Bull. Fac. Bioresources, Mie Univ.
No. 8: 19-26
March 26. 1992

Notes on the Pattern of Diatom Fouling in Three Southern Rorqual Species

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Abstract

The pattern of diatom fouling in three southern rorqual species caught during the 1967/68 season was observed. The diatom fouling being presumably associated with *Bennettella ceticola* (Nelson *ex* Bennett) Holmes, showed wide range of distribution in fin whales whereas it mainly distributed only in the regions around the eyes and the upper and lower jaws in sei whales. Minke whales are uncertain, but probably have a similar pattern as fin whales. These difference in the pattern of colonization sites of the diatoms in the observed rorquals is likely due to a possible difference between whale species in microscale structure of the superficial skin film together with the past history of migration within the season.

Key words: Diatom fouling, *Bennettella ceticola*, Rorquals, Antarctic

Introduction

Since the finding that brownish fouling on the skin of whales is caused by diatoms with more than an accidental association[1], great attention has been paid to both the taxonomy of film forming diatoms[1-3], and its relation to whale movements on migrations[4-8]. Among many previous data on the diatom infection, very few authors described the distribution pattern of the fouling by patchy colonization of diatoms. In connection with this, Bennett[1] stated that "... No. 44, female, had the upperside of the pectoral sulphureous in hue, 'apparently from algae, which also are frequent on underside'...". In sei whales, Matthews[9] stated that "... small or scattered patches were found on the flukes, tail, jaws or snout in seven, and this film was wider distribution in one." The following observations may help to elucidate such questions as, "Does the diatom fouling develop similarly over the whole body?", and "Does it grow similarly in all the rorqual species in the Antarctic waters ?"

Materials and Methods

In the Antarctic summer of 1967/68, I observed the distribution patterns of diatom fouling in 14 fin, 10 sei and 2 minke whales taken during January and February (except one fin whale in March) (Table 1). The distribution patterns of the diatom fouling were observed by naked eye and sketched. All animals were caught in the Indian Ocean sector. Only rarely did an animal roll over from one side to the other while being towed onto the flensing deck, so the skin of at least one side of the whale usually received little damage. The diatom films were generally well preserved. When they were damaged from the towing, the trace of scratches were easy to see. The diatom fouling, especially in the dark colored region, became particularly clear once the skin had

Accepted December 17, 1991

Table 1. Data from Whales Taken by the Nisshin Maru Fleet in the Indian Sector of the Antarctic Ocean During January–March, 1968*) Alphabets on the Left Column Correspond to Those in Fig. 1

No. of animal	Body length (m)	Sex	Foetus (Sex, Body length, cm)	Date of catch	Position (S Lat; E Long)		Thickness of blubber (cm)
Fin whales							
A 336	20.2	Male	—	1 Jan	53–45	79–40	7.0
B 376	22.8	Female	♀78	3 Jan	54–01	79–46	9.0
C 509	19.6	Male	—	11 Jan	48–33	70–46	7.0
D 514	18.5	Female	Np	11 Jan	48–33	70–46	6.5
E 685	19.9	Female	Np	19 Jan	56–39	80–35	4.5
F 699	18.6	Male	—	21 Jan	57–11	72–22	4.0
G 703	20.4	Female	♀244	21 Jan	57–11	72–22	7.5
H 1356	20.0	Male	—	19 Feb	53–12	78–26	6.5
I 1374	22.0	Female	♂337	20 Feb	54–12	79–35	7.5
J 1551	18.7	Male	—	27 Feb	56–06	81–27	7.5
K 1555	19.9	Male	—	28 Feb	54–45	80–18	6.5
L 1556	21.8	Female	♀342	28 Feb	54–45	80–18	9.5
M 1565	19.1	Female	Np	29 Feb	54–08	80–35	6.5
N 1612	19.4	Male	—	2 Mar	54–36	80–42	7.0
Sei whales							
A 760	15.7	Female	Np	26 Jan	47–38	56–11	4.0
B 797	15.0	Female	Np	27 Jan	47–16	55–03	4.0
C 801	14.7	Male	—	27 Jan	47–16	55–03	4.0
D 885	13.8	Male	—	30 Jan	45–45	49–27	5.0
E 888	13.9	Female	Np	30 Jan	45–45	49–27	5.0
F 950	15.1	Female	♂244	31 Jan	46–17	49–08	7.0
G 1109	14.2	Male	—	7 Feb	44–40	50–07	5.0
H 1119	15.5	Female	♂193	8 Feb	43–44	51–05	6.5
I 1127	15.4	Male	—	8 Feb	43–44	51–05	7.0
J 1205	12.8	Female	Np	10 Feb	43–55	52–09	4.5
Minke whales							
A 4	8.4	Male	—	21 Jan	57–11	72–22	4.0
B 5	8.4	Male	—	21 Jan	57–11	72–22	5.0

*) Based on the catch logs of Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, Japan.
Np: Non pregnant

dried. Although the diatom species was not identified in these observations, past studies[1–2),10–11)] and the recent findings (Holmes, pers. comm.) indicate *Bennettlla ceticola* (Nelson *ex* Bennett) Holmes, which formerly belonged to the genus *Cocconeis,* is the most likely agent in rorqual whales. Holmes[3)] stated that he could identify *B. ceticola* only from rorqual whales of both hemispheres and Dall's porpoise in Monterey Bay.

Results

At first glance, the diatom fouling appears to develop randomly in fin whales (Fig. 1, A-N). In such a pattern on infestation, the diatoms usually grow patchily, and the distribution and degree of colonization differs

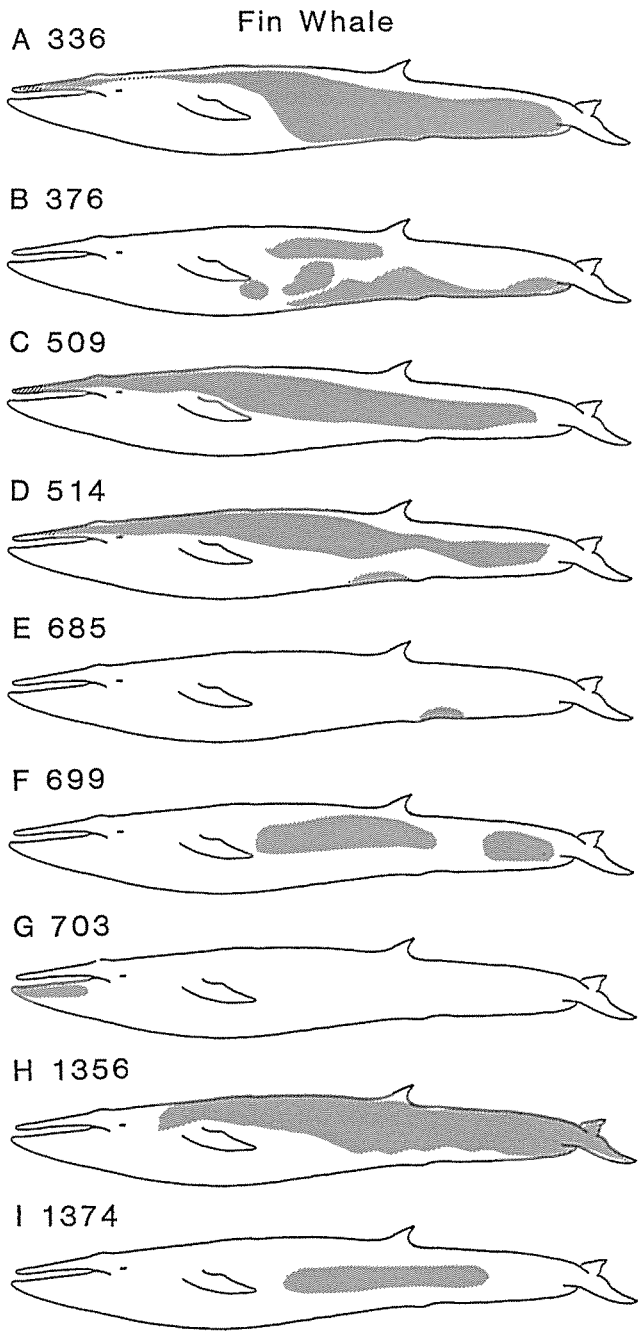

Fig. 1. Patterns of diatom colonization in southern fin, sei and minke whales as observed during January–March, 1968 in the Indian sector of the Antarctic Ocean.
Numeral for each animal corresponds to that given in Table 1.

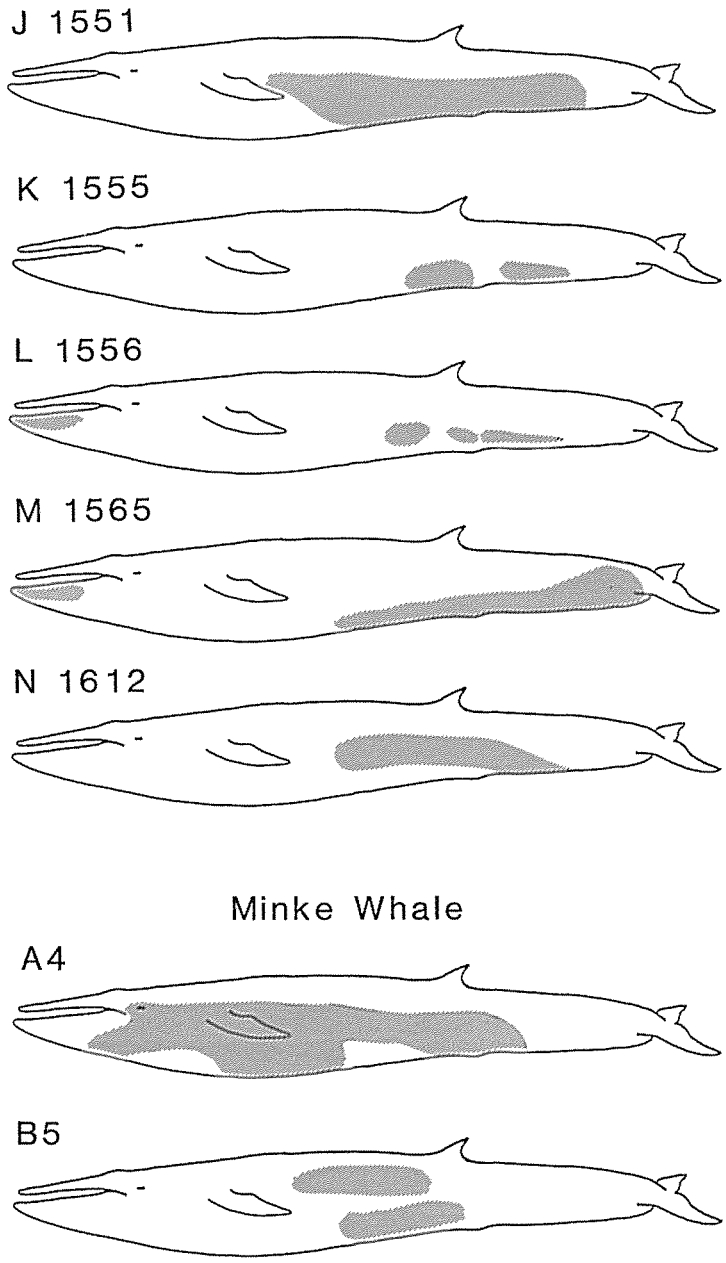

Fig. 1. Continued (1).

among individuals. These variable patterns of the diatom fouling were found covering large areas of the back and the posterior half of body. No diatom colonization was observed in the region of the ventral grooves. In 3 out of 14 fin whales fouling occurred around the anterior part of the lower jaw. In the white skin region of the posterior part of the body, the diatom fouling frequently showed a mottled pattern due to such many small patches of 2–3 cm across in diameter as Karcher[12] (e.g. Figs. 1 & 2) shown for the southern blue and fin whales.

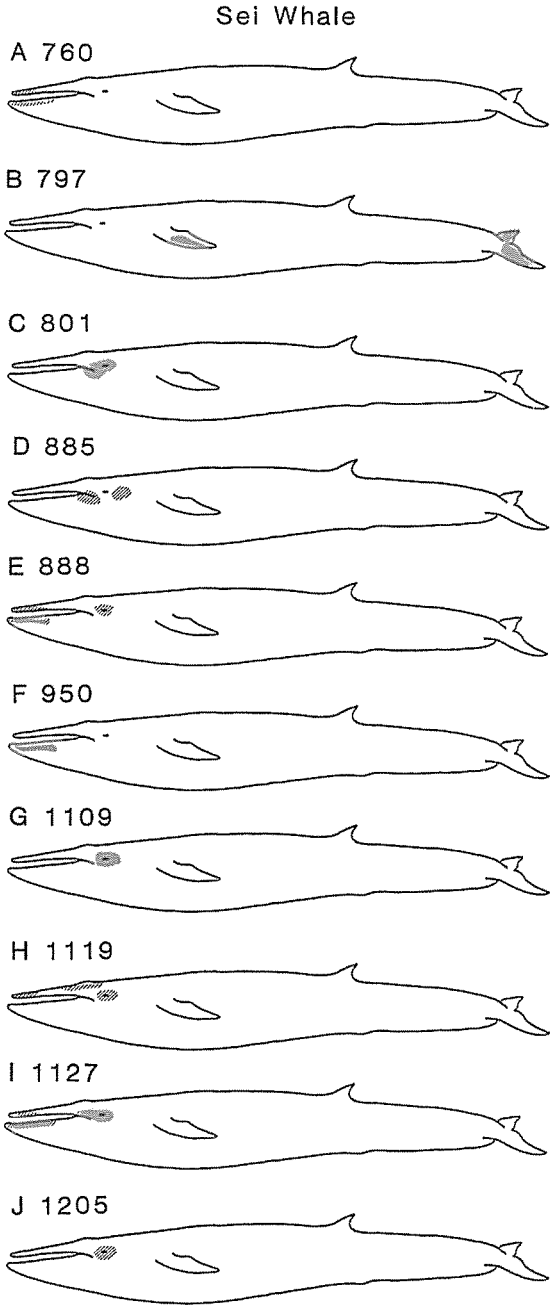

Fig. 1. Continued (2).

In general, the diatom fouling seems likely to develop first in the white region, and then expands into the dorsal region. Little can be said about patterns in minke whales, although in one of two specimens of this species diatom film was present in the region of the ventral grooves (Fig. 1(1), A4-B5). Ohsumi et al.[13] reported thin diatom fouling in the regions around the anus and genital apertures.

In sei whales, however, the diatom film was found exclusively to occur in small patches restricted to the anterior half of both the upper and lower jaws, and even smaller patches around the eyes and the angle of the gape (Fig. 1(2), A-J). Although they are not illustrated, the animals caught during January 13–15 were curiously infested only at the anterior-most tip of their lower jaws. Patchy film was also found around the blow-hole in one animal (Fig. 1(2), H1119) while another one was coated only on the upper surface of the tial flukes (Fig. 2, B796). In contrast to the fin whales, the most remarkable feature of the distribution of diatom film in the sei whale was the absence of colonization from the whole back and belly. These observations agree with the earlier descriptions[9]. The development of diatom patches in isolated small patches in the anterior regions only seems to be characteristic of sei whales.

Discussion

All the animals of this study were taken during January and February. The differences in the distribution pattern of the diatom film among the three rorqual species are unlikely to be due to seasonally different growth stages of the diatoms. The only noticeable difference among the animals was that the sei whales were caught in waters about 10 degrees of latitude further north than the fin whales. Diatoms on whales newly arrived in the cold waters are believed to take about a month or so until to grow to the point where they are easily visible to the naked eyes[5]. If this is so, then the diatom film in 'February' sei whales does not seem to propagate to the same extent as that of the fin whales before both leaving the Antarctic waters.

In contrast to the case of ectoparasitic animals such as the barnacles, *Cryptolepas rhachianecti* in gray whales[14–15], the distribution pattern of the diatom film does not show any sign of relation to water flow around moving whales. Although Matthews[9] reported *Cocconeis ceticola* (=*Bennettlla ceticola*), *Lycmophora luynbyei*, *Fragilaria antarctica* and *Navicula* sp. on southern sei, the latter three species are known best as free-living diatoms. Probably they are temporary contaminants[2]. Only *B. ceticola* is known from minke[11,13], fin[16] and blue whales[1]. The reason why distribution patterns of the diatom fouling are so different, especially between sei and fin whales is still unknown. It may be hypothesized that they grow at different rates depending on the varying nature of skin substrate, especially in superficial layer of the epidermis, since the epizoic diatoms are probably saprophytic to some extent[1] and can utilize organic substances such as the mucopolysaccarides being found in cetaceans skin film[17]. In some toothed whales the thickness of epidermis differs by region with the thickest part in the tip of snout, whereas the eyelids thinest[17]. Recently, Tanaka and Ohwada[18] found that some epiphytic diatom species of the genera, *Grammatophora, Licmophora, Navicula* and *Nitzchia* can decompose various organic compounds and use the products for their growth in natural habitats. At present, any differences in the nature of whale skin in different species in terms of part of the substrate for parasitic organisms is unknown. However, closer relationship in cyamid amphipods to the region of ventral grooves[19] may suggest some local difference in the nature of skin substrate for such parasitic organisms. The present observations may indicate possible difference in growth conditions for epizoic diatoms, and as a result, the diatoms demonstrate fouling patterns differently depending on the rorqual species.

Acknowledgments

I am greatly indebted to Professor David E. Gaskin of Univ. of Guelph, Canada, who carefully read and

corrected the manuscript. Many valuable suggestions on the parasitic diatoms are due to Dr. Sachiko Nagasawa of Ocean Research Institute, Univ. of Tokyo. I am also grateful to Robert W. Holmes, Professor Emeritus of Univ. Calif. Santa Barbara for his instructive suggestions through the personal communication. Dr. Ken Furuya of Fac. Bioresources, Mie Univ. kindly made a final check on the manuscript.

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南極海産のロルクォール類3鯨種にみられた珪藻付着のパターン

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1967/68年漁期に南極海で捕獲されたロルクォール類3鯨種について，体表にみられる珪藻，おそらく，*Bennettella ceticola* (Nelson *ex* Bennett) Holmes によるパッチ状コロニーの付着パターンを肉眼的に観察した。ナガスクジラは付着部位やパッチの広がり規模が個体毎に変化に富むが，多くは体側面から背面及び後体部腹面側に付着の中心があった。これに対して，イワシクジラでは，頭部，特に眼の周辺と上下顎の先端部に主な付着がみられ，前者とは明かに異なった付着パターンにあることが認められた。ミンククジラの観察例数は少なく，不確かながらナガスクジラの付着パターンに類似するもののように思われた。寄生性珪藻の栄養生態は不明であるが，このような付着部位あるいはそのコロニー形成の表れ方にみられる相違は鯨種間で表皮組織に何らかの相違があり，また当該シーズンにおける回游経歴の相違なども関与しているのではないかと考えられた。