland Island, 40 fathoms.

Terebratella sanguinea var. Thomson.—Off Cape Colville, 20 fathoms.

Terebratella sp., cf. *Magella carinata* Thomson.—Foveaux Strait.

The New Zealand fauna consists mainly of wide ranging southern genera with the exceptions of *Neothyris* and *Amphithyris*. The former is not known with certainty elsewhere, although some South American species have in the earlier part of this paper been compared with this genus. *Amphithyris* is a very primitive genus, presumably of considerable antiquity, found elsewhere only in the Mediterranean, and is doubtless, like the primitive Australian genera discussed above, an element derived from the ancient Gondwana coasts.

THE MACQUARIE ISLANDS DISTRICT.

The only brachiopods known from the Macquarie Islands, which are separated from New Zealand by seas of over 2,000 fathoms in depth, are the new species described above, *Magellania macquariensis* Thomson, and *Gyrothyris mawsoni* Thomson.

THE KERGUELEN DISTRICT.

The Kerguelen District includes Kerguelen, Heard, and McDonald Islands, and some smaller islets, and is separated from St. Paul and Marion Island districts by seas of over 1,000 fathoms, and from the latter by seas of over 2,000 fathoms. The following brachiopods have been described from this group :—

Hemithyris pyxidata (Davidson).—150 fathoms.

Liothyris uva Davisdon (? of Broderip).—150 fathoms.

Terebratella enspergeni Blochmann.—20–30 fathoms.

Waldheimia kerguelensis Davidson.—20–150 fathoms.

Magellania kerguelensis Eichler (? of Davidson).—10 fathoms.

This fauna is of typically southern type, with possibly a distinctive stock of the *Magellaninæ* in *Waldheimia kerguelensis* Davidson. The *Liothyris uva* will doubtless prove to be a new species of *Liothyrella*.

THE ST. PAUL ISLAND DISTRICT.

The St. Paul and Amsterdam Islands rise from a common base above the 1,000 fathom line, and are united with the Kerguelen group by a submarine ridge, which has a broad top between the 1,500 and 2,000 fathoms lines, and for the most part is less than 1,500 fathoms below the surface. The following species are known :—

Liothyrina winteri Blochmann.—371 fathoms.

Megerlina davidsoni Velain.—Abundant at low water in the interior crater.

Mergerlina occurs elsewhere only in Australia, but is closely related to the South African *Kraussinæ*. A very slight elevation of the sea bottom would connect the group above the 1,000 fathoms line with the Kerguelen group, and a greater community of fauna is perhaps to be expected. The difference in latitude, amounting to about 10 degrees, is, however, sufficient to account for the difference in the shallow water forms, even if former connections had existed.

THE MARION ISLAND DISTRICT.

The Marion Island District consists of a group of Islands all rising from an elongated east and west submarine elevation of less than 1,000 fathoms depth. It consists of Crozet, Possession, Prince Edward and Marion Islands, and is separated from the Kerguelen group by a submarine trough of more than 2,000 fathoms in depth, whereas the seas between Marion Island and South Africa are less deep than 2,000 fathoms. The distance between Crozet and Kerguelen Island is only 625 nautical miles, and between the 1,000 fathom contours there is about 450 miles. The Marion Island group has usually been included faunally with the Kerguelen group, but it seems desirable to separate them in order to call attention to the differences in their brachiopod faunas.

From the Marion Island group the following species are known :—

Terebratulina septentrionalis Davidson (? of Couthouy).—150 fathoms.

Terebratula moseleyi Davidson.—210 fathoms.

Waldheimia kerguelensis Davidson.—150 fathoms.

Platidia anomioides (Scacchi).—150 fathoms.

The occurrence of *Platidia* in this southern station is surprising, and, if confirmed, becomes of profound significance. Before the recognition of the generic distinctness of *Amphithyris* one might have said that the beak characters and shape were so distinctive that Davidson could hardly have been mistaken as to the genus. In view, however, of the fact that Davidson considered *Amphithyris seminula* a synonym of *Platidia anomioides*, the Marion Island specimens need re-examination. It is true that

the figure published by Davidson shows the typical loop of *Platidia*, but it is not explicitly stated that this specimen came from Marion Island, although the presumption is that it did.

Platidia anomioides has a very wide range, being common in shallow water in the Mediterranean, but extending into 600 fathoms in the Atlantic, where it ranges from the Shetland Islands to the south of Morocco, and on the American side from North Carolina to the Antilles. Dall has also identified specimens from the Californian Coast. It is known from the Miocene of the Vienna basin, and doubtfully from the Oligocene of Italy. It seems, then, to be a species of the ancient Tethys, which has spread west to America and through the ancient Strait of Panama to the Californian coast. If the identification of the Marion Island specimens is confirmed, it will also be necessary to conclude that it has come from the Eastern Tethys, through the Indian Ocean, down the African coasts, or has spread to the Tethys from the Gondwana region. In either case it becomes probable that the Marion Island Group has in Tertiary times been connected, above the 1,000 fathoms line at least, with South Africa. *Terebratulina* is also common to these two districts, and absent from the Kerguelen group. *Waldheimia kerguelensis*, which appears to be a shallow water species, occurs also in the Kerguelen group, but the distance is not so great that transportation in the free-swimming larval stage can be neglected in this case, although it should be noted that the prevailing currents set in the opposite direction. The absence of the South African genera, *Kraussina* and *Agulhasia*, from the Marion Island group is not a weighty argument against the former connections of these two districts, since it is easily explicable on grounds of latitude.

THE SOUTH AFRICAN DISTRICT.

No additions have been made to the brachiopod fauna of South Africa during the last thirty years, and one cannot help suspecting that numerous additions will yet be made. The following is a list of the species known to occur near the coasts :—

Terebratulina abyssicola Adams and Reeve.—Cape of Good Hope. 120 fathoms.

Terebratulina radiata Reeve.—Probably from the Cape of Good Hope.

Terebratulina septentrionalis Davidson (? of Couthouy).—Off Cape of Good Hope, 150 fathoms.

Agulhasia davidsoni King.—Agulhas Bank, 45–60 fathoms.

Terebratula vitrea var *minor* Davidson (not of Philippi).—Off Cape of Good Hope, 150 fathoms.

Kraussina rubra (Pallas).—Port Elizabeth.

Kraussina cognata (Sowerby).—Near Cape of Good Hope.

Kraussina deshayesi (Davidson).—Off Cape of Good Hope, 120 fathoms.

Kraussina pisum (Valenciennes).—Off Cape of Good Hope, 150 fathoms, near Natal.

Terebratella rubiginosa Dall.—Cape of Good Hope (?).

Of the genera represented *Agulhasia* alone is confined to this district, the only other known species being from the Cretaceous of Europe. "*Terebratula vitrea* var. *minor*" Davidson is a species not yet well known, and may be, like *Terebratulina*, either of southern or northern facies. *Terebratella* is a typically southern genus, but its occurrence in this district must be accepted with reserve. *Kraussina* is a primitive genus, probably of considerable antiquity, and its distribution in South Africa and Australia, coupled with the occurrence of its near relative *Megerlina* in St. Paul Island and Australia, probably finds an explanation in, and at the same time is an argument for, the former existence of a more or less continuous Gondwana land across the site of the Indian Ocean. Had South Africa had former land connections with the Antarctic, one would expect many southern genera amongst its fauna, since it is in the same latitude as New South Wales. As pointed out above, these may possibly yet be found with further collection.

No brachiopods are known from the Madagascar coasts, but two have been reported from Mauritius, which lies just within the Tropic Capricorn. *Terebratula cernica* Crosse was obtained from the stomach of a fish, while *Lacazella mediterranea* is stated by Sir H. Barkly to occur off Mauritius; but Davidson observes that this statement must be taken with reserve.

THE SOUTH AMERICAN DISTRICT.

The following species are known from this region :—

Discinisca lamellosa (Broderip).—Chiloe north to Gulf of Panama, 0–10 fathoms.

Discinisca laevis (Sowerby).—Concepcion, 15 fathoms. Also Peru.

Crania patagonica Dall.—West coast of Patagonia, 122 fathoms.

Terebratulina crossei Fischer and Oehlert (? of Davidson).—New Year Sound, 185 fathoms; Punta Arenas, Strait of Magellan, 10 fathoms.

Liothyrella uva (Broderip).—Gulf of Tehuantepec, South Mexico, 10–12 fathoms (type); Peru, shallow water; Strait of Magellan, 18 fathoms; Beagle Canal, 75–90 and 128 fathoms; off Tierra del Fuego, 121 fathoms; Burdwood Bank, south of W. Falkland Island, 56 and 75–90 fathoms; off east coast of Patagonia, 77 fathoms; off Buenos Ayres, 600 fathoms.

Bouchardia rosea (Mawe).—Rio Janeiro, 13 fathoms.

Magellania fontanei (d'Orbigny).—Coquimbo, Chili.

Magellania venosa (Solander).—Falkland Island (type), 6–7 fathoms; Burdwood Bank, 56 fathoms; Tierra del Fuego, Beagle Canal and Strait of Magellan, 10–79 fathoms; west coast of Patagonia, 1–33 fathoms; Coquimbo, Chili (? *M. Fontanei*).

Terebratella dorsata (Gmelin).—Falkland Islands, 9 fathoms; Burdwood Bank, 7–56 fathoms; Tierra del Fuego, Beagle Canal and Strait of Magellan, 7–120 fathoms; Bay of Valparaiso, 60–90 fathoms; Coquimbo, Chili.

Terebratella (Jackson)* vel *Magellania* (Blochmann) sp.—Burdwood Bank, 56 and 75–90 fathoms.

Macandrevia americana Dall.—West coast of Patagonia, 122 fathoms; also Gulf of Panama, 1,672 fathoms.

The deep-sea forms off the western American coast have already been listed under the Abyssal fauna. From Peru north to the Gulf of Panama, the shallow-water forms are chiefly species of *Discinisca*, besides *Liothyrella uva* as mentioned above (Dall, 1909).

Lying between South America and the Antarctic Continent there are several groups of islands—South Georgia, the Sandwich Group, and the South Orkney and South Shetland Islands—which rise from a curved submarine ridge of less than 1,500 fathoms in depth connecting the two continents, the two latter groups being separated from the Antarctic mainland by water of less than 1,000 fathoms in depth. Excluding them there is only one species known from the other groups, namely *Waldheimia smithi* Pfeffer.—South Georgia.

THE ANTARCTIC DISTRICT.

The following species are known from the Antarctic coast :—

Pelagodiscus atlanticus (King).—Off Coats Land, 1,410 fathoms (Jackson); off Kaiser Wilhelm II Land, 1,640 fathoms (Eichler, "*Discinisca* sp.").

Crania lecointei Joubin.—Off Alexander Land, 273 fathoms.

Crania joubini Thomson.—Davis Sea, 240 fathoms.

Frieleia gerlachei (Joubin).—Off Alexander Land, 273 fathoms; South of Peter Island, 246 fathoms.

Hemithyris racovitzæ (Joubin).—Off Alexander Land, 273 fathoms.

Hemithyris sp. Jackson.—Off Coats Land, 1,410 fathoms.

Hemithyris striata Thomson.—Davis Sea, 358 fathoms.

Liothyrella notorcadensis (Jackson).—South Orkneys, 6 fathoms.

Liothyrella blochmanni (Jackson).—Off Coats Land, 1,410 fathoms.

* See antea, page 17.

Liothyrella antarctica (Blochmann).—Off Kaiser Wilhelm II Land, 209 fathoms; off Adelie Land, 288–300 fathoms.

Liothyrella ovata (Thomson).—Davis Sea, 358 fathoms.

Macandrevia diamantina Dall.—Off Coats Land, 1,410 fathoms; also Gulf of Panama, 1,175 fathoms.

Macandrevia lata Thomson.—Davis Sea, 325 fathoms.

Macandrevia vanhoffeni Blochmann.—Off Kaiser Wilhelm II Land, 209 fathoms; Davis Sea, 325 and 358 fathoms; off Adelie Land, 288–300 fathoms.

Stethothyris antarctica Thomson.—Davis Sea, 358 fathoms.

Magellania joubini Blochmann.—Off Kaiser Wilhelm II Land, 209 fathoms; Davis Sea, 60 fathoms; off Adelie Land, 157 and 288–300 fathoms; Coulman Island, 100 fathoms; Ross Island, 178 fathoms; off Alexander Land, 245 and 273 fathoms.

Magellania fragilis Smith.—Agassiz Island, 300 fathoms.

Magellania vel *Terebratella* sp. Thomson.—Davis Sea, 325 fathoms.

Magellania (?) sp. Thomson.—Off Adelie Land, 288–300 fathoms.

The Antarctic fauna may be divided into cosmopolitan genera, such as *Terebratulina*, *Hemithyris*, and *Crania*, typical southern forms such as *Liothyrella*, *Stethothyris*, and *Magellania*, and recent northern immigrants such as *Macandrevia* and probably *Frieleia*.

SUMMARY OF THE DISTRIBUTION.

Excluding deep-sea forms, there are few species common to the Southern and Northern seas, and in the case of the species of *Lingula* and of *Platidia*, the identifications of the southern forms are in need of confirmation. The following is a list of the species in question :—

Lingula rostrum (Shaw).—Moreton Bay, Australia, and Indian Ocean to Japan.

Lingula hians Swainson.—Port Jackson, Australia, and China.

Lingula tumidula Reeve.—Moreton Bay, Australia, and Philippine Islands.

Platidia anomioides (Scacchi).—Marion Island, Mediterranean, North Atlantic and California.

Frenulina sanguinolenta (Gmelin).—North-east Australia and Central and North Pacific.

Only one species is common to two of the southern geographical districts, viz. *Waldheimia kerguelensis* Davidson in the Marion Island and Kerguelen groups. All the other southern species are confined to single geographical districts, and cases of discontinuous distribution, such as are known between the European and American coasts of the North Atlantic, are not found in the southern seas.

The generic distribution is shown in the following table. The most commonly occurring genera are *Crania*, *Hemithyris*, *Terebratulina*, *Liothyrella*, *Terebratella*, and *Magellania*, of which the last three only are restricted to a southern habitat. In addition to them the following less commoner genera are also peculiar to southern seas :—*Aetheia*, *Agulhasia*, *Murravia*, *Megerlina*, *Aldingia*, *Bouchardia*, *Magadina*, *Campages*, and the higher members of the *Magellaninæ*. *Kraussina* is similarly restricted except for a single species, *K. gardinera* Dall, in the Northern Indian Ocean.

	Number of Southern Districts.	Australia.	New Zealand.	Macquarie Islands.	Kerguelen Island.	St. Paul Island.	Marion Island.	South Africa.	South America.	South Georgia.	Antarctic.	Northern Hemisphere.
CRANIACEA.												
Crania	4	×	×	...	...	...	...	...	×	...	×	×
DISCINACEA.												
Discinisca	1	...	...	...	...	...	...	...	×	...	...	×
LINGULACEA.												
Lingula	1	×	...	...	...	...	...	...	...	...	...	×
RHYNCONELLACEA.												
Cryptopora	1	×	...	...	...	...	...	...	...	...	...	×
Aetheia	1	×	...	...	...	...	...	...	...	...	...	...
Hemithyris	3	...	×	...	×	...	...	...	...	...	×	×
Frieleia	1	...	...	...	...	...	...	...	...	...	×	×
TEREBRATULACEA.												
Terebratulidæ	...	...	...	...	...	...	...	...	...	...	...	...
Agulhasia	1	...	...	...	...	...	...	×	...	...	...	...
Murravia	1	×	...	...	...	...	...	...	...	...	...	...
Terebratulina	4	×	...	...	...	...	×	×	×	...	...	×
Liothyrella	5	×	×	...	..	...	...	...	×	...	×	...
"*Terebratula Liothyrina*" or "*Liothyris*"	...	...	...	...	×	×	×	×	...	...	...	...
Terebratellidæ.												
Argyrotheca	1	×	...	...	...	...	...	...	...	...	...	×
Amphithyris	1	×	...	...	...	...	...	...	...	...	...	×
Platidia	1	...	...	...	...	...	×	...	...	...	...	×
Kraussina	2	×	...	...	...	...	...	×	...	...	...	...
Megerlina	2	×	...	...	...	×	...	...	...	...	...	...
Aldingia	1	×	...	...	...	...	...	...	...	...	...	...
Bouchardia	1	...	...	...	...	...	...	...	×	...	...	...
Magadina	1	×	...	...	...	...	...	...	...	...	...	...
"*Magasella*"	1	×	...	...	...	...	...	...	...	...	...	...
Campages	1	×	...	...	...	...	...	...	...	...	...	...
Terebratella	4	×	×	...	×	...	...	?	×	...	?	...
Gyrothyris	1	...	...	×	...	...	...	...	...	...	...	...
Magellania s. str.	4	×	...	×	×	...	...	...	...	...	...	...
"*Magellania*" or "*Waldheimia*"	...	...	...	...	×	...	×	...	×	×	...	...
Neothyris	1	...	×	...	...	...	...	...	...	...	...	...
Stethothyris	1	...	...	×	...	...	...	...	...	...	...	...
Higher members of the *Magellaninæ* ...	8	×	×	×	×	...	×	?	×	×	×	...
Frenulina	1	×	...	...	...	...	...	...	...	...	...	×
Macandrevia	2	...	...	...	...	...	...	...	×	...	×	×

DISCUSSION OF THE DISTRIBUTION.

There are gaps of different kinds in our knowledge that preclude any final conclusions as to the manner in which the present distribution of southern brachiopods has been effected. The first of these is our ignorance of the fauna of large strips of the coastal seas. Schuchert considers that brachiopods have been so assiduously collected that little will be added to our knowledge of the distribution of the species. Since there are but few cases of discontinuous distribution in the southern seas, it is not probable that the range of the known species will be greatly extended, except along the coasts from which they are already known, but there is every reason to suppose that a very large number of new species will yet be found between the 100 and the 1,000 fathom line, where the dredgings are few. Fischer and Oehlert gave in 1892 a list of five species, belonging to four genera, from Bass Strait and the coast of Tasmania. From this part of the Australian coasts twelve species belonging to eleven genera are now known. Again, within the last three years the known fauna of the New Zealand coast has been more than doubled. There can be little doubt that further dredging would bring to light many new forms, especially on the West Australian, Madagascar, South African, and South American coasts. Even for the very shallow water genera, such as *Megerlina*, it is unsafe to presume that the distribution is accurately known, as there have been no systematic students of the class in Western Australia and in South Africa.

The second gap in our knowledge lies in the incompleteness of our recognition of distinct genetic stocks. Some students object to the process of minute distinctions between genera, mainly on the ground that it renders the study more complex, and a matter only for the specialist. But the narrow definition of genera, if it is based on phylogenetic grounds, prevents the assimilation of apparently similar, but historically distinct forms, and for the purpose of discussing geographical distribution and geological correlation becomes an instrument of the utmost utility. It is only necessary to specify the genus *Magellania sensu lato*, which has been fully discussed above, in illustration of this point. When all the Recent and Tertiary species of the southern hemisphere have been correctly placed genetically, it may be possible by the aid of brachiopods alone to gain a fairly accurate idea of the latest former land connections of the Southern Hemisphere.

There is a gap in our knowledge of still another kind which can hardly be remedied, and must be made the best of. That is caused by the absence of Tertiary marine rocks in South Africa and the western coast of Australia, and in that part of the Antarctic Continent facing South Africa and Australia. This absence of Tertiary rocks can only mean that these lands existed as such in Tertiary times, and then extended further seawards, since apart from probable faulting marine erosion alone must have since encroached some distance landwards. The marine beds marginal to the Tertiary lands have never become raised above sea level, else remnants of them would surely have been preserved in the present continents and islands by unequal uplift or subsequent down-faulting. The Tertiary faunas of these coasts can never become known until it is found practicable and desirable to obtain borings from the sea-bottom.

Tertiary marine faunas are known from South America (Chile, Argentine, and Patagonia), the Antaretie (islands in the Weddell Sea), New Zealand, Tasmania and south-east Australia, *i.e.*, only in the southern eircum-Pacifie lands. The greater part of the beds containing them belong approximately to the same age, variously estimated in the different countries and by different authors from Eocene to Miocene. Following Buekmann, I shall term it the Oligoeene-Mioeene. In New Zealand and South America there are also still younger faunas, whieh are generally referred to the Plioeene.

The following list shows the genera of whieh these Oligocene-Miocene faunas are eomposed :—

South America.—

(*a*) Chile—"Magellania," Megathyris, Diseina.

(*b*) Argentine and Patagonia—Hemithyris, Aetheia, Terebratulina, Bouehardia, Pachymagas, Terebratella, "Magellania."

Antaretic.—Lingula, Hemithyris, Terebratulina, Liothyrella, Bouchardia, Magella, Pachymagas, "Magellania."

New Zealand.—Thecidellina, Aetheia, Hemithyris, Terebratulina, Murravia,* Liothyrella, Argyrotheca,* Bouehardia,* Magadina, Rhizothyris, Stethothyris, Pachymagas, Neothyris, Gyrothyris, Magella, Terebratella.

Australia.—Crania, Laeazella, Hemithyris, Terebratulina, Murravia, Liothyrella, Megerlina,* Aldingia, Magadina, Magadinella, Rhizothyris,* Stethothyris, Magella, Terebratella, Magellania.

Probably further study will show a still greater number of common genera in the above districts. Meanwhile they suffiee to show the source of the most important elements of the Reeent fauna. Thus the younger Tertiary (Wanganuian) fauna of New Zealand, so far as it is at present known, is a direct development of a small section only of the older Tertiary (Oamaruian) fauna, and eonsists only of the genera *Hemithyris*, *Terebratella* and *Neothyris*, including the majority of the Recent species of these genera in the New Zealand area. The remaining elements of the Reeent fauna include one genus, *Liothyrella*, not known from the Wanganuian, but eommon in the Oamaruian, and only two genera not recorded fossil from the area, viz., *Crania* and *Amphithyris*. There can be little doubt that they will yet be found fossil in the Tertiary. The Recent New Zealand fauna is merely a diminished remnant of the rieh Oamaruian fauna, and needs no land conneetions since the Miocene to explain its character. If later imgrations to and from Australia had been possible, we should expect to find, *e.g.*, *Magellania* in New Zealand and *Neothyris* in Australia. The speeific and generic distinctness of the Reeent New Zealand and Australian faunas precludes any land connections between the areas in the Plioeene or Post-Plioeene.

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* Determinations litherto unpublished. A new speeies of *Bouchardia* occurs in the Mount Brown beds, Canterbury, and of *Argyrotheca* in the limestone of Flat Top Hill, Oamaru, New Zealand.

Murravia catinuliformis (Tate) is found in the glaueonitie limestone of Landon Creek, Oamaru, New Zealand. *Waldheimia corioensis* MeCoy is a speeies of *Rhizothyris*. A new speeies of *Megerlina* is included in Mr. R. N. Atkinson's colleetion of fossils from Table Cape, Tasmania.

The Australian Recent fauna, leaving aside the subtropical elements on the northern parts of the east coast, must be similarly regarded as a remnant of the Miocene fauna of that area. The only genera which have not been determined fossil are *Cryptopora*, *Aetheia* (fossil in New Zealand and South America), *Argrotheca* (fossil in New Zealand), *Kraussina*, and *Campages*, most of them small forms which may easily be overlooked, As in the case of New Zealand, Pliocene or Post-Pliocene migrations from other southern areas are unnecessary from a consideration of the brachiopod fauna.

The South American Recent fauna is also in great part generically similar to the Miocene faunas of that continent, the most important exceptions being *Liothyrella*, which is unknown fossil in that area, although it is not a genus that could easily be overlooked, and *Macandrevia* which has not been recorded fossil anywhere in the southern hemisphere. Von Ihering points out also that *Magellania venosa* has no ancestral form in the Patagonian Miocene, and considers it a Recent immigrant in the Magellan district from Chile, where the related form *Magellania fontanei* occurs fossil. This appears probable enough as *Macandrevia* must certainly be considered a recent immigrant from the North Pacific, but it should be noticed that *Magellania fontanei* has since been recorded from the Antarctic Oligocene-Miocene.

The Antarctic Recent fauna is the least like the Tertiary fauna of the same district owing to the presence, on the one hand, of the recent northern immigrants *Macandrevia* and *Frieleia*, and on the other species of *Magellania* s. str., a genus apparently confined in the Miocene to Australia. The absence of this genus in New Zealand and its presence in the Macquarie Islands seems to point to a former bridge connecting Tasmania with the Antarctic through the Macquarie Islands. Too much stress must not be laid on this genus, however, for even with the narrow restriction that it has undergone it may still be polyphyletic. There is nothing to prevent any species of *Terebratella* attaining Magellaniform loop characters by simple absorption of the jugal band, and *Terebratella* s. str. had already spread to South America, New Zealand, and Australia by the Oligocene-Miocene. On the whole, then, it appears that in the districts from which Oligocene-Miocene faunas are known, the recent faunas are descendants of those fossil faunas, and the only connection which is made likely by the Recent brachiopod fauna is one between South America and the Antarctic. Even this is not definitely demanded, for the genus *Macandrevia* is one which can live below the 1,000 fathom line, and although the South American species and two of the Antarctic species have so far only been found in much shallower waters, the first mentioned, *M. americana*, also occurs in the Gulf of Panama in 1,672 fathoms, while *M. diamantina* is found at a depth of 1,410 fathoms in the Antarctic and 1,175 fathoms in the Gulf of Panama.

The elements of the southern faunas which can be definitely considered as descendants of the southern Oligocene-Miocene faunas are :—*Crania*, *Hemithyris*, *Aetheia*, *Murravia*, *Terebratulina*, *Liothyrella*, *Argyrotheca*, *Megerlina*, *Aldingia*, *Bouchardia*, *Magadina*, *Gyrothyris*, *Stethothyris*, *Neothyris*, *Terebratella* and *Magellania*. Of these

Crania, *Hemithyris*, *Terebratulina*, *Liothyrella*, *Terebratella* and *Magellania* are still widespread in the southern seas in spite of considerable diversities of climate and sea temperature.

There is abundant evidence from the associated molluscan faunas that the Patagonian of South America and the Oamaruian of New Zealand enjoyed a much warmer climate than the present, and the occurrence of brachiopod species and genera in the Oligocene-Miocene of the Antarctic, which are also found in the Patagonian and the Oamaruian and the "Miocene" of Australia, strongly suggests a warmer climate for the Antarctic seas of that date also. Tate Regan (1916) supposed from a study of the Antarctic fish that that continent was washed by cold seas probably throughout the Tertiary period, but the geological evidence all points the other way, and it is probable that the fish, like the brachiopods, have accommodated themselves to the increasing cold. The suggestion of Willis (1910) that the oceanic deep circulation may have been reversed in periods of diastrophic inactivity like the early Tertiary, and that there was a creep of warm saline equatorial water along the ocean bottom towards the poles, is worthy of serious consideration by zoologists.

Several genera occurring in the warm Oamaruian seas of New Zealand, and probably also of Australia, have apparently been able to survive the late Tertiary cooling only in the warmer Australian waters, viz., *Aetheia*, *Murravia*, *Argyotheca*, and *Magadina*. In a similar way *Bouchardia*, which once extended from Patagonia to New Zealand, is now confined to the warm seas of Brazil, while *Thecidellina* has left the southern seas altogether and now occurs only in the tropics (Funafuti, New Hebrides,and Jamaica). On the other hand *Gyrothyris* and *Stethothyris* persist only in the cooler water of Macquarie Island and the Antarctic.

The larger circum-Pacific southern districts above discussed all agree in the presence of *Crania*, *Liothyrella*, and of one or more of the higher genera of the *Magellaninæ*. The generic dissimilarities now existing between the faunas are of three kinds, viz. (1) dissimilarities inherited from the Oligocene-Miocene, such as the restriction of *Megerlina* and *Aldingia* to Australia, and of *Neothyris* to New Zealand; (2) dissimilarities due to unequal survival of formerly widespread genera as *e.g.*, the absence of *Hemithyris* from Australia, and of *Terebratulina* from New Zealand, and the restriction of *Aetheia* to Australia, and of *Bouchardia* to Brazil; (3) dissimilarities due to post-Miocene immigrations, such as that of *Macandrevia* to western South America and the Antarctic.

There are certain generic dissimilarities distinguishing the Recent and Tertiary faunas of New Zealand and Australia on the one hand from those of the Antarctic and South America on the other that seem to be of great significance. These consist in the absence of certain primitive genera of the *Terebratellidæ* from South America and the Antarctic, which are present in New Zealand and Australia, viz., *Argyrotheca* (fossil in New Zealand, Recent in Australia), *Amphithyris* (Recent in New Zealand), *Kraussina* (Recent in Tasmania), and *Megerlina* (fossil in Tasmania, Recent in Tasmania and

Australia). While it is still possible that these small forms will turn up in the former districts, it appears more probable that they formed an endemic element in the Oligocene-Miocene of New Zealand and Australia, and never attained a southern circum-Pacific distribution. On the other hand these genera are also found in the Indian Ocean and the Mediterranean, viz., *Argyrotheca* and *Amphithyris* in the Mediterranean, *Megerlina* at the Island of St. Paul, and *Kraussina* in South Africa and the Indian Ocean. This distribution suggests that Australia had former connections with South Africa and the Mediterranean. This probability will be greatly strengthened if the generic groupings suggested in the first part of this paper are substantiated, viz., the grouping on the one hand of the Mediterranean and Marion Island *Platidia* with *Amphithyris* and *Argyrotheca*, and on the other of the Mediterranean *Mühlfeldtia*, the Indian Ocean *Kingena*, and the Australian *Aldingia* with *Kraussina* and *Megerlina*.

Argyrotheca occurs in the Eocene of North America and in the Miocene of Europe, *Platidia* and *Mühlfeldtia* in the Miocene of Europe, and *Kingena* in the Cretaceous of Europe. All the above-mentioned genera, therefore, except *Amphithyris* and *Kraussina*, are at least as old as the Miocene, and it is probable that these two primitive genera are at least Cretaceous if not Jurassic. Except for the South African and Indian Ocean forms, which exist in districts where no fossil faunas are known, the fossil species show that the genera had attained practically their present distribution by the Miocene at least, and the connections which made this possible were probably still older.

The most obvious explanation of all the above facts is that these two groups of the *Terebratellidæ* originated on the coasts of Gondwana land, on the remnants of which they now survive, and to which they are almost restricted. *Kingena* had attained the northern coasts of the Tethys by the Cretaceous and *Argyrotheca* had crossed to America by the Eocene, while *Platidia* probably crossed about the same time. *Argyrotheca* and presumably *Amphithyris* had crossed from Australia to New Zealand by the Oligocene-Miocene. From the considerations that this Gondwana-land element did not reach the Antarctic and South America, and that the southern circum-Pacific Oligocene-Miocene fauna did not reach South Africa and Marion Island, it seems necessary to conclude that the connections between Australia and South Africa had broken down before that between Australia and the Oligocene-Miocene Pacific *via* New Zealand or New Caledonia was established, and further that before this Gondwana-land element reached New Zealand, the connections between that land and the Antarctic had been severed.

The Recent fauna of the Kerguelen Islands, consisting of *Hemithyris*, *Terebratella*, "*Magellania*" and "*Liothyris*" is a typical southern fauna of the circum-Pacific type, and is derived without doubt from an Oligocene-Miocene fauna similar to those above described. So far as the Recent Brachiopods are concerned, the group may have been isolated from all other southern lands since the close of the Miocene, and it does not appear to have retained any evidence of a Gondwana-land connection.

Excluding "*Magellania*" *kerguelensis* of the Marion Island group, which has in all probability been recently derived from the Kerguelen group, and the doubtfully localised *Terebratella rubiginosa* of the Cape, the Marion Island and South African faunas have not a typically southern fauna of the circum-Pacific type since they do not contain *Crania*, *Hemithyris*, or the higher members of the *Magellaninæ*, while the species of *Terebratulina* and "*Terebratula*" may be of southern or of northern facies. The Gondwana-land element exists in four species of *Kraussina* at the Cape, and connections with the Mediterranean are shown by the presence of *Platidia anomiodes* in Marion Island and of *Agulhasia* in South Africa. It seems safe to conclude not only that these two districts have been isolated from the rest of the southern lands since the Miocene, but that they did not share in the still earlier means of communication which permitted the southern Pacific Oligocene-Miocene fauna to attain the Kerguelen area.

The distribution of southern Recent Brachiopods, then is satisfactorily explained by an ancestral distribution in the Miocene, and not only does it not call for any land bridges or shallow submarine connections between the various southern continents and islands since that date, but is distinctly opposed to any such means of intercommunication except between South America and the Antarctic.

The generic similarities between the four southern Oligocene-Miocene faunas, on the other hand, are of such a nature as to demand at some earlier date much greater means of intercommunication between the lands bordering the South Pacific Ocean than exist at the present day. The fact that the Gondwana-land element occurs both in New Zealand and Australia, but not in the Antarctic and South America suggests that the intercommunication between New Zealand and Australia did not occur at the same time as that between New Zealand and the Antarctic, but that the latter was the earlier, or we may suppose a land barrier from New Zealand to New California separating a sea south of Australia from the Pacific Ocean and not breaking down till the Oligocene. A Tertiary fauna from New Caledonia would help materially in picturing the former connections and is likely to be found. Unfortunately little is known of the ancestral forms of the peculiarly southern Oligocene-Miocene genera, so that it is impossible in this way to form an estimate of the dates of the necessary intercommunications. So far as the genera are concerned they might have occurred as far back as the Cretaceous.

Certain specific similarities between the Oligocene-Miocene faunas, however, demand a considerably later date for the intercommunications. The following species, or perhaps more correctly nearly related forms, are common to two or more of the four districts :—

Hemithyris squamosa (Hutton).—New Zealand, Australia, and Antarctic.

Murravia catinuliformis (Tate).—Australia and New Zealand.

Terebratulina suessi (Hutton).—New Zealand and Australia.

Liothyrella tateana (Tenison-Woods).—Australia and Antarctic.

"*Magellania*" *sufflata* Tate.—Australia and New Zealand.

"*Magellania*" *fontanei* D'Orbingy.—Chili and Antarctic.

It is not probable that the intercommunications necessary for the above-stated distribution occurred in the Oligocene-Miocene, since the period was one of warm and nearly uniform conditions when climatic bars to migration were probably at a minimum, and yet the great majority of the species of that age are quite distinct in the four districts. On the other hand it is not likely that the above species are much older in origin than the Oligocene-Miocene. Their distribution was most probably effected in the late Eocene or Oligocene. Since, however, the main part of the Oligocene-Miocene faunas are generically similar but specifically distinct, it is necessary to conclude that inter-communication was possible at a still earlier date in order to allow for dispersal of the genera and subsequent specific differentiation.

By a consideration of the distribution of brachiopod faunas above, then, it seems necessary to make the following assumptions. By connections is implied not necessarily land connections but at least relatively shallow submarine ridges or chains of islands at no great distance from one another. Connections between Australia and South Africa at some date prior to the Tertiary must have existed by which the primitive genera of the *Terebratellidae* attained their present distribution in South Africa, St. Paul's Island, Marion Island, Australia, and New Zealand. The connection which permitted this Gondwana-land element to reach New Zealand was probably later. The Kerguelen district apparently did not share in this Gondwana-land connection. Connections between Australia, New Zealand, the Macquarie Islands, the Kerguelen Islands, the Antarctic and South America must have occurred in the early Tertiary, but New Zealand was not connected at the same time with Australia and the Antarctic. The connections between New Zealand, the Antarctic, and South America may have existed from an earlier date. It does not appear probable that Australia was connected directly with the Kerguelen Islands and the Antarctic during the Cretaceous or early Tertiary. The circum-Pacific southern connections were all broken much as at present by the Miocene, and since that date there have been no renewed connections between the southern continents and island districts, except possibly between South America and the Antarctic and the adjacent islands.

How far these assumptions fit in with the assumptions required by the study of the distribution of other groups of animals or plants is too large a subject to discuss in the present paper and may be left to other workers. It remains to be considered how they accord with the known geological history of the southern lands.

The views held by Hutton on the geological history of New Zealand have been considerably modified in recent years, particularly in relation to a supposed marked break between Cretaceous and Tertiary accompanied by mountain folding. Hutton recognised a major break at the close of the Jurassic, with folding of the Triassic and

Jurassic (Hokonui) sediments into an alpine range of which the present New Zealand Alps are the diminished representatives. Recent stratigraphical and physiographical studies emphasise the importance of this great post-Hokonui deformation, but demonstrate quite decisively that the majority of the present mountain ranges are due to a much later Kaikoura deformation commencing in the late Tertiary and perhaps not yet exhausted. Between these two major deformations peneplanation of the Hokonui mountains ensued, and the land was nearly all submerged in the Oamaruian (Oligocene-Miocene). Within the central part of New Zealand the Cretaceous and Tertiary beds are accordant, and any possible break between them is a disconformity and not an unconformity. There has been no mountain-forming diastrophism in New Zealand between the post-Hokonui and Kaikoura deformations. In one part or another of the area now New Zealand there was practically continuous deposition between these two major epochs of diastrophism, resulting in a series of beds from Middle Cretaceous to probably Upper Pliocene, which in their totality I have termed the Notocene (Thomson, 1917, No. 2.). In the middle of the Oamaruian the sea transgressed on both the east and the west coasts of both islands so that the land was at a minimum, and during this period any connections with Australia are most improbable. The Cretaceous transgressions, however, affected only the eastern coasts except in the north of Auckland, and during this period the land may have extended far to the west and north-west, and may have continued to do so during the Eocene.

Diastrophic considerations in distant correlation have not yet been fully appraised, but their value in the form advocated by Willis (1910), in which distinct dynamic districts bordering the different oceans are recognised, seems to be considerable. No geological facts known to me controvert the probability that the diastrophic history of the New Zealand area in its major outlines is also that of eastern Australia and western America, both North and South, in fact of the circum-Pacific lands.* According to this view, the late Jurassic or early Cretaceous was a period of major diastrophism with emergent lands around the Pacific, coupled with diversities of climate similar to those of the present. Base-levelling and rise of the strand-line, the latter modified by local warpings, and perhaps intermittent owing to the different diastrophic history of other connecting oceans, followed throughout the Cretaceous and Eocene, and attained its climax in the Oligocene-Miocene, when the continents were low-lying and peneplained, and their margins largely overflowed by the ocean. At the same time the climate, which in the New Zealand Senonian had well-contrasted seasons (Stopes, 1914), had altered to become more uniform and mild. With the early stages of the Kaikoura deformation the land areas were again increased, and the climate became diversified, the climate of the New Zealand Wanganuian not being greatly different from that of the present day. With the full attainment of the

* Since the above was written, A. Windhousen (Am. Journ. Sci., ser. 4, vol. xlv, pp.1-53, 1918) has discussed the problem of the Cretaceous-Tertiary boundary in South America, and concludes that both in Chile and Patagonia there is a hiatus between Cretaceous and Tertiary sediments, corresponding to the first phase of the Andine orogenetic movements. The latter, therefore, seem to be earlier in inception that the Kaikoura deformation. Nevertheless, the transgressions in Patagonia increase in area from the Cretaceous to the Oligocene-Miocene, as in New Zealand, and the diastrophic history of the two areas is broadly parallel.

Kaikoura deformations New Zealand and Australia passed through glacial climates, not very pronounced but with a much greater development of glaciers than exists at the present day.

If this view of the geological history of the circum-Pacific lands is sustained, former land connections between them are most to be expected in the late Jurassic or early Cretaceous and in the late Pliocene and post-Tertiary, but not in the Oligocene-Miocene. The distribution of the land faunas and floras negatives any land connections by means of the Kaikoura deformations, and with this the specific distinctness of the coastal brachiopod faunas stands in agreement. The former connections that are demanded by the distribution of the brachiopods as well as of land animals must have been due to the post-Hokonui deformation.

According to the diastrophic theory, periods of climacteric diastrophism are periods of climatic diversity and provincial faunas with restrictional evolution, while the period of early base-levelling is a period of rapidly-expanding and competing faunas, giving rise to cosmopolitan faunas at the period of climacteric base-levelling.

Unfortunately little is known of the brachiopods of southern lands in the Cretaceous and Eocene. The cosmopolitan faunas of the period of climacteric base-levelling and maximum sea transgression, the Oligocene-Miocene, fail because by this time the southern rim of the Pacific had broken down Only a very few species attain a cosmopolitan distribution, and the presence of these demands that the connections remained effective almost till the Oligocene-Miocene.

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EXPLANATION OF PLATES.

Plate XV.

Fig.

1, 2, 3, 4, 5.—*Gyrothyris mawsoni* Thomson. One mile off south end of Macquarie Island. Holotype. Enlarged 1½ diameters.

6, 7.—*Magellania joubini* Blochmann. Station 8, Davis Sea, 60 fathoms. Enlarged 1½ diameters.

8, 9.—*Liothyrella antarctica* (Blochmann). Station 2, off Adelie Land, 288-300 fathoms. Enlarged 1½ diameters.

10.—*Macandrevia vanhöffeni* Blochmann. Station 11, off Shackleton Glacier, 358 fathoms. Dorsal valve, ventral view; the same specimen as figs. 57-59, plate III. Enlarged 1½ diameters.

11, 12.—*Terebratella vel Magellania* sp. Station 10, off Shackleton Glacier, 325 fathoms. Enlarged 1½ diameters.

13, 14, 15, 16, 17.—*Magellania macquariensis* Thomson. Beach, Wireless Cove, Macquarie Island. Figs. 13, 14, holotype; fig. 15, paratype, showing greater elongation and a straightened front; figs. 16, 17, interior views of paratype.

18, 19.—*Crania joubini* Thomson. Station 9, Davis Sea, 240 fathoms. Holotype (dorsal valve). Fig. 18 is a dorsal or exterior view, and fig. 19 a ventral or interior view. Enlarged about 3½ diameters.

20, 21, 22.—*Liothyrella fulva* (Blochmann). Off Maria Island, Tasmania, 65 fathoms. Figs. 20 and 21 show the interior of the valves with the dried animal, and particularly the course of the sinuses of the mantle, which are white owing to the presence of spicules; fig. 20 shows the interior of the dorsal valve after the removal of the animal. Natural size.

23.—*Magellania* (?) sp. Station 2, off Adelie Land, 288-300 fathoms. Enlarged about 2½ diameters.

24, 25, 26.—*Stethothyris antarctica* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Holotype. Natural size.

27, 28.—*Stethothyris uttleyi* Thomson. Ototaran, Weston, New Zealand Anterior portions of dorsal and ventral valves of paratypes. Natural size.

29.—*Amphithyris buckmani* Thomson. Cook Strait, near Wellington, New Zealand. Dorsal valve of holotype with the animal, mounted in balsam, viewed ventrally by transmitted light. Enlarged about 15 diameters.

Plate XVI.

Fig.

30, 31, 32.—*Hemithyris striata* Thomson. Station 11, off Shackleton Glacier, 358 fathoms. Holotype. Enlarged $1\frac{1}{3}$ diameters.

33, 34.—*Magellania joubini* Blochmann. Station 3, off Adelie Land, 157 fathoms. Natural size.

35.—*Amphithyris buckmani* Thomson. Cook Strait, near Wellington, New Zealand. Holotype, ventral valve, ventral view. Enlarged about $3\frac{1}{2}$ diameters.

36, 37, 38.—*Liothyrella neozelanica* Thomson. Cook Strait, near Wellington, New Zealand. Figs. 36, 37, holotype; fig. 38, dorsal valve of paratype, ventral view showing part of body wall and mantle adhering to the shell. Natural size.

39.—*Stethothyris antarctica* Thomson. Station 10, off Shackleton Glacier, 358 fathoms. Pores and mosaic of interior ventral valve of holotype, near the left margin. Enlarged 100 diameters.

40.—*Magellania macquariensis* Thomson. Beach, Wireless Cove, Macquarie Island. Pores and mosaic of interior of ventral valve of paratype, a little in front of the middle. Enlarged 100 diameters

41.—*Magellania joubini* Blochmann. Pores and mosaic of the interior of the ventral valve of the specimen shown in fig. 34, plate XVI, a little in front of the middle. Enlarged 100 diameters.

42.—*Liothyrella ovata* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Pores and mosaic of interior of ventral valve of holotype, a little in front of the middle. Enlarged 100 diameters.

43.—*Macandrevia vanhöffeni* Blochmann. Station 11, off Shackleton Glacier, 358 fathoms. Pores and mosaic of interior of ventral valve, a little in front of the middle. Enlarged 100 diameters.

44.—*Macandrevia lata* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Pores and mosaic of interior of ventral valve of paratype, a little in front of the middle. Enlarged 100 diameters.

45.—*Hemithyris striata* Thomson. Station 11, off Shackleton Glacier, 358 fathoms. Mosaic of interior of ventral valve.

Plate XVII.

Fig.

46, 47, 48, 49, 50.—*Macandrevia lata* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Figs. 46, 47 holotype; fig. 48, posterior view of portion of the ventral valve of an old shell, showing the position of the foramen; fig. 49, dorsal-anterior view of the same specimen, showing the dental plates united by a deposit of callus; fig. 50, interior of dorsal valve of another paratype. Enlarged $1\frac{1}{2}$ diameters.

51, 52.—*Liothyrella neozelanica* Thomson. Cook Strait, off Wellington, New Zealand. Fig. 51, spicules of dorsal body wall of the holotype, near the middle; fig. 52, spicules of the ventral body wall, on the side. Enlarged 45 diameters.

53.—*Liothyrella fulva* (Blochmann). Off Maria Island, Tasmania, 65 fathoms. Spicules. of the ventral body wall, near the middle. Enlarged 45 diameters.

54, 55, 56.—*Liothyrella ovata* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Holotype. Fig. 56 shows the left part of fig. 55, differently lighted to bring out the radial ornament. Enlarged $1\frac{1}{2}$ diameters.

57, 58, 59.—*Macandrevia vanhöffeni* Blochmann. Station 11, off Shackleton Glacier, 358 fathoms. Fig. 59 is an anterior view of the specimen shown in figs. 57 and 58, with the valves gaping as far as the articulation will allow. Enlarged $1\frac{1}{2}$ diameters.

60.—*Stethothyris pectoralis* (Tate). Miocene, Aldinga, South Australia, after a specimen in the Dominion Museum. Anterior portion of dorsal valve, ventral view. Slightly enlarged.

Plate XVIII.

Fig.

61, 62.—*Liothyrella neozelanica* Thomson. Cook Strait, off Wellington, New Zealand. Spicules of dorsal body wall of holotype at the side. Fig. 61, enlarged 30 diameters; fig. 62, enlarged 45 diameters.

63.—*Liothyrella ovata* Thomson. Station 10, off Shackleton Glacier, 325 fathoms. Spicules of right arm of the holotype, near the proximal end. Enlarged 45 diameters.

64.—*Liothyrella neozelanica* Thomson. Spicules of dorsal side of right arm of the holotype, near the distal end. Enlarged 45 diameters.

65, 66.—*Liothyrella antarctica* (Blochmann). Station 2, off Adelie Land, 288-300 fathoms. Fig. 65, spicules of left arm of the specimen figured in fig. 8, plate XV., near the proximal end. The spicules in focus are those of the dorsal side. Those underneath them and not in focus are the main plates of the ventral side. Fig. 66, spicules of the arms of a young specimen of 6 mm. dorsal view. Enlarged 45 diameters.

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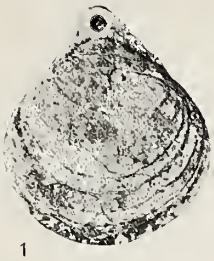
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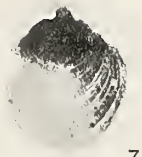
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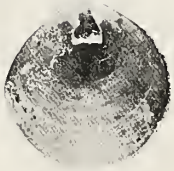
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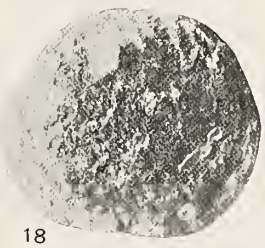
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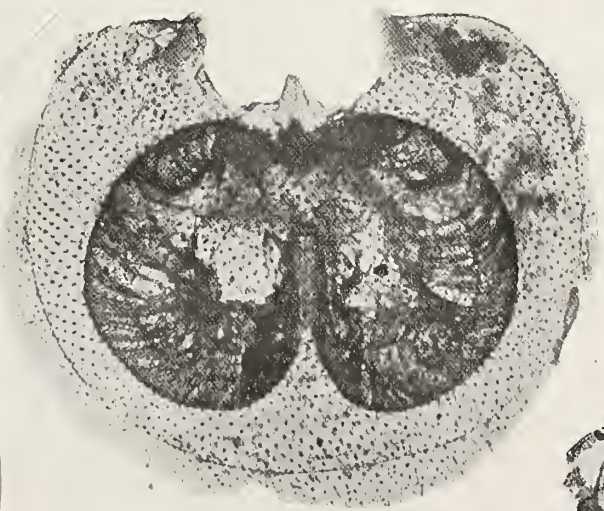
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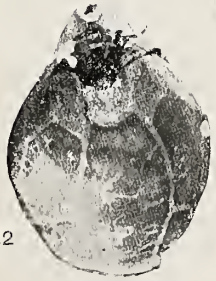
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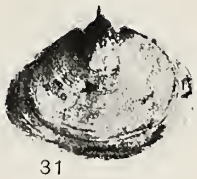
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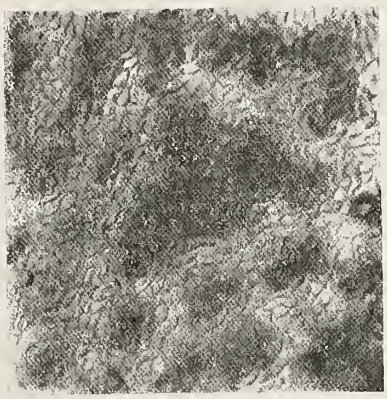
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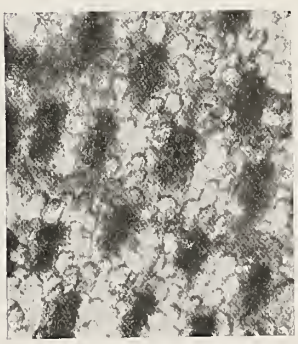
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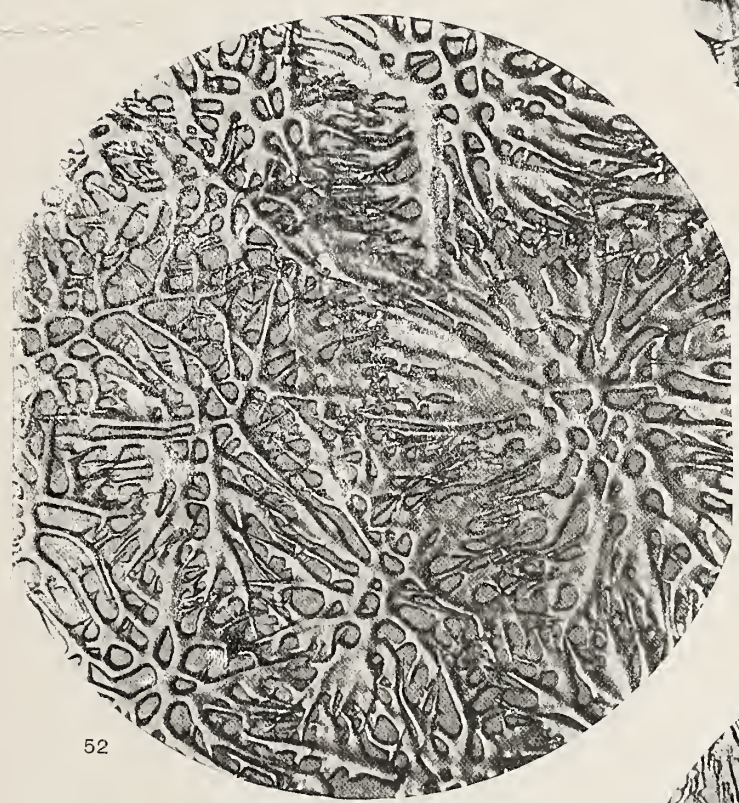
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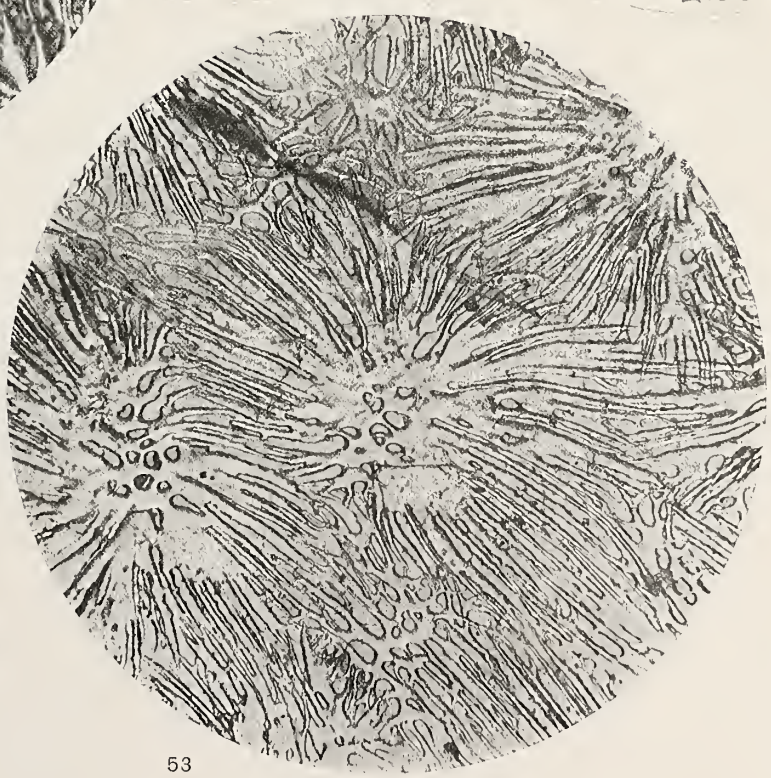
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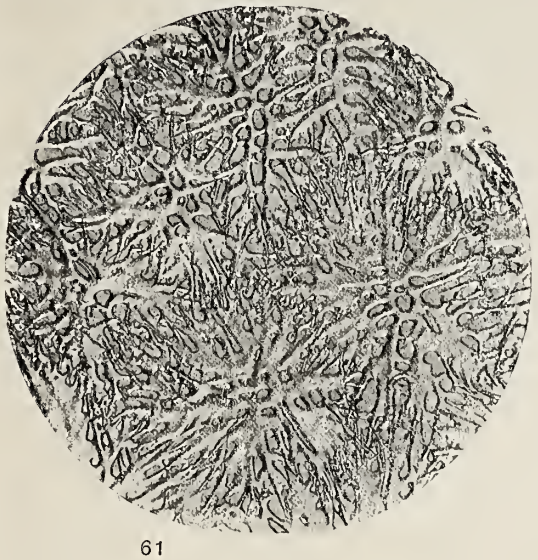

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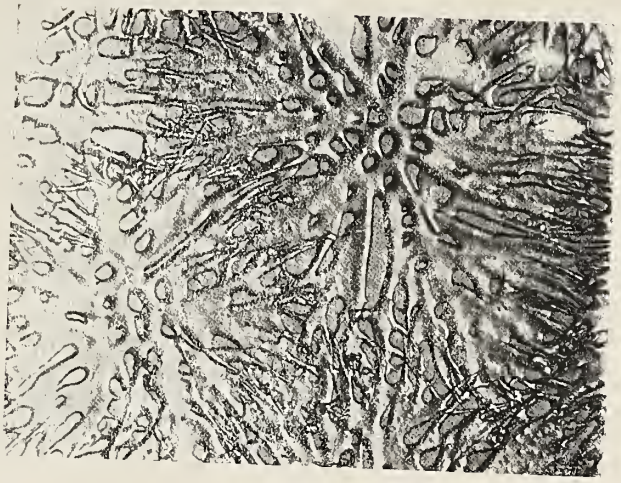

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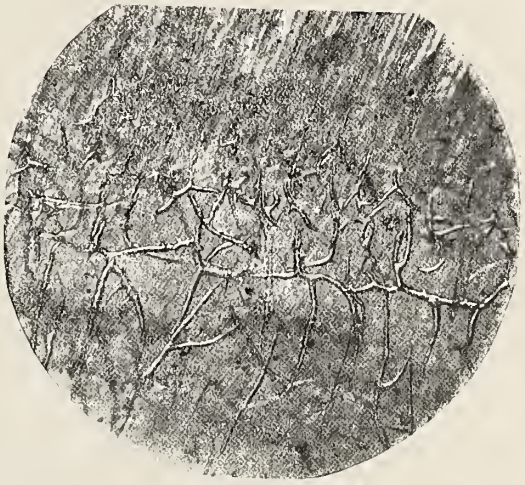

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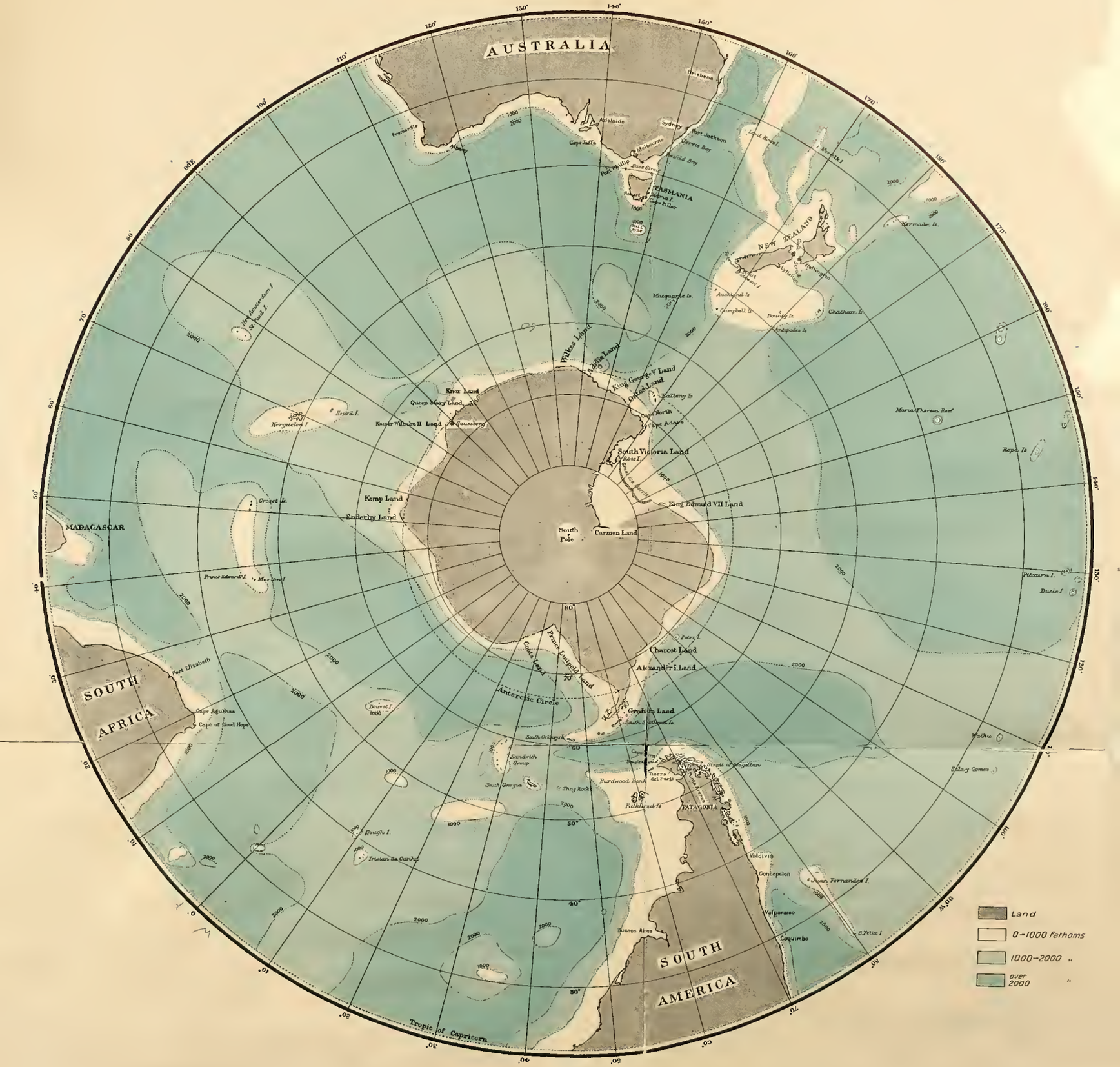
BATHYMETRIC MAP
OF THE ANTARCTIC AND SOUTHERN OCEANS

COMPILED BY
J.A. THOMSON
1917



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