of forms which so wide an extent of land should have developed. A much harsher climate would have prevailed over Forbes' broad continental area than over a chain of islands or a narrow strip of land. *Had the conditions indicated by Dr. Forbes once existed, then each of the southern land masses should have preserved an equal heritage of Antarctic life*, which is not the case. A sharing of population may not be invariably cited (as it is in this paper) as indicative of former land passages, for it has been clearly demonstrated in the case of the Azores and Galapagos that considerable immigration may occur across wide expanses of ocean.

Mr. H. A. Pilsbry has remarked,[1] that "the presence of very similar forms in southern South America and Tasmania and New Zealand, has been accounted for by the hypothesis of a former more extensive Austral continent or "Antarctica," which may have been supplied with these snails, as well as with certain marsupials, fishes, &c. from Australia, and subsequently became united at Cape Horn, transferring the fauna. The connection could hardly have been in reverse order, or why should not Edentates and Hystricomorph Rodents have invaded Australia."

The opposite view, viz. that Antarctica transferred a fauna from America to Australia is favoured by the facts that the fossil marsupials from the Patagonian Eocene antedate[2] any fossil

[1] Guide to the Study of Helices, p. xxxix., Philadelphia 1895.

[2] This statement is derived from the following data, for which I am chiefly indebted to the kindness of my friend Mr. W. S. Dun, Assistant Palæontologist to the Geological Survey of N.S.W., himself the author of important papers on the subject. The oldest DESCRIBED Australian mammalia are Pliocene; viz. *Ornithorhyncus maximus*, Dun, and *Echidna robusta*, Dun, (Records Geol. Survey, N.S.W., IV., p. 119) from this Colony. From Victoria Prof. McCoy has claimed as Pliocene (Prodromus, Palæontology of Victoria, Decades I. - VII.) *Phascolomys plocenius*, McCoy, *Diprotodon longiceps*, McCoy, *Macropus titan*, Owen, and *Procoptodon goliah*, Owen. Some bones recognised by Johnston (Geol. Tasmania, p. 261) and Tate (Proc. Roy. Soc. N.S.W., 1893, p. 168) as *Halmaturus* from the Eocene of Table Cape, Tasmania, can hardly be discussed till they have been studied, described and named. Yet on *a priori* grounds the Diprotodontia can scarcely be supposed to have so far proceeded on the path of differentiation from the radical Polyprotodont stock as to have evolved into *Halmaturus* at the early date of the Eocene; further, the sea shells of this deposit form an incongruous environment for a wallaby. For a list of the numerous marsupials extracted from the Upper Eocene beds of Santa Cruz, South America, see Zittel, Geol. Mag., X., p. 456.

marsupials recorded from Australia, that the marsupialia dawn upon the Australian horizon as a highly differentiated group, and that Prof. Spencer has demonstrated[1] "that the diprotodonts had their origin in the Euronotian region," meaning that their centre of dispersal lay to the south east of Australia. Von Ihering has suggested[2] that a large area of South America was separated in Mesozoic times from the remainder and maintained a distinct fauna and flora. If from this tract, which he terms Archiplata, were excluded, as he holds, placental mammals, it may have peopled Australia with marsupials and yet not have transferred thence Edentates or Hystricomorph Rodents.

The relation of Antarctica to African lands is a subject on which an Australian student has little chance to form an opinion. Perhaps the faint though real affinity (as shown in the distribution of the molluscs Endodontidæ, Rhytididæ, and Acavinæ), would be explicable on the supposition that before either America or Australia had united with Antarctica, Africa had already been joined to and broken from it, receiving a colony thence or leaving one there to mix with American and Australian forms when the vicissitudes of continental growth permitted.

In an inquiry[3] into the distribution of the pond snail *Gundlachia* I lately proposed as the simplest solution of the problem. That DURING THE MESOZOIC OR OLDER TERTIARY, A STRIP OF LAND WITH A MILD CLIMATE EXTENDED ACROSS THE SOUTH POLE FROM TASMANIA TO TERRA DEL FUEGO, AND THAT TERTIARY NEW ZEALAND THEN REACHED SUFFICIENTLY NEAR TO THIS ANTARCTIC LAND, WITHOUT JOINING IT, TO RECEIVE BY FLIGHT OR DRIFT MANY PLANTS AND ANIMALS, as the Galapagos received their population from America, or the Azores theirs from Europe.

This conclusion was built upon the following evidence. A minimum of land extension, compared with that asked for by Hutton or Forbes, was demanded. A milder climate is admitted by

[2] Report Austr. Assoc. Adv. Science, 1892, p. 118.
[3] Trans. New Zealand Institute, 1891, XXIV., p. 434.
[1] Proc. Linn. Soc. N.S.W., (2) VIII., p. 508.

geologists, even by those who dispute its cause, to have formerly prevailed in Arctic regions; a mild Antarctic climate should therefore be admissible. Dr. Murray remarks[1] of the fossils collected by Capt. Jensen, close to the Antarctic Circle, that they "are probably of a Lower Tertiary age, and they indicate a warmer temperature than now prevails in these high southern latitudes." A cursory survey of a collection of Eocene Mollusca from the Muddy Creek beds of Victoria, suggests to me that warmer seas then prevailed. Its wealth of *Cypræa* and *Voluta* point to a tropical climate. I observe there tubes of *Kuphus*, a genus now ranging from Sumatra to the Solomons, whose evidence is corroborated by extinct allies of *Nautilus*. That New Zealand once extended very far south of its present position to or perhaps beyond the Macquarie Islands, is granted by all who have investigated the subject.[2] Possibly this southward extension was synchronous with the northward extension indicated[3] by the range of *Placostylus*. That this southward extension of New Zealand did not, during the marsupial exodus, actually touch the highway between Tasmania and South America, I infer from the fact that such passengers as the venomous snakes, extinct *Palimnarchus*, cystignathous frogs, monotremes and marsupials, failed to arrive in New Zealand. The southward prolongation of Tasmania in the direction of Royal Company Island is suggested by the Tasmanian axes described[4] by Prof. David.

The evidence collected tends to show Antarctica as an unstable area, at one time dissolving into an archipelago, at another resolving itself into a continent.

How this would affect the marine shallow water fauna has not been previously considered. Under the circumstances I have

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[1] Notes on an important Geographical Discovery in the Antarctic Regions—Scottish Geographical Magazine, Vol. x., p. 195.

[2] Vide Blanchard, Comptes Rendus, 1882, p. 386.

[3] Proc. Linn. Soc. N.S.W., (2) VII., p. 335.

[4] Presidential Addresses, Proc. Linn. Soc. N.S.W., (2) VIII., p. 606, and Vol. x., p. 155.

described, the South Pacific would stretch within a few degrees of the Pole into a deep bight or gulf extending from Tasmania to Cape Horn. Into the western extremity would open the long and narrow tongue of what is now the Tasman Sea. When the climate cooled, the fauna at the head of this Antarctic Gulf, as I propose to call it, would be driven northwards to milder zones. By diverging meridians a similar fauna would reach New Zealand, New South Wales and Chili.[1] In a precisely similar manner, Darwin[2] has shown how the northern Glacial period drove the same Polar flora by radiating paths to the Alps, Himalayas and Alleghanies, where they now survive stranded on mountain tops.

If, when this northward migration occurred, continuous land had reached from Australia to Chili, then none of the fauna of the Antarctic Gulf could have entered either the Indian or the South Atlantic Oceans. We have, however, no warrant for believing that the Antarctic bridge long endured as continuous and contemporaneous land ; and that it was pierced by channels is proved by the escape of stray members of that characteristically Antarctic genus *Struthiolaria* to Patagonian coasts (*S. ornata*, Sowerby)[3] on the one hand, and to Kerguelen (*S. mirabilis*, Smith)[4] on the other.

The destruction[5] which the ancient fauna of the Antarctic Gulf has endured and the length of time which has elapsed since its expulsion, deprives us of much hope of reconstructing it. Since that event, for instance, the genus *Haliotis* has probably altogether grown up as a characteristic feature of the modern Australian

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[1] *Cf.* The occurrence of *Concholepas*, recent only in South America, as a fossil in Australia.—These Proceedings, ante, 1893, p. 171.

[2] Origin of Species, Chap. xi.

[3] Darwin, Geol. Obs. S. America, pp. 376, 618, pl. iv., f. 62.

[4] Trans. Roy. Soc., Vol. clxviii., p. 170, pl. ix., f. 3.

[5] "We seem [in the Pliocene] to be dealing with the remains of an earlier fauna disappearing rapidly before the conquering host of the recent fauna which had invaded New Zealand some time previously."—Hutton, Macleay Memorial Vol., p. 36.

molluscan fauna. A search among the more persistent of living types may produce some torn pages of its history. One such is recognised by the writer in *Lucapinella*, whose occurrence in Australian waters is noted.[1] But palæontology must be chiefly called on to relate the story of the decline and fall of the Antarctic marine fauna.

ICEBERGS IN THE SOUTHERN OCEAN.

By H. C. Russell, B.A., C.M.G., F.R.S., &c.

[With Plate XII.]

[*Read before the Royal Society of N. S. Wales, September 4, 1895.*]

I have prepared this short paper upon icebergs, not because I consider myself an expert on the subject, but because I entirely agree with Lieutenant Maury, a great authority, when he said that "a sudden accession of icebergs is a danger to navigation." We have had within the last two years, or rather eighteen months, an extraordinary accession of icebergs between the Cape of Good Hope and Australia, and the danger caused by innumerable icebergs in these waters is so real that the publication of the facts cannot be delayed.

The literature known to me on the subject of icebergs in relation to navigation is not very extensive, and very little is said about it in the ordinary books of reference, and some of that little would have been inaccessible to me but for the aid of Captain Bedford, Examiner to the Marine Board, who has very kindly lent me a book that covers a greater part of the ground, seeing that it has discussed every record of icebergs in the southern ocean from the time of Captain Cook to 1858. It is called a paper on "Icebergs

[1] Proc. Roy. Soc., Vict., 1894, p. 197.

in the Southern Ocean," prepared by John Thomas Towson, F.R.G.S., and was published by the Board of Trade and Admiralty, London. But for the period intervening between 1858 and my own work, I find very little in print. Mr. Towson claims to have selected the well-known ocean tracks for vessels coming to Australia in 1848, and he adds that for six years thereafter there were no complaints of icebergs as a danger in the tracks he had laid down, until the latter part of 1854, when alarming accounts of ice in the southern ocean began to come in. In November, both in the outward and homeward tracks, more particularly between Cape Horn and Cape of Good Hope, many icebergs were seen; and writing in 1858 he goes on to say, "Since April, 1855, however, the only reports of icebergs sighted in this part of the ocean are much farther south and confined to a small area."

Noticing the frequent reports of icebergs recently I began to collect them, and found in the *Australian Shipping News* of August 5, 1893, two articles on icebergs, one copied from the *Nautical Magazine*, the other from the *Sydney Morning Herald*. The *Nautical Magazine* says, "Since November, 1891, reports of ice in the southern ocean have been very frequent."

In addition to these, I have collected all the reports from the daily press, and record here my obligations to the following gentlemen who have very kindly furnished me with detailed reports of icebergs:—Mr. R. Woodget, master of the ship "Cutty Sark," Nos. 69 and 70 on list; Mr. Charles Dixon, master of the ship "Erin's Isle," No. 103; Mr. T. Messenger, master of the barque "Ladas," No. 89; Commander Burgess, R.N.R., sub-lieutenant s.s. "Bungaree," No. 82; Mr. Thomas J. Cook, master of the ship "Oronsay," No. 102.

The reports detailed in subsequent pages prove, I think, that there has been of late another remarkable outburst of icebergs in parts of the ocean where they are very dangerous to navigation.

Many years since, Lieutenant Maury studied this subject and condensed what he learned into the statement, "We can only say

that to the north of latitude 50°, Antarctic icebergs most abound between the meridians 15° west and 55° east. Mr. Towson, after an elaborate study, repeats the statement, but alters the limits to 50° west to 10° east; and the result of my own work would make these limits 50° west and 110° east. This, in itself, shews the greater area now affected and the necessity for some one to take the matter up. (See *Plate* 12).

It is, I think, evident that for a convenient study of these records, one must have a chart, and I have marked each record in the same way, viz., by a small circle on the ship's position at the time, each circle is marked with lines which shew the the date. Thus: a circle with one vertical bar is for 1891; two bars, 1892; three bars, one being across, 1893; four bars crossed, 1894; and a circle with a V in it, 1895; for 1888 a circle alone is used. The convenience of this is at once obvious when we come to use it. Each record also has a number, by means of which the original report can be found in the letterpress.

I have had put on the chart another remarkable record—the track of the abandoned ship "Dumbartonshire." This extends from longitude 48° west to 14° 20′ east, nearly the whole of it being in latitude 40° The starting-point is in the iceberg region, and her progress therefore is the best possible guide to the direction and rate of motion of the icebergs.

The several positions of the derelict are marked on the chart by circles a little larger than the iceberg circles. The centre of the ring has been in each case placed as nearly as possible over the position in which she was seen, and these have been joined by a thick line. The derelict shews a very decided current from a region crowded by icebergs in 1892, nearly due east. If the icebergs followed the same course, their position in subsequent years about the Cape of Good Hope and thence towards Australia would be fully accounted for.

AS TO THE LOCALITIES OF THE ICEBERGS.

It will be seen on the chart that a very large group of icebergs, found soon after passing Cape Horn northwards, are nearly all

marked 1893, and the next group going northerly are marked 1892. At first sight this would look as if the icebergs had gone southerly against the current, but that view is obviously improbable, for they must go with—not against—the current. I think the relative positions would be satisfactorily accounted for thus: The 1892 lot, being right in the fairway of vessels taking the usual track round the Horn, would be avoided as soon as they were reported, and ships would shape a course nearer the main land in 1893 and find the icebergs recorded of that date. Meantime the whole lot were drifting eastward, like the "Dumbartonshire," and left a clear course near the Horn for homeward-bound ships, and hence, so far as I can learn, no icebergs are recorded there in 1894 and 1895.

From 1891 onwards, however, vessels bound for Australia viâ the Cape of Good Hope found icebergs east of the Cape. At first a few were seen, and the number has gradually increased, until now (July 26th, 1895) the chart is fairly strewn with record spots from the Cape to the longitude of Perth, and from 40° to 48° south, 1895 having far the greater number to its credit. As a whole they are more to the east than those of the preceding years; and in considering their numbers, it is necessary to remember that it is not one iceberg but one position of the ship that is marked on the chart, and that in almost every instance great numbers of icebergs were seen. Many of the ships saw forty or fifty a day, and others still more and up to one hundred and fifty.

I do not mean to assert that all these icebergs drifted over from the lee of Patagonia, but that many of them did do so I think there can be no doubt, in view of the very strong evidence of easterly drift which we find in the derelict "Dumbartonshire."

Fitzroy's[1] experience also favours this view, for he says:—"Immediately round Cape Horn and the Falkland Islands ice seldom remains, as any that is drifted there is carried eastward

[1] "Weather," 1862, p. 149, and Maury, p. 467.

by the current that always sets around the great southern promontory, and the south-easterly winds help this."

From what little is known about the currents concerned in transferring these icebergs, one would expect that such groups as those of 1892 and 1893 under Patagonia would, when they began to go eastward, separate and draw into lines as we find them in 1894 and 1895, because the current is more rapid from latitude 30° southwards, and therefore the most southerly icebergs would travel fastest and also have fewer miles in a degree; and we cannot overlook the effect of the wind, which would necessarily be greater on icebergs presenting large flat surfaces than on those presenting sloping sides. Simply as evidence on this point, it is to be hoped that the "Dumbartonshire" will be sighted again.

Although the evidence of easterly drift appears to me to be so strong, I do not mean to assert that all the icebergs seen recently between the Cape and Australia came from the icefields under the lee of Patagonia. The experience of the master of the "Ladas" barque, bound from South America to Australia, shews that in latitude 50° to 53° he passed enormous fields of ice, and after passing the prime meridian they became so thick that he had to work northwards to avoid them, and it is more than probable that some of these made northing and joined the others drifting eastward.

Reference has already been made to the unusual position of icebergs between latitudes 40° and 50°. Maury, as we have seen, made the easterly limit 55°, Towson made it 10° east; the reports now under discussion make it 110° east.

Similar, but not so great uncertainty as to the extent of ice seems to attach to the area between New Zealand and Cape Horn. Admiral Fitzroy[1] says:—"In the South Pacific, between 150° and 100° west longitude, and 50° to 60° latitude, every ship that risks a passage through it finds numerous and some enormous masses of ice. Immense islands rather than icebergs have been

[1] "Weather," p. 160.