On the Diatoms of the Skin Film of Whales in the Northern Pacific

By
Takahisa NEMOTO

Introduction

It is well known that diatoms infect the skin film of whales. Whales with heavy diatom infections are called by whalers as 'Algae Whales' (Japan) or 'Sulphur bottom' (Alaska, on blue whales). But comparatively few studies have been carried out on the subject of diatom infections of whales as compared with many excellent works on planktonic and littoral diatoms in the sea. Those works have been mostly done in the southern hemisphere. Hart (1935) describes in detail of these previous works. He also makes clear the correlation between the fatness of whales and diatom infections, and the problems of movements of whales suggested by Bennett (1920) to some extent. Karcher (1940) and Omura (1950, a) studied the variation and the fluctuation of these diatom (*Cocconeis ceticola* Nelson!) infections of whales according to the species, the sex, the age and the locality of whales taken, and inform that the tendency of diatom infections differs markedly among these groups of whales in addition to the seasonal variation of the infection. In recent years, Hustedt (1952) describes 3 new species, *Stauroneis olimpica*, *Lycmophora Onassis*, and *Nitzschia Barkleyi* from antarctic humpback whales and contributes greatly to the present knowledge of the diatom infection on whales.

In the northern Pacific, Amemiya (1916) observed the diatom (he wrote as *Navicula* sp.) infection on a fin whale (*Balaenoptera physalus*) treated at a landstation in Japan, though he did not study taxonomically. Further, Hollis (1939) describes the presence of *C. ceticola* Nelson on whales captured in the Alaskan waters. Perhaps it may be the first description of *C. ceticola* Nelson from the northern hemisphere.

Since 1942 Japanese biologists have been collecting material on diatom infections of whales following the method adopted by the Discovery (Mackintosh and Wheeler, 1929; Hart, 1935; Omura 1952, *et al.*) and some samples of diatom on the skin of whales have been collected on factory ships of Japanese whaling expeditions. A similar research has been performed also at various coastal whaling stations in Japan. Works on above data collected through many whaling seasons in the northern Pacific waters have been published for respective seasons in official reports of Japanese whaling expeditions, in addition to other

studies of whales taken (Matsuura and Maeda, 1942 ; Sakiura and others, 1953, *et al.*). Some observations based on the material collected at various landstations prior 1951 were also reported by Omura (1952).

The present paper deals essentially with the constituents of the diatom films on whales captured in the northern Pacific. Some planktonic species found in the film, which is thought as attached accidentally, are also included in the present paper too. Studies on more broader problems as to the correlation between the diatom infection and the movement of whales, studied firstly by Bennett (1920), will appear in future publications.

I wish to express my grateful thanks to Dr. Hideo Omura, the Director of the Whales Research Institute in Tokyo for his valuable suggestions rendered during the course of this work. My sincere thanks are also due to Mr. Hideaki Takano, a member of Tokai Regional Fisheries Research Laboratory for the fruitful discussion of the problems, and to Mr. Shigeo Sakata of Department of Radiology, Faculty of Medicine, the University of Tokyo, for the preparation of electron microscopical studies, and to Dr. Morizo Hirata, of the Professor of Faculty of Science, the University of Tokyo, for constant guidance in studying electron-micrographs.

Material and Method

The material at disposal for present study is obtained on factory ships by the following men in the respective seasons.

1953	" Baikal-maru "	Mr. Yasutake Nozawa
		Mr. Iwao Takayama
		Mr. Takahisa Nemoto
1954	" Kinjo-maru "	Mr. Setsuo Nishimoto
		Mr. Takehiko Kawakami
		Mr. Seiji Kimura
1955	" Kinjo-maru "	Mr. Tamenaga Nakazato
		Mr. Zenya Takahashi

Samples of diatoms have been collected by the inspectors or biologists listed above during the flensing of whales from the various parts of whales' body after the observations on degree of infection were made. Skins of whales with diatom patches were cut off from the body and then fixed directly with 5 % formalin sea water. Some other materials were collected by myself at coastal whaling stations, Monbetsu and Abashiri facing to the Okhotsk Sea, and Kushiro facing to the Pacific Ocean, during the months of August and September 1954. These samples were treated as above mentioned.

For the identification of the species, the diatom materials are boiled in hydrochloric acid in the usual way, and the part of them are examined before boiling with acid. Mountings are made of the lakeside cement and T.M.M. (Tsumura & Iwahashi, 1955). The rest of materials, including some new species named by me, have been kept in the collection of Whales Research Institute in Tokyo for the further examination in future. Both phase-microscope and electron-microscope are used besides the ordinary light-microscope. Electron-micrographs are taken by S. Sakata and by the operator of Hitachi Central Research Laboratory of Hitachi Co., Ltd. In the taxonomical arrangement, I have followed the order established by Hustedt (1930). I have used some technical terms proposed by Hustedt and Aleem (1952). The locations described after species show the localities of whales taken.

Notes on the Species

Genus *Melosira* Ag.

Melosira sulcata (Ehr.) Kütz. (Hustedt, 1928, Kieselalg. p. 276, fig. 119). Rare. Perhaps removed from plankton.

Bering Sea. Adjacent waters to Near Islands.

Genus *Thalassiosira* Cleve

Thalassiosira Nordenskiöldi Cleve (Hustedt, 1928, Kieselalg. p. 321, fig. 157). Rare. Removed from littoral plankton.

Okhotsk Sea.

Genus *Coscinodiscus* Ehr.

Coscinodiscus anguste-lineatus A. Schmidt (Hustedt, 1928, Kieselalg. p. 391, fig. 203). Rare.

Bering Sea. Adjacent waters to Near Islands.

C. Kützingi A. Schmidt (Hustedt, 1928, Kieselalg. p. 398, fig. 209). Rather common.

Bering Sea. Adjacent waters to Andreanof Islands.

C. radiatus Ehr. (Hustedt, 1928, p. 420, fig. 225). Rare.

Adjacent waters to Japan. Adjacent waters to Near Islands, Rat Islands, Andreanof Islands, Fox Islands.

C. weilesii Gran & Angst (Gran & Angst, 1930. p. 448, fig. 26). Rare.

Adjacent waters to Near Islands.

The flagments of *Coscinodiscus* species are sometimes found among

the patches of diatom films on whales. Hart (1935) describes one species *Coscinodiscus, C. spiralis* Karsten, from whales in the antarctic waters, and thinks it is accidental presence. Few perfect specimens of cells of *Coscinodiscus* has been observed in the northern Pacific waters, suggesting that *Coscinodiscus* species may adhere whales apart from their planktonic life by chance like some other *Coscinodiscus* found in littoral mudy flats. (Hustedt & Aleem, 1952, p. 179).

Genus ***Detonula*** Schütt

Detonula confervacea (Cleve) Gran (Hustedt, 1929, Kieselalg. p. 554, fig. 315). Rare.

Adjacent waters to Andreanof Islands.

Genus ***Leptocylindrus*** Cleve

Leptocylindrus minimus Gran (Hustedt, 1929, Kieselalg. p. 560, fig. 321). Rather rare.

Adjacent waters to Fox Islands.

Genus ***Rhizosolenia*** Ehr.

Rhizosolenia styliformis Brightwell (Hustedt, 1929, Kieselalg. p. 585 fig. 333). Only few flagments are found.

Okhotsk Sea. Bering Sea. Adjacent waters to Andreanof Islands.

Genus ***Chaetoceros*** Ehr.

Chaetoceros atlanticus Cleve (Hustedt, 1930, Kieselalg. p. 641, fig. 364). Rare.

C. densus Cleve (Hustedt, 1930, Kieselalg. p. 651, fig. 368).

C. concavicornis Mangin (Hustedt, 1930, Kieselalg. p. 665, fig. 376).

Only fragments of above planktonic species are found, and accurate systematizations are difficult, because most of them are broken. The setae of *Chaetoceros* species are also occasionaly found on whales.

Genus ***Biddulphia*** Gray

Biddulphia aurita (Lyngh.) Bréb. (Hustedt, 1930, Kieselalg. p. 846, fig. 501). Rare.

Bering Sea. Okhotsk Sea.

B. mobilensis Bailey (Lebour, 1930, p. 147, fig. 134). Rare.

Adjacent waters to Japan.

Genus *Lycmophora* Ag.

Lycmophora abbreviata Ag. (Hustedt, 1931. Kieselalg. p. 66–67, fig. 590). Rare.

Adjacent waters to Andreanof Islands.

Broken specimens of *Lycmophora* species are occasionary found. It is, however, difficult to identify their species as perfect specimens are seldom met with.

Hart (1935) and Hustedt (1952) report *Lycmophora* species consisting diatom films on the whales from antarctic waters.

Genus *Rhaphoneis* Ehr.

Raphoneis amphiceros Ehr. (Hustedt, 1931. Kieselalg. p. 174, fig. 680). Rare. Comparatively small size specimens (14 μ!) are observed.

Adjacent waters to Andreanof Islands.

Genus *Synedra* Ehr.

Synedra Camtschatica Grun. (Hustedt, 1932. Kieselalg. p. 214–215. fig. 708). Only few perfect specimens are found on sperm whales.

Bering Sea. Adjacent waters to Andreanof Islands.

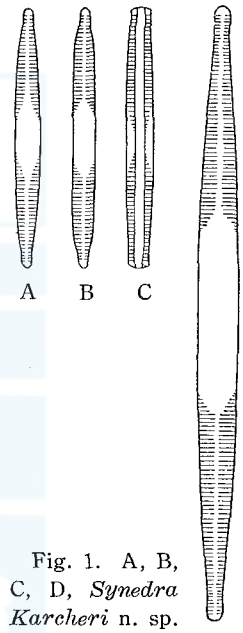

Fig. 1. A, B, C, D, *Synedra Karcheri* n. sp. ×1000.

The thickened cellwall of central area of found specimens is longer than those described by Hustedt. The specimens seem rather to resemble to the indistinct figure by O'meara (1874, pl. 8, fig. 5). Transapical striae of the valves are about 13 in 10 μ (12–14 in 10 μ after Hustedt, 1932). This value is 15–20 in 10 μ by Gemeinhardt (1926, p. 28) which is estimated to be rather too heigh. The variety forms bearing such many striations have never been observed in the past. The variety forms of this species will be reported when further examination is finished.

S. tabulata (Ag.) Kütz. (Hustedt, 1932. Kieselalg. p. 218, fig. 710). Rather common on sperm whales.

Adjacent waters to Fox Islands, Andreanof Islands.

S. Hennediyana Greg. (Hustedt, 1932. Kieselalg. p. 222–223, fig. 713). Only few flagments, the central portion of the valve, are found on a sperm whale. Okuno (1942) reports this species from more warmer waters adjacent to Japan.

Adjacent waters to Andreanof Islands.

Synedra Karcheri **spec. nov.** Valva angusta lineari lanceolata, apicibus rotundis capitatis, circiter 45–80 μ longa, 4–6 μ lata. Pseudoraphe angusta, area centrali longa elliptica lanceolata. Striis delicatis ad pseudoraphen perpendicularis, 12–14 in 10 μ. (Fig. 1, A, B, C, D).

Valves slender linear lanceolate with rounded capitate ends, 45–80 μ long, 4–6 μ broad. Pseudraphe narrow, central area long elliptic lanceolate. Striae delicate perpendicular to the pseudraphe, about 12–14 in 10 μ.

The figures of *Synedra Karcheri* bear some resemblance to those of *Fragilaria islandica* Grun. (V. Heurck, 1881, pl. 45, fig. 37; Hustedt, 1931, Kieselalg. p. 146–147, fig. 660). The former is distinguised from the latter by numbers of striations, the lack of intercalary bands and the longer central area. Striae of *Synedra Karcheri* are between 12–14 in 10 μ, on the other hand, those of *Fragilaria islandica* between 16–18 in 10 μ (Hustedt, 1931, Kieselalg.) or 14–15 in 10 μ (Grunow, in V. Heurck, 1881, pl. 45). Occasionaly found, on sperm whales.

Adjacent waters to Andreanof Islands.

Genus *Thalassionema* Grun.

Thalossionema nitzschinoides Grun. (Hustedt, 1932. Kieselalg. p. 244–245, fig. 725). Rare. Perhaps it adhered whales incidentally from the planktonic inhabitancy.

Adjacent waters to Japan.

Genus *Thalassiothrix* Cleve & Grun.

Thalassiothrix longissima Cleve & Grun. (Hustedt, 1932. Kieselalg. p. 247, fig. 726). Few flagments and cells recruited from plankton (Hustedt & Aleem, 1951) are found among the patch of *Cocconeis ceticola*.

Bering Sea. Okhotsk Sea.

T. Frauenfeldii Grun. (Hustedt, 1932. Kieselalg. p. 247–248, fig. 727). Few flagments are found too.

Adjacent waters to Japan.

Genus *Cocconeis* Ehr.

Cocconeis costata Greg. (Hustedt, 1932. Kieselalg. p. 332, fig. 785). Few specimens are found. Some questions of *C. costata* on the indistinct point are discussed in the following description.

Adjacent waters to Andreanof Islands.

C. costata var. *pacifica* form. *plana* **form. nov.** Synonym, *C. imperatrix* A. Schmidt (1894, Atl. pl. 189, fig. 12). Cells are solitary, valves are elliptical oval. The raphe-valve possesses straight raphe, the axial area is very narrow, the central area is enlarged transversely to a narrow fascia in the median portion, sometimes does not so. The raphe is surrounded transapical costae consist of two lines of puncta about 6–10 in 10 μ crossed by a blank line, punctations about 12–14 in 10 μ. Rapheless-valve possesses a narrow pseudraphe which is somewhat fusiform, and strong costae on the surface. Two lines of punctions, 12–16 in 10 μ, are found along the inner margins of costae. Apical axis of cell 10–40 μ, transpical axis of cell 7–20 μ. Often found among the patch of *Gomphonema* spp. and *Navicula* spp. (Fig. 2, A, B, C, D)

Bering Sea Adjacent waters to Andreanof Islands.

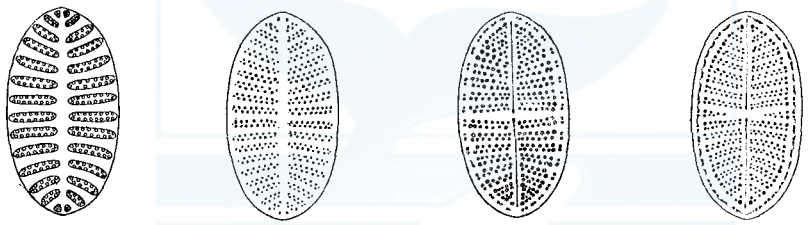

Fig. 2. *Cocconeis costata* var. *pacifica* form. *plana* n. fo. ×1000.
A, B, Rapheless-valve. C, D, Raphe-valve.

The illustrations and descriptions on *C. costata* referred to are following. (Gregory, 1855, p. 39, pl. 4, fig. 10; Gregory, 1857, p. 68, pl. 1, fig. 27; A. Schmidt, 1894, Atl. pl. 189, figs. 6–7; V. Heurck, 1881, pl. 30, figs. 11–12; Wolle, 1894, pl. 33, fig. 10; Cleve, 1895, p. 182; Peragallo, 1997, p. 10, pl. 2, fig. 10; Mann, 1907, p. 329; Boyer, 1927, p. 250; Hustedt, 1932. Kieselalg. p. 332, fig. 785; Mills, 1933, p. 414; Okuno, 1954 a, p. 19, pl. 2, fig. 3), and those on *C. costata* var. *pacifica* are followings (Grunow 1867, p. 11, pl. 1, fig. 10; V. Heurck, 1881, pl. 30, figs. 13–14; Cleve, 1895, p. 182).

Cleve (1895) and Mann (1907) describe *C. imperatrix* (A. Schmidt, 1894, pl. 189, figs. 11–15) as the synonym of *C. costata* or *C. costata* var. *pacifica* in their papers. Boyer (1927) also quotes Cleve's description on the synonymy of *C. costata* var. *pacifica* in his remarks. On the other hand, Hart (1935) and Hendey (1937) consider *C. imperatrix* is uniform species separated from *C. costata*. Besides, Hart (1935) consideres *C. scutellum* var. *ampliata* Grun. (V. Heurck, 1881, pl. 29, figs. 4–5) should be included in the synonym of *C. imperatrix*, however, the figure of *C. scutellum* var. *ampliata* (Rapheless-valve, V. Heurck, pl. 29, fig. 4) seems not to be so closely related to *C. imperatrix*, if *C. imperatrix* is the distinguishing species.

In the account for *C. imperatrix* A. Schmidt, the description in the atlas is as follows.

> 12 älmlich V.H. XXX. 14, *C. costata* var. *pacifica* Grun. Aber die Oberschale 13 weicht von den Oberschalen unseren Form bedeutend ab. Cleve zieht 11–15 zu *C. costata* var *pacifica* Grun. dem meine älteren *Cocconeis*-Bilder vorgelegen haben, bezeichnete 10 und 11 als. *C. costata* form. *maxima*.

After the examination of above many figures of *C. costata* and *C. costata* var. *pacifica*, I consider that one figure of *C. imperatrix* A. Schmidt (A. Schmidt, 1894, Atl. pl. 189, fig. 12) is perfectly coinside with the figure of *C. costata* var. *pacifica* Grun. (V. Heurck, 1881, pl. 30, fig. 14) except the structure of the margin of the raphe-valve, and other figures of *C. imperatrix* by A. Schmidt are nearly the same as the description and the illustrations of *C. imperatrix* by Hendey (1937, p. 342, pl. 10, figs. 8–9). The distinguishing traits of raphe-valve between *C. costata* and *C. costata* var. *pacifica* are rather indistinct. *C. costata* var. *pacifica* form. *plana* bears remarkable resemblance to *C. costata* var. *pacifica* Grun. but with no lines on the rapheless-valve, that is, the median area of each side of the rapheless-valve is not crossed by a longitudinal lines as illustrated by Grunow (1867, 1881 in V. Heurck !). Two lines of puncta consisting striae of rapheless-valve are almost pallarel and spaces between the two lines are not so expanded as Hendey's figures. Cleve (1895) and Boyer (1927) also describe that lower valve (raphe-valve) with a well defined margin separated from the faintly costate surface by a blank line. I consider this distinct blank line, and the want of longitudinal lines on the rapheless-valve may be the valid key to the identification of the species.

Boden (1950, p. 410, fig. 91) reports *C. costata* with one illustration of somewhat rhomboid form, the costae of which reached the margin. This figure rather resembles to the figure of *C. imperatrix* illustrated by A. Schmidt and Hendey (1937, pl. 10, fig. 8), differs considerably from *C. costata* from the antarctic waters (Okuno, 1954, a, p. 19, pl. 2, fig. 3) in size and outline of valves. The size of valves of *C. costata* and *C. costata* var. *pacifica* typical elliptical forms, are in the range of 8–50 μ, which are far smaller than *C. imperatrix*. On the other hand, the size of *C. imperatrix* is in ranges 80–150 μ by Hendey (1937), averaging 60 μ by Hart, with exception of that (20–30 μ !) by Barkley (1940). These variations of valves and the synonymy of *C. costata* must be treated after further investigation on many materials. So, I left *C. imperatrix* untouched in this report for future.

C. scutellum var. *stauroneiformis* W. Smith (Hustedt, 1932. Kieselalg. p. 339, fig. 792). This typical neritic diatom, *C. scutellum* var. *stauronei-*

formis, is found on the skins of whales among other species. It never be considered as the true constituent of diatom films.

Adjacent waters to Andreanof Islands.

C. ceticola Nelson (Bennett & Nelson, 1920, p. 352–357 ; Mills, 1933, p. 413 ; Hart, 1935, p. 256, pl. 2, figs. 1–4 ; Hendey, 1937, p. 341–342 ; Hollis, 1939, p. 17 ; Kalcher, 1940, p. 14–34, phs. 1–4 ; Barkley, 1940, p. 70, fig. 8 ; Omura, 1950, p. 4 ; Okuno, 1954, b, p. 271–277, figs. 1–2, pls. 3–4).

Nelson (1920), Hendey (1937) and Okuno (1954, b) give full account on this characteristic species from the antarctic whales.

Cells are solitary, but found often forming diatom films on whales. Valves are strongly concavo-convex. The rapheless-valve possesses a narrow straight pseudraphe which is dilated slightly in the median area of the valve, forming a small lanceolate hyaline area. The surface of rapheless-valve is covered with subradiated striae, consists of lines of

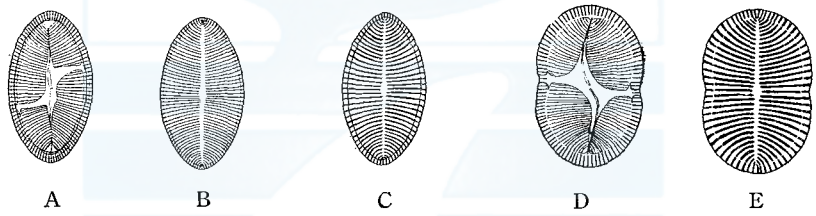

Fig. 3. A, B, C, *Cocconeis ceticola* Nelson ×1000;
A, Raphe-valve. B, C, Rapheless-valve.
D, E, *C. ceticola* fo. *constricta* n. fo. ×1000.

punctations, about 11–16 in 10 μ. The raphe-valve possesses a strong sigmoid raphe, which is surrounded by a narrow axial area which dilated towards the centre of the valve to form an oblique stauros that tapers to a fine point as it approaches the valve margin. The raphe-valve surface is covered with extremely fine striae, consisting of two series of punctations, about 10–15 in 10 μ along the margin of the valves, 16–20 in 10 μ along the axial area. Apical axis of the valve, 13–38 μ, transapical axis of the valves 7–24 μ. The size of valves from the northern hemisphere does not differ from the antarctic one. (Fig. 3, A, B, C. Pl. 1. C, D)

Bering Sea. Adjacent Sea to Near Islands, Rat Islands, Andreanof Islands, Fox Islands, Pribilof Islands. Okhotsk Sea ! British Columbia (Pike).

Above stated structures are also fully described by Okuno (1954 b) with electron-microscopical observations. This famous parasitic diatom is well known its wide distribution on the skins of various species of

whales. Hollis (1939) first reports its presence on whales captured at Alaskan coast, the identification of this species is made by P.S. Conger. Many Japanese biologists have observed this *Cocconeis* species and dealt with the subject of migration of whales in connection with the stages of infection by diatoms' patches since the year 1942 (Matuura & Maeda, 1942, *et al.*). But the identification of *C. ceticola* has not been carried on. Perhaps all these *Cocconeis* diatoms described by them may belong to the most popular species *C. ceticola* with exception of those on sperm whales (*Physeter catodon*). *C. ceticola* forms yellowish-brown diatom patches and films on many different portions of various whales, especially on lower jaws of fin whales (*Balaenoptera physalus*) as in the antarctic waters. The dispositions of these diatom patches, the size of diatoms, the variation of seasonal growth, vary considerably throughout the whaling season, and the investigation of these fluctuations will add something to the knowledge of the migration of the northern whales.

This species has not been reported as a pelagic form in the northern Pacific. Endo (1905), Akatsuka (1914) and Skvortozow (1929, 1931. a.b, 1932. a. b) never report from Japanese coast, Kisselew (1937) from Bering Sea, Gran & Angst (1930) and Cupp (1943) also report none of them from west coast of America. Their very few fortuitous inclusion in the tow nets (Nelson, 1920) has also never been noticed by quantitative studies on diatoms by Aikawa (1933), Takano (1954) and many other research workers. But, as the parasitic form, not only on many large species of whales, but also on the small species of whales, such as the killer whales (*Orcinus orca*; Bennett, 1920), the bottle-nose (*Hyperoödon rostratus*; Bennett, 1920), the baired beaked whales (*Berardius bairdi*; Pike, 1953) and the dolphins (*Lagenorhynchus cruciger*, *Cephalorhynchus commersoni*; Hart, 1935) their occurrences have been considered.

Barkley (1940) reports *C. ceticola* in stomacks of *Euphausia superba* Dana (1940, p. 80, fig. 8), and I have also found *C. ceticola* in digestive guts of *E. superba* from the stomacks of the whales captured in the Kerguelen Sea area (Area IV) by the Japanese whaling expedition in 1955 to 56.

C. ceticola form. *constricta* **form. nov.** Cells are solitary often form yellowish brown patches on sperm whales. Valves are broadly oval, constricted at the median margin of the valve. The oblique stauros which reaches the margin of the valves are wider than the original form of *C. ceticola*. The structures of the valves by electron microscopical studies are nearly the same as the original types of *C. ceticola*, but the margin of valves where oblique stauros reaches. Apical axis of the cell, 10–40 μ, transapical axis of the cell 7–30 μ. (Fig. 3, D, E, pl. 1, A, B, pl. 2).

Bering Sea. Adjacent waters to Rat Islands, Andreanof Islands, Fox Islands.

The median constriction of valves of *Cocconeis* species as a variety form has never been reported though close examination of variety forms of some *Cocconeis* species fully carried out in the past (Geitler, 1932, on *C. placentula*).

Geuus ***Rhoicosphenia*** Grun.

Rhoicosphenia Pullus M. Schmidt (A. Schmidt, 1899, Atl. pl. 213, figs. 24–26 ; Aleem, 1949, p. 435, fig. 7, X–A′). Rare. Perhaps accidental appearance from the littoral form adjacent waters to Andreanof Islands. Aleem (1949) describes this fine species, " Cells small, with intercalary bands and septa, girdle view mostly a curved rectangle although slightly wedge-shaped, Valves linear 10–20 μ long. about 3–4 μ broad. Striae parallel 15–20 in 10 μ."

Adjacent waters to Andreanof Islands.

I have found few specimens among *Gomphonema Kamtchaticum* and *C. ceticola* form. *constricta*. Aleem (1949) reports this from British south coast, he notes, however, Schmidt's species seemed to have been obtained from a fresh water habitat. So further examination is necessary on this point.

Genus ***Stauroneis*** Ehr.

Stauroneis olympica Hustedt (Hustedt, 1952, p. 288, figs. 1–5). Valves are linear lanceolate, apices are rounded with the deep intruded pseudsepta at the ends. The raphe is straight, the axial area is very narrow, the central area is narrow crossband. Transapical striae are perpendicular to the raphe, 30–35 in 10 μ, indistinctly punctate. Apical axis of the valve 15–30 μ, transapical axis 1.5–2 μ.

Adjacent waters to Andreanof Islands.

Stauroneis olympica was first reported by Hustedt (1952) from the antarctic humpback whales (*Megaptera novae-angliae* (Borowski)) in the Ross Sea area. While, many *Stauroneis* specimens perhaps belong to the same species have been found on whales from the northern Pacific. As the taxonomical distinctions by further examinations are firmly coincide with those of *S. olympica* by Hustedt, I describe these as *S. olympica*. It constitutes parasitic diatom patches on whales' skin like *C. ceticola*. I have observed *S. olympica* on a blue whale (*Balaenoptera musculus*) and sperm whales. I have also found *S. olympica* Hustedt in digestive guts of *Euphausia superba* from the stomacks of whales caught in Kerguelen Sea area by Japanese whaling expedition in 1955 to 56.

Stauroneis aleutica **spec. nov.** Valva angusta lineari lanceolata, apicibus modice rotundis, pseudoseptis apicibum profundis, circter 28–45 μ longa, 3.1–4 μ lata. Raphe directa, area axiali angustissima, area centrali modice lata. Striis transapicalibus ad raphen perpendicularibus, circiter 30 in 10 μ, punctis inconspicuis (Fig. 4, A, B, C. Pl. 2, Pl. 3).

Valves narrow linear lanceolate with rather rounded apices with deep pseudsepta at the ends, 28–42 μ long, 3.1–4 μ broad. Raphe straight, axial area very narrow, central area rather broad fascia. Transapical striae perpendicular to the raphe about 30 in 10 μ, indistinctly punctate.

This species bears remarkable resemblance to *S. olympica* Hustedt (1952), it may be distinguished by bearing broader stauros edges of which is not so thickened as *S. olympica*. Comparatively common on sperm whales.

Bering Sea. Adjacent waters to Aleutian Islands.

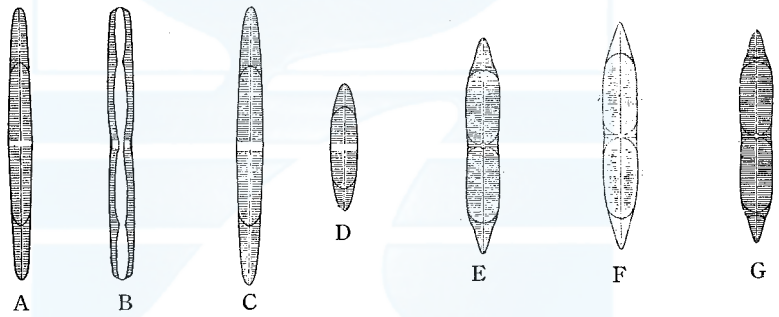

Fig. 4. A, B, C, *Stauroneis aleutica* n. sp. ×1000; D, *S. aleutica* fo. *brevis* n. fo. ×1000; E, F, G, *Stauroneis Omurai* n. sp. ×1000.

S. aleutica form. *brevis* **form. nov.** Valves are very short, the ratio length : breadth are 4 to 5, 12–20 μ long, 3–4 μ broad. The numbers of striae are about 30, the same as the original species. Often found among the patches of original species. (Fig. 4, D. Pl. 3)

Bering Sea. Adjacent waters to Andreanof Islands.

Stauroneis Omurai **spec. nov.** Valva lineari lanceolata, apicibus rostratis. Pseudoseptis apicibum modice profundis, circiter 20–30 μ longa, 4–5 μ lata. Raphe directa, area axiali angustissima, area centrali lineari angustissima. Striis transapicalibus ad raphen perpendicularibus, circiter 30 in 10 μ, punctis inconspicuis. (Fig. 4, E. F. G, Pl. 4).

Valves linear lanceolate with rostrate ends, with rather deep pseudsepta at the ends, 20–30 μ long, 4–5 μ broad. Raphe straight, axial area narrow, central area very narrow linear fascia. Transapical striae perpendicular to the raphe about 30 in 10 μ, indistinctly punctate.

This species is named in hour of Dr. Hideo Omura, the Director of the Whales Research Institute in Tokyo.

The colour of the diatom patch of *S. Omurai* varies according to their parasitic condition on skin films of whales. I have observed *S. Omurai* also among the patch of *C. ceticola*, not the variety form of *C. ceticola* form. *constricta*! Not so common as *Stauroneis olympica* and *S. aleutica*.

Bering Sea. Adjacent waters to Near Islands, Andreanof Islands.

S. Omurai bears some resemblance to fresh water diatoms, *Stauroneis parvula* Grun. (Hustedt, 1930, p. 260, fig. 417 a), *S. Smithii* Grun. (Hustedt, 1930, p. 261, fig. 420) and *S. tenera* Hustedt (1937, p. 225, figs. 19–21) as Hustedt describes in his remarks on *S. tenera*, and as well as to *S. ignorata* Hustedt (1939, figs. 58–60). *S. Omurai* may be distinguished from above species by numbers of striation and the narrower stauros and uniform median subconstriction of the valves.

Hustedt (1953) describes one *Navicula* sp. reported by Hart (1935) would perhaps be the synonym of *Stauroneis olympica* Hustedt. But *S. olympica* seems to be a more slender form than the *Navicula* sp. illustrated by Hart (1935), so I consider the *Navicula* sp. of Hart should belong to the fixed variation, if not another *Stauroneis* species. Judging from the outline of valves and the position of pseudsepta, it resembles rather to *S. Omurai* than *S. olympica* Hustedt.

Genus ***Navicula*** Bory

Some *Navicula* species found on whales all belong to the **Navicula lineolatae** Cleve (Cleve, 1895, p. 10).

Navicula ammophila Grun. var. *intermedia* Grun. (Cleve, 1895, p. 30). Valves are linear lanceolate. Axial and central areas are indistinct. Striae are 12–13 in the middle. Occasionally found.

Adjacent waters to Andreanof Islands.

N. arenaria Donk. (Donkin, 1871–2, p. 56, pl. 8, fig. 8). Rare. Perhaps accidental adhereance.

Adjacent waters to Andreanof Islands.

N. cancellata Donk. (Cleve, 1895, p. 30). Rare. *N. cancellata* often reported from Japanese coast. Perhaps accidental adherance.

Adjacent waters to Japan.

Plumosigma **gen. nov.**

Valva sigmoidea, plana, raphe sigmoidea, striis leniter radiantibus.

Valves sigmoid, flat. Raphe sigmoid. Striae radiate, not oblique,

not longitudinal, not perpendicular to the raphe. *Plumosigma* belongs to subfamily **Naviculeae** (Naviculeae, Hustedt, 1933, Kieselalg. p. 434).

Plumosigma Hustedti **spec. nov.** Valva sigmoidea, apicibus rotundis, circiter 15–20 μ longa, 5–7.5 μ lata. Raphe sigmoidea centrali, area axiali nulla, area centrali parva. Striis delicatissimis in media parte valvae leniter radiantibus, 35–45 in 10 μ (Fig. 5. A, B, Ph. 1, a. b, Pl. 5).

Valves sigmoid with rounded ends, 15–20 μ long, 5–7.5 μ broad. Raphe sigmoid, axial area absent, central area small. Striae excessively faint, slightly radiate in median portion of valves, 35–45 in 10 μ.

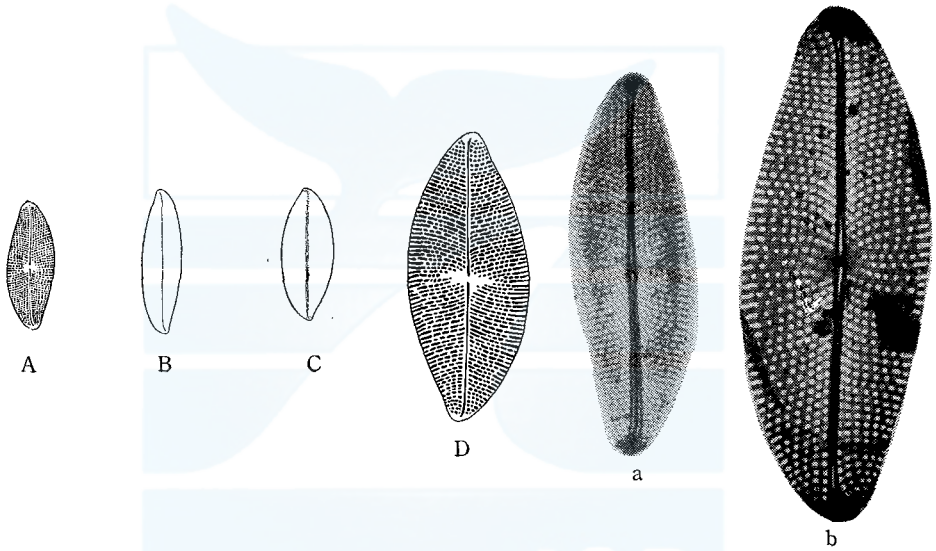

Fig. 5. A, B, *Plumosigma Hustedti* n. sp. ×1000, C, *Plumosigma rimosum* n. sp. ×1000, D, *P. rimosum* n. sp. ×2000.

Ph. 1. Electron-micrographs of *Plumosigma Hustedti* n. sp. a. Notice the two lines of raphe of slided valves of a cell at the lower end of the cell. ×3300 (200 KV). b. ×3500 (50 KV).

Plumosigma rimosum **spec. nov.** Valva elliptica sigmoidea, apicibus acutis, circiter 12–18 μ longa, 3.5–7 μ lata. Raphe leniter sigmoidea centrali, area axiali nulla, area centrali minima, Structura delicatissima, striis tenuissimis, leniter radiantibus, 50–70 in 10 μ (Fig. 5. C, D. Pl. 6, 7.).

Valves elliptic, sigmoid, with acute ends, 12–18 μ long, 3.5–7 μ broad. Raphe sigmoid, axial area absent, central area excessively small. Structure extremly delicate, Striae excessively faint slightly radiate in the median portion of valves, difficult to observe with light-microscope, 50–70 in 10 μ.

The form of *Plumosigma* bears some resemblance to some species of *Navicula*, *Cocconeis* and small forms of *Gyrosigma* or *Pleurosigma*. *Navicula laevis* Cleve-Eular (1922, p. 71, pl. 1, fig. 11) and *Cocconeis binotata* var. *atlantica* Grun. (1867, pl. 1 fig. 11, b) have confusing valves to *Plumosigma rimosum* in the first impression, and the hyaline minimum form of *Gyrosigma* and *Pleurosigma* seems to like *Plumosigma Hustedti*.

The structures of *Plumosigma* are extremly delicate as it is very difficult to examine them fully with light-microscope. To solve this surface structures completely, electron microscope is used on samples boiled with acid, some were applied 'shadowing' with Chrome. The striae of the valves solved by electron-microscopes are all disposed in radiately rows, not in longitudinal and perpendiculary rows, or oblique and perpendiculary rows like *Gyrosigma* or *Pleurosigma*.

Cleve (1894, 1895) fully describes other flat sigmoid Naviculoid diatoms, deviding into 2 genera *Pleurosigma* W. Smith (1853) and *Gyrosigma* Hassal (1845). It is a appropriate argument, *Gyrosigma* is named for the formes with the puncta in transverse and longitudinal rows, and *Pleurosigma* for the forms with the puncta disposed in transverse and oblique rows of which, though, Hendey (1937, p. 348) does not agreed. This classification has been properly accepted by Hustedt (1930, 1933, Kieselalg.) and others.

On the value of the characteristic sigmoid flexure of the valves, in systematization of diatoms is discussed by Cleve too (1894, p. 6). According to his description, this characteristic is subject to great variation, and some different forms of diatoms belonging to other genera are sigmoid, as *Navicula Räeana*, *Navicula Sigma*, and *Caloneis staurophora*. He also find a sigmoid valve of *Frustulia Lewisiana* and one of *Navicula cincta* var. *Heufleri*, so he concludes the sigmoid flexure of the valve can only be regarded as a specific character. Cleve corrects the name *Pleurosigma staurophorum* Grun. (Cleve & Grunow, 1880, p. 61) to the Genus *Caloneis*, because it has the distinct longitudinal lines and the striae which are not distinctly punctate. *Staurosigma asiaticum* Tempère & Brun (Brum & Tempère, 1889, p. 56, pl. 9, fig. 1) is also placed in *Caloneis* by Cleve. The above conclusion by Cleve, however, may be a subject for consideration. The latter distinction (1894, p. 47), "the striae, which are not distinctly punctate" can not be maintained, because closer examinations on striae of some *Caloneis* species, reveal fine puncta consisting striae (Hustedt, 1930, p. 213, *et. al.*). The meaning of the words 'not distinctly punctate' is very difficult to define. For example, Meister (1912, p. 110) states, "Streifen fein, nicht punctiert" in the description of the Genus *Caloneis*, on the other hand Cleve states (1894,

p. 46), "not distinctly (rarely finely) punctate.", Hustedt also states (1933, Kieselalg. p. 438) "Transapical streifen zart punctiert order gestrichelt." These descriptions may be due to specific characters of different species treated by the above authors. Accordingly, this distinction 'punctate distinctly or not' is not so important as to set sigmoid valves and raphe at naught. I consider the sigmoid flexure of the valve of *Caloneis staurophorum* (Grun.) Cleve will be the Key which defines its proper Genus instead of the aspect of the striation.

Navicula Räeana Cast. (*Pinnulaia Räeana* by Castracan) has sigmoid valves, raphe and radiate striae, frustule of which is twisted as Cleve's description. The valve after the figure of Castracan (1886, pl. 15, fig. 3) seems not so sigmoid compared with the distinctly sigmoid raphe. It is perhaps attributable to the contorted valves, which seems to be not so sigmoid from right above view. The frustules of this *Navicula* are not so flat as *Plumosigma* although above some distinctions are confusing.

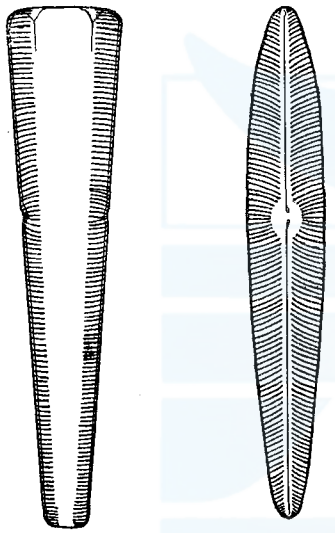

Fig. 6. A, B. *Gomphonema Kamtschaticum* Grun. ×1000.

Other diatoms with the sigmoid raphe, that are, *Scoliopleura* Grun., *Scoliotropis* Cleve, *Eucocconeis* Cleve and some species of *Achnanthes* Bory are also may confusing. The last two, however, belong to **Monoraphidinea** and valves of *Scoliopleura* and *Scoliotropis* are not usually sigmoid (Cleve, 1894, p. 72; Hustedt, 1933, Kieselalg. p. 437, *et al.*). So above species completely differ from the species of *Plumosigma*.

Genus **Gomphonema** Agardh

Gomphonema Kamtschaticum Grun. (A. Schmidt, Atl. pl. 213, figs. 46–51; Cleve, 1894, p. 188–189). Cells are solitary. Valves are elongated clavate with rounded and narrower basis. Rache is straight, the axial area is distinct and narrow, the central area is dilated around the central nodules, the central area rounded oval without stigma. Valves surface are furnished with transverse striae, 12–17 in 10 μ, very finely punctata, radiate in the middle of the valve. Apical axis of cell 40–100 μ, greatest transapical axis 8–15 μ. (Fig. 6, A, B).

Adjacent waters to Andreanof Islands.

G. Kamtschaticum constitutes yellowish brown diatom patches on

sperm whales in the Bering Sea and adjacent waters to Andreanof Islands. These patches bear some resemblance to those of *C. ceticola*, though they seem to be more coarse texture when observed by naked eyes. Elenkin (1914) states that *G. Kamtschaticum* has been found in many localities and he points out that it is not a characteristic species of Kamtschatic region. It is clear that *G. Kamtschaticum* distributes widely in the northern Atlantic and Pacific according to the reports by Cleve & Grunow (1880), Cleve (1895), Gran (1900), Östrup (1910, 1916) and others.

Accordingly, its adherence on whales does not necessarily mean the lapse of time since the arrival of sperm whales at Aleutian waters, on the contrary to the fact often reported as regards the infection of *Cocconeis ceticola*. While, generally speaking, *G. Kamtschaticum* may propagates on sperm whales after whales had arrived to the neighboring waters of Bering Sea from the warmer southern seas. Accordingly the presence of this species on the skin may suggest something about the movement of the whales.

G. Kamtschaticum has never been reported from Japanese coast. One vague specimen *G. Kamtschaticum* var. *Japonica* Skvortozow (1929, fig. 27 ; 1932. b) found on the sea weed belonging *Laminaria* sp. is perhaps a synonym of the well known littoral diatom *G. exiguum* Kützing.

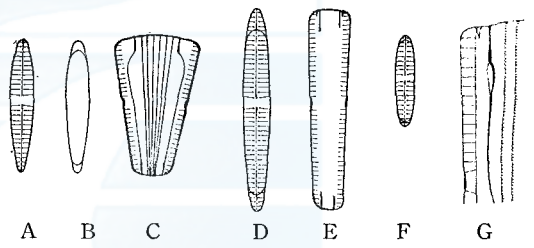

Fig. 7. *Gomphonema Harti* n. sp.
A—F, ×1000,
G, Upper end of the cell. ×2000.

G. Kamtschaticum var. *californica* Grun. (V. Heurck, 1881, pl. 25, fig. 28 ; Cleve, 1894, p. 189). Striae are not so radiate as *G. Kamtschaticum*. Comparatively small forms have been found.

Bering Sea. Adjacent waters to Andreanof Islands.

Gomphonema Harti **spec. nov.** Valva liniari lanceolata claviforma, apicibus rotundis, circiter 12–30 μ longa, 3–5 μ lata. Septis apicibum profundis distinctis. Raphe directa, area axiali angusta, area centrali lata. Striis transapicalibus ad raphen perpendicularibus, 14–16 in 10 μ, quattuor striis mediis radiantibus, punctis conspicuis (Fig. 7. A—G.).

Valves linear lanceolate clavate with rounded ends, with distinct deep septa at both ends, 12–30 μ long, 3–5 μ broad. Raphe straight, axial area narrow, central area broad fascia. Transpical striae perpendicular to the raphe, 14–16 in 10 μ, median two paires of them radiate, distinctly punctate. Östrup (1910) describes a somewhat confusing species

Gomphonema boreale Östrup (p. 239 ; pl. 2, fig. 5) with broad central area forming transverse fascia, but this has only 8 striae in 10 μ on valves, neither septum nor intercalary bands. Skvortozow (1929) also describes *Gomphonema* of this type, *G. Okamurai* Skvortozow with 7–8 striae in 10 μ from the Siberian coast of Japan Sea, on which accounts for septum bulding and intercalary bands are also lacking.

This new form of *Gomphonema Harti* bears a striking resemblance to *Gomphonema Aestuarii* Cleve (Le Diatomiste, Vol. 2, p. 55, pl. 3, fig. 4). Cleve states in his original description (Le Diatomiste, Vol. 2, p. 55) "A la base de la valve inferieure se trouve un diaphragme distinct." He describes *G. Aestuarii* for the second time in his Synopsis of the Naviculoid Diatoms (1894, p. 188).

"V. linear, narrow, slightly clavate with obtuse end and basis. L 0.02 to 0.028 ; B. 0.002 to 0.0035 mm. Axial area indistinct ; central area broad transverse fascia. Striae parallel (the median radiate) 20 in 0.01 mm. Ends of the valve with rudimentary diaphragms."

These distinctions nearly coincide with above description on *G. Harti* except the numbers of striae and the presence of septum building and intercalary bands. However, the means of diaphragms in his description is very indistinct. The figure illustrated in plate (Le Diatomiste Vol. 2, pl. 3, fig. 4), a valve of *G. Aestuarii*, has a partition line on the base of the valve which perhaps means "diaphragm", but no figure of girdle view of *G. Aestuarii* is illustrated by Cleve. So it is uncertain whether diaphragms mean septum or pseudseptum. Unfortunately I cannot refer the description on *G. Aestuarii* by Östrup (Mar. Faroe, p. 536, quoted by Mills (1933–34) in his Index,) this argument may be incomplete.

Agardh (1824) and others (Smith, 1853–56 ; Müller, 1886 ; De Toni, 1891–94 ; Cleve, 1894 ; Boyer, 1916, 1927 ; Elmore, 1921 ; Kokubo 1955 et al.) have described no account for septa in *Gomphonema* species. But Schütt (1896, p. 136) and Karsten (1928, p. 286) state "Zwishenbänder mit Septen" like in their descriptions on the genus *Rhoicosphenia* Grunow. But this description may be questionable because their illustrated figures of *Gomphonema geminatum* (Lyngh.) Agardh (This combination is corrected as *Didymosphenia geminata* (Lyngh.) M. Schmidt,) described by Smith, (1853, pl. 27, fig. 235, a, b !) has neither septum nor intercalary bands. On the other hand, Hustedt states (1930, p. 340), "Zwishen-bänder oft vorhanden, Septen fehlen." in his descriptions on **Gomphocymbelloideae** and, "Ohne Zwichen bänder und Septen." also in the description on the genus *Gomphonema* (1930, p. 367).

All figures of *Gomphonema* species illustrated in the past have possessed no septum except some vague figures with questionable septum-like

structures on girdle bands. The figures of *Gomphonema herculeana* var. *septiceps* M. Schmidt (A. Schmidt. Atl. pl. 215, figs. 13, 14), *G. dubravicense* Pant. (Atl. pl. 216, figs. 24, 25) and *G. scapha* M. Schmidt have septum-like structures on upper ends of valves drawn as partition lines. Skvortzow also describes often these septum-like partition lines on valves in his illustrations. But almost all of them are considered not to be true septum buildings. The figure of *G. lanceolatum* illustrated by Skvortzow (1937, pl. 14, fig. 25) has this partition line, but those by Hustedt (1930), Schönfeldt (1913) and others have none of them.

Accordingly this distinct septum building may be the valid mark in systematization of *Gomphonema*-like diatoms. I propose to place *Gomphonema* with septa in *Pseudogomphonema*, the new subgenus of the genus *Gomphonema*. Heretofore, the Genus *Gomphonema* is devided into two groups, *Asymmetrica* and *Symmetrica* by Grunow (V. Heurck, 1880–81, pls. 23–25) or *Stigmatica* and *Astigmatica* by Cleve (1894, p. 179, 180) and others. These classifications may be maintained under above subdivision of the genus.

Genus *Nitzschia* Hassall

Nitzschia tubicola Grun. (V. Heurck, 1880–81, pl. 69, fig. 14). Valves are narrow lanceolate with acute ends, not constricted in the middle, 25–50 μ long, 3.5–4.5 μ broad in widest point. The kiel is excessivelly eccentric, kielpuncta are very strong distinctly observed, 7–13 in 10 μ, very irregularly disposed, the two median ones are remote. Transapical striae are extremly fine 35–45 in 10 μ, indistinctly punctate (Fig. 8).

Fig. 8. *Nitzschia tubicola* Grun. ×1000.

The description in Synopsis of V. Heurck is following "7 à 10 points carénaux en 0.01 mm,—Stries transversales tres fines—Se rencontre souvent en abondance dans les gaînes des Schizonemées."

Occasionaly found among *Navicula* spp and *Cocconeis ceticola* fo. *constricta*.

Adjacent waters to Andreanof Islands.

N. closterium (Ehr.) W. Smith (Cupp, 1943, p. 200, fig. 153). only few specimens are found. Cupp reports (1943) this species very common in the littoral zone of west coast of North America. *N. closterium* is also observed by Hart (1935) on whales in the antarctic waters.

Discussion

The greater part of diatoms found on skin films of whales belong

to the PENNATAE (Schütt, 1896), and some less significant species of CENTRICAE (Schütt, 1896) have been observed incidentally. The latter perhaps never propagate themselves on whales' skin films. Among the many species of PENNATAE, some of which are considered to be fortuitous appearances.

The vast majority of the diatom forming the films belongs to the one species *Cocconeis ceticola*, as often reported from the southern hemisphere (Hart, 1935. Kalcher, 1940). *C. ceticola* is found on many whales, especially on blue, fin and sei whales (*Balaenoptera borealis*), whereas *C. ceticola* form. *constricta* is mostly common on sperm whales. On the other hand, it is seldom to find the original form of *C. ceticola* on sperm whales. In that case few original types of *C. ceticola* found on sperm whales belong to comparatively large type specimens. As sperm whales differ considerably from the so-called baleen whales in morphological and physiological points, this variation of *C. ceticola* must be partly due to the affection by the condition of skin films of sperm whales in some ways. The photographs of *C. ceticola* by Kalcher (1940, fig. 3–4) are not the typical form of *C. ceticola*. It is suggested that they might be collected from skins of sperm whales. Hart (1935, p. 260, pl. 11, figs. 5–7) describes new form of *C. Wheeleri* on the antarctic humpback whales, which is larger than *C. ceticola* Nelson. On this species, Okuno (1954, b) states that "the size of valves is not so important to separate the species from *C. ceticola*", because he found the variation of sizes of *C. ceticola* extending from 13 to 37.5 μ long, covering over that of *C. Wheeleri* reported by Hart. Thus, Okuno describes *C. Wheeleri* as a synonym of *C. ceticola* in his report for want of full account for the structure of valves in original description. In addition, *C. Wheeleri* has been found only on humpback whales by Hart, Okuno's deduction must be noted to suggest that *C. Wheeleri* may be one variety form of *C. ceticola* on humpback whales alike *C. ceticola* form. *constricta* on sperm whales. The intermediate form between *C. ceticola* and *C. ceticola* form. *constricta* is also found on sperm whales to which Kalcher's illustrations are closely related. It belongs to rather the large type, and the median constriction of valves are scarcely observed.

The tendency that *C. ceticola* ejects another diatoms to form diatom patches of itself except few diatoms and some of accidental appearances is very interesting. One of the few exceptional diatoms is *Stauroneis Omurai* **spec. nov.** which is found among *C. ceticola* in faily abundance. Usually, the commensality of *C. ceticola* and other species has seldom observed in contrast to *C. ceticola* form. *constricta* constitutes the diatom colonies with other species of diatoms, *Gomphonema Kamtscha-*

ticum, *C. costata* var *pacifica* form. *plana*, *Navicula* spp., and *Synedra* species. Hart (1935) states the appearances of ' other species ' decreased in number in contrast to *C. ceticola* propagated on whales as the time proceeded in the whaling season. Such conclusion may be partly attributable to the exclusive feature of the organism of propagation of *C. ceticola*.

Above findings support the view that it must be the most comfortable condition for *C. ceticola* to adhere to whales' skin films. Planktonic occurrence of *C. ceticola* may be transient.

In addition to *C. ceticola*, following species are considered as real parasitic forms and true constituents of diatom patches on whales.

Cocconeis ceticola form. *constricta* **form. nov.**
Stauroneis olympica Hustedt
S. Omurai **spec. nov.**
S. aleutica **spec. nov.**
Plumosigma Hustedti **spec. nov.**
P. rimosum **spec. nov.**

Above species may be observed in their few chances of planktonic forms separate from whales in future investigation. Among them, *Stauroneis olympica*, *Stauroneis aleutica* and *Plumosigma rimosum* are comparatively abundant. *Stauroneis Omurai* and *Plumosigma Hustedti* are somewhat rare species. The seasonal appearance and variations of adhesive percentage of the above species are not so regularly as those of *C. ceticola*. Aspects of diatom patches of the above species seem to be attacked by some skin deseases, especially the case of *Stauroneis* species. Kalcher (1940) reports those brown wounds caused by *Navicula* species (?) (may be *Stauroneis* species !). Severely inflammed wounds by *Stauroneis* species on whales are frequently observed on blue and sperm whales in the northern Pacific.

The following species are the fortuitous, to constitute barren diatom patches on skins of whales.

Cocconeis costata Greg.
C. costata var. *pacifica* form. *plana* **form. nov.**
Synedra Karcheri **spec. nov.**
S. tabulata Kütz.
Gomphonema Kamtchaticum Grun.
G. Kamtchaticum var. *californica* Grun.
G. Harti **spec. nov.**

Cocconeis costata, *C. costata* var. *pacifica* form. *plana*, *Gomphonema Kamtchaticum* have observed most popularly, *Synedra Karcheri* and *S. tabulata* are not so frequent. Some of them are often found as planktons by close examination in the northern Pacific.

The accidental appearances of planktonic diatoms recruited from their planktonic inhabitancy may be followings.

Melosira sulcata	*Biddulphia aurita*
Thalassiosira Nordenskiöldi	*B. mobilensis*
Coscinodiscus anguste-lineatus	*Raphoneis amphiceros*
C. Kützingi	*Synedra Camtschatica*
C. radiatus	*S. Hennediyana*
C. weilesii	*Thalassionema nitzschinoides*
Detonula confervacea	*Thalassiothrix longissima*
Leptocylindrus minimus	*T. Franenfeldii*
Rhizosolenia styliformis	*Cocconeis scutellum* var. *stauroneiformis*
Chaetoceros atlanticus	*Rhoicosphenia Pullus*
C. densus	*Nitzschia tubicola*
C. concavicornis	*N. closterium*

Above species are all fortuitously occurring on whales recruited from their plankton inhabitancy. These planktonic diatoms are considered to live in the patches of diatoms until finally they die, not propagating in themselves. So they bear no significance as constituents of diatom patches. But the dominant numbers of the neritic diatoms are included in the above lists. *C. scutellum* var. *stauroneiformis, Tharassionema nitzschinoides* are the most popular littoral diatoms from Japan coast. It is considered that they gain access to the whales while they are lying waiting to be flensed (Hart, 1935, p. 256) in the case of landstations.

More variety of diatoms are found especially on sperm whales than baleen whales. This phenomenon may partly due to the coarse texture of skin films of sperm whales compared with those of baleen whales. Besides, sperm whales are the most skillfull divers, and dive so deep the water that they often catch crabs and fish from the bottom of the sea. A chance of attachment of diatom pieces from there can be considered on the case of sperm whales, though these species reported by Bailey (1856), Skvortzow (1932, c) and other workers have scarecely been observed by myself.

Summary

The first systematic study of the diatoms constituting the diatom patches on the skin of whales in the northern Pacific waters is stated. Including 1 new genus, 6 new species, 3 new forms, 43 species which occur on the skin of whales are described. Comparatively rare genus and species : *Plumosigma, Synedra Karcheri, Cocconeis costata* var. *pacifica* fo. *plana, C. ceticola* fo. *constricta, Stauroneis Omurai, S.*

aleutica, *S. aleutica* fo. *brevis*, *Gomphonema Harti*, *Plumosigma Hustedti*, *P. rimosum* are new genus, species and forms of them.

These parasitic and adhesive diatoms are somewhat similar to those found in the marine littoral diatom samples of the northern hemisphere. Perhaps adhesive micro-organisms on another matters hold more abundant diatoms of unfamiliar species and some littoral forms compared with planktonic diatoms in the sea.

The organism of these parasitic diatoms on organic matters must be studied in future investigations.

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* Many valuable references listed above were lent to me by the courtesy of Professor Haruo Okuno of Kyoto University of Industrial Arts and Textile Fibres, by the courtesy of Professor Kohei Tsumura of Yokohama Municipal University, and by the courtesy of Mr. Akio Miura of the assistant of Tokyo University of Fisheries.

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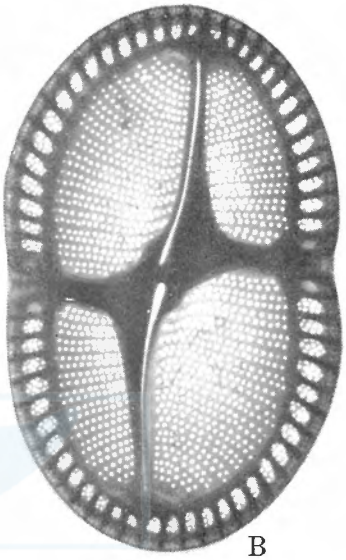
A



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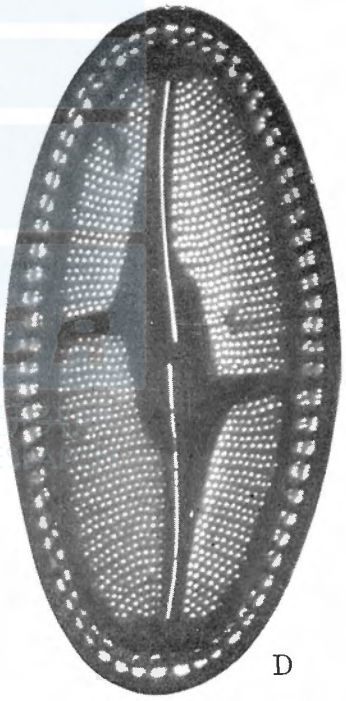

D

Explanation of Plate I.

Electron micrographs of *C. ceticola* and *C. ceticola* form. *constricta* form. nov.

A. Electron micrograph of rapheless-velve surface of *C. ceticola* form. *constricta* (×3200) prepared by Hitachi Central Research Inst. with the heigh tension electron-microscope (228 KV).

B. Electron micrograph of raphe-valve of *C. ceticola* form. *constricta* (×3300) prepared by H.C.R.I. with the heigh tension electron-microscope (200 KV).

C. D. Electron micrographs of raphe-valves of *C. ceticola* (×3000) applied shadowing with Chrome prepared by S. Sakata, Department of Radiology, Faculty of Medicine, the University of Tokyo.

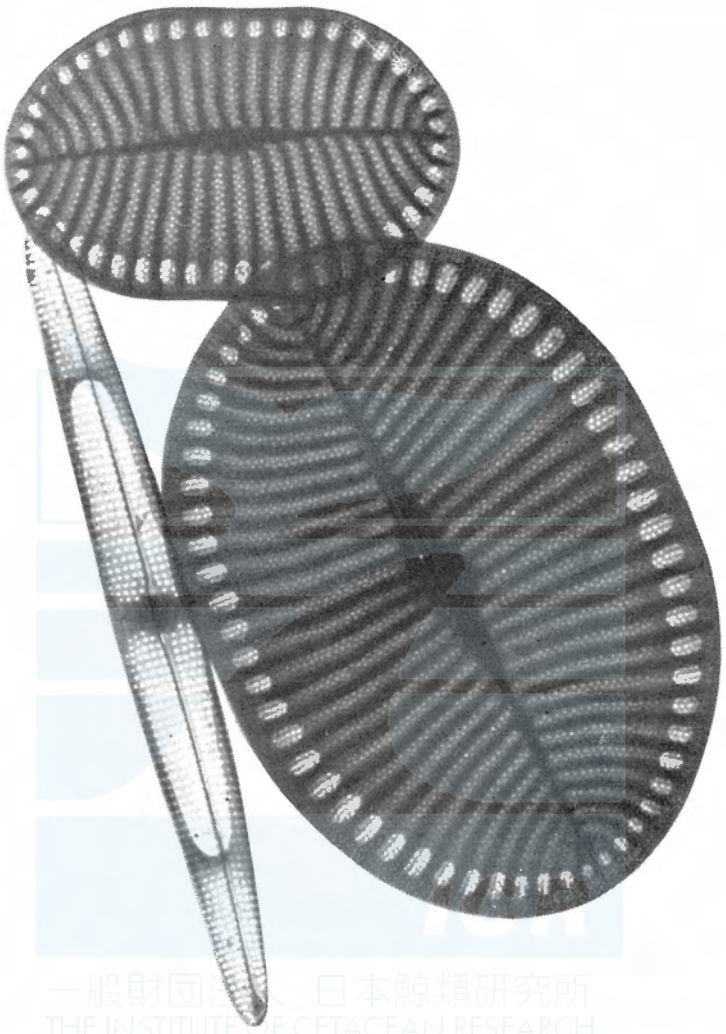

Plate II. Electron micrographs of rapheless-valves of *C. ceticola* form. *constricta* form. nov. and *Stauroneis aleutica* spec. nov. (×3400) by H.C.R.I. with the heigh tension electron-microscope (200 KV).

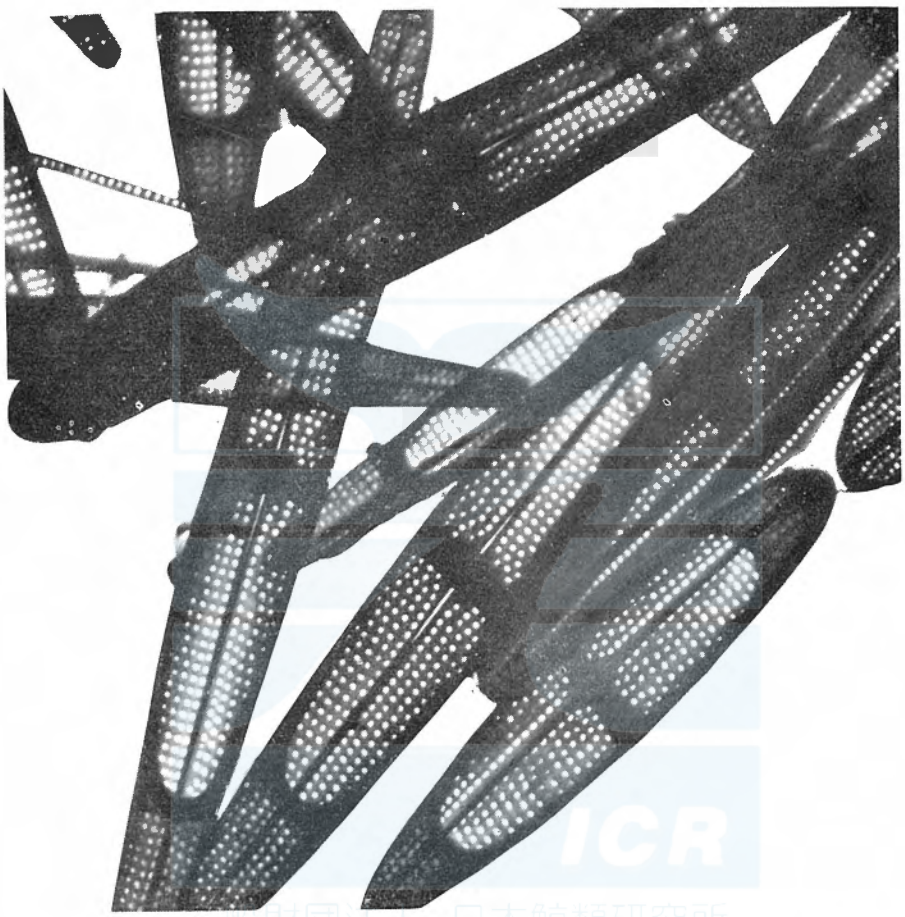

Plate III. Electron micrographs of *Stauroneis aleutica* spec. nov. and *S. aleutica* form. *brevis* form. nov. prepared by S. Sakata. Applied shadowing with Chrome.

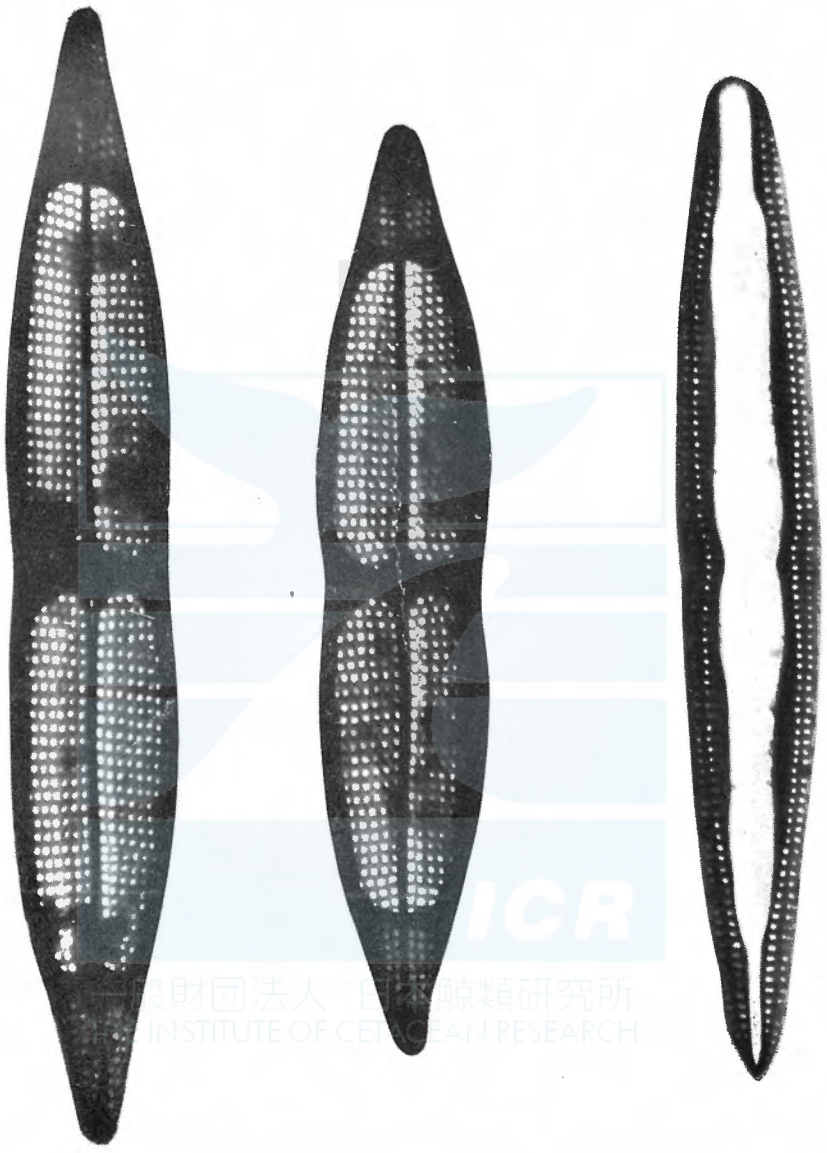

Plate IV. Electron micrographs of *Stauroneis Omurai* spec. nov. prepared by S. Sakata (×5000). Applied shadowing with Chrome.

Plate V. Electron micrograph of *Plumosigma Hustedti* spec. nov. prepared by S. Sakata (×9000). Applied shadowing with Chrome.

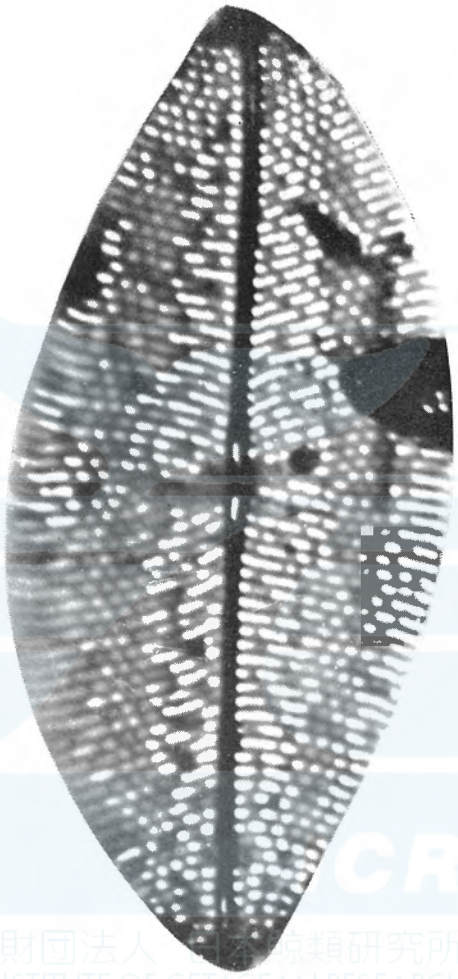

Plate VI. Electron micrograph of *Plumosigma rimosum* spec. nov. prepared by S. Sakata (×8000).

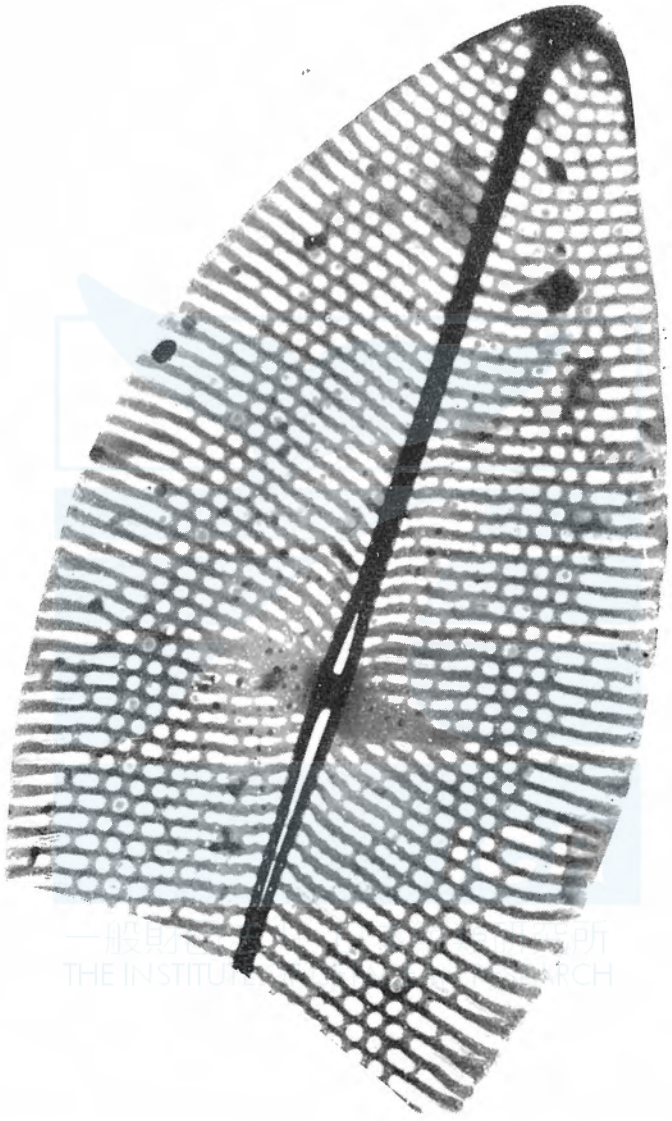

Plate VII. Electron micrographs of *Plumosigma rimosum* prepared by S. Sakata (×15000).