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ON THE RECENT DISCOLOURATION OF THE WATERS OF PORT JACKSON.

By Thomas Whitelegge.

(Plate xxviii.)

Towards the latter end of last March, the citizens of Sydney were astonished and alarmed by the sudden discolouration of the water in Port Jackson. The water in the harbour in many places presented the appearance of blood, and the Board of Health immediately requested Mr. W. M. Hamlet, the Government Analyst, to report on the matter. He found that the red colour was due to the presence of a minute organism, which he thought might be the *Englena sanguinea*, Ehrenberg. Immediately after the publication of this report, quite a number of people gave their views of this somewhat mysterious discolouration. It was suggested that it was due to *zoospores* of some marine *Algæ;* to the *Trichodesmium* which discolours the Red Sea; and to the young of *Medusæ;* whilst others maintained that it was caused by blood and other refuse turned into the harbour from the abattoirs.

On the 31st March I proceeded to Dawe's Point and procured a bottle full of water, in which there was a good supply of the organism in question. After a careful examination I satisfied myself that it belonged to the family *Peridiniidæ*, and I published a letter in the *Daily Telegraph* to that effect. At the time I thought it was a species of the genus *Peridinium*, but further research led me to the conclusion that it was a new species of the closely allied genus *Glenodinium;* in the former genus the cuirass is marked by the presence of facets, whilst in the latter the cuirass is smooth. After the publication of my first letter on the subject, I was requested by Dr. E. P. Ramsay, Curator of the Museum, to make a detailed examination of the shores of the harbour, and to ascertain what effect the organism had had on the fauna generally.

The result of my investigation was embodied in a preliminary report furnished to the Department of Fisheries; this report was published in the Sydney daily papers, and also in the "Records of the Australian Museum," No. 7. During my investigation I visited the head of Tarban Creek, Hunter's Hill on the Parramatta River, Mossman's Bay, Little Sirius Cove, Farm Cove, Darling Harbour, Woolloomooloo Bay, Watson's Bay, Manly, Coogee, Maroubra, and Middle Harbour. I found the organism at all the above-mentioned places in larger or smaller

quantities. At Coogee, Maroubra, and the outer beach at Manly, I failed to obtain specimens in water taken direct from the sea, but I found them frequently in rock-pools. My visit to Middle Harbour was made in a waterman's boat which started from Long Bay. During the trip I examined many of the smaller bays and also the water round about the mangrove flats. At the time of my visit the organism was not abundant, but there was ample evidence to show that it had been there in quantity from the fact that many of the oysters had been killed; in the lower parts of Middle Harbour a large percentage of the oysters were seen with the valves gaping widely and the animals gone, or in a high state of decay, whilst those towards the head of the harbour seemed to be unaffected. So far as the harbour proper is concerned, I found that the oysters and mussels with few exceptions were destroyed, and it was a difficult matter to obtain living specimens for examination. Abundant evidence of the destructive influence of the organism on the oysters, mussels, and other bivalves living within tidal limits was plainly visible on the piles of the jetties and along the shores from Manly to the head of Tarban Creek. The rest of the shore fauna, consisting of limpets, the various species of univalves, starfish, worms, ascidians, and other lower forms of life, was all more or less seriously affected, and the dead and the dying were strewn about in great profusion. As a consequence nearly the whole of the higher forms capable of rapid movements had retired to deep water.

Some of the places where I have been in the habit of visiting, and which under normal conditions were literally swarming with life, seemed to be almost deserted. After turning over the stones the only living forms met with were a few worms, one of which, *Phymosoma japonica*, appeared to be unaffected. The crustacea and small fish usually so plentiful were entirely absent. As far as I am able to judge, fully one half of the shore fauna must have been destroyed, and the bivalves almost exterminated, at least such was the case in those localities where the organism was abundant during the whole of the visitation. The great destruction of life brought about by such an apparently insignificant organism, is of the highest interest from a biological point of view, as shewing our limited knowledge concerning the causes which influence our marine food supplies. This is particularly the case in regard to the cultivation of the oyster, for there are many cases on record of its almost total disappearance from localities which formerly yielded abundant supplies,* without any satisfactory reason being given. The facts ascertained in connection with this somewhat mysterious visitation may possibly throw light on the matter, for no doubt the presence of similar

* See Prof. Huxley's paper in the English Illustrated Magazine, 1883 (November), pp. 115-121.

organisms in other parts of the world have had the same effect, indeed there are numerous cases recorded, and probably many such instances have escaped notice. For example, had the organism which appeared in Port Jackson been colourless its presence might have been overlooked, and the destructive effects produced by it would have remained enshrouded in mystery. As a proof of this I may mention the fact, that another and allied species (*Gymnodinium spirale*, Bergh,) made its appearance during the period in which the *Glenodinium* reached its climax, and in a short time it appeared to equal the latter in number in many parts of the harbour. Yet it remained unnoticed by the public generally, owing no doubt to its being colourless, and had it not been accidentally met with during my examination of the water its advent would probably have been unrecorded.

From my observations of the habits of the *Gymnodinium*, I am of the opinion that it had a very important bearing on the final disappearance of the organism causing the discolouration, inasmuch as nearly every individual had in the gastric cavity one or two specimens of the *Glenodinium*, while many of them were so gorged with food as to be almost unrecognizable, being forced wholly out of shape by the contents of the stomach. The *Gymnodinium spirale*, Bergh, was first observed about the middle of April in water from Tarban Creek, only a few specimens being seen; during the latter part of the month they seemed to increase rapidly, and by the second week in May they were found in great abundance in many parts of the harbour, the water appearing to be quite thick with them, and it was only necessary to dip a tube into the water to secure some thousands of specimens. Concurrently with the increase of the *Gymnodinium*, the *Glenodinium* gradually disappeared. The above mentioned facts point to the conclusion that the former organism was mainly instrumental in considerably reducing the number of the latter, and no doubt contributed largely towards its final disappearance.

The sudden discolouration of the harbour by the appearance of a minute organism in such vast numbers is rather a difficult matter to explain, except on the supposition that the whole of the conditions favourable to its full development were nearly perfect, and the causes which would tend to retard it were reduced to a minimum. There is no reason to suppose that this was the first time that the organism had appeared in Port Jackson. Mr. J. Brazier informs me that he has noticed similar discolourations at various times, and in the year 1866 the oysters, mussels, &c., were killed in large numbers. No doubt the causes which contributed towards the development of the organism were exceptionally favourable, the very large rainfall and the remarkable period of calm weather that prevailed during the whole of the visitation, may have had some bearing on its appearing in greater numbers than in other seasons. If the

weather had been stormy the organism would have been more diffused, and consequently might have been less injurious, and it might possibly have remained unnoticed.

The destructive effects brought about by the *Glenodinium* are difficult to account for. As far as the family *Peridiniidæ* is concerned there does not appear to be any valid reason why they should be regarded as injurious when taken as food,* their chemical constituents are similar to what is found in diatoms, desmids, and many other minute forms of life which are known to provide a highly nutritious food for oysters, mussels, and other lower forms of animal life. Several samples of highly discoloured water were obtained from different localities and at some distance from the shore, with a view to ascertain if the *Glenodinium* gave off any fœtid odour, such as is often the case with water in which there exists living organisms in large numbers—particularly fresh water containing *Peridinia*, unicellular *Algæ*, and other forms rich in protoplasm—but I could not detect any unpleasant smell in the water examined. At several places where the organism existed in great abundance, I collected some of the mud by carefully skimming the surface with a spoon in order to determine if its death and subsequent decay had anything to do with the fouling of the water, but I failed to find any evidence that such was the case either in the mud or in the water. If the organism is not in itself injurious when used as food, and it does not affect the water by its death and decay, how has it acted so injuriously on the shore fauna? This is a question that could only be satisfactorily answered by a long series of experiments. After giving the matter serious attention, and making a careful examination of a number of the oysters and mussels, I am of the opinion that they died from suffocation brought about by the presence of vast numbers of the organism in question. It is very evident that water so thickly charged with millions of minute forms for a period of six weeks in succession would be unfit to support life in a healthy condition, and even if only a small percentage of the oysters, mussels, and other forms were killed

* Since the above remarks were written, I have seen a paper by MM. G. Pouchet and J. de Guerne, "On the Food of the Sardine" (Comptes Rendus, 1887, p. 712), an abstract of which is given in the Ann. & Mag. N. H. Vol. xix. 5 ser. 1887, p. 323. The authors, after enumerating some of the organisms constituting the food of the sardine, go on to state that "The chief interest of the viscera from La Corogne is the extraordinary abundance of Peridinians which fill them. These belong to two types, *Peridinia divergens* and *P. polyedricum*. The latter literally fills the digestive tube of the sardines, being recognizable even in the rectum." After estimating the cubical capacity of the intestine and the size of the Peridinium, the authors conclude that the number of individuals found in the viscera of one specimen is no less than 20 millions. The facts recorded by Pouchet & Guerne show that the Peridinia are not injurious to fish as a food.

by being suffocated, their death and decay would help to make the conditions still more unfavourable, and bring about the destruction of others in the immediate neighbourhood. All along the shores, after the red colour had disappeared, abundant evidence was visible to shew that most of the organisms had been killed by secondary causes chiefly due to the presence of the putrid bodies of the oysters and mussels. At Watson's Bay and at Vaucluse Point, although the red colour was not noted to the same extent as at other places, the effects produced were equally destructive, and the stench from the mussel beds at the former place was almost unbearable. I received a bottle of water from Vaucluse, and with it a note to the effect that the discoloured water had not been observed there, and yet the oysters were dying just as in other parts of the harbour. On examining the water, which appeared to the eye quite clear and free from impurities, I found the *Glenodinium* present in considerable quantity.

The *Glenodinium* appeared to be almost confined to the surface of the water and to swim in lines or clouds, not only in the harbour but also when seen in a bottle; and if placed near a light it invariably collected at the point at which the light was most intense. It is therefore probable that the fauna in the deeper parts of the harbour would escape or be only slightly affected. The area of surface water more or less discoloured by the presence of the *Glenodinium* is rather difficult to estimate, it was observed in nearly all the bays and inlets throughout Port Jackson, and I was told that Mr. H. Prince saw a large patch of red water about two miles off Manly, and which was about a mile in length. I also obtained specimens at Coogee and Maroubra, which shew that it existed in greater or less number for some distance along the coast.

The species enumerated in the following list have been obtained during the author's visits to various localities in Port Jackson and the neighbourhood; they were mostly taken in the tow-net. Amongst them is the one which I regard as a new species (*Glenodinium rubrum*), and two previously known to occur only in fresh water, namely, *Ceratium hirundinella* and *Anurea cochlearis*. The latter is found in ponds near Sydney, while the former as well as the twenty-nine additional species have not hitherto been recorded from Australian waters:—

PROTOZOA.

Grade CORTICATA, *Lankester.*

Class DINOFLAGELLATA, *Bütschli.*

Order ADINIDA, *Bergh.*

Family PROROCENTRINA.

1. *Exuviaella lima*, Ehr. ; Saville-Kent, Manual of Infusoria, 1882, Vol. i. p. 462. Bütschli in Bronn's Klass, und Ord. d. Thier-Reichs, Abt. ii. p. 1002, pl. 51, f. 2, a-b-c.
   Rock-pools, Coogee Bay.

2. *Prorocentrum micans*, Ehr. ; Kent, l. c. Vol. i. p. 461, pl. 25, f. 37-39. Bütschli, l. c. p. 1002, pl. 51, a-b.

The typical form of this species was obtained from rock-pools at Coogee Bay ; I also found what may be a variety in gatherings from the tow-net. The body is elongate, narrowed towards each end, and the spine is longer and finer ; the cuirass is distinctly and coarsely cribate.

Surface, off Green Point ; rock-pools, Coogee Bay.

Order DINIFERA, *Bergh.*

Family DINOPHYIDA.

3. *Phalacroma rapa*, Stein. ; Bütschli, l. c. p. 1009, pl. 55, f. 2.
   Surface, off Green Point, P. J.

4. *Dinophysis lævis*, Bergh. Morp. Jahrbuch, Vol. vii. p. 224, pl. 15, f. 55.
   Surface, off Green Point, P. J.

5. *D. homunculus*, Stein. ; Bütschli, l.c., pl. 55, f. 3, b. (Plate xxviii., figs. 9-16.)

A large series of specimens of this fine species in various stages of development were obtained from the surface off Green Point. The youngest specimens met with had the form of a round disc, without any trace of the transverse groove. During my examination of the material obtained by the tow-net, I saw some hundreds of examples exhibiting almost every gradation between the disc-like form and that of the adult. The various changes during the development appear to be as follow :—The round disc assumes an oblong shape, and the transverse groove appears at the anterior end of the body, which is slightly narrower than the posterior ; afterwards the longitudinal furrow is formed by the gradual extension of the membranous crests downwards, from the margin of the transverse groove. The next change is marked by the growth of the medium spine-like prolongation of the body, and afterwards by the formation of a similar, but much shorter, process at the base of the dorsal surface. Although the above mentioned stages have not been followed out in the life history of the individual, I am of the opinion that the presence of a large series of intermediate forms—gradually passing from the discoidal stage up to what I consider to be the adult—in one gathering, render it highly probable that they are simply the various stages in the development of one and the same species. The cell contents are green, and the cuirass is ornamented by the same cribriform markings in all the different forms. Several specimens were seen in process of division, the line of cleavage

being longitudinal, and extending along the dorsal and ventral surfaces. When viewed from above, the cup-like membrane above the transverse groove, was seen to be divided so as to appear like two half circles, having a space nearly as wide as the body between them. I regret that owing to a want of books I am unable to go fully into the synonymy of this species. However, judging from the published descriptions and figures available, I think it highly probable that the form described by Stein as *D. homunculus* is identical with *D. inæqualis*, Gourret, and *D. allieri*, Gourret, and that all three are simply immature forms of *D. tripos*, Gourret.

6. *Ornithocercus magnificus*, ? Stein ; Bütschli, l. c. p. 1011, pl. 55, f. 7.

Two examples were observed, and although the main characters of the species were present in the specimens, there appeared to be a slight difference in the width and ornamentation of the membranous crests ; this may be due to immaturity, and from the facts noted in the growth of the previous species—*D. homunculus*—it may be safely inferred that the crests vary in size and structure in keeping with the age of the individual.

Surface, off Green Point, P. J.

Family PERIDINIDA, *Bergh.*

7. *Diplopsalis lenticula*, Bergh, l. c. p. 244, pl. 16, f. 60-62 ; Kent, l. c. Vol. ii. Appendix, p. 859. Bütschli, l. c. p. 1003, pl. 53, f. 2.

Surface, off Green Point, P. J.

8. *Peridinium divergens*, Ehr. ; Kent, l. c. Vol. i. p. 453, pl. 25, f. 8-13. (*Ceratium*) Bütschli, l. c. pl. 53, f. 1, a-b.

A very variable species, scarcely any two individuals being found alike.

Common on the surface, off Green Point.

9. *P. michaelis*, Ehr. ; Kent, l. c. p. 453. (*Ceratium*) pl. 25, f. 23. Bütschli, pl. 52, f. 8.

Surface, off Green Point, P. J.

10. *P. globulus*, Stein. ; Bütschli, l. c. pl. 52, f. 7.

Surface, off Green Point.

11. *Goniodoma acuminata*, Ehr. ; Bütschli, l. c. pl. 52, f. 5, a-b-c.

Surface, off Green Point, P. J.

12. *Gonyaulax polyedra*, Stein. ; Bütschli, l. c. pl. 52, f. 3, a-b.

Surface, off Green Point, P. J.

13. *Ceratium fusus*, Ehr. ; Kent, l. c. p. 456, pl. 25, f. 40. Bergh. l. c. p. 208, pl. 12, f. 7-8, pl. 13, f. 28-32.

Common on the surface, off Green Point.

14. *C. furca*, Ehr.; Kent, l. c. p. 455, pl. 25, f. 31-32. Bergh. l. c. p. 195, pl. 12, f. 1-3; pl. 13, f. 13-20. Gourret. Ann. d. Mus. d'Hist. Nat. Marseille Mem. No. 8, 1883, p. 45-47, pl. iv., f. 58-59, 67-68.

There seem to be two well marked forms, which may be regarded as varieties of this species. Besides the typical form (Bergh. figs. 13-20) there is the *C. pentagonum*, Gourret, and its variety *rectum* (pl. 4, f. 58-59), which are fairly constant in size, shape, length of horns, and the strongly areolate cuirass. One of the specimens which came under my observation had nearly the whole of the areolate plates broken away, and there remained a rigid homogeneous shell, having the same shape as those in which the plates were intact. This fact suggested to my mind two questions, to which as yet I am unable to find answers: Is the cuirass double? or does the individual cast it off naturally when it is too small, and secrete a larger one?

The forms described by Gourrett, under the following names, *C. dilatatum* and its variety *parvum*, and *C. globatum* were well represented in my gatherings, and seemed to be constant as to length of horns, sculpture, &c.; the only noticeable variations appeared to be in the form of the body and the distance between the posterior horns. In some specimens the body was well rounded and the horns but a little distance apart; others had the body compressed and the horns widely separated, whilst many examples had a deeply concave ventral surface, and the aspect of the body when viewed from behind exhibited a cresentic outline, with the horns closely approximate, and the dorsal surface strongly convex.

Obtained in tow-net off Green Point (very common).

15. *C. gravidum*, Gourret, l. c. p. 58, pl. 1, f. 15.

In the description of this species the (inferieure) anterior portion of the body is described as globose. The specimen met with by me had the body strongly compressed, otherwise it agrees with the description and figure.

Surface, off Green Point, P.J.

16. *C. tripos*, Müll.; Kent, l. c. p. 454, pl. 25, f. 24-33. Bergh. l. c. p. 204, pl. 12, f. 4-6, pl. 13, fig. 21-27. Gourret, l. c. pl. 1, f. 1,2,3-7, pl. 2, f. 33-35.

This is a very variable species, scarcely any two individuals being found alike. The references given above indicate the varieties observed.

Very common in surface gatherings off Green Point, P.J.

17. *C. hirundinella*, Müll.; Kent, l. c. p. 457 (*C. longicorne*), and p. 859, pl. 25, f. 26. Bergh. l. c. p. 215, pl. 13, f. 12. Bütschli, l. c. pl. 53, f. 9, a-b.

As far as I have been able to ascertain, this species has not hitherto been found in salt water. After a very careful examina-

tion of many specimens, I cannot find any essential differences upon which it could be separated from the European fresh water form. As yet it is not recorded from fresh water in this part of the world.

Surface gatherings of Green Point, P.J.

18. *Glenodinium rubrum*, sp. n. (Plate xxviii., figs. 1-7.)

Cuirass ovate; anterior half of the body unevenly conical, the posterior rounded, ventral surface slightly depressed, the dorsal evenly convex; equatorial groove well marked, symmetrically developed; longitudinal furrow straight, ill defined; cuirass smooth without facets or pores; cell contents conspicuous, consisting of yellowish granular protoplasm, and large starch grains; nucleus round, large, and almost colourless in young individuals, ultimately assuming a bright red colour in adults. $\frac{1}{1000}$ of an inch in length.

When viewed in active motion, this species would easily be mistaken for a member of the genus *Peridinium:* the very dense protoplasmic contents and the somewhat polygonal aspect when swimming rapidly, led me to assign it to that genus in the preliminary report on the subject. Subsequently I saw that although the cuirass by its contour appears as if facetted, still it is homogeneous and quite smooth. For a time I experienced some difficulty in keeping the specimens alive on a glass slip for more than a few seconds. Every time they were placed on the slip they all fell down to the bottom of the water, first casting off the longitudinal flagellum, then the transverse flagellum, and finally the cuirass, which is so transparent that it is only seen with difficulty. This casting off of the cuirass I thought might be due to the pressure of the cover-glass, but the same results happened when the objects were placed in a cell. I ultimately found that it was caused by the change of temperature, and by thoroughly warming the microscope and glass slips, I could keep them alive for several hours, and that the pressure of the cover-glass did not affect them in the least. After taking the above precaution, I was enabled to watch the process of the throwing off of the flagelli, and also of the cuirass. The first indication of these changes is the gradual reduction of the speed of the swimming motion, which becomes more like a series of irregular waddling jerks, first in one direction and then in another; some time before these movements cease, the longitudinal flagellum is thrown off, and it falls down with a wriggle like that of a nematoid worm; the body continues to move by the aid of the transverse flagellum, but only for a short space of time, when this also leaves the body, and the undulatory movements of the flagellum are noticeable for a short period.

In a few seconds after the organism comes to rest, the cuirass is cast off by the rupture of its wall at the posterior end. After the shedding of the cuirass the body presents the appearance of a

thick walled cell, and it immediately begins to increase in size and assume a more rounded outline. The subsequent changes lead up to the formation of what I regard as resting spores. The yellowish-brown colouring matter which is at first diffused throughout the body becomes concentrated in the nucleus, the latter then assumes a brilliant red colour; afterwards the nucleus undergoes division, and either one or two orange-coloured spores are formed, at the expense of the granular protoplasmic contents, which gradually disappear as the spores increase in size. Unfortunately I have not been able to ascertain what takes place after the spores are fully formed, the specimens which I had under observation having all remained in the same condition for the last two months. The cell wall appears to resist the attacks of the bacteria and infusoria, which exist in vast numbers in the vessel containing them.

This species made its appearance during the month of March last in such vast numbers as to render the water in Port Jackson quite red, and for a period of six weeks the whole of the surface water was more or less discoloured by the presence of this minute organism. When viewed from a distance, the surface of the water presented a variegated appearance, consisting of long streaks and patches of glaucus-green, yellowish-brown, and blood-red colour. The various streaks of red changed about from time to time owing no doubt to the direction of the wind and tidal currents. In nearly all the bays and small inlets the water on the surface was quite thick with the organism, and if a bottle full of water was taken up and allowed to stand for a few minutes, there was a thick brown deposit formed at the bottom, consisting of the bodies of the *Glenodinium*.

Port Jackson, March, April, and May, 1891.

Family GYMNODINIDA, *Bergh*.

19. *Gymnodinium spirale*, Bergh, l.c., p. 223, pl. 16, f. 70-71. Kent, l.c. p. 858, Appendix. Bütschli, l.c. pl. 51, f. 5. (Plate xxviii., fig. 8.)

During the months of April and May, this species was obtained in abundance by dipping a tube into the water. To my mind it appeared to be just as plentiful as the *Glenodinium*, but owing to its being transparent it did not perceptibly influence the colour of the water.

Hunter's Hill, Mossman's Bay, Woolloomooloo Bay, and Middle Harbour.

Class RHYNCHOFLAGELLATA, *Lankester*.

Family NOCTILUCIDÆ.

20. *Noctiluca miliaris*, Suriray; Kent, l.c., p. 397, pl. 1, f. 33-34.

It is with some hesitation that I venture to record this species. So far, I have not seen the flagellate form. The stationary form

figured in the "Challenger" Narrative, under the name of *Pyrocystis pseudonoctiluca* (Vol. I., pt. ii., p. 936, f. 335-37.) was obtained in abundance in surface gatherings off Green Point. June, 1891.

21. The form figured in the "Challenger" Narrative as *Pyrocystis fusiformis*, Vol. I., pt. ii., p. 937, f. 338, was also met with, but only a few individuals were seen.
Surface, off Green Point, June, 1891.

Class CILIATA.

Family TINTINNODÆ.

22. *Amphorella ganymedes*, Entz., Mitt. Zool. Sta. Neapel, Bd. 5, 1884, p. 409, pl. 24, f. 17, 18.
Surface, Woolloomooloo Bay, April, 1891.

23. *Tintinnopsis curvicauda*, Daday, Mitt. Zool. Stat. Neapel, Bd. 7, p. 554, pl. 19, f. 33.
Very common on the surface, off Green Point, May and June, 1891.

24. *T. cyathus*, Daday, l.c., p. 556, pl. 20, f. 2.
Surface, off Green Point, June, 1891.

25. *T. ventricosa*, Cl. & L., Etudes sur les Infusoires, 1858-59, p. 208, pl. 9, f. 4. Kent, l.c., p. 609, pl. 31, f. 31. Daday, l.c., p. 559, pl. 2, f. 19, 20.

This species was found in plenty in the surface gatherings, and I saw several cases in which conjugation was taking place. At this time their appearance presented a strong resemblance to what I have seen in the genus *Difflugia*, and I was not aware of the true nature of the occupant of the test, until I saw the animal protrude the wreath of cilia and swim rapidly away. June, 1891.

26. *Codonella annulata*, Cl. & L., l.c., p. 207, pl. 9, f. 2. Kent, l.c., p. 609, pl. 31, f. 25. Daday, l.c., p. 571, pl. 20, f. 21.
Surface, off Green Point, June, 1891.

27. *C. lagenula*, Entz., Mitt. Zool. Sta. Neapel, Bd. 5, 1884, p. 409, pl. 24, f. 17-18. Kent, l.c., p. 616, *(C. galea)* pl. 31, f. 32, 33, pl. 31, f. 21-22.
Very common in surface gatherings, off Green Point, June, 1891.

28. *Cyttarocylis claparedei*, Daday, l.c., p. 582, pl. 21, f. 5, 16.
Surface, off Green Point, June 1891.

29. *C. cassis*, Haeckel., Jena. Zeits. Med. Naturu. 1873, Bd. vii. p. 563, pl. 27, f. 1-3. Daday, l.c., p. 580, pl. 21, f. 3. Kent, l.c., p. 624 (*Dictyocysta*) pl. 32, f. 29-31.
Surface, off Green Point.

30. *Dictyocysta templum*, Haeckel., Jena. Zeit. p. 564, pl. 27, f. 6. Kent, l.c., p. 625, pl. 32, f. 27. Daday, l.c., p. 585, pl. 21, f. 8, 9.
Surface, off Green Point, June, 1891.

Class ROTIFERA.

31. *Anurea cochlearis*, Gosse, Ann. & Mag. Nat. Hist., 2 ser. Vol. VIII., 1851, p. 202. Hud. & Gosse, Rotifera, p. 124, pl. 29, f. 7, 7a.

About twenty specimens of this species were obtained in the tow-net off Green Point. The species is common in fresh-water all round Sydney, but it has not hitherto been found in the sea. See Dr. C. T. Hudson's list in Journ. Roy. Micro. Soc., 1889, pt. 2, April, p. 176.

ALGAE.

32. *Halosphaera* sp.

This species is closely allied to, if not identical with *H. viridis*, Schmitz, Mitt. Zool. Sta. Neapel, Bd. 1, p. 67-92, pl. 3. figs. 1-15. Jour. Roy. Micro. Soc. 1879, p. 458, pl. xvi.

Frequent on the surface, off Green Point, P.J.

The following is a list of the more important books and papers bearing on the organisms dealt with in this paper. I have also attempted to compile a bibliography of the Dino-flagellata published since the issue of Bütschli's Protozoa, in Bronn's Klass. u. Ord. d. Thier-reichs 1885. In the latter work will be found (p. 915) a very complete guide to the literature of the class from 1786 down to the date of publication.

Note on the Red Colouring Matter of the sea around the shores of the Island of Bombay, by H. J. Carter, Ann. & Mag. N. H., 3rd ser., Vol. I., 1858, p. 258.

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DESCRIPTIONS OF THREE NEW PAPUAN SNAKES.

By J. Douglas Ogilby.

Hypaspistes, *gen. nov.*

Body very much elongated and compressed; tail of moderate length, rounded, or but slightly compressed anteriorly, prehensile. Head quadrangular, completely shielded, distinct, but not markedly so, from the neck. Snout rather short. Eye of moderate size, the pupil eliptical. Nostril lateral, pierced in a single nasal which is grooved behind. Shields regular, the occipitals increased in number to three pairs; loreal present. Scales smooth, quadrilateral, the vertebral series not dilated.

Hypaspistes dipsadides, *sp. nov.*

Scales on the body anteriorly in thirty, posteriorly in twenty-three series; the series bordering the abdominal plates much the largest; abdominal plates three hundred and twenty-seven; anal plate single; sub-caudal plates in two rows of one hundred and seventeen each, preceded by a semicircular band of eleven small scales. Head very distinct from neck. Muzzle of moderate length, broad, very obtuse, and rather depressed; the occiput rounded. Eye lateral, the outer skin rather opaque, the pupil elliptical and erect. Body slender in front, becoming much higher behind. Skin of the throat loose, forming a distinct

EXPLANATION OF PLATE XXVIII.

Fig. 1. *Glenodinium rubrum*, sp. n., dorsal aspect × 1000.

„ 2. Ditto ventral aspect.

„ 3. Ditto example without the cuirass.

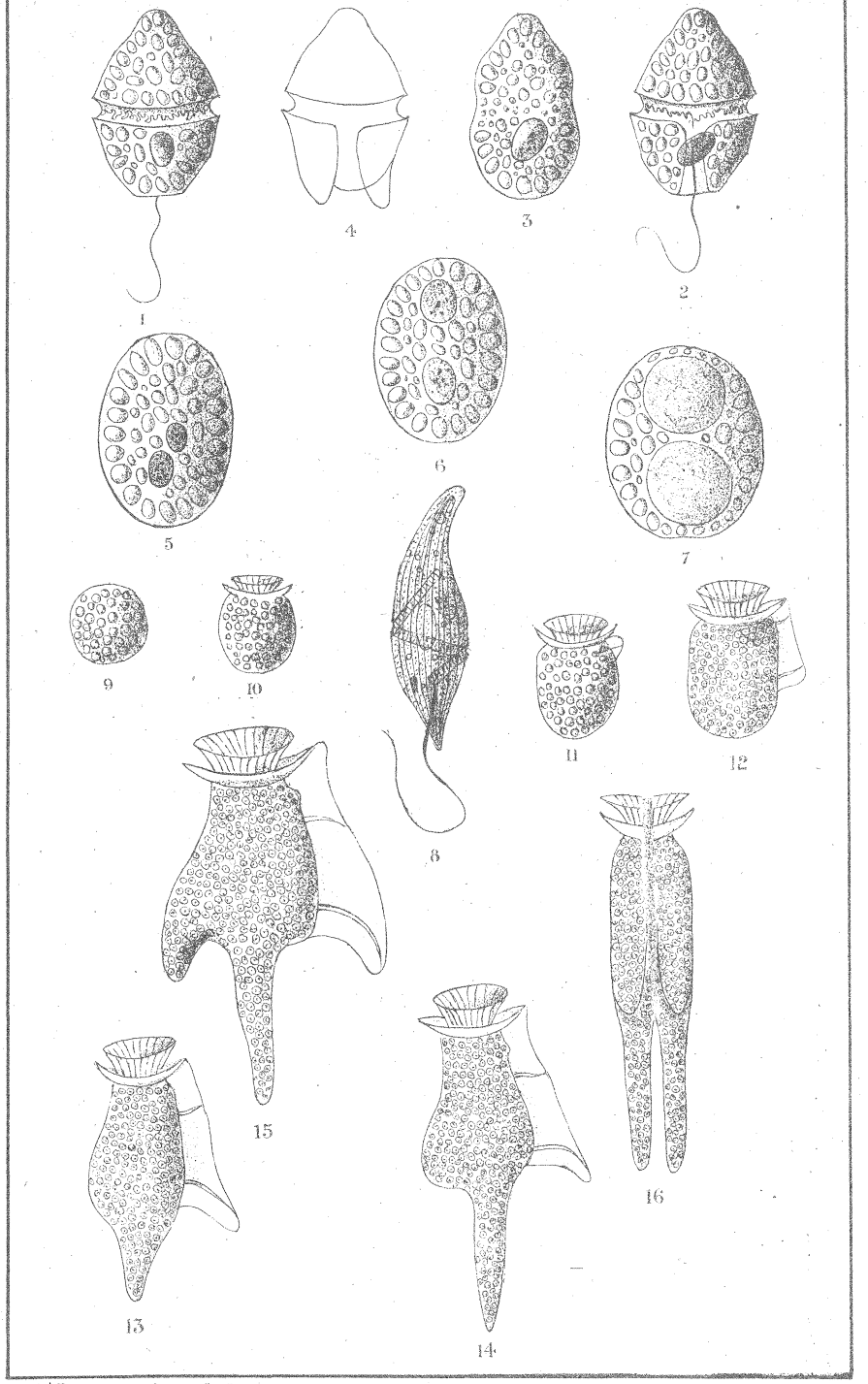
„ 4. Ditto empty cuirass.

„ 5, 6, 7. Ditto examples showing the formation of the resting spores.

„ 8. *Gymnodinium spirale*, Bergh., after Bergh.

„ 9 - 15. *Dinophysis homunculus*, Stein., showing progressive phases of development; highly magnified.

„ 16. Ditto example dividing by longitudinal fission.



G.H. Barrow del et Lith.

GLENODINIUM RUBRUM Figs. 1-7.
GYMNODINIUM SPIRALE Fig. 8.
DINOPHYSIS HOMUNCULUS Figs. 9-16.