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On the Occurrence of Diatoms on the Skin of Whales.

By A. G. BENNETT.

With an Appendix by E. W. NELSON.

(Communicated by Sir S. F. Harmer, K.B.E., F.R.S. Received June 10, 1920.)

In the course of my official duties during whaling operations at the South Shetlands and the South Orkneys, extending over four seasons between 1913 and 1919, I have observed that whales, and particularly the very fat individuals, are frequently covered with a film of a buffish colour. This film is easily removed, but owing to the excessively dirty conditions under which whaling is carried out, it is not an easy matter to obtain it free from admixture with other substances. The Blue Whale (*Balænoptera musculus*) and the Fin Whale (*B. physalus*) are species which are often thus coated. The film is equally thick on all parts of the skin, and it is easily seen on the white parts of the body. It is not nearly so obvious against the background of the darker parts of the skin, where it may easily be overlooked. A Blue Whale in this condition is known to the whalers as a "Sulphur-bottom."

It did not at first occur to me to investigate the cutaneous coating in question, but on examining microscopically, with a low power, a portion from a Fin Whale killed at the South Shetlands late in the season 1918-1919, I found it to consist of large numbers of what appeared to me to be Diatoms. When fresh, each of these organisms was seen to contain a yellowish speck of what seemed to be oil, near its centre. A small quantity of the film removed later from the skin of a Blue Whale, killed at the same locality, proved to agree closely, in its microscopical characters, with what had already been studied in the Fin Whale.

My attention has been called to certain observations recorded in the papers, relating to the whales of South Georgia, which were left by the late Major G. E. H. Barrett-Hamilton, and are preserved in the British Museum (Natural History). I am indebted to Mr. M. A. C. Hinton, who edited these papers in 1915, for the opportunity of quoting the following extracts from his completed Memorandum on the subject, which was printed though not actually published.

Under the heading of the Finback (or Fin Whale) Major Barrett-Hamilton stated that in four of the nine cases in which he had observed parasites, the parasites were "yellow algæ." Under the Blue Whale he recorded the following observations:—

On nine specimens the skin was covered with a 'yellow slime' believed

to be *algæ*; No. 44, female, had the upper side of the pectoral sulphureous in hue, 'apparently from *algæ*, which also are frequent on underside'; they were also present on Nos. 42 and 43."

Although there is no evidence to show what further use Major Barrett-Hamilton would have made of these observations, if it had not been for his regretted death at South Georgia, it may be assumed that they refer to the same facts which I have myself noticed.

I have not at present had an opportunity of making a microscopic examination of similar skin-deposits in other species, but the following observations suggest that the occurrence of a superficial investment of Diatoms is by no means restricted to the Rorquals. During a whaling cruise in Orleans Channel, in about lat. 64° S., long. 61° W., the "Killer" (*Orcinus*) was excessively abundant, many of them coming alongside the ship. The light parts of all that were close enough to see clearly were of a distinct buff colour, sufficiently pronounced to be visible even while the animals were submerged, and closely resembling that of the corresponding parts of the Fin Whale and Blue Whale. A "Bottle-nose" (probably *Hyperoodon*), killed at the South Orkneys in 1915, had a similar colour, probably due to the same cause. I have not noticed this colouring in the "Humpback" (*Megaptera nodosa*). This might easily be overlooked, however, since the number of these animals which have been killed, in recent years, has not been large, and most of them have been almost entirely black.

The same colour is extremely common on most pieces of sea-ice, at water-level, in Antarctic waters, and is sufficiently pronounced on icebergs to form straight and wide bands, which remain *in situ* after the iceberg has tilted to another angle. I have not at present had an opportunity of making a microscopic examination of this material.

As Diatoms are abundant on ice, and the bands, presumably formed by them, have a similar colour to that of the Diatoms found on whales, I came to the conclusion that the colour was due to the same cause in both cases. The whales visibly infected are, almost without exception, very fat, a condition they are known to acquire when they have been feeding for some time on the food which is abundant in these icy waters, and from which, it appears to me, they probably receive their coating of Diatoms. Individuals of both the Blue Whale and the Fin Whale are abundant that look extremely clean, and these are usually poor in oil. I have long considered them to be new arrivals from warmer waters, but there is no evidence to show whether these individuals are coated with Diatoms from other seas.

I early saw that, should these Diatoms from whales prove to correspond with those on sea-ice, it might reasonably be anticipated that all or almost

all whales would be found, on closer examination, to be hosts to Diatoms, and that the extensive collection of samples of their cutaneous investment might be of material assistance in tracing their migrations.

Appendix to the above Note, by E. W. Nelson.

I have received, through the British Museum (Natural History) a series of samples which were collected by Mr. A. G. Bennett as evidence of the conclusion he has come to with regard to the nature of the yellow colour of certain Antarctic Fin Whales and Blue Whales. These consisted of four mounted slides, three tubes containing the dried epidermal film, and a small tube containing portions of the film, from either a Blue Whale or a Fin Whale, which had been treated with nitric acid. In every case the sample contained specimens of a Diatom belonging to the genus *Cocconeis*, Ehrb., probably belonging to a new species which I describe below as *C. ceticola*, n.sp. With one exception, this species constituted the whole of the film, and of course occurred in immense numbers. The exception referred to was the tube containing the material which had been treated with nitric acid; and this consisted of *C. ceticola* and *Navicula viridis* (Nitzsch) in about equal proportions, with a sparse admixture of another species of *Navicula*. *N. viridis* is usually a fresh-water species, but it has been recorded as marine by Petit,* who describes it as "très commune sur les Algues marines." This is the only record I can find of this species, or of the closely related species *N. major*, *N. nobilis*, and *N. dactylus* being found, presumably living, in marine material, although they sometimes occur in marine soundings.† It may be noted, however, with regard to this sample, that from evidence which has been supplied by Mr. Bennett it is by no means unlikely that the material from the skin of the whale was contaminated with material from another source during its preparation.

It thus appears that, with one exception which is doubtful, the whole of the material collected by Mr. Bennett consists entirely of great numbers of a single species of Diatom, in a state of absolute purity. This fact goes far towards showing that the association of the Diatoms with the whale's skin is more than an accidental one. Several of the samples were of a distinct yellow colour; and that of the dry samples corresponded with No. 171 of Klinkensieck et Valette's "Code des Couleurs." The samples were all from Blue Whales or Fin Whales collected at the South Shetlands in 1919; and those

* Petit, P., "Diatomées récoltées dans le voisinage du Cap Horn," 'Miss. Sci. du Cap Horn,' vol. 5, Botanique, p. 121, Paris (1888).

† See Mann, A., "Diatoms of the Albatross Voyages," 'Contr. U. S. Nat. Herbarium,' vol. 10, Part V, p. 359, Washington (1907).

that were distinctly dated were obtained either in February or in March. These are dates on which the whales had probably spent a considerable time in Antarctic waters, in agreement with what is said by Mr. Bennett above.

The genus *Cocconeis* is characterised by having, generally, two different valves, the upper one being strongly convex and without a true raphe, and the lower valve being slightly concave and always bearing a true raphe. The plant lives attached to Algæ, etc., with the lower valve in contact with its host. It is capable of moving about to a limited extent. It is not a plankton-form, and when taken in the tow-net its inclusion is probably fortuitous.

Certain Diatoms are known to take on a saprophytic mode of nutrition under suitable circumstances. This is usually accompanied by a more or less profound change in the colour of their cell-contents. The colour can only be seen in the fresh, living material, and it may be hoped that Mr. Bennett will have the opportunity, on his return to the Falkland Islands, of recording it more accurately. It would be desirable to compare the colour of the Whale-Diatoms with that of other Diatoms living under other conditions in the same region.

Cocconeis ceticola Nels., n. sp.

Valvis late lanceolatis ellipticisve, $18-30 \times 12-18 \mu$; valva superiori valde arcuata, striis subradiantibus ordinatis ornata, $10-15$ in 10μ , striis subtilissime punctatis, quarum puncta haud vel ægerrime conspicienda; pseudorraphe angusta, recta, in medio leviter dilatata; valva inferiori coronula intra



1.
Upper valve.

2.
Lower valve.

Cocconeis ceticola n. sp.
 $\times 1000$.

marginali costarum valde abbreviatarum instructa, hinc inde striis debilissimis ad centrum evanescentibus ornata; rraphe leviter subsigmoidea, utroque apice breviter transverse ramosa; area centrali oblique dilatata, in diversas partes axis transversalis ad marginem recurvata.

Exemplum No. 33771, in Museo Britannico, Londinii.—Hab. in cuti cetorum,

Balænoptera musculus et *B. physalus*. South Shetlands (found in all Mr. Bennett's samples).

The striæ on the upper valve, under the best conditions and with oblique light, could not be resolved into dots, but had a strong appearance of being punctate. The material examined did not permit any description of the cell-contents. Minute examination of the figure will show certain markings which are inherent to the process of reproduction, and are not intended to represent structure seen in the specimens. As explained above, no dotted structure could be made out, and the lower valve within the border is here shown far too strongly striate.

I desire to thank Mr. E. Ford for kindly making the drawings which illustrate this note.

Navicula viridis (Nitzsch) Ehrb.

Ehrenberg, 1838. 'Infus.,' p. 182, Plate 13, fig. 16 (in part), Plate 21, fig. 12.

Kützing, 1844. 'Bacill.,' p. 97, Plate 4, fig. 18; Plate 30, fig. 12.

Petit, 1888. 'Mission Scientif. du Cap Horn,' vol. 5, p. 121.

Mann, 1907. 'Diat. of the Albatross,' p. 359.

Bacillaria viridis Nitzsch, 1817. 'Neue Schrift. Naturf. Ges. Halle,' vol. 3, p. 97, Plate 4, fig. 1-2.

Found only in the tube containing the material which had been treated with nitric acid.

It is quite impossible to define the exact limits between this species and *Navicula major* Kütz., and these specimens might be referred to the latter with almost equal reason.

The name has, however, been chosen as the oldest specific designation which adequately describes the organism, and also since this species has already been reported from Cape Horn by Petit (*loc. cit.*).

This species is normally found in fresh water and the above is the only known record where this Diatom has been found *living* in salt water. It has been recorded from marine soundings (see Mann, *loc. cit.*) but this fact does not necessarily prove a marine habitat when it was a living organism.

As explained above, it is not quite certain that this and the following species were really derived from the skin of a whale.

Navicula sp.

Pinnularia interrupta W. Sm.

Smith, W., 'Brit. Diat.' 1853, p. 59, Plate 19, fig. 184; 1856, p. 96.

Cleve, P. T., 1895, 'Kongl. Sv. Vet. Akad. Handl.,' 27³, p. 76.

Pinnularia biceps Greg.

Gregory, W., 1856, 'Q. J. M. S.' IV, p. 8, Plate 1, fig. 28.

This form was sparsely represented in the sample containing *Navicula viridis*, and in no others. These specimens are smaller (30 μ) and less robust than the type, and the costæ are not completely interrupted. If, as here, the genus *Pinnularia* is not admitted, the specific name *interrupta* is not available, being pre-occupied by Kützinger (1844). The taxonomy is further complicated by the use of the specific name *biceps* by Ehrenberg (1843), for a form differing from Gregory's. A complete discussion of the synonymy would be outside the scope of this paper.

It is desirable to investigate the question of the occurrence of Diatoms on the skin of whales further, and suitable material would be gratefully received by the British Museum (Natural History). For this purpose numerous samples should be collected, from various localities, or from the same locality at different seasons of the year. A careful record should be kept of the species of whale, with the locality and date. Special care should be taken to obtain samples which have not been contaminated by contact of the whale's skin with foreign bodies. Material of similar appearance should be collected, if possible, from ice, algæ, wood, shells, stones, or other submerged objects. The method of preservation recommended is as follows: To every 250 c.c. of the material in sea-water add 10 c.c. of strong Flemming's solution (15 volumes of 1 per cent. chromic acid, 4 volumes of 2 per cent. osmic acid, and 1 volume of glacial acetic acid), and store in stoppered bottles. A simpler procedure is to put the material direct into 10 per cent. formalin solution.
