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PAPERS READ.

ON SOME OF THE LITTORAL MARINE FAUNA OF NORTH-EAST
AUSTRALIA.BY THE REV. J. E. TENISON-WOODS, F.G.S., F.L.S., &c.,
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During the years 1875-76, I was partly engaged in investigating the littoral marine fauna of Tasmania, and my observations have been published in the Transactions of the Royal Society of Tasmania for 1876, and those of the Royal Society of New South Wales for last year. I was very glad of an opportunity recently afforded me for examining the Coast Shells of North-East Australia not only because this part of the continent has been so little visited, but also for the sake of comparing results obtained from these two extremes. It may be observed that though the tropical coasts of Australia, have been visited and examined by such

accomplished naturalists as Huxley, Jukes, Darwin, McGillivray, Mosely, Dana, and others, yet the Littoral Shells have never been specially studied. There are so many other objects of great importance and interest in these localities that the littoral fauna has been passed over, and so I find the field quite untrodden.

The places to which my observations more especially refer are from Trinity Bay to the Endeavour River, a distance, in a straight line, of about 100 miles, and lying between S. Lat. 17° and $15^{\circ} 30'$. There are only a few places on this coast line where an examination is possible, as not only are there few settlements, but the coast itself is as a rule inaccessible, and the natives implacably hostile. There are three different kinds of littoral fauna to be seen. One is on the coral reefs. There is not much of this close in shore, but occasionally fringing reefs are found. I shall not deal with these in detail, because I purpose making them the subject of a series of special papers. There are two others which bear marked and distinct characters, that is the mangrove fauna and that of the exposed rocky coast. Sandy beaches are rare in this part of the coast of Australia. Generally speaking the precipitous hills of the cordillera seem to plunge direct into the sea and are covered with the dense jungle of tropical vegetation to the very water's edge. Still there are some fine sandy beaches, such as at the mouth of the Endeavour, the Bloomfield, the Daintree, and the Mossman Rivers, besides a magnificent stretch of sandy beach in the south side of Island Point, Trinity Bay. For the whole of these distances there are no signs of upheaval or subsidence, but a gradual reclamation of the land by the drifting up of marine sand. The rocks wherever exposed are volcanic or granite. They are ancient in appearance. There are no recent dolerites, such as we so frequently observe on the south coast.

The first thing that strikes the observer is the bare character of the rocks in many places. One frequently meets with spots where there is not a single mollusc to be seen adhering to the

cliffs and boulders along the shore. A few serpulæ and a number of a small species of *Balanus* may be noticed, but no molluscs and no seaweeds. The broad green fronds of the *Ulva latissima* so frequently covering the rocks in temperate latitudes, are absent as well as the confervoid growth of the sides of the rocky pools. The comparative absence of Algæ and Confervæ prevails everywhere as much around the coral reefs as on the rocky shores, but in the latter places, the mollusca vary in amount. Along the black rocky boulders of Island Point, Port Douglas, molluscan life is very abundant. A very large portion of the rocks is literally covered with a species of oyster. In habit and in mode of aggregation it is closely similar to the Port Jackson oyster, *Ostrea mordax*, Gould, but it is a different and probably described species. The edges of the valve are much more regularly undulate so as to have a frilled appearance, and the lower or adherent valve is subquadrate, and the edge comes up squarely all round just like a little box into which the upper, free valve fits like a lid. I believe it to be *Ostrea cucullata*, of Born (*Mus.* p. 114, plate 6, figs. 11 and 12) and Chemnitz *Ostrea cornucopiæ* (*Conch. Cab.* 8, p. 41, plate 74, f. 679). Born describes it as "Shell oblong, parasitical, with longitudinal plaits and strong imbricated, transverse wrinkles; upper valve flat, and its margin by the hinge somewhat toothed." In the figure of Born the lower valve is concave and ends in a long beak. This is a common form but not the usual one. It is quoted by various authors as from the Atlantic (West coast of Africa), Ascension Island, China, Arabia, and Sumatra. Humphreys (*Conchology, or Natural History of Shells*) says it is found in the South seas. I observed the same species in many places on blocks of dead coral on the reefs, in fact it seems to be abundant everywhere upon the coast within the tropics. It is of delicate flavour, and highly prized by the inhabitants, both black and white.

Next to this in abundance upon the rocks is *Plaraxis sulcata*, called perrywinkle by the settlers, and is boiled and eaten in

considerable quantity. There are places on the rocks just above the tidal marks where a basket can be filled in a few minutes by sweeping one's hand along the surface. They are packed quite close together. I shall add a few remarks upon the genus and species further on, but I may observe now that the habits of this mollusc are entirely those of the *Littorina*, which it almost completely replaces in the tropics. It extends abundantly, to my knowledge as far south as Moreton Bay. It reaches a larger size than *Littorina carulescens*, of our coasts. It was my impression at first that the *Littorinas* of our south coasts and of Tasmania were not found within the tropics. But with a very careful search I was able to discover here and there solitary examples of *Littorina carulescens*. When dwarfed in size, it was somewhat rugged with lines of growth showing how slow was its progress, and sometimes curiously mottled with brown. On the reefs it was occasionally met with, but a much finer and more solid shell with very little of the elegant bluish-white tint so common on all the south coasts. This shell reaching its maximum of development in South Tasmania, and as I believe with Deshayes and others, identical with *L. carulescens* of the Mediterranean, and *L. mauritiana* of the Cape, as far as Natal. I have paid some attention to this little species, and have watched the effect of climate upon it with interest. Just as we notice the old residents of North Australia by their peculiar aspect, so we may notice the old established *Littorina*. It is evident that certain rocks do not agree with it, and few are found to live within their limits, and those only in a stunted, distorted condition. I was inclined to think that *Littorina pyramidata*, Quoy, had entirely died out. This is the pagoda-like perrywinkle, with the double line of tubercles on the body whorl, and an elegant single row upon the spine; I soon found that I was mistaken. It is somewhat common at Port Douglas, though I never saw it anywhere else, and it never attains one-fourth the size of the Port Jackson specimens. The distribution of this species is remarkable. In South

Tasmania it is unknown, on the east coast it is very rare, and then they are only poor, small, and distorted specimens. About the region of Port Jackson it attains its maximum of development and is sometimes an inch and more in length. But it is not common inside the harbour. It is only seen at intervals along the east coast and I did not notice it about Cape Moreton or in Moreton Bay. I did not see it at any place on the coast, except Port Douglas, and there the size never exceeded a quarter of an inch. The climate appears to stunt its growth completely, though preserving its colour and shape. The result is interesting as a climatic influence if we compare its efforts with what we should witness if particular regions were to affect horses or cattle in a similar way. In contrast with this we have a remarkable illustration of the effects of climate in an exactly different manner. The rocks are frequently covered with a large species of *Acmæa*, which may have been described many times by different observers as it varies so much. It is common on all parts of the east coast which I have visited and equally common on Tasmania. It passes into Bass' Straits, but is not common on the south coast. In Tasmania it may be seen at its lowest state. It is small, irregular in growth, very much stunted, and sordid in appearance. Though not at all uncommon it is not easy to recognize on the rocks. The best point of resemblance throughout is the peculiar mottled spathula which is very characteristic and never can be mistaken. It is a true *Acmæa*, with the gill plume at the back of the neck, and by this feature also and the peculiar ribbed structure it can always be known. As it is traced northward from the extreme south of Tasmania, where I first saw it and described it as a new species under the name of *Acmæa marmorata*. (See Proc. Roy. Soc. Tas. 1875, p. 153.) it gradually increases in size and the colors of the shell become brighter and more clear. It can be thus followed over the Straits and on to the Australian coast. It receives its maximum of development in North-east Australia; thus inhabiting a line of coast from South Tasmania to Cape

York, a distance of very near 3,000 miles. It is evidently a tropical species, and grows largest and is in the finest condition within the tropics. I do not think that an impartial person could avoid recognizing it as one species, even though a comparison were instituted between specimens from the two extremes, that is from South Cape in Tasmania and Cape York in Australia. It is not very common at Port Douglas, of large size—(1½ inch in length)—and of bright colours. The brown spots in the spathula are paler and more distant, and all the colouring is more distinct. The radula or lingual ribbon is exactly similar in the specimens wherever they are obtained. We have therefore in this an example of a species which thrives through a very wide area, but is evidently better adapted for a warm climate. The case is thus the reverse of the *Littorina pyramidata*.

But we have another example on this coast which is different again. *Acmæa septiformis*, Quoy and Gaimard, is as all naturalists are aware very common on all the coasts of Southern and South-eastern Australia and Tasmania. It is not so well-known that it is found at intervals all along the coast into the tropics. At Port Douglas it is very common in places, but generally far up on the rocks and not very easy to discover. It is neither smaller nor larger than the specimens in my possession from the coldest part of Tasmania, and it does not seem to have varied in its colouring. That is to say it is as variable on the North Coast as on the South. but much within the same limits. It has always been my impression that no distinction could be made between this species and *A. testudinaria*, of Muller, which is so common in Great Britain, and since our species can be traced in the hottest as well as the coldest seas in Australia, without alteration, and on thousands of miles of coast we may well believe that it is of world-wide distribution.

I call attention here to these facts, because they show how no general rule can be adopted for the way in which mollusca are affected by climate. We have thus—1. *Acmæa marmorata*, which

is stunted in a cold climate to a fourth its size, and reaches its maximum of development in the tropics. 2. *Littorina pyramidata* which reaches its maximum of development in the temperate seas of Australia, and is dwarfed and deformed in the tropics. 3. *Acmaea septiformis*, which ranges through every climate from the extreme of cold to the extreme of heat, and is not affected by climate at all.

The conclusions to be drawn from these facts are far more important than would appear at first sight. We are accustomed to say that certain shells are tropical in character, and indicate a tropical fauna, and this would appear justifiable as far as the present fauna of Australia is concerned, but when we apply it to geology the conclusions are not by any means so certain. There may be species with a very wide range, and the development of one species which we are inclined to refer to the influence of warmer seas, may be from quite a contrary course. We have an instance of this in *Pectunculus laticostatus*, Lam., which is found extensively developed in our Tertiary rocks, but principally in the Miocene of Victoria. It is still found on the coasts of Australia but rarely, and of small size. But its maximum development is now in New Zealand, where it reaches as large a size as any of the fossil forms, but generally in the colder parts of the Middle Island coast.

We have only one *Patella* on the coast of Trinity Bay, that is to say only one true *Patella*, with the gills as a fringe round the foot. This is *P. tigrina* ? Gm., with its very conspicuous, silvery-white nacre. It is a shell of moderate size and not very common, generally preferring the very outermost rocks where it is washed by the spray of even low tides. The older shells are much corroded, one distinguishing feature about the species is the well-defined spathula which is of light brown color, and has even the impression of the tentacles on each side of the head. It would seem as if the spathula is caused by some corrosive action of the mantle on the shell, because on old shells a slight pressure from the inside

will make it break clean away. The radula of this species is short in comparison with *P. tramoserica*, being seldom over three inches in length.

A mollusc, which is here in far greater abundance than any of the *Patellidæ* whose form it resembles, is a species of *Siphonaria*. It would be very difficult to assign a name to it without considerable study into the claims of species, but I certainly think it is only one of the many varieties which from time to time have been distinguished by the names of *S. diemenensis*, *Baconi*, *funiculata*, and many other synonyms. It is a ribbed shell, with white ribs and brown interstices, but I cannot see any or even much difference between the varieties that have been named. It is just as common within the tropics as all along the east and south coasts of Australia and Tasmania. The animal is the same in every respect and the radula also. I think the typical specimens have a little advantage in point of size, but that is the only difference I can detect. It is more numerous than any of the *Patellidæ*, and this holds good of every part of the coast which I visited, within the Barrier Reef, but I have not often found it on coral reefs or anywhere except rocks, fringing the shore above the tidal marks. I consider it as especially characterizing the littoral fauna of Australia. I am not aware whether or not it has been remarked that the genus *Siphonaria* is more peculiar to the Southern hemisphere than the Northern.

In estimating the peculiarities of the littoral fauna at Island Point, Port Douglas, it must be borne in mind that the rock formation may have something to do with it. That formation is a dark phonolite stone which does not easily decompose, neither does it give rise apparently to much ferruginous earth or clay. Yet I attribute something to its influence. It abounds with *Planaxis sulcata*, as I have already remarked, the *Patellidæ* are also abundant, so are oysters and several species of *Nerita* to be mentioned presently. On the coral reefs close at hand there are equal numbers of oysters. *Patellidæ* are not common, though not

entirely absent. Here and there you meet with *Planaxis*, but no *Nerita*, and *Littorina cærulescens* is quite a different shell: large, solid, ivory-white, with the purple-brown markings of the interior and the rose spots near the mouth very brilliant and distinct. The rock of the coral reefs is a light-brown mass of coral and coral sand, and for the most part is covered at high water. This may be one of the reasons why there are so few littoral shells. But even on those reefs where a portion of the rock is always uncovered, *Siphonaria* is nearly the only species that is common, besides oysters.

There are four or five species of *Nerita* on the Port Douglas rocks. They are generally congregated together above high water mark in groups of 20 or 30. *Nerita costata* is the most common. This species is distinguished by its uniform, dull olive-green colour, and its few broad, nearly flat, spiral ribs. It does not seem to vary. On the other hand an equally common one is *Nerita polita* and of this there are endless patterns in its bands, spots, and zigzag markings of black, white, and grey. *Nerita grossa* is another common form. It is a large, somewhat thin, tumid shell, deeply toothed at the mouth. It may be mistaken for *N. costata*, with finer ribs and a more elevate spine, but the operculum is quite different. But there is a doubt about the identification of *N. costata*. It was originally described by Gmelin thus:—"Shell yellowish within, subglobular, surrounded with thicker striae, the interstices snowy, both lips toothed, the outer one crenate throughout, inner one sub-convex, wrinkled and tuberculate. Inhabits Nicobar Islands. Shell russet-brown or piceous, crown very obtuse, generally worn and yellowish or white." Born and Chemnitz are quoted for the figures. The latter corresponds with our shell, and so does the description, except the yellow interior, which is a variable character. I cannot well understand how Nicobar Islands can be the habitat and for it not to have been seen at intermediate stations. All the other *Neritas* of Port Douglas are Linnean shells and were

described by Rumphius from specimens obtained by him in the Mollucas.

Nerita albicilla, L., is another common form on the Port Douglas rocks. It is distinguished by a less oblique form than *N. costata* the ribs are not so coarse, the columella concave, teeth on both lips, fine and numerous, and the whole shell is conspicuously marked black and white in a varied style of ornamentation, of which a broad, white, spiral band is the most common. It was described from Rumphius by Linnæus, who refers to the former's figure. According to Hanley, type specimens are preserved in the cabinet of Linnæus. The habitat given is the Cape of Good Hope and Indian Ocean, but the first locality may be erroneous.

All the species have the peculiarity of keeping on the rocks above tidal marks, like the *Littorina*. The various species seem to group together and keep very distinct; the only wanderers being *N. albicilla*, which are sometimes found at the bottom of pools.

There is one point of distinction between all the *Neritas*, and that is in the operculum. Shells that resemble each other in many ways are found to have quite different opercula. I shall speak presently of a characteristic instance of this when dealing with the mangrove fauna. The opercula of *N. polita*, *N. costata*, and *N. albicilla*, are very characteristic. The latter though a more finely marked shell than *N. costata*, has an operculum covered with much coarser granulations. *N. polita* has a smooth and beautifully polished operculum, with a defined margin of rugæ. This renders the shell easy of identification. It has been long known to naturalists. This we gather from the host of figures quoted by Linnæus. There is an exceptional uniformity in these figures; the type specimens still exist in the Linnean cabinets. *N. mollucensis* is also found at Port Douglas, and some others to be mentioned presently.

Two species of *Chiton* are sufficiently common on the rocks. One appears to be the *Chiton spinosus* of Reeve. The other may

be a new species, and requires examination. The first is very common and equally so on the coral reefs. Both these species keep above the tidal marks, but just within reach of the surf and spray.

Besides the *Ostrea*, which may be regarded as representing *O. mordax*, there is a larger species, a *Chama* and a *Spondylus*, all common. *Purpura*, (*Polytropha*) *tuberculosa* is common also, but not so large as the specimens found at Port Jackson. The rocks are also conspicuously covered with two species of *Balanus* which are unknown to me as yet. One is a pyramidal form not observed further south.

Thus it will be seen that the tropical littoral fauna of the rocks does not differ much from the fauna we meet with outside the tropics. Some of the species are the same, but there is a change in others; thus the *Trochocochleæ* of the south have disappeared. Instead of seeing on every rock and stone crowds of *Trochocochlea australis*, *T. odontis*, and *T. constricta*, the place is occupied by very many species of *Nerita*, species which have a wide range throughout the tropics. The *Patellidæ* are partly different, and so are the *Littorinidæ*, *Planaxis sulcatus*, being the common form. The *Trochidæ* are entirely different. *Monodonta labio*, and *Trochus niloticus*, *T. cærulescens*, and some others are frequently met with. In many of the pools two or three species of cones will be found such as *C. hebraica*, *C. textilosa*, *C. capitaneus* and some others. *Cyprea arabica* is found almost under every stone. I might extend the list, but this will suffice to give an idea of what is the general character.

On the rocks at Port Douglas there are few or no corals. Very rarely one may meet a small patch of *Porites* or *Favia Bowerbankii*, but I never saw any other. These I may say are two of the hardiest species of coral as well as the commonest in this locality. *Favia Bowerbankii* does not seem to mind mud or sediment, which is fatal to most corals. Thus I have seen it encrusting a large proportion of the stones at the mouth of the Mangrove Creek.

All these stones are covered with mud and slime, and the place is washed over twice in the 24 hours by muddy, brackish water.

Far out upon the rocks there are a good number of *Aleyonaria* or soft corals as they are called belonging to the genera *Aleyonum*, *Ammonothea*, *Xenia*, *Anthelia*, and *Telesto*. I believe they are all of undescribed species. In every pool there are *Anemones* belonging to the families *Actininae*, *Thalassianthus*. The same pools are also distinguished by two or three long snake-like *Holothurids*, probably belonging to the genus *Synapta*, they are not of any value to the trepang fishermen and so are not molested. They may be seen stretching out for two feet and more gathering their food with the beautiful arborescent tentacles which form a ring around their heads; they are of a deep brown colour covered with wort-like papillæ. There are no anchor-like spines in the skin.

I have made but few special observations on the crustaceans, but I cannot help noticing a species of crab which abounds on the rocks. This is the *Grapsus pictus* of Latreille. It may be seen running away over the boulders and into the surf on the approach of any moving object. It is strange how tenaciously it can fasten to the bare surface of the rock so that the heaviest surf has no effect in moving it. They seem to have very low powers of hearing as they cannot be startled by the loudest noise. They make up for this by their powers of sight, as the smallest movement makes them start off for the water. They appear to feed upon an algal which grows upon the rocks, and certainly it is most ludicrous to watch them raising their claws alternately to their mouths while feeding, and at the same time standing, as it were, upon tiptoe, so that the sharp points of the rest of the legs may hold well into the inequalities of the rock surface. The species has an immense range, being equally common in the Cape Verde Islands, St. Helena, South Africa, the Mauritius, California, Peru, Georgia, West Indies &c. Miers quotes it as belonging to the New Zealand fauna, but I think the species is different. It is not at all uncommon on the temperate regions of the Australian

coast. When alive it has a dark, but clear green carapace, beautifully mottled and lined into a pretty pattern of lighter and darker spots and cloudings. When dead in cabinets, the colours fade into a redish brown. I could not discover whether the natives used it for food, but it is eagerly devoured by a large Octopus (*O. indicus* ?) which is common here.

The settlers gather and use another species, this is *Thalamita stipsoni*, with very beautiful blue tips to the claws. It is found under stones, and is very warlike, biting furiously, and holding tenaciously. I noticed two other species, *T. sima*, M.-Ed., and *T. danae*, Stimpson. Both these are said to occur in New Zealand, but I am doubtful about *T. sima*, which is, as far as I know only tropical in Australia. On the sands of Port Douglas and as far as Cleveland Bay, I noticed *Ocypode brevicornis*, I never saw it except on a sandy beach, and when pursued it took readily to the water.

On all the sandy places on the north side of Island Point a species of starfish, *Pentagonaster (Stellaster) Incei*, Gray, is very common. I did not notice it on any other part of the coast, but in one spot it is drifted up in dozens at every tide. Here also *Pentaceros Franklinii*, was found by me as well as *Anthenea tuberculosa* and an *Astropecten*, which I take to be *A. polyacantha*. Had I been able to dredge at this spot I have no doubt I should have found many other species from the fragments I saw upon the beach.

I turn now to the fauna of the mangroves, which is peculiar and entirely different from that of the coast. The creek at the back of Island Point, is a salt water inlet running between the township and the mountain range, which rises about a mile further inland. It is not navigable for more than four miles. Only in the rainy season does it ever bring down much fresh water, but it is always a muddy tidal stream with a coral reef at the mouth, and a dense growth of mangroves on the banks. The common species is the *Brugiera Rheedii*, with occasionally a fringe of

Ægiceras majus; this is different from the mangrove vegetation of the southern parts of Australia, where the growth is principally *Avicennia tomentosa*. Those who have never seen a true mangrove scrub can have no idea of how thickly it covers the banks of a stream with its narrow roots. The seed, as is well-known, germinates upon the branches ere the flower falls. The fruit enlarges until it becomes a long, pendulous, slender, green branch, often 10 to 20 feet long swaying in the wind until it roots in the mud beneath. The mud banks as they are uncovered by the tide present a most peculiar appearance. It is a close net work of light-brown stems, usually not thicker than an inch in diameter, and rooting in the mud in all directions. There are no thick stems amongst them. Only here and there a close thicket of young, straight shoots of *Ægiceras majus*, spring up amid the mud.

The first thing that one notices in the mangrove at Port Douglas is the abundance of a crustacean, *Gelasimus coarctatus*, M.-Edw. It makes its nest in the mud by the side of a mangrove root. This retreat is a mere round hole which the crab digs out by the aid of his large, disproportionate claw. I have watched these little animals with great interest. They come out when the tide is low, moving very stealthily and with their large claw folded up under them. They feed on some animaculæ in the mud, but I could not ascertain what was the nature of this food. The smallest movement causes them to start back to their holes. If they are not molested they continue feeding until the tide begins to rise; then they go back to their retreats, and shovelling up a great mass of mud with the large claw, they draw it after them as they go in, completely closing up the hole so that a careful examination will not enable one to discover it. They are beautiful objects when living. The claw is a bright orange-color, paler towards the tip, but this tint fades rapidly after death.

Next after these crabs, I know of no object more interesting than the "hopping fishes" as they are called. This is the

Periophthalmus australis of Castelnau. The mud is literally alive with them when the tide is out. They are about eight or ten inches long with large scales, and fins like seal's flippers, with which they move very rapidly, a kind of leap. They are difficult to catch, but a native boy I had with me was able to knock them over easily with small stones, which he threw with unerring aim. They say that this fish climbs on the roots of the mangrove, but I never saw it do so. It keeps on the wet mud, and is always more or less moistened with the slime. It never comes out on the sand. I think it feeds on the small crustaceans or worms, but I could not ascertain this to my satisfaction. They say that it utters a loud clicking noise, not unlike the crack of a whip. I heard the noise repeatedly, in fact it is quite remarkable and continuous but I could not satisfy myself that it came from the fish. My own opinion was that it was caused by one of the crustaceans. There is however a fish in the Port Douglas Creek, which gives utterance to croaking sounds when captured, of which I was repeatedly a witness.

On the roots of the mangroves, and sometimes high up on the stems of the trees, four or five species of mollusca are found. Of these two species of *Nerita* are the most common. *Nerita lineata* is very abundant, and of large size; from an inch to an inch and a-half in diameter is the usual size. The natives have used them extensively as an article of food, for large mounds of them are seen in the sandy banks of the creeks near Bowen, with quite a heap of the shelly opercula. They do not climb high up on the trees. This species has a wide range through the Indian Archipelago, and in Australia as far south as Moreton Bay. It is surprising that it was not known to Linnæus: as all the other Indian *Neritas* seem to have passed through his hands. Side by side with other species, but by no means so common, is the *N. atropurpurea* of Recluz. It is apt to be mistaken for *N. lineata*, though it is smaller. I was collecting the radulas of the latter and did not observe that I had got *N. atropurpurea*, until I found

I had some very distinct opercula amongst those of *N. lineata*. That of *N. lineata* is large and rough, completely covered with granulations of light color. That of *N. atropurpurea* is smooth, highly polished, and of dark blue-black color.

Occasionally there is found upon the mangroves, but rather high up on the branches small groups of *Cassidula angulifera*, I never noticed any other species though *A. auris-judæ*, is common on the mangrove further south.

Cerithium (Pyrazus) sulcatum, Born, is found occasionally. *Cerithidea decollata*? Linn., is very common in places far out of reach of the tide marks and far above high water, I have found the latter on small stems of *Melaleuca leucodendron* which is rather abundant outside the margin of the mangroves on the flooded flats. *Littorina scabra*, is also abundant and of large size. The range of this species is very great. It is common on the *Avicennia* mangrove of Port Jackson, though of small size and variable color, and it extends along all the coast as far as it is known, in N.E., N. and N.W. Australia. But it is unknown off mangrove swamps, in fact it only flourishes upon them. The shell of this species is thin and translucent. I presume that the mollusc is a vegetable feeder and may perhaps live upon land plants as it is always found upon them. It always frequents salt or brackish water, but the latter not commonly, and in water so very nearly like the sea that it can scarcely be called brackish, except for a very short time during each tide. Still there are times when the animal must be exposed to the influence of quite fresh water, perhaps for some days during periods of flood. This would be fatal to many marine mollusca, but is borne evidently without harm by *Littorina scabra*. Fresh water is instantly fatal to *Echini* and starfishes. I think I may say that the shell of *Littorina scabra* is the thinnest of any marine shell known to me, and that in this feature it approaches the fresh water shells. That the habit of living on the roots of trees is not sufficient to account for this, is seen from the fact that *Nerita lineata*, *Cerithium (Pyrazus) sulcatum*

and *Cassidula angulifera*, are very solid shells; in fact none of those living on the mangrove are thin except *Cerithidea decollata*.

Imbedded in the mud and quite within reach of salt water, but generally not very close to the sea are large numbers of *Cyrena Jukesi*, Deshayes, (Proc. Zool. Soc. 1854). This is a very solid, large, ovately trigonal shell, irregularly and lightly striate with and when fresh covered with conspicuous, shining, olive periostraca which easily flakes off. Some of the lines of growth are often eroded, and the umbones always are. This erosion it appears to me is the work of some parasite, and not as many think, from the influence of fresh water. The hinge teeth are three in number, with two of them distinctly bifid at the apex. The lateral teeth are distant, one (the anterior) being a blunt tubercle. I enter into this detail because this mollusc is the common form in all the brackish water streams or estuaries, I visited in North-East Australia. I found it in the Endeavour River, in the Daintree, the Herbert, Port Douglas Creek, Ross Creek, the Burdekin, and in the mangroves and swamps around Port Denison. The blacks prize it as an article of food, and large numbers of the shells are always in refuse heaps by the side of the mangroves.

It will be seen from these facts what a great difference there is between the fauna of the mangroves and that of the rocky coast exposed to the sea. Though only a short distance from one another and the water quite salt, there is not one species of shell fish common to both, and the crustaceans seem all to be different as well. The mud has something to do with it, though other circumstances come into play which are well worth an attentive study.

If I refer now to the fauna of the coral reefs near Port Douglas it must not be thought that my remarks are anything more than as to what came under my observation during a few brief visits. The subject is too immense to be dealt with in an exhaustive manner except by a voluminous treatise. There are many reefs

in the neighbourhood of Port Douglas, and there is the Great Barrier Reef at about 16 miles distance from the shore. All these literally teem with life, so that a life time would not be enough to enable one to know and see all. I shall confine my remarks first of all to those matters to which I have been calling attention in the first part of this paper.

Littoral shells are not common on the reefs—that is to say, such shells as *Patella*, *Littorina*, *Nerita*, *Planaxis*, &c. The reason of this is probable that these molluscs live for the most part out of the water, and there are only very few parts of the reefs that are not covered for more than 12 of the 24 hours; those portions that are uncovered are not, as a rule, favorable stations for the species I mention. There are not many solidified rocks, but only loose banks of a coarse sand, composed of coral and shell debris. This sand becomes cemented in the course of time into a hard dark-brown, calcareous rock. If there is much coral in it: the structure is very coarse and hard. Large masses of coral, with equally ponderous clams, volutes, *Cassis*, *Trochus*, &c., making up a peculiar and highly ornamental stone, the finer portions become stratified into thin flags with a gentle dip towards the sea. On such rocks I noticed *Siphonaria denticulata*, or a variety of it. Probably some other specific name has been given to it, but where the differences are so very slight, and the features upon which specific distinctions are made to rest are so liable to vary for almost every individual, it would be hazardous to attempt to determine which variety it is. The whole genus needs a thorough revision, and when it receives that, the Australian species will no doubt be found confined to four or five.

Two of the most common univalve shells upon the reefs are *Pterocera lambis*, Linn. and *Strombas luhuanus*, Linn. They must have a very wide range, as they are described as occurring at the Red Sea, and through the whole of the Indian Ocean. Both species are amongst the oldest known to men of science. They

were first figured by Lister, nearly 200 years ago, and types are still preserved in the Linnean cabinet.

On the edges of the reefs *Trochus niloticus* is very common and of large size. This is a shell of wide range and ancient history like the last. It is found with *T. ceruleus*, Gmelin, which is not so common. All the shell sand is more or less full of *Chrysostoma nicobarica*, Gmelin. This also has a wide range. In fact except in the relative abundance of species, we may say that for one third of the shells of the Indian Ocean, there is no difference in what we find on the north-east Australian coral reefs. *Cyprea tigris*, L., is not very common, but *C. arabica*, L., *C. lynx*, L., and *C. annulus*, L., are all very abundant. The cones are *C. litteratus* L., (very common) *C. marmoreus*, L., *C. generalis*, L., *C. hebraeus*, L., *C. textile*, L., and *C. capitaneus*, L. I made no special search or no doubt I could have extended this list, but I merely wish to record the species which are the most common.

The bivalves are by far the most prominent part of the molluscan fauna of the coral reefs. *Hippopus maculatus*, Chem., is the most common, so common indeed that the reef is thickly strewn with them on every side. It varies in size and in color. I have seen a specimen which was at least ten inches across the valves. The color of the animal varies also. As a general rule it is a dull brown, but very often individuals are found with a fringe of the most brilliant blue or green. The same variation in color is found in *Tridacna squamosa*, Gm., which is equally common. *Hippopus maculatus*, lies loose upon the reef, but *T. squamosa* is attached to the coral rock and requires a considerable amount of care to detach it without breaking the shell. It is not at all unusual to find specimens completely imbedded in the rock in a cavity which allows room for the opening of the shell, but which in other respects fits it exactly. In fact one cannot escape the conclusion that the mollusc must have hollowed out the cavity for itself. It is not uncommon to see a loose block of dead coral with three or four of these large molluscs imbedded in it, fitting

exactly into the cavities and lying open with their beautiful blue and green tentacles exposed. On approaching them they close their valves suddenly, sending up a jet of water into the air. I have often had my foot caught between the valves in passing. They can hold with great strength, but a knife inserted into the muscle soon detaches them. It seems to me, strange how they can exist on a loose block of stone, which must be moved about by almost every tide.

The large *Tridacna gigas* is not met with except on the edge of the reef. It is rather common, but not so much so as the former species. There is some confusion about this shell, the name of which is usually referred to Linnæus. But no example was found in his cabinet. His definition agrees with *T. squamosa*, and Mr. Hanley observes that the synonymy quoted is incorrect and leads one to suppose that Linnæus regarded all the various species of *Tridacna* as varieties of one. Mr. Hanley seems also to think that we should restrict the specific name *gigas* to that which is generally regarded as *squamosa*, a change which will hardly be adopted. The animals seem to vary in color, but I had too few opportunities of observing to record much about them. I don't think the beautiful blue and green hues occur in this species. A very common bivalve shell upon the reefs is *Asaphis rugosa*, Lamarck. *Circe crocea*, Lam., is pretty common. The oyster which I regard as *O. cucullata*, Born, is very abundant on the "negro heads" or blocks of dead coral, which project above the rest of the reef. It may be that the cucullate form is an exceptional variety of the common oyster referred to already as existing in such abundance on the rocks at Port Douglas.

On turning over the loose blocks of dead coral, which strew the flat parts of the reef left dry at each tide, a large amount of marine life is revealed. Under nearly every one, the Urchin *Echinometra lucunter*, Leske, is found in groups, two or three together. It varies very much in color. The species are brown-grey, nearly white, or a delicate flesh color. They do not cling to the rock,

but move with ease along the ground, keeping the spines erect in a regular "cheveux-de-frise" around them. They are easily handled, however, in spite of their formidable appearance. But it is not so with *Echinothrix calamaria*, which is much more rarely met with. This is a very dangerous animal to approach. It is found under stones like the former and presents a rather pretty appearance, from its long, rather stout, tapering spines of sea-green color, transversely striped with brown. It glides slowly along, moving the spines in all directions. Between these there are many fine spines, as fine as hair. They are not easily perceived and though so fine and slender, yet they penetrate to great depths into the hand when any attempt is made to seize the animal. I did not know their powers, and at my first effort to secure one got five or six of these spines in my hand, one piercing right through the side of the finger. It was no use trying to extract them, as they are so fine and brittle. After a few hours they did not cause any inconvenience, and I suppose they must have worked themselves out, for I never felt them afterwards. I am not aware that this species was found on the Australian coast previously.

Equally uncommon is the urchin *Diadema setosum*, certainly one of the most beautiful of all the species. Those who have only seen the dried specimens can have no idea of what it is in its natural state. The spines are all of one size, very long and slender of very dark purple color. They spread out in rays all round the test, while the anal tube projects like a large eye, which in fact most observers suppose it to be. The spines penetrate the hand very easily, but as they are not so fine as in *Echinothrix* they work themselves out in a short time. *Diadema setosum* was noticed by me in a few rock pools, and generally where an overhanging ledge affords some shelter.

The other urchins found on the reef were *Hippoonoe variegata*, and *Salmacis rarisipina*. The first was always the beautiful bright violet variety, and the second was always denuded of spines. On the beach away from the coral reefs I found *Temnopleurus toru-*

aticus, and amid the basaltic rocks of Island Point, *Stomopneustes atra-purpurea*, *mihi*, but as I intend to give a separate paper on the *Echini* of this part of the coast and their various habits I shall not refer to them further at present.

In all the rock pools fishes of some sort are found. It would be useless to attempt an enumeration, but I may mention especially the striped *Muraena nebulosa*, and the immense number of young dog-fish or sharks of the genus. Occasionally large specimens of *Conger marginatus*, Forsk., may be seen floundering through the rock pools.

On nearly all the reefs visited by me I found large shallow pools from two to three feet deep at low water, in which there was an extensive growth of coral. The genera were mostly the solid corals, such as *Solenastrea*, *Favia*, *Prionastrea*, *Pavonia*, *Plesiastrea*, *Astraea* (rare) *Meandrina*, *Mussa*, *Symphyllia*, *Hydnophora*, *Galaxea*, *Turbinaria*, *Fungia*, *Pachyseris*, *Turbinaria*, *Pocillopora*, *Seriotopora*, *Psammocora*, *Millepora*, *Heliopora*, *Madrepore*, &c. I think that a good many of these are of undescribed species, but the resemblances to known forms are so close that a very careful examination and comparison with typical forms will be necessary before any specific determination is made. *Madrepores* were common in places, but confined to two or three species. I intend to publish in a separate paper what I have to say in detail about the corals. I may remark now that in the pools and lagoons to which I am referring, branched corals were the exception. The common forms were large hemispherical masses or large round flattened slabs like tables. These were for the most part species of *Porites* or *Alveopora*. The flat upper surface was dead and like brown concrete. The thick rounded edge was of rose-pink color generally, and only this part was alive. The cells of this species are so small that the stellate rays can only be seen by a good lens. When undisturbed a kind of tentacular expansion could be observed, a constant movement such as would be caused by the water. A touch of any foreign substance, or a blow caused them

to withdraw immediately, and a closed appearance was very manifest over a considerable area of the cells. There must be millions on each one of the round flat tabular masses of *Porites*, which are so common on the reefs. These "tables" are quite loose and can be turned over without difficulty. They are seldom more than a foot thick and the under surface is like the upper.

I have reserved for the last any mention of the *Holothuridae* which give such a commercial importance to the reefs at the present time. Any detail on the subject of species would require a special essay. So much has been done by observers in Europe—especially northern Europe—that to examine our Australian species under the light of these investigations would be an extensive undertaking. I trust that the time is not distant when it may be done, but I don't think it can be done unless on the reefs themselves, where anatomical examinations of the living examples will alone furnish the required facts. I merely record now that the species collected in abundance are those classified as *Trepang* by G. F. Jaeger, in 1833 in the well known essay *De Holothuriis*.* The genus is not adopted, and has no better definition from its author than "body sub-cylindrical, mouth anterior, surrounded by ten to twenty petately capitate tentacles." He enumerates four, viz. *Trepang edulis*, *T. ananas*, *T. impatiens*, and *T. peruviana*. The first of these is certainly found on the reefs, and is called by the fishermen "red fish." It is an elongated oval, somewhat shapeless mass of dull, reddish-brown color, and covered all over with papillary suckers. It is eight or ten inches long and very heavy. Next to this is the "tit-fish," a somewhat smaller species of elongated shape, black in color, and studded with somewhat distant, large tentacles, which project nearly an inch or so. Another species is the "milk-fish," or "cotton-fish," so called from its power of emitting a white viscid fluid from its skin, which clings to any object like shreds of cotton. The fishermen do not use it, and it is said that the white

* De Holo. Dissertatio inaug. Turici, 1833, 4 to with plates.

fluid stings the skin. There are many other species which have not been named or described, nor do I think they can be until they are studied in the living state, at least according to the present system of classification. They are found in large numbers crawling over the reefs at low tide. No doubt the extensive way in which the edible species are gathered will make them scarce, and some are beginning to get scarce at certain portions of the reef. But the enormous extent of coral reef, not only on the Barrier, but in the islands enclosed within the Barrier, renders it very easy for the fishermen to seek new grounds for their operations.

A very common species on the island reefs which I visited, is *Synapta Bessellii*, Jaeger, or an allied form. This is said to be an inhabitant of Celebes, but no doubt has a wide range. One cannot mistake the genus for any other. Immediately on putting one's hand on it, the animal adheres to the skin. With a very ordinary lens the skin is seen to be covered with small spicules, shaped like an anchor. With these the animal adheres readily to any soft object. These anchors have the heads fixed in a round calcareous plate imbedded in the skin. This accounts for the numbers of small perforated, calcareous disks which strew the reefs, and look just like shirt buttons. Mr. Moseley, in his "Naturalist Voyage of the Challenger" mentions this animal, and states how the anchors in the skin were favorite objects for microscopic exhibition to visitors. It was thought by sight-seers to be one of the most important discoveries of the Expedition, and got in consequence the name of the "Admiralty Worm." Otto Semper mentions having seen one *Synapta (Bessellii ?)* at the Philippine Islands, 6 ft. long. When fully extended on the reefs near Port Douglas, a length of four feet was not unusual. They are often mistaken for water snakes. The anchors on the skin easily break, and the animal does not seem to have any control over them. They serve for the purposes of locomotion in connection with the voluntary contractions of the muscles.

Properly speaking the *Synaptidæ* are the only "lungless" family of the *Holothuriæ*. Semper mentions two others,* the *Eupyrigidæ* and the *Oncinolabidæ*, both containing only one genus but all the species according to Theel† have lungs or the evidence of the absence of these organs is doubtful. The definition of *Synapta* according to the same author is as follows. Body more or less vermiform, cylindrical, without feet or ambulacral areas along the body, hermaphrodite, calcareous concretions in the skin either wanting or forming anchors and wheels.

I have been able to make some observations on the development of the young of this species, but these and some other remarks on this part of the reef fauna I must reserve for a future occasion.

On every portion of the coral islands on the Barrier *Ophiuridæ* were very abundant. Their long arms might be seen protruding from under almost every block of coral; the bodies were generally concealed. One species in particular with very long arms I took to be *Ophiocoma scolopendrina*, Lam., *Ophioglypha Kinbergi*, Ljungman and *O. multispina*, are both Port Jackson forms, but I fancy allied species are represented in the coral regions. *Ophiolepis annulosa* is common, as also *Ophiocoma erinaceus*, Mull. and Tros., and *O. lincolata*, Mull. and Tros., who give it as *O. pica*. I also saw species which I referred to *Ophiomastix annulosa*, Mull. and Tros. (p. 107) *Ophiothrix longipeda*, Lam., (Mull. and Tros. p. 113) *O. nereidina*, (Mull. and Tros. 115) Lamarck (p. 224, vol. 3, 2nd edit.) *Ophiocnemis marmorata*, Lam., p. 223. and Mull. and Tros., p. 87. Some of these identifications are doubtful and the whole of the species noticed by me need revision, a work which I hope to effect in detail hereafter.

It is very curious to watch the manner in which these starfishes ply their search for food. The long arms are extended from the smallest possible holes or cracks from whence the cirrhi can be

* Reisen in Archipel der Philipinea I. Holothurica 1, p. 8.

† Holoth. des Mers N. Zemble. Upsal 1877.

seen moving in the water. Any foreign object is rapidly seized and conveyed to the mouth, though I could not ascertain what was their favorite food. They are very easily captured. By turning over any block of dead or living coral four or five of them will be seen slowly moving away. The fishermen seem to have a dread of them, so they are quite unmolested, except by the naturalist or whatever marine enemies they may have.

In the preceding observations only a few of the objects of interest on our coral reefs have been touched upon. To deal with all would require many volumes instead of essays. When we remember what the sea coast is to the naturalist, we may form an opinion of what a coral reef must be. The whole structure is the result of animal activity, and every portion on which the eye rests reveals some new phase of animal life. We may take it as certain that only a very small portion of our reefs have been explored by naturalists, and that therefore there is no more promising field of zoological discovery in the whole world, none where the interest is greater, or where distinction may be more easily won. For my own part the few weeks I spent in the coral region were the most intensely interesting of any I remember in a life-time of observation as a naturalist, and I trust that one result of my few scattered notes will be to attract others on to the same enchanting field.