THE EFFECT OF THE BASSIAN ISTHMUS UPON THE EXISTING MARINE FAUNA: A STUDY IN ANCIENT GEOGRAPHY.

By C. Hedley, F.L.S.

The marine mollusca of Western Port and Port Phillip in Victoria have been carefully examined by Messrs. G. B. Pritchard and J. H. Gatliff. The results of their work appear in an admirable Catalogue published in parts by the Royal Society of Victoria, and now approaching completion. If this fauna be compared with the marine mollusca of South Australia as reflected in the writings of the late Prof. Tate, it will be found to be in essential points the same. I have lately been favoured by my friend Mr. A. U. Henn with a small but important collection illustrative of the molluscan fauna of Geraldton in 29° S. lat. in West Australia.

Though here the Melbourne fauna commences to fade away and to be masked by the overlap of species characteristic of the tropical Indian Ocean, yet it is still recognisable. So the same fauna extends from Melbourne westward for 2250 miles to sub-tropical West Australia.

In the expectation of meeting at least some traces of the Melbourne fauna, I once devoted some days to collecting at Twofold Bay in southern New South Wales. Though at this point Melbourne is only distant about 450 miles along the coast, its fauna is quite absent. One misses, for instance, the large and handsome *Phasianella australis*, abundant on every beach along the whole south and south-west coast of this Continent. As the smallest fragment of this beautiful shell is readily recognisable, the absence of the species from the east coast of Australia is a matter of certainty.

Melbourne zoologists have frequently expressed to me their surprise at the difference between the fauna they find on the shores of Sydney Harbour and that they know at home.

It has occurred to me that the break in the marine molluscan fauna, which happens, as we know, somewhere between Twofold Bay and Western Port, or, as I suppose, at Wilson's Promontory, is associated with the vanished Bassian Isthmus.

Granted two propositions, to be considered later, viz., that the Bassian Isthmus existed, and that Tasmania then stretched further to the south; migration of marine forms from east to west, that is to say along isothermal zones, would be interrupted. To regain the accustomed temperature, an individual or species travelling east from the Great Australian Bight would require to double the south cape of Tasmania. At the present time this would mean the endurance of a low temperature. But at that time the prolongation of land to the south meant to the wanderer a still lower temperature. For we may fairly postulate that though the absolute positions of the zones of temperature might have varied in the past, yet the relative proportion of so many degrees of higher latitude to so many degrees of greater cold doubtless remained unchanged.

The check low temperature opposes to migration has been clearly expressed by Dr. W. H. Dall as follows :—"The temperature limits of many species are more sharply defined on the side of cold than on that of heat. The difference between 45° and 40° F. may absolutely check the distribution of a species which would find no inconvenience in a rise of temperature from 45° to 80°. It is probable that this is connected with the development of the young rather than the resisting powers of the adult mollusc."*

The union of Tasmania and Australia has been discussed by Mr. A. W. Howitt,† who points out that between Wilson's Promontory in Victoria and Cape Portland in Tasmania, by way of Flinders Island and the Kent Group, the greatest depth is 32

* Dall, Bull. Mus. Comp. Zool. Harv. Coll. xii., p. 180.

† Howitt, Rep. Austr. Ass. Adv. Sci. vii., 1898, pp. 723-758.

fathoms. A 35-fathom line on either side would indicate a plateau 80 or 90 miles wide about midway between the shores of the Strait, and on the Victorian side widening out so as to extend up to Cape Howe. The neck of the former isthmus, if the depths remain relatively unchanged, is between Wilson's Promontory and Kent's Group. An elevation of 300 feet would lay dry a tract of comparatively level country between Victoria and Tasmania rising to a central ridge on the eastern side.

The proofs advanced by Mr. Howitt are so complete that no opposition is anticipated to the proposition that the Bassian Isthmus existed at a late geologic period. My second proposition that Tasmania at that date stretched farther south is perhaps more in need of support. If the depression of Bass Strait was associated with an undulatory south-north movement, then the Strait would be a trough, Tasmania a crest and the vanished southern tail of Tasmania would fall in a second greater trough. The dissected coast-line and the drowned river valleys of southern Tasmania indicate a recent subsidence.

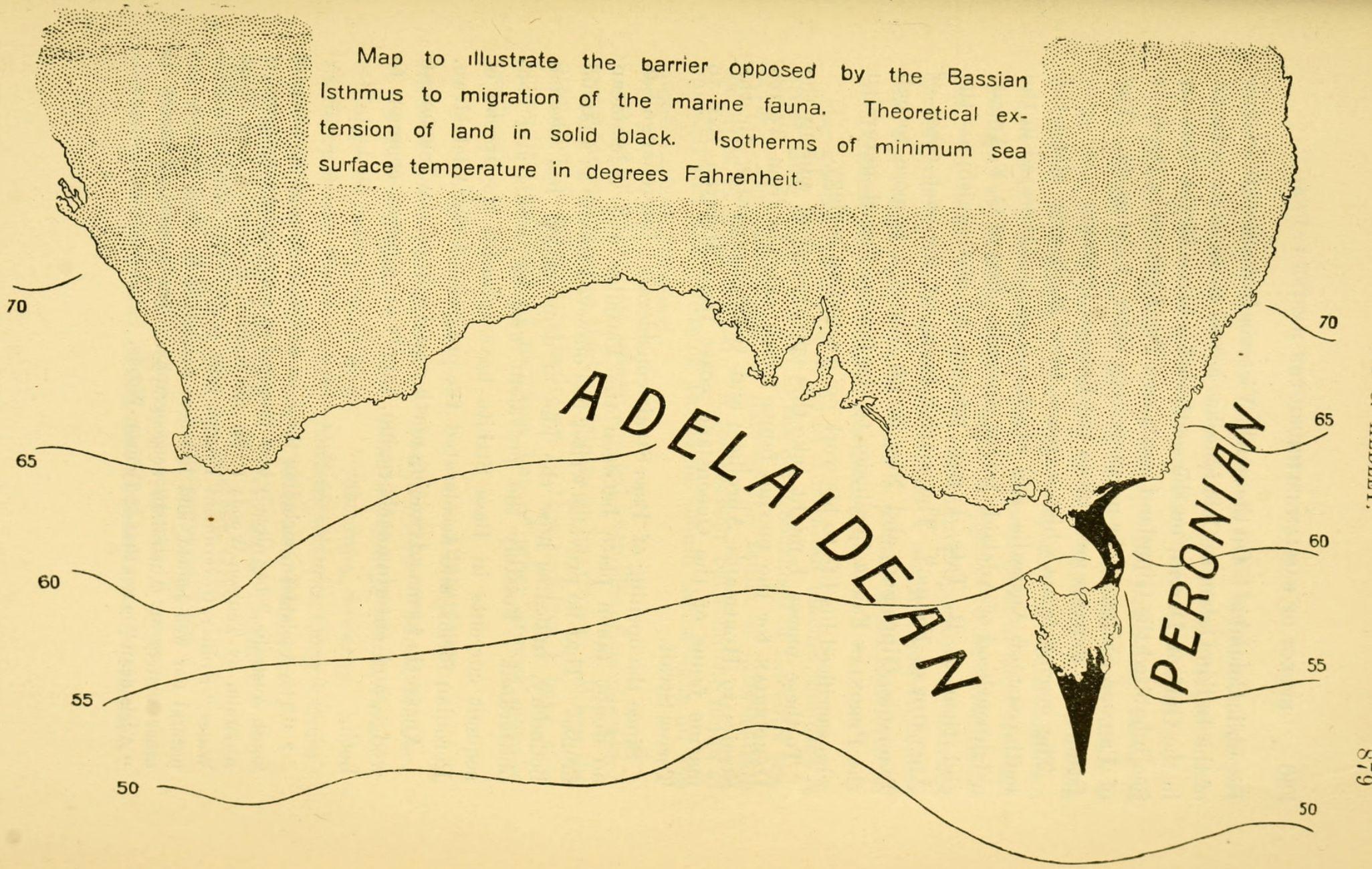
Former writers on Antarctica, Dr. H. O. Forbes* for example, "restored" the Antarctic Continent by filling solid with land the southern quarter of the hemisphere. I have proposed† as a more probable condition, and one that would better suit the distribution of existing animals, that a comparatively narrow tract of land joined Tasmania with Antarctica. This suggestion has received the approval of Dr. A. E. Ortmann,‡ and for the purpose of the present inquiry may be admitted as a working hypothesis.

The arrangement of land and water sketched in the accompanying map and described above would be of later date, say Early Pliocene, than the Antarctic connection. If it at all approximates to the truth, the then condition of what is now the State of Victoria might be compared to the South American

*Forbes, Supplementary Papers. Vol. iii. Royal Geographical Society, 1893.

† Hedley, Ann. Mag. Nat. Hist. (6) xvii., Feb. 1896, pp. 113-120.

‡ Ortmann, Rep. Princeton Univ. Exped. Patagonia, iv., Pt. 2, 1902, pp. 310-319.



Map to illustrate the barrier opposed by the Bassian Isthmus to migration of the marine fauna. Theoretical extension of land in solid black. Isotherms of minimum sea surface temperature in degrees Fahrenheit.

Republic Columbia. On the south, Victoria had access to a fauna of the Indian Ocean, as Columbia has access to an Atlantic fauna in the Gulf of Darien; on the south-east a fauna of the Tasman Sea inhabited the Gippsland coast, as a Pacific fauna in the Gulf of Panama occurs on the north-western shore of Columbia. The Isthmus of Panama answers to the Bassian Isthmus.

The marine fauna which extends from Melbourne along the south coast of Australia, and which was early elaborated in the neighbourhood of Adelaide by the researches first of G. F. Angas, and then of R. Tate, I now propose to distinguish as the ADELAIDEAN Fauna.* The marine fauna of the east coast of Tasmania, Gippsland, and New South Wales I propose to call the PERONIAN Fauna, in allusion to the famous French naturalist who sacrificed his life to his work on Australian zoology.

To these names I might take this opportunity of adding the DAMPIERIAN for the marine fauna which extends from Torres Straits to Houtman's Abrolhos; and the SOLANDERIAN for the marine fauna of the Queensland coast from Moreton Bay to Torres Strait.

Since the opening of Bass Strait considerable interchange has no doubt taken place between the Peronian and Adelaidean faunas. That no previous writer has observed its site as a faunal boundary, indicates how the line of demarcation has become obliterated. Possibly the prevalent westerly winds and consequent currents in Bass Straits have retarded the spread of Peronian forms, and accelerated the progress of the Adelaidean.

Antarctic forms advancing north would split on the Tasmanian wedge, and entering each region, supply an element common to both.

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* "The Adelaidean, including the coast and watersheds of the colony of South Australia," has already been proposed as a zoological subprovince of Australia by Tenison-Woods ("On the Natural History of New South Wales," Sydney, Government Printer, 1882, p. 49). His scheme is neither natural nor well-defined, and has been overlooked by Tate, Spencer and other writers on Australian zoogeography. The meaning I attach to "Adelaidean" is not that of Tenison-Woods.

It will probably be found that closely allied but distinct species, *Cryptoplax striatus* and *C. gunnii* for example, represent one another on either side of the site of the Bassian Isthmus.

West from Wilson's Promontory the coast-line included between the lines of 65° and 55° F. of minimum temperature is more than four times the extent of that between corresponding isotherms on the east. The endemic species of the Adelaidean region may therefore be expected to exceed those of the Peronian. So far as my studies have gone, this appears to be actually the case. I have been struck by the high proportion of endemic species among the Diotocardia. And I am inclined to believe that the range of species in space is usually more restricted in the Diotocardia than in the Monotocardia.

Our knowledge of the range of Australian marine mollusca is brief, being almost limited to the neighbourhood of the chief sea-ports. The compilation of lists of the fauna of intermediate localities is much needed. A comparison between the fauna of the east and west coasts of Tasmania should throw light on the questions here discussed.

In the following lists I have selected examples of species which appear to characterise the two faunas under review. When the attention of naturalists is drawn to this problem, I hope that fuller lists not only of mollusca but of other groups may be produced.

Peronian.	Adelaidean.
Haliotis cocoradiata, Reeve.	*Lucapinella pritchardi*, Hedley.
brazieri, Angas.	*Macroschisma producta*, A. Ad.
Callomphala lucida, Ad. & Ang.	*tasmaniæ*, Sowerby.
Liotia clathrata, Reeve.	*Haliotis albicans*, Quoy & Gaim.
Astele scitulum, A. Ad.	*excavata*, Lamarck.
Calliostoma speciosum, A. Ad.	*tricostalis*, Lamarck.
Monilea bellula, Angas.	*emmæ*, Gray.
pulcherrima, Angas.	*Liotia mayana*, Tate.
Cantharidus decoratus, Philippi.	*australis*, Kiener.
Clanculus omalomphalus, A. Ad.	*Astele subcarinata*, Swainson.

PERONIAN.	ADELAIDEAN.
Clanculus floridus, Philippi.	*Calliostoma legrandi*, Ten. Woods
clangulus, Wood.	*meyeri*, Philippi.
Calcar tentoriforme, Jonas.	*Monilea preissiana*, Philippi.
Turbo exquisitus, Angas.	*Cantharidus conicus*, Gray.
Cæcum amputatum, Hedley.	*irisodontes*, Quoy & Gaim.
Turritella gunni, Reeve.	*bellulus*, Dunker.
sinuata, Reeve.	*lehmanni*, Menke.
Zemira australis, Sowerby.	*Clanculus yatesi*, Crosse.
Potamides ebeninum, Brug.	*dunkeri*, Koch.
Cassis nana, Ten. Woods.	*maxillatus*, Menke.
Lotorium parkinsonianum, Perry.	*limbatus*, Quoy & Gaim.
	flagellatus, Philippi.
Trophon speciosus, Angas.	*Phasianella australis*, Gmelin.
laminatus, Petterd.	*Turbo gruneri*, Philippi.
Typhis phillipensis, Watson.	*jourdani*, Kiener.
Murex acanthopterus, Lamk.	*Capulus australis*, Lamarck.
Morula marginatra, Blainv.	*Turritella australis*, Lamarck.
Nassa peritrema, Ten. Woods.	*Cypræa thersites*, Gaskoin.
Cominella filicea, Crosse & Fisch.	*Cassis fimbriata*, Quoy.
Siphonalia maxima, Tryon.	*Lotorium verrucosum*, Reeve.
Voluta mamilla, Gray.	*Murex umbilicatus*, Ten. Woods.
magnifica, Chemnitz.	*planiliratus*, Reeve.
marmorata, Swainson.	*Sistrum adelaidensis*, Cr. & Fisch.
punctata, Swainson.	*Nassa fasciata*, Quoy & Gaim.
brazieri, Cox.	*Cominella costata*, Quoy & Gaim.
Microvoluta australis, Angas.	*alveolata*, Kiener.
Drillia oweni, Gray.	*Trophon eburneus*, Petterd.
Terebra venilia, Ten. Woods.	*Typhis yatesi*, Crosse.
Dolabrifera brazieri, Sowerby.	*Josepha tasmanica*, Ten. Woods.
Pugnus parvus, Hedley.	*Siphonalia tasmanica*, Ad. & Ang.
Ischnochiton australis, Sowerby.	*Fusus lincolnensis*, Crosse.
Liolophura gaimardi, Blainv.	*Voluta papillosa*, Swainson.
Cryptoplax striatus, Lamarck.	*fulgetrum*, Sowerby.
Acanthochites retrojectus, Pilsbry.	*Lyria mitræformis*, Lamarck.

PERONIAN.

Glycymeris australis, Quoy & G.
Arca fasciata, Reeve.
Trigonia strangei, A. Ad.
Chlamys hedleyi, Dautzenberg.
Lima brunnea, Hedley.
Modiolaria varicosa, Gould.
Arcoperna recens, Tate.
Cuspidaria brazieri, Smith.
Cardita dilecta, Smith.
cavatica, Hedley.
Lucina ramsayi, Smith.
rugifera, Reeve.
Meretrix disrupta, Sowerby.
Chione calophylla, Philippi.
Solen sloani, Gray.
Mactra eximia, Deshayes.
Zenatia victoriæ, Prit. & Gatliff.

ADELAIDEAN.

Cancellaria purpuriformis, Val.
Triphora scitula, A. Adams.
Terebra ustulata, Deshayes.
albida, Reeve.
Drillia quoyi, Desmoulins.
Operculatum corticale, Tate.
Ringicula australis, Hinds.
Ischnochiton juloides, Ad. & Ang.
novæ-hollandiæ, Reeve.
Cryptoplax gunni, Reeve.
Acanthochites asbestoides, Carp.
Chlamys undulatus, Sowerby.
Pecten bifrons, Lamarck.
Limæa australina, Tate.
Modiola victoriæ, Prit. & Gatliff.
Ectorisma granulata, Tate.
Cuspidaria tasmanica, Ten. Wds.
Crassatellites aurora, Ad. & Ang.
Cardita squamigera, Desh.
Lucina perobliqua, Tate.
Mylitta deshayesii, Recluz.
gemmata, Tate.
Ephippodonta lunata, Tate.
macdougalli, Tate.
Dosinia crocea, Deshayes.
Meretrix kingii, Gray.
Katelysia peronii, Lamarck.
Solen vaginoides, Lamarck.
Mactra abbreviata, Lamarck.
Anapella cuneata, Lamarck.
Gastrochæna tasmanica, Ten. W.