CRETACEOUS FORAMINIFERA (ALBIAN-CENOMANIAN) FROM THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA, CANADA

by

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A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
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and Research acceptance of the thesis

"CRETACEOUS FORAMINIFERA (ALBIAN-CENOMANIAN) FROM THE QUEEN CHARLOTTE ISLANDS, BRITISH COLUMBIA, CANADA"

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Thesis Supervisor

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ABSTRACT

Sixty-two species of benthic and planktic Cretaceous foraminifera recovered from mudstones, shales, and sandy shales, were identified in 267 samples from 20 localities on the Queen Charlotte Islands, British Columbia, Canada. This is the first major survey of the Cretaceous foraminifera of the islands, although previous Cretaceous biozonation had been determined using macrofossils, primarily ammonites.

Fauna from the Longarm Formation, recovered from west-central Graham Island, suggest an Early Albian age for the unit but low species diversity makes a paleoenvironmental interpretation difficult. Fauna recovered from Haida Formation outcrops along the shores of Beresford Bay, northwestern Graham Island, as well as the northern coast of Cumshewa Inlet and southern coast of Skidegate Channel (Onward Point), both on the northeastern portion of Moresby Island, indicate a Middle Albian to Cenomanian age for these sections. The ratio of benthic to planktic specimens from most of the Beresford Bay, the Cumshewa Inlet, and Onward Point localities is high, indicating a near-shore basin as the most likely depositional environment, although species diversity is low in many of the sections.

Many of the specimens were in a poor state of preservation due long-term recent tectonic activity in the area. Most taxa correlate well with those from the north slope of Alaska (57.4%), and to a lesser extent with those from the Western Canadian Sedimentary Basin (WCSB) (42.6%). Thus, though the Queen Charlotte Islands were formed allochthonously with respect to the North American continent, faunal similarities between the regions suggest a close paleogeographic link between the study area and North America during the Middle Cretaceous. Hypotheses for the link include a possible sea link between the WCSB and the Pacific coast during the Middle to Late Albian, or more likely enhanced migration routes for foraminifera through polar regions.

ACKNOWLEDGEMENTS

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I also thank Eduard Reinhardt and Susan Burbidge for showing me how to use the various software packages that were used in making this thesis, and to Arun Kumar, whose advice on many other areas proved very helpful. I would also like to thank Dr. A. Desrochers, Department of Geology, University of Ottawa, Dr. M. Forbes, Department of Biology, Carleton University, Dr. F. Michel and Dr. R. Taylor, Department of Earth Sciences, Carleton University, for critical review of the manuscript.

Finally I would like to thank the people who run the Carleton University Research Facility for Electron Microscopy (CURFEM), Dr. Cheng Huang, Lewis Ling, and Peter Jones, who all helped me master the use of the JSM scanning electron microscope.

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CHAPTER 1. INTRODUCTION

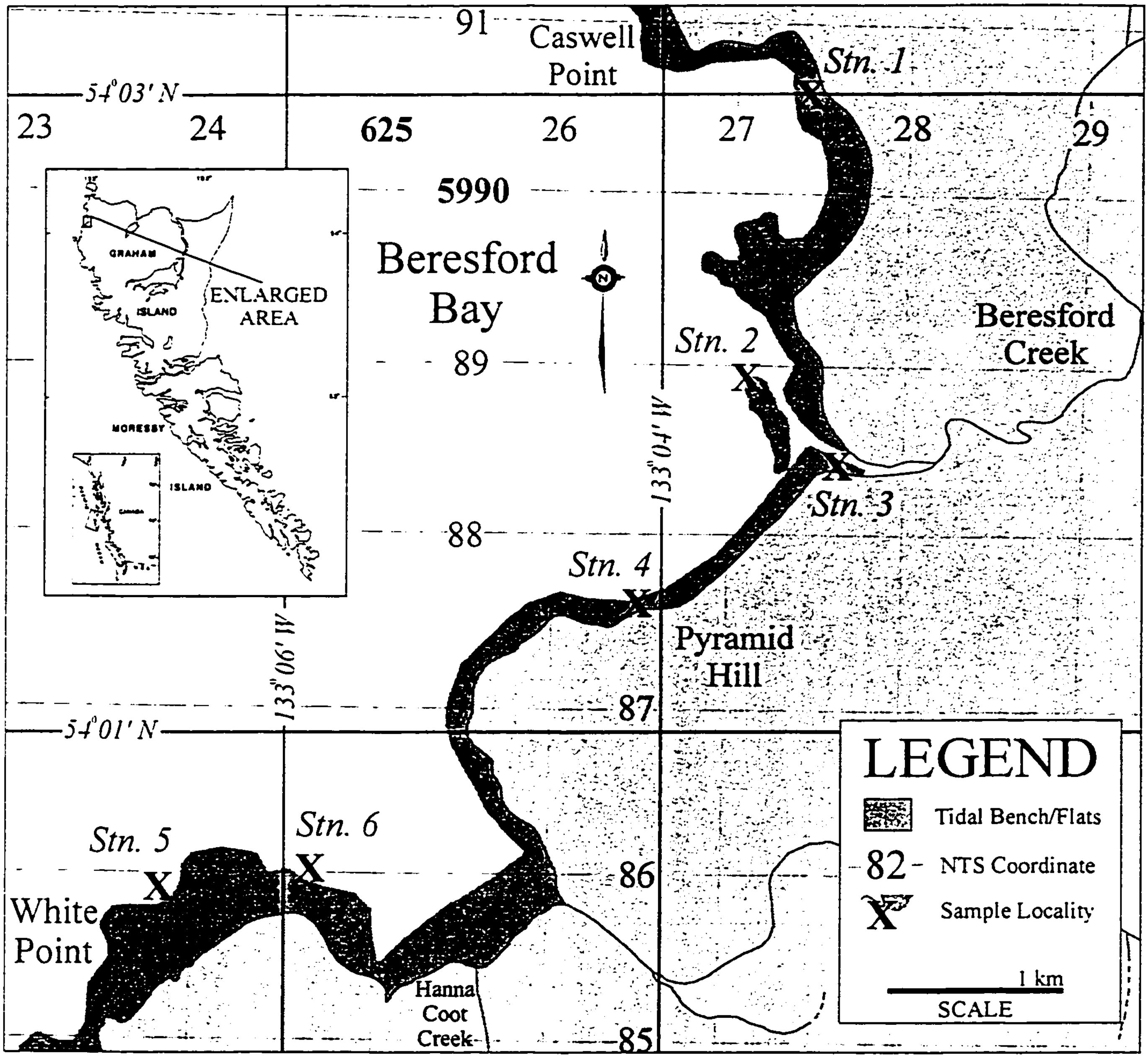
From 1980 to 1988, several field parties from the Geological Survey of Canada, Cordilleran Division, Vancouver, B.C., collected Cretaceous sedimentary rock samples from various locations on the Queen Charlotte Islands. A systematic survey of the foraminifera from those samples was undertaken at Carleton University in 1995, to determine the faunal makeup and biostratigraphic framework.

This is the first systematic survey of Cretaceous Foraminifera from the Queen Charlotte Islands, British Columbia. Foraminiferal specimens were recovered from 267 samples from 20 localities from the Beresford Bay area, northwestern Graham Island (Fig. 1), the north shore of Cumshewa Inlet (Fig. 2) and Onward Point (Fig. 3), northeastern Moresby Island, and the Rennell Sound Road roadcut, southern Graham Island (Fig. 4). This research forms part of a larger multidisciplinary study of Cretaceous strata of the area, which includes a survey of macrofossils, chiefly ammonites (Haggart, 1991).

This biostratigraphic analysis is important as these sections are lithologically undifferentiated (mudstones, shales, and sandy shales), and stratigraphic relationships are impossible to work out by stratigraphy alone in this structurally complex region. This study will thus provide a baseline database for future research, and for determining the hydrocarbon potential in the area as the formations of the study areas are overlain by Honna Formation sandstone, a potential reservoir (Higgs, 1991).

FIGURE 1. Sample locality map of the Beresford Bay area, northwestern Graham Island. Inset adapted from Haggart *et al.* (1997)

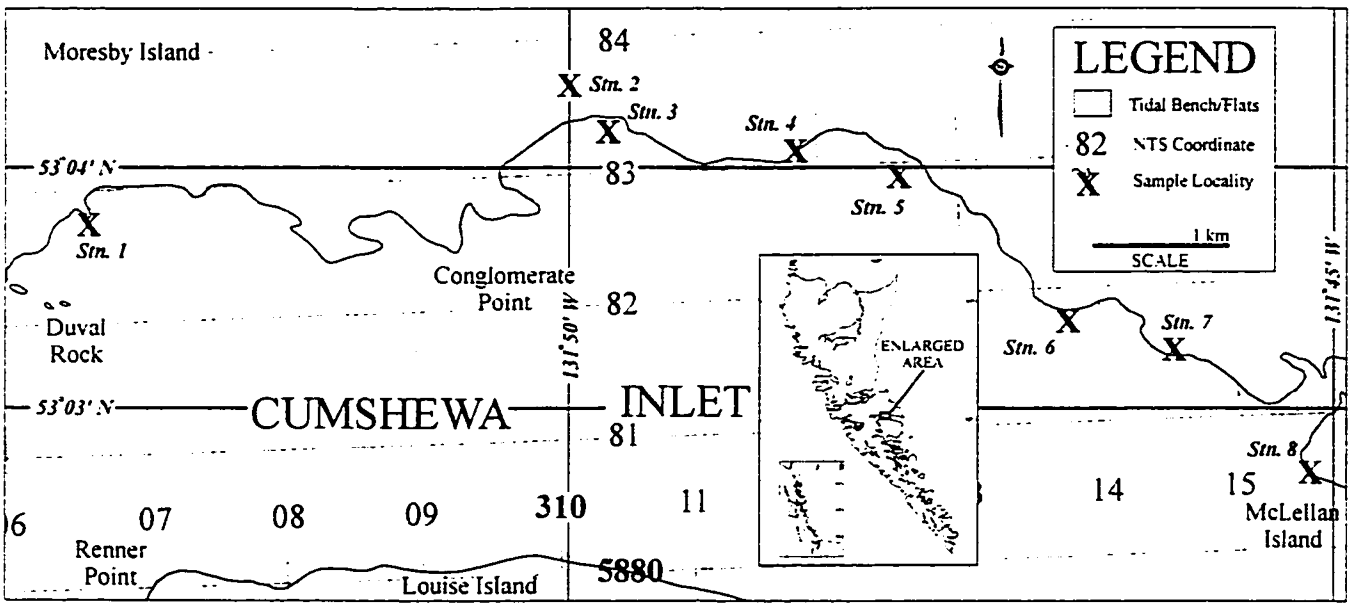
FIGURE 1



Caswell
Point
91
54°03'N
23
24
625
26
27
28
29
5990
Beresford
Bay
ENLARGED
AREA
GRAHAM
ISLAND
MORESBY
ISLAND
Stn. 1
Stn. 2
Stn. 3
Stn. 4
Stn. 5
Stn. 6
Beresford
Creek
89
88
87
86
85
133°04'W
133°06'W
54°01'N
Pyramid
Hill
White
Point
Hanna
Coot
Creek
LEGEND
Tidal Bench/Flats
82 - NTS Coordinate
Sample Locality
1 km
SCALE

FIGURE 2. Sample locality map of the northern coast of Cumshewa Inlet, northeastern Moresby Island. Inset adapted from Haggart *et al.* (1997)

FIGURE 2



Moresby Island
84
Stn. 2
Stn. 3
Stn. 4
53°04' N
83
Stn. 5
Stn. 1
Conglomerate
Point
82
Duval
Rock
131°50' W
Stn. 6
Stn. 7
ENLARGED
AREA
53°03' N
CUMSHEWA
INLET
81
Stn. 8
14
15
07
08
09
310
11
McLellan
Island
Renner
Point
Louise Island
5880
131°45' W
LEGEND
Tidal Bench/Flats
82 NTS Coordinate
X Sample Locality
1 km
SCALE

FIGURE 3. Sample locality map of Onward Point and area, northeastern Moresby Island. Inset adapted from Haggart *et al.* (1997)

FIGURE 3

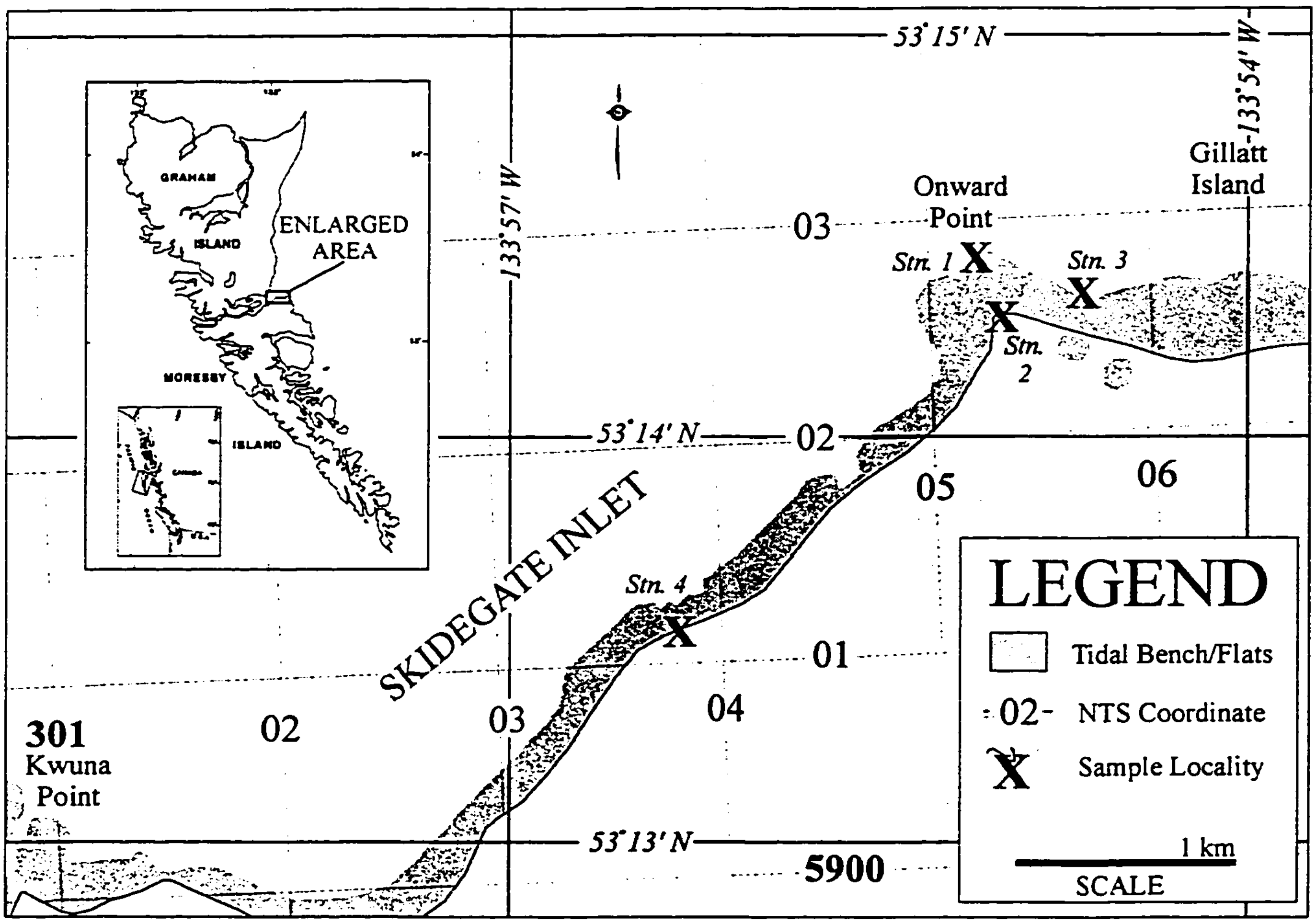
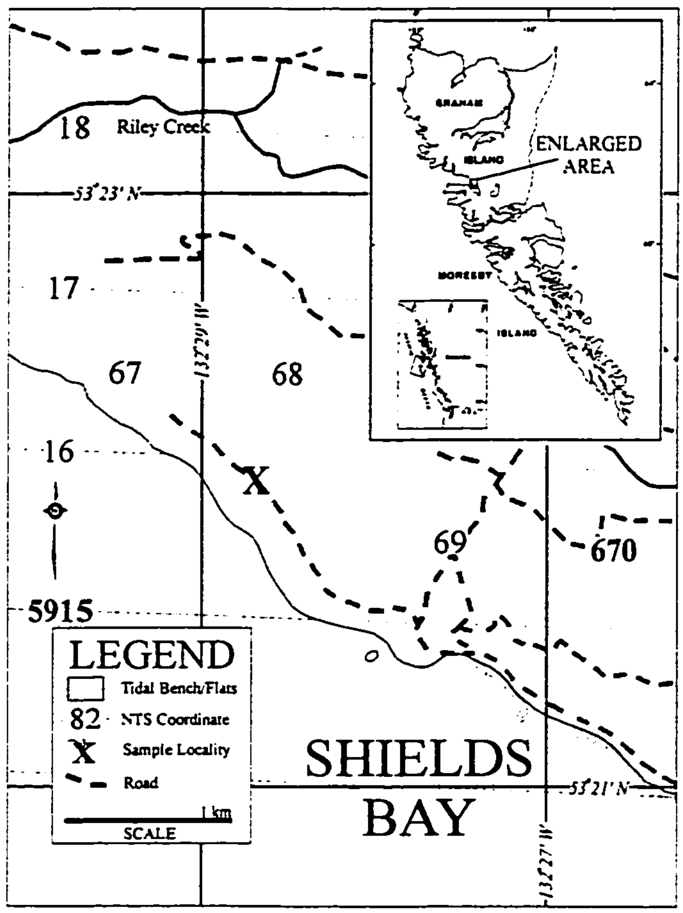

53°15' N
133°54' W
133°57' W
Gillatt
Island
Onward
Point
03
Stn. 1
Stn. 3
Stn. 2
ENLARGED
AREA
GRAHAM
ISLAND
MORESBY
ISLAND
53°14' N
02
05
06
SKIDEGATE INLET
Stn. 4
01
LEGEND
Tidal Bench/Flats
02 NTS Coordinate
Sample Locality
301
Kwuna
Point
02
03
04
53°13' N
5900
1 km
SCALE

FIGURE 4. Sample locality map of the Rennell Sound Road roadcut, northern shore of Shields Bay, southwestern Graham Island. Inset adapted from Haggart *et al.* (1997)

FIGURE 4



18
Riley Creek
53°23' N
ENLARGED AREA
17
67
68
16
X
69
670
5915
LEGEND
Tidal Bench/Flats
82 NTS Coordinate
X Sample Locality
Road
1 km
SCALE
SHIELDS BAY
53°21' N

CHAPTER 2. PREVIOUS WORK

Geological History

During the Mesozoic, allochthonous terranes of many different origins and ages were added to the west coast of North America. Most researchers accept four distinct groups (west to east): Wrangellia, Stikinia, Quesnellia, and the Liard Troughs of Alberta (Monger and Irving, 1980; Tipper, 1984). The Queen Charlotte Islands form part of the Wrangellia Terrane, the most recent to be added to the North American Craton. Non-correlation of Triassic strata indicates that these terranes were independant at this time.

Early Jurassic plutons are found between the Stikinia and Quesnellia terranes, which probably represent amalgamation sutures. Late Middle Jurassic shale sequences are found on the three westernmost terranes indicating that they were part of the North American Craton at this time (Tipper, 1984). It has been suggested that these terranes originated in the central Pacific Ocean, but there is no compelling evidence in support of this hypothesis (Tozer, 1982).

Most of the bedrock of the Queen Charlotte Islands (>90%) consists of the Triassic Karmutsen Formation (volcanic, mainly pillow basalts) and Tertiary Masset Formation (mixed volcanics), attesting to the tectonic history of the area (Sutherland-Brown, 1968). Shales, mudstones, and sandy shales were deposited in the area during an Albian transgressive sequence (Tipper, 1984). These strata correlate well with shales on the adjacent mainland, reinforcing the evidence that the study area had already accreted onto western North America during the Cretaceous.

Stratigraphy

It has been difficult for researchers to construct an accurate lithostratigraphic sequence for the Cretaceous shales of the Queen Charlotte Islands as outcrops are lithologically undifferentiated, relatively isolated, and thus their relationships to each other is unclear (Haggart, 1991). A general stratigraphic sequence for the Queen Charlotte Islands is shown in Fig. 5 A. Woodsworth and Tercier (1991) provide a thorough historical review of the stratigraphic nomenclature of the Queen Charlotte Islands.

Sutherland-Brown (1968) divided the Cretaceous shale sequences into the earlier Longarm and later Haida Formations. Since then, Haggart (1991) concluded that the deposition of the Longarm and Haida formations was continuous with no clear unconformity observed between them. However, other researchers place an unconformity between the two (Fogarassy and Barnes, 1991).

The Haida Formation consists of a basal conglomerate member, a sandstone member, and the shale member at the top. Along with the later(?) Honna and Skidegate formations, the Haida forms part of the Queen Charlotte Group (Fogarassy and Barnes, 1991). Fig. 5 B-E outline the different, and discrepant, interpretations of the lithostratigraphy of the Queen Charlotte Group (Sutherland-Brown, 1968; Haggart, 1987; Cameron and Hamilton, 1988; and Fogarassy and Barnes, 1991).

Study Areas

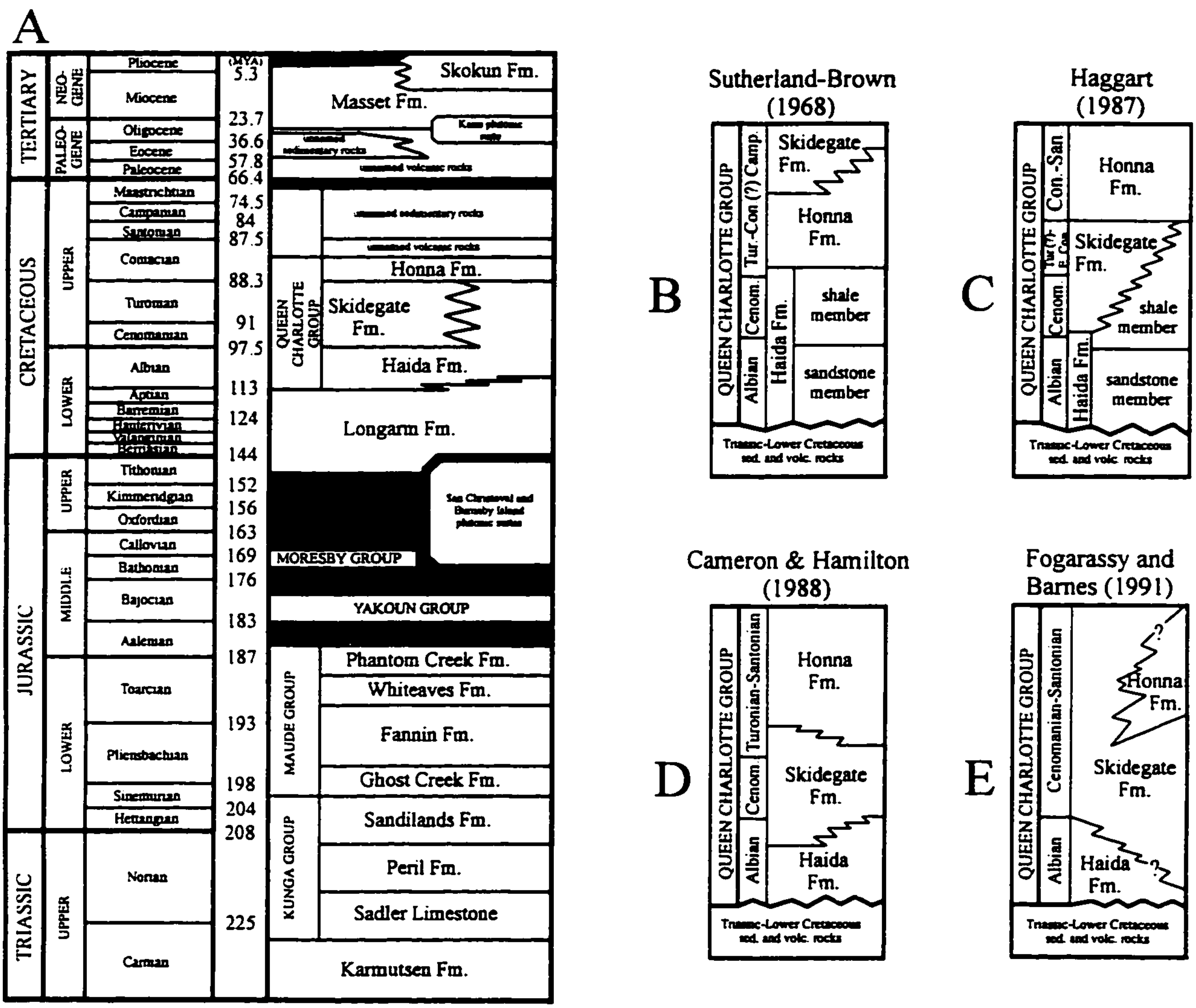
The Beresford Bay area consists primarily of Tertiary Masset Formation volcanics, with Cretaceous Haida Formation (latest Albian-Cenomanian) outcropping along the shoreline and tidal benches (Fig. 1). The bedrock of the north shore of Cumshewa Inlet and the Onward Point area is entirely Haida Formation (Albian) (Figs. 2, 3). The older

Longarm Formation (Early Albian) is exposed in a roadcut along the Rennell Sound Road, on the north shore of Shields Bay (Fig. 4).

The foraminiferal assemblages share many common species with the Albian of the north slope of Alaska (Tappan 1951; 1957; 1960; 1962), and to a lesser extent the Western Canadian Sedimentary Basin (Cushman, 1927; 1946; McNeil and Caldwell, 1981). This is not surprising as northern Alaska was accreted in much the same manner as the Queen Charlotte Islands and both regions were paleogeographically close during the Cretaceous (Haggart, *pers. comm.*). As only one foraminiferal species, *Haplophragmoides concava* (Chapman 1892; Plate 5, fig. 1 a-b), was found in common between Japanese and the Queen Charlotte Islands Albian strata (Takayanagi, 1960), there seems to have been little pan-Pacific interconnections between these regions, also due to physical separation (Smith et al., 1981; Smith et al., 1994).

FIGURE 5. A. Stratigraphy of the major lithologic units of the Queen Charlotte Islands, adapted from Lewis and Ross (1991). B-E. (Adapted from Fogarassy and Barnes, 1991) Various interpretations of the stratigraphy of the Queen Charlotte Group, which includes the shale member of the Haida Formation of the study area (Sutherland-Brown, 1968; Haggart, 1987; Cameron and Hamilton, 1988; and).

FIGURE 5



A
TERTIARY
NEO-GENE
PALEO-GENE
CRETACEOUS
UPPER
LOWER
JURASSIC
MIDDLE
TRIASSIC
Pliocene
Miocene
Oligocene
Eocene
Paleocene
Maastrichtian
Campanian
Santonian
Coniacian
Turonian
Cenomanian
Albian
Aptian
Barremian
Hauterivian
Valanginian
Berriasian
Tithonian
Kimmeridgian
Oxfordian
Callovian
Bathonian
Bajocian
Aalenian
Toarcian
Pliensbachian
Sinemurian
Hettangian
Norian
Carnian
(MYA)
5.3
23.7
36.6
57.8
66.4
74.5
84
87.5
88.3
91
97.5
113
124
144
152
156
163
169
176
183
187
193
198
204
208
225
Skokun Fm.
Masset Fm.
unnamed sedimentary rocks
unnamed volcanic rocks
unnamed sedimentary rocks
unnamed volcanic rocks
Honna Fm.
QUEEN CHARLOTTE GROUP
Skidegate Fm.
Haida Fm.
Longarm Fm.
San Christoval and Burnaby Island plutonic suites
MORESBY GROUP
YAKOUN GROUP
MAUDE GROUP
Phantom Creek Fm.
Whiteaves Fm.
Fannin Fm.
Ghost Creek Fm.
KUNGA GROUP
Sandilands Fm.
Peril Fm.
Sadler Limestone
Karmutsen Fm.
Sutherland-Brown (1968)
B
QUEEN CHARLOTTE GROUP
Albian
Cenom.
Tur.-Con (?) Camp.
Haida Fm.
Skidegate Fm.
Honna Fm.
shale member
sandstone member
Triassic-Lower Cretaceous sed. and volc. rocks
Haggart (1987)
C
QUEEN CHARLOTTE GROUP
Albian
Cenom.
Con.-San
Honna Fm.
Skidegate Fm.
shale member
Haida Fm.
sandstone member
Triassic-Lower Cretaceous sed. and volc. rocks
Cameron & Hamilton (1988)
D
QUEEN CHARLOTTE GROUP
Albian
Cenom
Turonian-Santonian
Honna Fm.
Skidegate Fm.
Haida Fm.
Triassic-Lower Cretaceous sed. and volc. rocks
Fogarassy and Barnes (1991)
E
QUEEN CHARLOTTE GROUP
Albian
Cenomanian-Santonian
Honna Fm.
Skidegate Fm.
Haida Fm.
Triassic-Lower Cretaceous sed. and volc. rocks

CHAPTER 3. MATERIALS AND METHODS

Sedimentary samples were collected during several field seasons from 1980-1988 by B.E.B. Cameron. formerly of the Geological Survey of Canada, Cordilleran Division, Vancouver. The samples were then processed and picked for microfossils and mounted on slides at the Geological Survey of Canada's Pacific Geoscience Centre Paleontology Laboratory at Sidney, British Columbia. The slides were then shipped to Carleton University in 1995 for identification and interpretation.

Most specimen images were collected electronically with the JEOL 6400 scanning electron microscope at the Carleton University Research Facility for Electron Microscopy (CURFEM). For those specimens whose chamber arrangements were obscured by the Au-Pb coating required for scanning electron microscopy, a Javelin video camera mounted on an Olympus SZH stereo microscope collected optical specimen images, transferring them to an Apple Macintosh computer using an ATI Xclaim VR capture board. Certain specimens had such coarse agglutination that the chamber arrangement was all but obscured. These were embedded in Lakeside 70 and carefully ground on 15 μm wet/dry emery paper until the inner structure of the test was exposed, unfortunately no internal structures were discernable. The plates were digitally produced using Adobe Photoshop and printed using an Epson Stylus 1520 printer.

Specimens were identified and plotted according to the localities and stratigraphic levels at which they were recovered. Multiple samples at single localities were taken stratigraphically through the exposed sections, but detailed information on lithology and measurements of the stratigraphic sequences are missing from the Geological Survey of Canada in Vancouver for most sections in this study (Haggart *et al.*, 1997; Jim Haggart and

Steve Irwin, *pers. comm.*).

Foraminiferal biostratigraphic research is difficult in the Queen Charlotte Islands, as much of the sedimentary strata has been deformed by orogenic processes rendering many contained specimens unidentifiable. To compound matters, microfossils are rare in most Cretaceous rocks on this archipelago (Haggart and Carter, 1993; Haggart et al., 1997). However, enough identifiable specimens were recovered to determine the ages of the studied sections.

CHAPTER 4. RESULTS

Sixty-two species of benthic and planktic Cretaceous foraminifera recovered from mudstones, shales, and sandy shales, were identified in 267 samples from 20 localities on the Queen Charlotte Islands, British Columbia, Canada. Previous Cretaceous biozonation had been determined using macrofossils, primarily ammonites (Haggart, 1991).

A Middle Albian to Cenomanian age is inferred for the Haida Formation, represented in this study by the Beresford Bay, Cumshewa Inlet, and Onward Point localities. The Longarm Formation, based on an exposure at a roadcut seems to have been deposited in the Early Albian. Station numbers have been assigned to the localities, and these along with Cameron's designations and NTS coordinates can be found in Table 1.

Most sections had low species diversity, but this may be because many specimens have been rendered unidentifiable by the almost constant orogenic and tectonic activity in the region from the Cretaceous to the Recent. The Haida Formation had not been assigned a specific age by Sutherland-Brown (1968), who was first to map the geology of the Queen Charlottle Islands in detail. The Haida Formation sections examined for this study can now be considered Middle Albian to Cenomanian, based on their foraminiferal content.

The age of one section of the Longarm Formation, at least for the single studied section, is revised in this study to Early Albian. This formation was previously interpreted by Sutherland-Brown as Valanginian to Barremian based on macrofossils (Sutherland-Brown, 1968; Haggart *et al.*, 1997).

Beresford Bay Area - Haida Formation

There are six localities in this area of the Haida Formation, but their stratigraphic relationship to each other is unknown in all but the last two (Fig. 1). The Haida Formation outcrops along the shoreline and on the tidal benches. The igneous Tertiary Masset Formation overlies much of the Cretaceous strata, obscuring it.

Beresford Bay Station 1 (Caswell Point; Fig. 5) can be assigned a Late Albian age exclusively based on the Albian index fossils *Haplophragmoides gigas* Cushman 1927 (Plate 5, fig. 3 a-b) and *Miliammina manitobensis* Wickenden 1932 (Plate 7, fig. 7 a-d). Beresford Bay Station 2 (North Beresford Creek; Fig. 6) is Middle to Late Albian, based on the Middle Albian index species*Ammobaculites wenonahae* Tappan 1960 (Plate 4, fig. 2 a-d) and the Late Albian *Miliammina manitobensis*. Beresford Bay Station 3 (Beresford Creek; Fig. 7) is Late Albian based on the presence of *Miliammina manitobensis*.

Samples taken from Beresford Bay Stations 4- 6 (Cameron's Beresford Bay and White Point; Figs. 8-9) are clearly Cenomanian in age based on the planktic index fossil *Schackoina cenomana* (Schacko 1897, Plate 8, fig. 1 a-b). The benthic index species include: the Albian *Ammobaculites fragmentarius* Cushman 1927 (Plate 4, fig. 1 a-d), the Albian *Ammodiscus kiowensis* Loeblich and Tappan 1950 (Plate 1, fig. 1 a-b), the Middle Albian *Ammobaculites wenonahae*, and the Late Albian *Miliammina manitobensis*. It is surmised that the benthic species existed until the Cenomanian, at least in this study area (see CHAPTER 4. DISCUSSION). This result agrees well with macrofossil (ammonites) determinations recovered from the area (Haggart, *pers. comm.*).

Planktic specimens were rare in all but Beresford Bay Station 4. This would seem to indicate a near-shore basin environment for all other stations (Berggren and Haq, 1976). The base of Station 4 contains almost exclusively planktic specimens, chiefly *Hedbergella delrioensis* (Carsey 1926; Plate 7, fig. 4 a-b) and to a lesser extent *Hedbergella planispira*

(Tappan 1940; Plate 7, fig. 6 a-b). However, benthic specimens begin to increase proportionally and in the Late two thirds of the section, the specimens are mostly benthic. Species diversity was low for Stations 1, 5 and 6, and relatively higher for Stations 2-4. At Station 4, many more samples were recovered in comparison increasing the probability of finding identifiable specimens, thus skewing species diversity.

Cumshewa Inlet North Shore - Haida Formation

There are eight localities in this area whose stratigraphic relationship is known (Fig. 2). The bedrock in this area is composed of shales and mudstones of the Albian portion of the Haida Formation. The assignment of a Middle to Late Albian age is based on the following index foraminifera: the Albian *Ammodiscus kiowensis* , the Albian *Ammobaculites fragmentarius*, the Middle Albian *A. wenonahae*, and the Late Albian *Haplophragmoides gigas* Cushman 1927 (Plate 5, fig. 3 a-b) . No exclusively Cenomanian index fossils were present (Fig. 10).

As with the Beresford Bay Stations, planktic specimens are rare indicating a basinal depositional environment. Species diversity was relatively higher compared to other studied sections.

Onward Point - Haida Formation

There are four localities in this area whose stratigraphic relationship is known (Fig. 2). The bedrock in this area is composed of shales and mudstones of the Albian portion of the Haida Formation. This formation crops out continuously to the Cumshewa Inlet shoreline (Sutherland-Brown, 1968). As with the north coast of Cumshewa Inlet, the assignment of a Late Albian age is justified by the presence of the Late Albian index fossils

Haplophragmoides gigas and *Miliammina manitobensis*.

No planktic specimens were recovered from these stations, which would indicate a basin depositional environment, but because species diversity was so low this interpretation may not be accurate (Fig. 11). It should be noted, however, that many more samples were taken from this area than from others, so species diversity in this case does not seem affected by the sampling methodology.

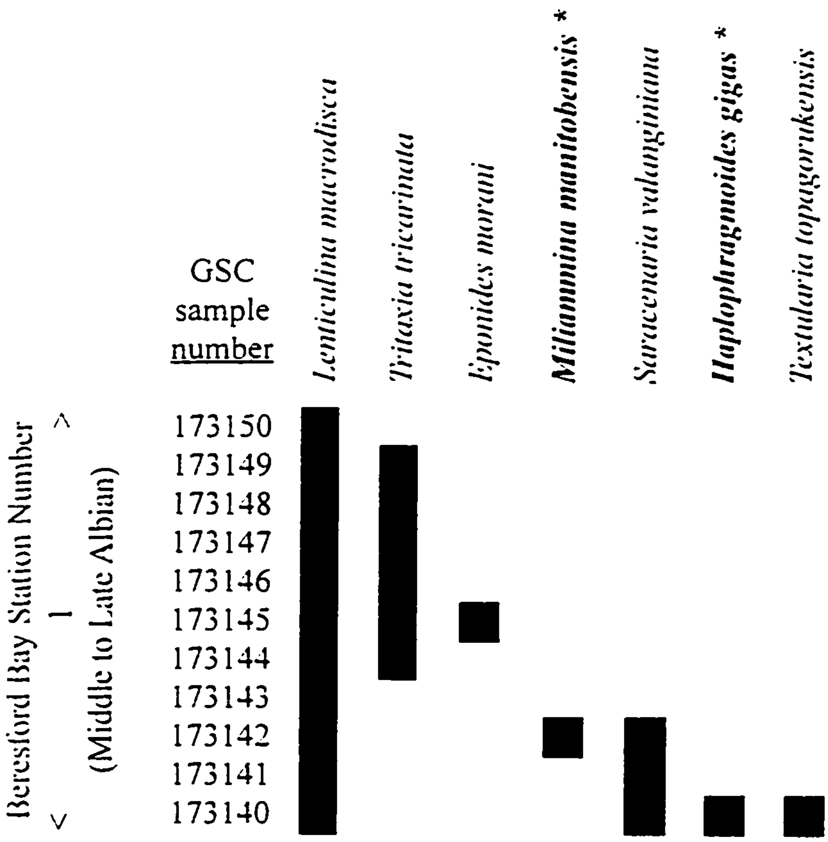
Rennell Sound Road Roadcut - Longarm Formation

Only one locality was examined as very few Longarm Formation (Early Albian) samples yielded microfossils. The assignment of an Early Albian age is based on the Late Aptian to the Early Albian *Hedbergella gorbachikae* Longoria 1974 (Plate 7, fig. 5 a-b), as well as the Albian *Ammodiscus kiowensis* and *Ammobaculites fragmentarius*. About one quarter of the specimens were planktic, almost exclusively *Hedbergella gorbachikae*. However, as species diversity was very low, probably due to so few samples being taken, a paleoenvironmental interpretation could not be done (Fig. 12).

TABLE 1. Sample localities from Albian-Cenomanian sedimentary rocks from the Queen Charlotte Islands.

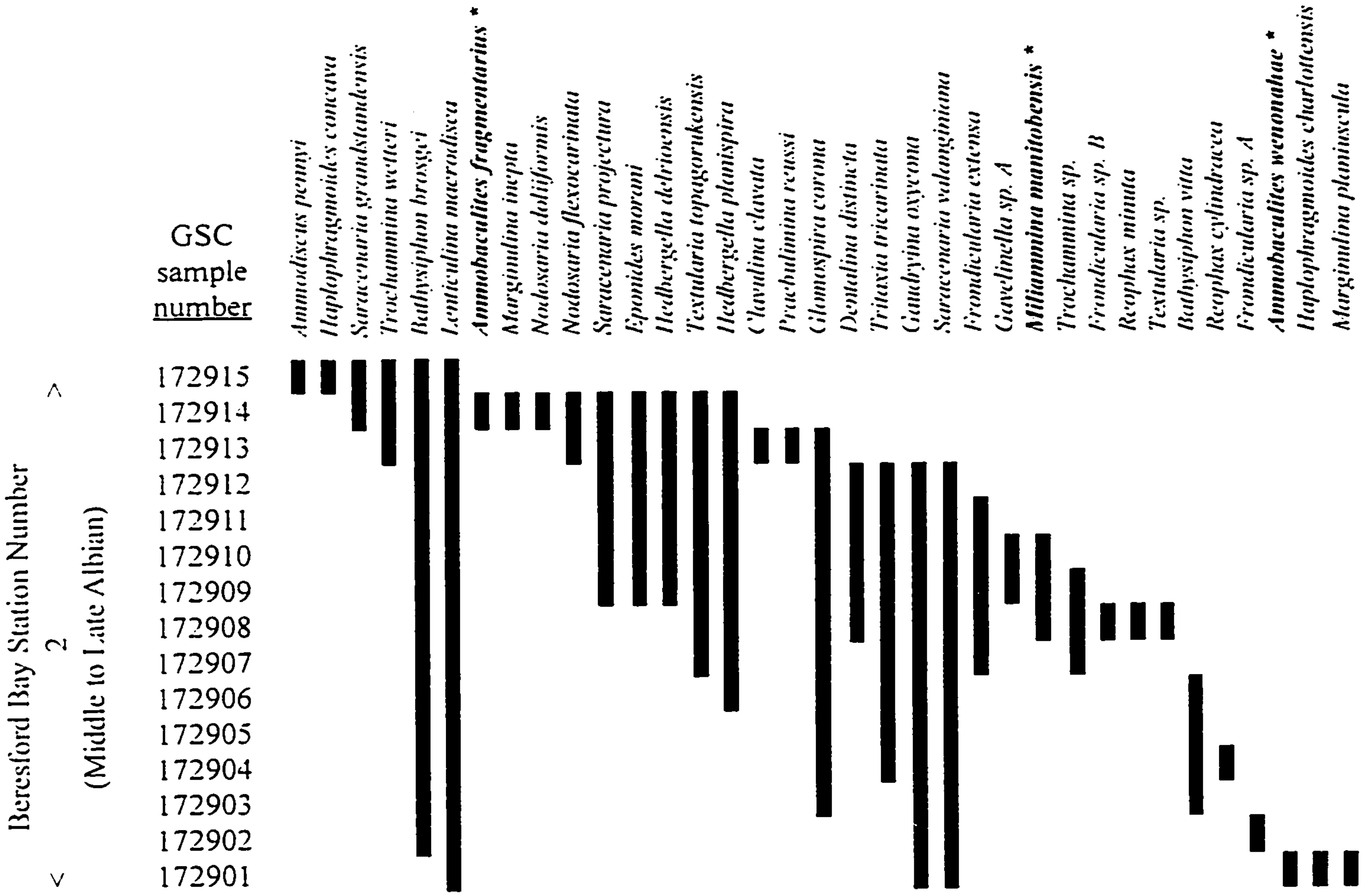
AREA	STA.	NTS COORDINATES	CAMERON'S DESIGNATION
Beresford Bay	1	103K/3 8:627380 5990530	Caswell Point
	2	103K/3 8:627000 5989000	North Beresford Creek
	3	103K/3 8:627550 5988400	Beresford Creek
	4	103K/3 8:626450 5987500	Beresford Bay
	5	103K/3 8:623700 5986000	White Point
	6	103K/3 8:624600 5986700	White Point
Cumshewa Inlet	1	103G/4 9: 306550 5882550	Cumshewa Inlet
	2	103G/4 9: 310100 5883700	Cumshewa Inlet
	3	103G/4 9: 310400 5883200	Cumshewa Inlet
	4	103G/4 9: 311900 5882250	Cumshewa Inlet
	5	103G/4 9: 312530 5882780	Cumshewa Inlet
	6	103G/4 9: 313800 5881780	Cumshewa Inlet
	7	103G/4 9: 314500 5881500	Cumshewa Inlet
	8	103G/4 9: 315500 5880590	Cumshewa Inlet
Onward Point	1	103G/4 9: 305200 5902800	Onward Point
	2	103G/4 9: 305300 5902600	Onward Point
	3	103G/4 9: 305588 5902713	Onward Point
	4	103G/4 9: 303817 5901100	Onward Point
Rennell Sound Road	1	103F/8 8: 678900 5916400	Longarm

FIGURE 6. Species occurrences from Beresford Bay Station 1. Species with an asterisk represent index fossils.



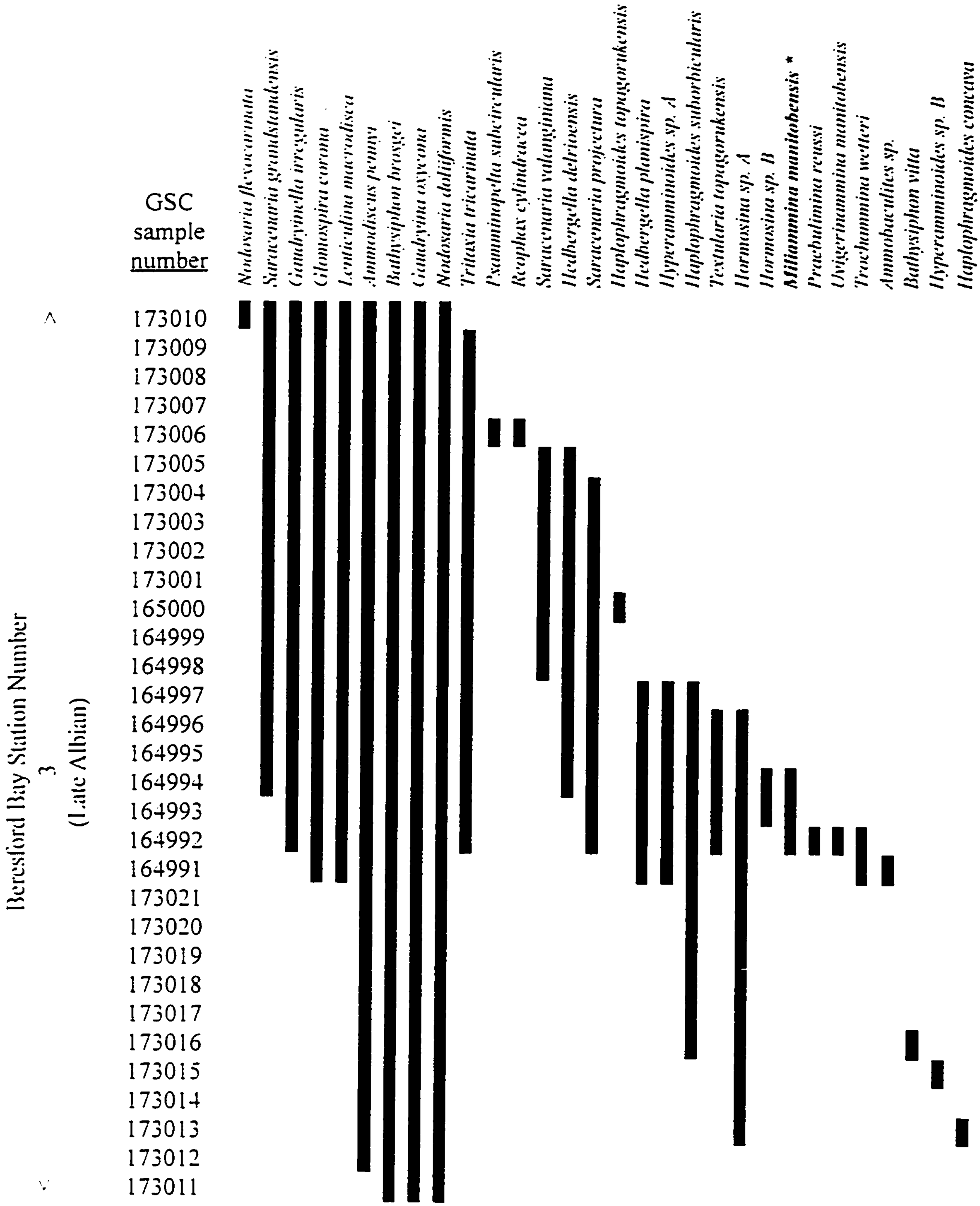
Beresford Bay Station Number
1
(Middle to Late Albian)
GSC sample number
Lenticulina macrodisca
Tritaxia tricarinata
Eponides morani
Miliammina manitobensis *
Saracenaria valanginiana
Haplophragmoides gigas *
Textularia topagorukensis
173150
173149
173148
173147
173146
173145
173144
173143
173142
173141
173140

FIGURE 7. Species occurrences from Beresford Bay Station 2. Species with an asterisk represent index fossils.



GSC sample number
172915
172914
172913
172912
172911
172910
172909
172908
172907
172906
172905
172904
172903
172902
172901
Beresford Bay Station Number 2 (Middle to Late Albian)
Ammodiscus pennyi
Haplophragmoides concava
Saracenaria grandstandensis
Trochammina wetteri
Bathysiphon brosgei
Lenticulina macrodisca
Ammobaculites fragmentarius *
Marginulina inepta
Nodosaria doliiformis
Nodosaria flexocarinata
Saracenaria projectura
Eponides morani
Hedbergella delrioensis
Textularia topagorukensis
Hedbergella planispira
Clavulina clavata
Praebulimina reussi
Glomospira corona
Dentalina distincta
Tritaxia tricarinata
Gaudryina oxycona
Saracenaria valanginiana
Frondicularia extensa
Gavelinella sp. A
Miliammina manitobensis *
Trochammina sp.
Frondicularia sp. B
Reophax minuta
Textularia sp.
Bathysiphon vitta
Reophax cylindracea
Frondicularia sp. A
Ammobaculites wenonahae *
Haplophragmoides charlottensis
Marginulina planiuscula

FIGURE 8. Species occurrences from Beresford Bay Station 3. Species with an asterisk represent index fossils.



Beresford Bay Station Number
3
(Late Albian)
GSC
sample
number
Nodosaria flexocarinata
Saracenaria grandstandensis
Gaudryinella irregularis
Glomospira corona
Lenticulina macrodisca
Ammodiscus pennyi
Bathysiphon brosgei
Gaudryina oxycona
Nodosaria doliiformis
Tritaxia tricarinata
Psamminopelta subcircularis
Reophax cylindracea
Saracenaria valanginiana
Hedbergella delrioensis
Saracenaria projectura
Haplophragmoides topagorukensis
Hedbergella planispira
Hyperamminoides sp. A
Haplophragmoides suborbicularis
Textularia topagorukensis
Hormosina sp. A
Hormosina sp. B
Miliammina manitobensis *
Praebulimina reussi
Uvigerinammina manitobensis
Trochammina wetteri
Ammobaculites sp.
Bathysiphon vitta
Hyperamminoides sp. B
Haplophragmoides concava
173010
173009
173008
173007
173006
173005
173004
173003
173002
173001
165000
164999
164998
164997
164996
164995
164994
164993
164992
164991
173021
173020
173019
173018
173017
173016
173015
173014
173013
173012
173011

FIGURE 9. Species occurrences from Beresford Bay Station 4. Species with an asterisk represent index fossils.

Beresford Bay Station Number
4
(Cenomanian)

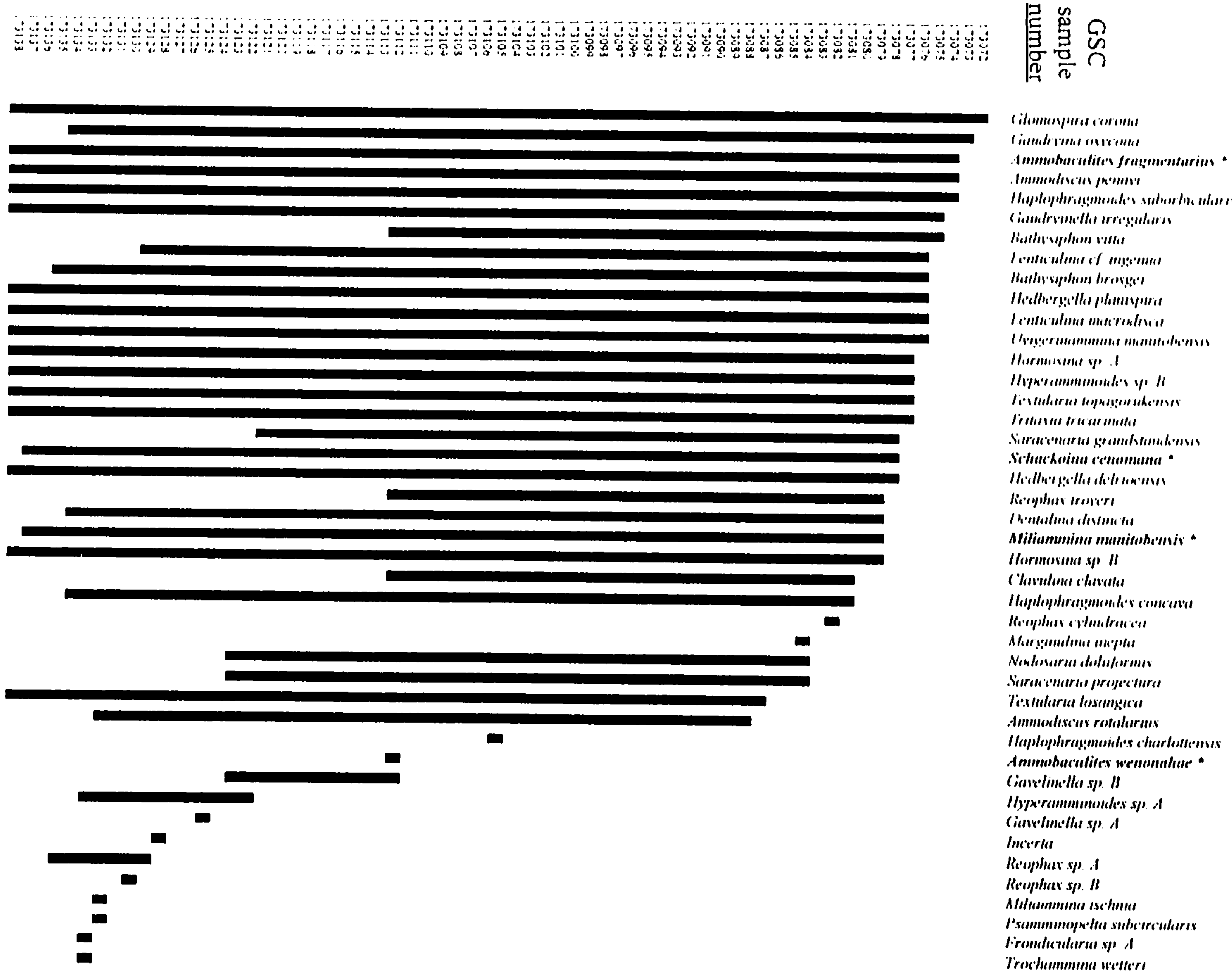


FIGURE 10. Species occurrences from Beresford Bay Stations 5 and 6. Species with an asterisk represent index fossils.

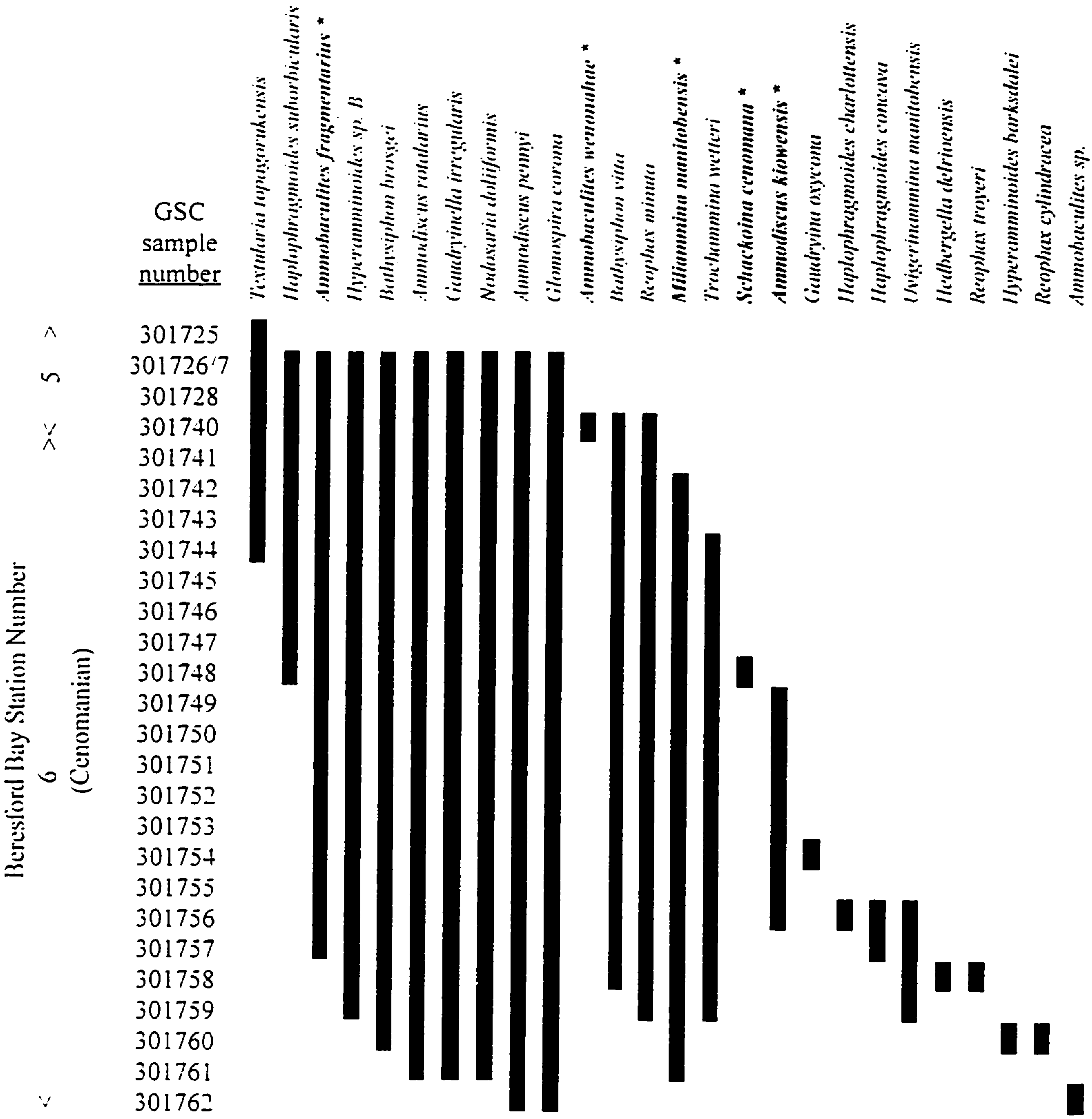

GSC sample number
Textularia topagorukensis
Haplophragmoides suborbicularis
Ammobaculites fragmentarius *
Hyperamminoides sp. B
Bathysiphon brosgei
Ammodiscus rotalarius
Gaudryinella irregularis
Nodosaria doliiformis
Ammodiscus pennyi
Glomospira corona
Ammobaculites wenonahae *
Bathysiphon vitta
Reophax minuta
Miliammina manitobensis *
Trochammina wetteri
Schackoina cenomana *
Ammodiscus kiowensis *
Gaudryina oxycona
Haplophragmoides charlottensis
Haplophragmoides concava
Uvigerinammina manitobensis
Hedbergella delrioensis
Reophax troyeri
Hyperamminoides barksdalei
Reophax cylindracea
Ammobaculites sp.
301725
301726/7
301728
301740
301741
301742
301743
301744
301745
301746
301747
301748
301749
301750
301751
301752
301753
301754
301755
301756
301757
301758
301759
301760
301761
301762
5
Beresford Bay Station Number
6
(Cenomanian)

FIGURE 11. Species occurrences from Cumshewa Inlet Stations 1-8. Species with an asterisk represent index fossils. Alternation of bold and non-bold sample numbers are meant to distinguish between different sampling localities.

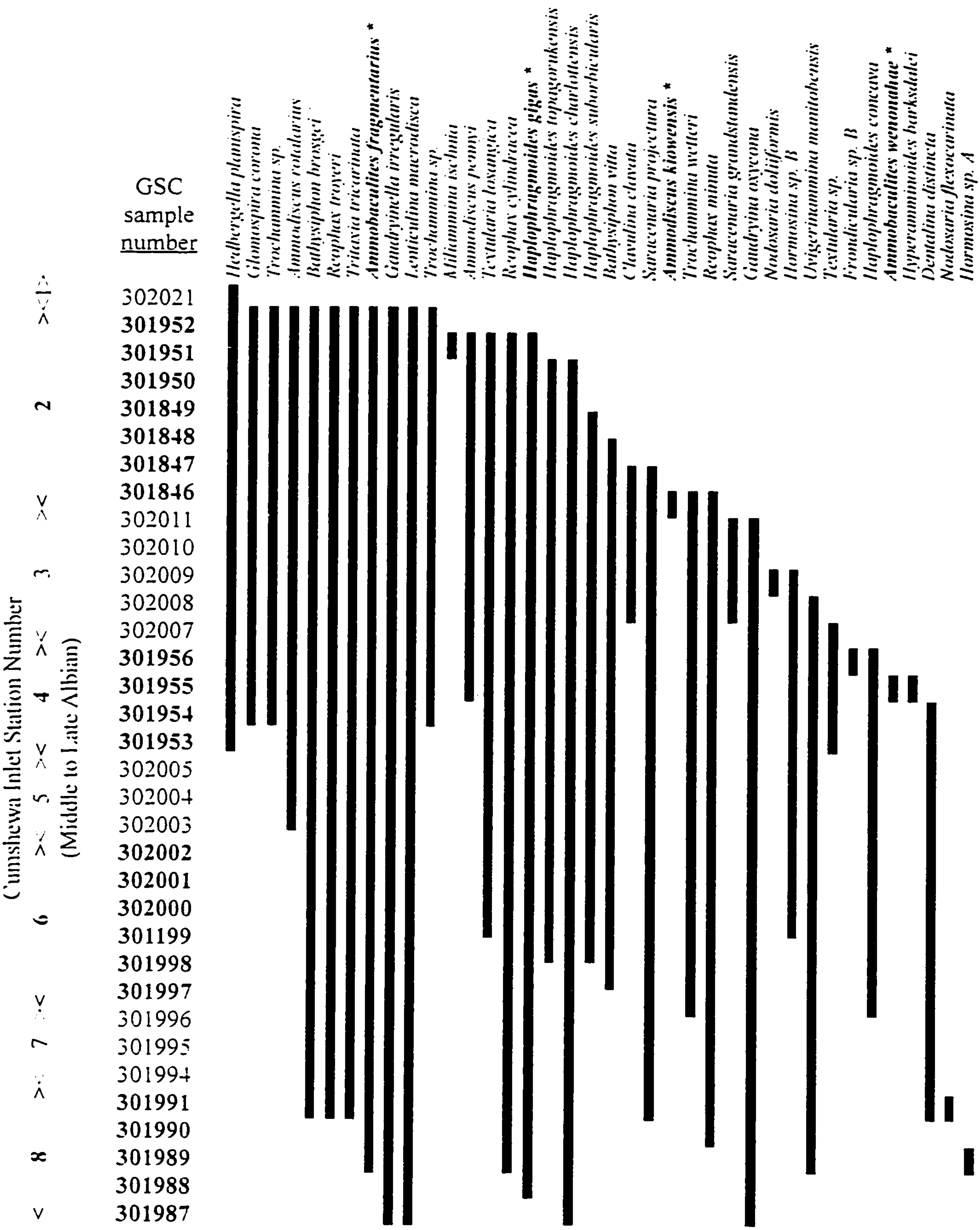
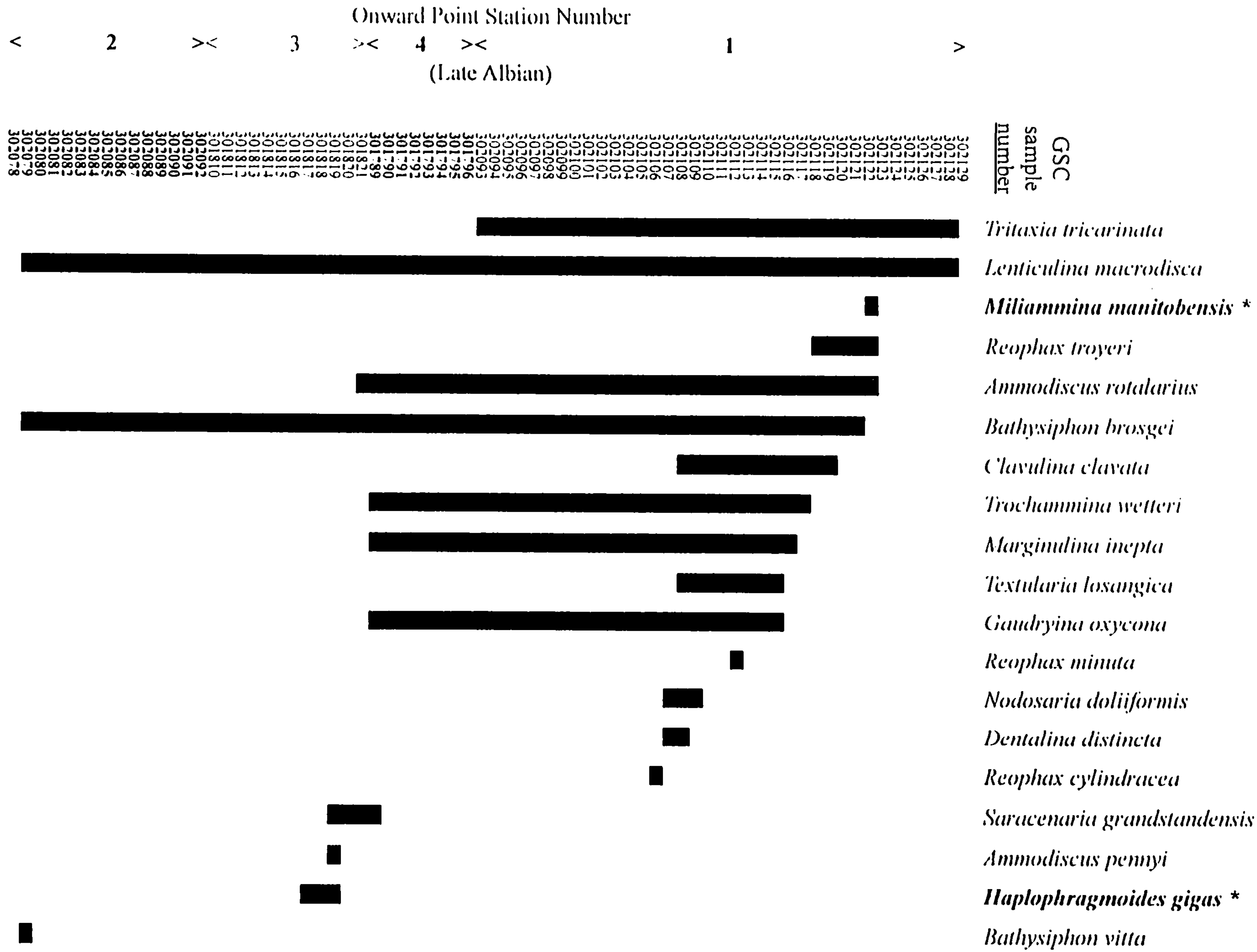
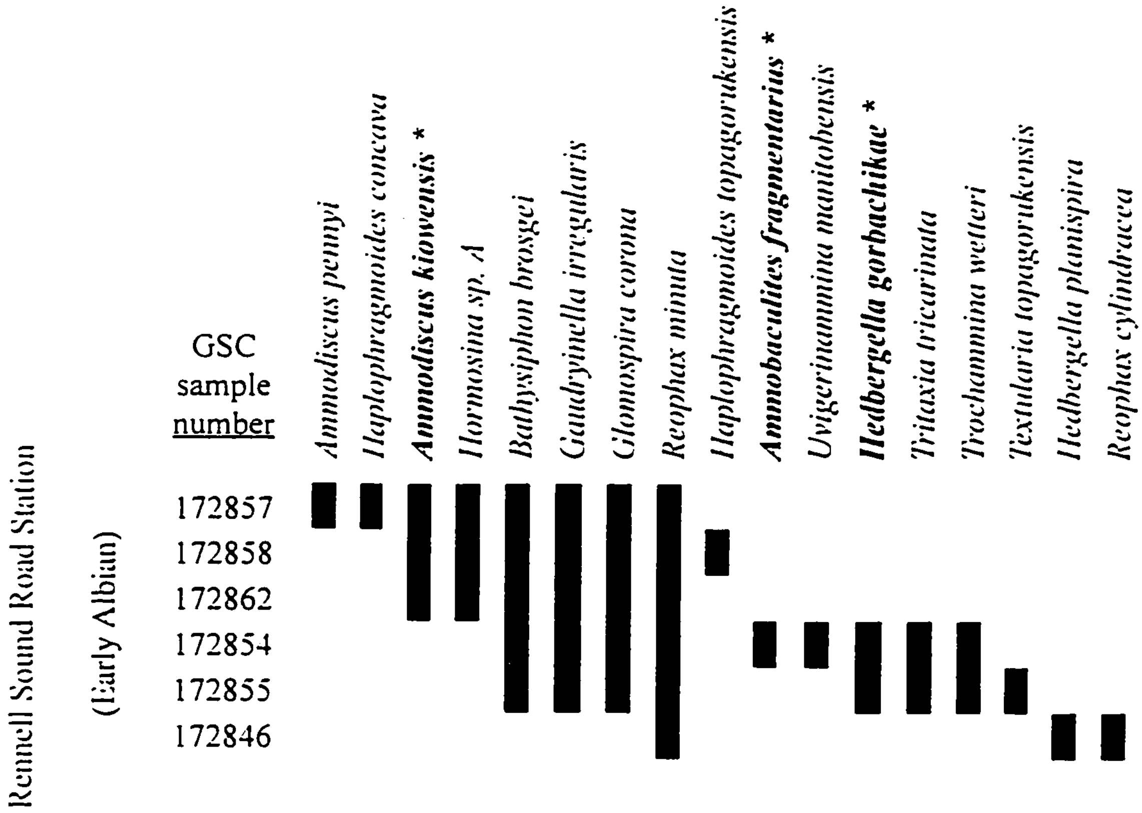

Cumshewa Inlet Station Number
(Middle to Late Albian)
1
2
3
4
5
6
7
8
GSC
sample
number
302021
301952
301951
301950
301849
301848
301847
301846
302011
302010
302009
302008
302007
301956
301955
301954
301953
302005
302004
302003
302002
302001
302000
301199
301998
301997
301996
301995
301994
301991
301990
301989
301988
301987
Hedbergella planispira
Glomospira corona
Trochammina sp.
Ammodiscus rotalarius
Bathysiphon brosgei
Reophax troyeri
Tritaxia tricarinata
Ammobaculites fragmentarius *
Gaudryinella irregularis
Lenticulina macrodisca
Trochammina sp.
Miliammina ischnia
Ammodiscus pennyi
Textularia losangica
Reophax cylindracea
Haplophragmoides gigas *
Haplophragmoides topagorukensis
Haplophragmoides charlottensis
Haplophragmoides suborbicularis
Bathysiphon vitta
Clavulina clavata
Saracenaria projectura
Ammodiscus kiowensis *
Trochammina wetteri
Reophax minuta
Saracenaria grandstandensis
Gaudryina oxycona
Nodosaria doliiformis
Hormosina sp. B
Uvigerinammina manitobensis
Textularia sp.
Frondicularia sp. B
Haplophragmoides concava
Ammobaculites wenonahae *
Hyperamminoides barksdalei
Dentalina distincta
Nodosaria flexocarinata
Hormosina sp. A

FIGURE 12. Species occurrences from Onward Point Stations 1-4 . Species with an asterisk represent index fossils. Alternation of bold and non-bold sample numbers are meant to distinguish between different sampling localities.



Onward Point Station Number
< 2 >< 3 >< 4 >< 1 >
(Late Albian)
GSC sample number
Tritaxia tricarinata
Lenticulina macrodisca
Miliammina manitobensis *
Reophax troyeri
Ammodiscus rotalarius
Bathysiphon brosgei
Clavulina clavata
Trochammina wetteri
Marginulina inepta
Textularia losangica
Gaudryina oxycona
Reophax minuta
Nodosaria doliiformis
Dentalina distincta
Reophax cylindracea
Saracenaria grandstandensis
Ammodiscus pennyi
Haplophragmoides gigas *
Bathysiphon vitta

FIGURE 13. Species occurrences from the Rennell Sound Roadcut. Species with an asterisk represent index fossils.


Rennell Sound Road Station
(Early Albian)
GSC sample number
172857
172858
172862
172854
172855
172846
Ammodiscus pennyi
Haplophragmoides concava
Ammodiscus kiowensis *
Hormosina sp. A
Bathysiphon brosgei
Gaudryinella irregularis
Glomospira corona
Reophax minuta
Haplophragmoides topagorukensis
Ammobaculites fragmentarius *
Uvigerinammina manitobensis
Hedbergella gorbachikae *
Tritaxia tricarinata
Trochammina wetteri
Textularia topagorukensis
Hedbergella planispira
Reophax cylindracea

CHAPTER 5. DISCUSSION

A study of the foraminiferal content of shales and mudstones found in Cretaceous rocks of the Queen Charlotte Islands was carried out to determine a more precise age for the rocks in the area. This work builds on previous biostratigraphic work in the area performed using ammonites (Haggart, 1991). There were difficulties associated with using foraminifera in this research, though.

Foraminifera are excellent biostratigraphic indicators in these Cretaceous rocks. As with many other microfossil groups, they preserve well, usually have a higher density of specimens per sample than macrofossils, and they are ubiquitous, being found in most marine depositional environments. Widely distributed and fast evolving, planktic species are particularly useful biostratigraphic indicators (Berggren and Haq, 1976). Although benthic foraminiferal species tend to have a more regional distribution and longer ranges, they are useful biomarkers as well.

Much of the Cretaceous strata from the Queen Charlotte Islands has been deformed by tectonic processes, thus many of the foraminiferal specimens found here have been highly deformed and are often unidentifiable. As a result, many of the planktic and more fragile benthic specimens are highly fragmented.

The total number of identifiable foraminiferal species observed in these samples was small due to low diversity and poor preservation. This created some difficulties in correlating sections within the Cretaceous of the Queen Charlotte Islands as species diversity was at least partially a function of the number of samples collected from individual sections. Biostratigraphic resolution was therefore much higher in sections where large numbers of samples were collected.

Biostratigraphy

Regardless of the poor state of preservation and the paucity of foraminiferal specimens, there were enough identifiable specimens to establish a biochronology for the studied sections. The index fossils used in this study are based primarily on those from the nearby north slope of Alaska (Tappan, 1951; 1957; 1960; 1962), as well as biomarkers used in the Western Canadian Sedimentary Basin (WCSB) (Cushman, 1927; 1946; Nauss, 1947; Stelck *et al*, 1956: Eicher, 1967; Eicher and Worstell, 1970; McNeil and Caldwell. 1981; Koke and Stelck, 1984).

Previous biostratigraphic work had been done using ammonites (Haggart, 1987). Megafossils recovered from the north shore of Cumshewa Inlet, from many of the same sections as in this study, yielded specimens that were altered beyond recognition by heating from local intrusive activity. In the Beresford Bay area, macrofossils were recovered from the tidal benches where the only Cretaceous rocks crop out. Haggart (1987) reports that the latest Albian *Desmoceras dawsoni* (Whiteaves) was recovered from the shale member of the Haida Formation cropping out in the intertidal zone adjacent to Beresford Creek, Caswell Point, and Pyramid Hill (Fig. 1). However, it is unclear if these fossils were recovered from the same stratigraphic levels as the samples collected for this study, though they seem to be of a similar age as the foraminifera recovered from the same areas.

Due to the paucity of the foraminiferal fossils recovered and the lithologically undifferentiated nature of the sections, the establishment of detailed biozones for the study area was not possible. For example, most of the species found in one of the better studied areas, Beresford Bay Station 4 (Fig. 8), ranged the entire length of the section. This trend was also seen in Beresford Bay Stations 5-6, and all of the Cumshewa Inlet Stations. In all other stations many fewer samples were recovered, so any biozonal conclusions would be suspect due to limited data.

With the exception of Beresford Bay Stations 4-6 (Haida Formation), a biostratigraphic framework was established fairly confidently based on index foraminifera from the north slope of Alaska and the WCSB (McNeil and Caldwell, 1981; Koke and Stelck, 1984). Important index fossils for the Haida Formation sites, Beresford Bay Stations 1-3 (Fig. 1), all Cumshewa Inlet stations (Fig. 2), and all Onward Point stations (Fig. 3) included *Ammobaculites wenonahae* Tappan 1960 (Plate 4, fig. 2 a-d) and *Gaudryina nanushukensis* Tappan 1951 (Plate 2, fig. 2 a-c). These taxa occur in the Middle Albian. Late Albian strata were defined by *Haplophragmoides gigas* Cushman 1927 (Plate 5, fig. 3 a-b), and *Miliammina manitobensis* Wickenden 1932 (Plate 7, fig. 7 a-d). *Ammodiscus kiowensis* Loeblich and Tappan 1950 (Plate 1, fig. 1 a-b) and *Ammobaculites fragmentarius* Cushman 1927 (Plate 4, fig. 1 a-d) was only found in rocks of Albian age. For the most part, these sections were all determined to be Middle to Late Albian.

Based on a single section from a roadcut along Rennell Sound Road (Fig. 4), foraminiferal specimens recovered from the Early Albian Longarm Formation, included the Late Aptian to Early Albian *Hedbergella gorbachikae* Longoria 1974 (Plate 7, fig. 5 a-b), the Albian *Ammodiscus kiowensis*, and the Albian *Ammobaculites fragmentarius* (Longoria 1974; Koke and Stelck 1984; Caron, 1985).

Discrepancies were found when WCSB biozones were applied to the biochronology of Haida Foramation Beresford Bay Stations 4-6. The planktic *Schackoina cenomana* (Schacko 1897; Plate 8, fig. 1 a-b), a WCSB Cenomanian index fossil, is found in association with the Late Albian WCSB benthic index fossils *Miliammina manitobensis*, the Middle Albian *Ammobaculites wenonahae*, and the Albian *A. fragmentarius* . This result suggests that the last occurrences of these three benthic species was in the Cenomanian in a northeastern Pacific refugium, long after they had disappeared elsewhere.

These taxa migrated from the WCSB, probably around Alaska. This hypothesis is preferred to that of an earlier appearance of *S. cenomana* as planktic species tend to be more widely distributed by ocean currents, and benthic species tend to take longer to migrate from region to region. For these reasons, a Cenomanian age is assigned to Haida Formation Beresford Bay Stations 4-6.

Comparison with other areas

As this study is mainly biostratigraphic in nature, a primary objective was to recognize faunal similarities between foraminifera of similar ages on the north slope of Alaska, and the Western Canadian Sedimentary Basin (WCSB). Both of these other areas are not only nearby paleogeographically, but have also been well studied. Details on faunal similarities between these areas would help researchers resolve paleogeographic issues concerning the presence and absence of sea links at different times in the Cretaceous. For example, 57.4% of the identified Albian species in this study were also found in the Albian of the north slope of Alaska (Tappan, 1951; 1957; 1960; 1962). This correlation is not surprising due to their proximity during the Albian and the Cenomanian (Haggart, pers. comm.).

Using the Queen Charlotte Islands-Alaskan correlation as a baseline, the commonality (42.6%) between the northern portion of the WCSB and the Queen Charlotte Islands seems surprisingly high. There was even less commonality between the Queen Charlotte Islands and the southern portion of the WCSB (21.3%), which is now the present day Texas, Oklahoma, and the southern Mississippi Valley (Carsey, 1926; Cushman, 1926; 1927; 1946; Nauss, 1947; Stelck *et al.*, 1956; Eicher, 1960; 1967; Eicher and Worstell, 1970; Loeblich and Tappan, 1949; 1950; 1951; Morrow, 1934; Tappan, 1940; 1943; McNeil and Caldwell, 1981; Koke and Stelck, 1984).

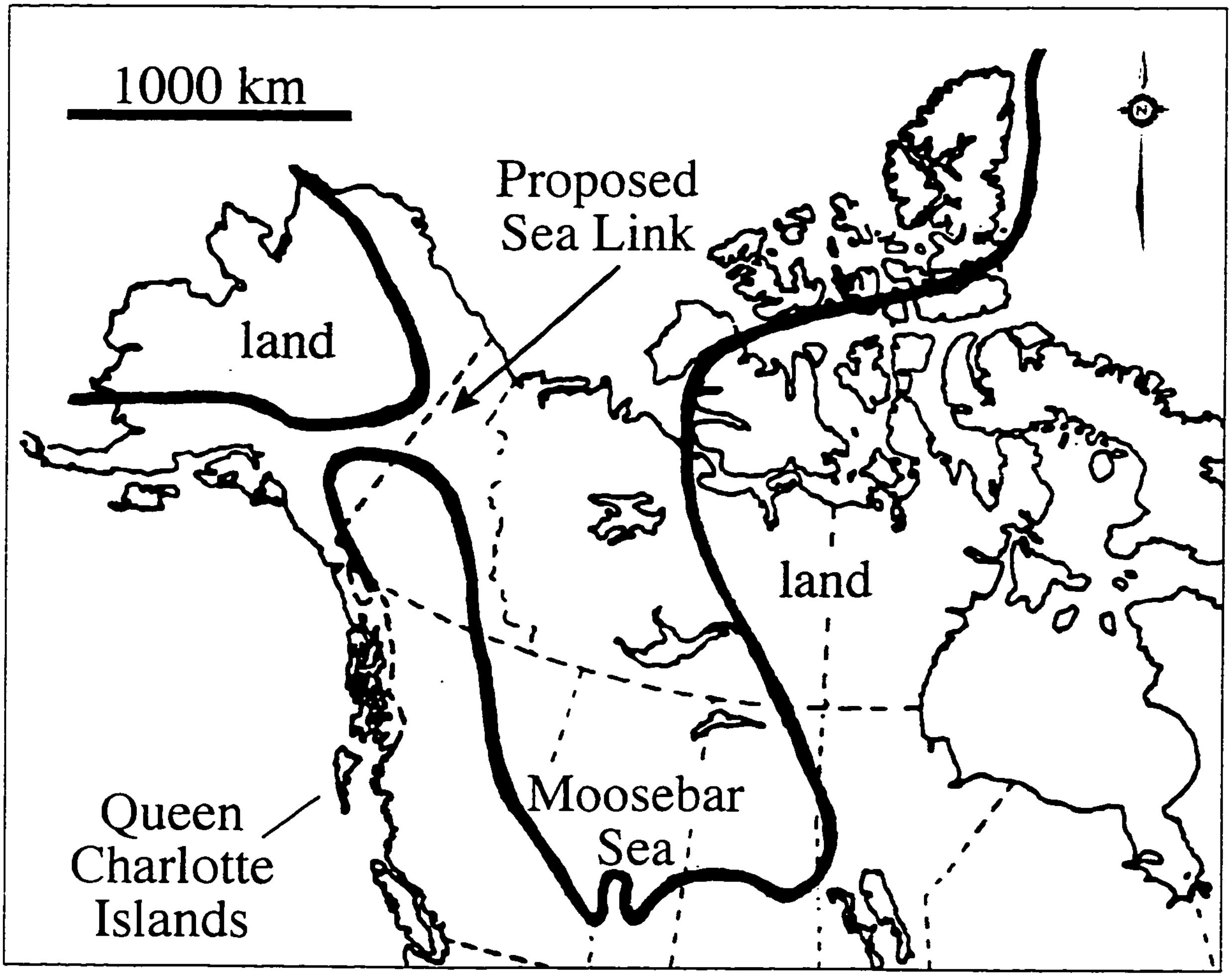
Even though this region is found in the southern portion of an intracontinental seaway, it was at a different latitude, so one would expect a different climate to harbour a slightly different faunal makeup. Although a seaway often existed all the way from the present MacKenzie Delta to the Gulf of Mexico during the Cretaceous, openings between the Pacific and the WCSB were less common. Williams and Stelck (1975) proposed a latest Early Albian link extending between the WCSB seaway and the Pacific Coast via southern Alaska (Fig. 13). This hypothesis was based on ammonites typical of the MacKenzie Valley and the Yukon being found in association with Pacific taxa from the latest Early Albian Matanuska Formation in southern Alaska. By the Middle Albian, ammonite faunas were distinctly polar or Pacific, thus no longer found in association, as they were before the latest Early Albian (Jones, 1967; Williams and Stelck, 1975; Koke and Stelck, 1984).

Based on the results of this study, the case for an Albian-Cenomanian seaway between the northeast Pacific and the WCSB is suggested. However, the link proposed by Williams and Stelck (1975) was closed by the beginning of the Middle Albian. Thus, migration of the Middle and Late Albian foraminiferal species found in common between the two regions in this study would not be possible.

Two alternative scenarios may explain this discrepancy. First, there may have been a subsequent WCSB-Pacific link during the latest Middle to earliest Late Albian, which introduced those index fossils to the Pacific. This is also a possibility as sea level was at a relative high for much of the Albian (Tipper, 1984). However, the divergence of ammonite taxa in the two regions seems to preclude this possibility. Therefore, the second scenario must be adopted, and that this is simply that these species migrated from the WCSB via northern Alaska to the Pacific coast.

FIGURE 14. Map showing Interior Seaway of the Western Canadian Sedimentary Basin (WCSB). A possible sea link exists between the WCSB and the west coast of North America via southern Yukon and Alaska (Adapted from Koke and Stelck, 1984).

FIGURE 14


1000 km
Proposed
Sea Link
land
land
Moosebar
Sea
Queen
Charlotte
Islands

CHAPTER 6. CONCLUSIONS

This is the first systematic and biostratigraphic survey of foraminifera from the Cretaceous Longarm and Haida formations from the Queen Charlotte Islands. A clearer picture now emerges on the age of these units and the relationships with other adjacent regions of the WCSB and the north slope of Alaska. These results are summarized as follows:

1. Sixty-two species of benthic and planktic Cretaceous foraminifera were recovered from mudstones, shales, and sandy shales, from in 267 samples from 20 localities on the Queen Charlotte Islands, British Columbia, Canada
2. The studied sections yielded many shared species with the Albian of the north slope of Alaska (57.4%) and the Albian of the Western Canadian Sedimentary Basin (WCSB) (42.6%). This suggests some kind of continuity between the three areas.
3. Fauna similar to both the study area and the WCSB seem to be predominantly Middle to Late Albian in age. It is proposed that migration was permitted around the north slope of Alaska and through the interior seaway of the WCSB.
4. Index foraminifera from the north slope of Alaska and the WCSB were used successfully to establish the ages of portions of the Longarm and Haida formations as Early Albian and Middle Albian to Early Cenomanian, respectively.
5. A restricted basinal depositional environment is suggested for the Haida Formation as one would expect a fair number of planktic specimens in an open shelf environment, though the specimens recovered are overwhelmingly benthic.

CHAPTER 7. SYSTEMATIC DESCRIPTIONS

The naming of species of extinct fauna is arbitrary because a species is generally governed by biological definitions, such as comparative anatomy or the ability to produce viable offspring. As these characteristics are not observable in fossil specimens, other criteria must be used, such as comparative morphology of any hard parts that are available. Differentiating polymorphic organisms, such as foraminifera, complicate matters further (Boltkovskoy, 1965, 1990; Boltkovskoy *et al.* 1991). For example, *Textularia topagorukensis* Tappan 1957 (Plate 8, fig. 6 a-b) was at one time described as both *T. topagorukensis* and *Spiroplectammina koveri* Tappan 1957 based on the distinctive microspheric and megalospheric generations. Careful systematic analysis was required to identify genuine taxonomic units.

ORDER FORAMINIFERIDA Eichwald 1830

Family AMMODISCIDAE Reuss, 1862

GENUS *Ammodiscus* Reuss 1862

Ammodiscus kiowensis Loeblich and Tappan 1950

Plate 1, fig. 1 a-b

*Ammodiscus kiowensis*LOEBLICH and TAPPAN 1950, p. 5-6, pl. 1, fig. 3

Ammodiscus kiowensis Loeblich and Tappan NORTH and CALDWELL 1975, pl. 1, fig. 7

Ammodiscus kiowensis Loeblich and Tappan McNEIL and CALDWELL 1981, p. 136, pl. 9, fig. 14

Ammodiscus kiowensis Loeblich and Tappan KOKE and STELCK 1984, p. 276-277, pl. 1, figs. 14-15

Description: Test free, discoidal, planispiral; small proloculus; second chamber with transverse growth constrictions, an undivided tube that gradually enlarges, with a slight overlap between whorls, about 6-8 per specimen; surface finely agglutinated and smooth; aperture at open end of the tube.

Discussion: This is an Albian index species.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Albian Haida Fm., Beresford Bay Station 6; Albian Haida Fm., Cumshewa Inlet Station 3.

Other localities: Albian, Kiowa Shale, Kansas (Loeblich and Tappan, 1950); Late Albian, Skull Creek Member, Ashville Fm., Manitoba and Saskatchewan (North and Caldwell, 1975: McNeil and Caldwell, 1981); Albian Hasler Fm., British Columbia (Koke and Stelck, 1984).

Ammodiscus pennyi Cushman and Jarvis 1928

Plate 1, fig. 2 a-d

Ammodiscus pennyi CUSHMAN and JARVIS 1928, p. 87, pl. 12, figs. 4-5

Description: Test free, large, discoidal and planispiral; periphery rounded; chamber an undivided tube that gradually enlarges, slightly irregular coiling with some coils overlapping the previous; approximately three whorls per specimen; surface finely agglutinated and smooth; wall thick; aperture semicircular, at open end of the tube.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm., Cumshewa Inlet Stations 2-4; Albian Onward Point Station 3.

Other localities: Late Cretaceous well at Lizard Springs, Trinidad (Cushman and Jarvis, 1928).

Ammodiscus cf. *pennyi* Cushman and Jarvis 1928

Plate 1, fig. 3 a-b

Glomospira reata EICHER 1960, p. 56-57, pl. 3, figs. 4-5

Description: Test free, large, discoidal and irregularly planispiral; periphery rounded; chamber an undivided tube that gradually enlarges, slightly irregular coiling with some coils overlapping the previous; approximately three whorls per specimen; surface finely agglutinated and smooth; wall thick; aperture semicircular, at open end of the tube.

Discussion: There is a morphological gradation of specimens from *Ammodiscus pennyi* to *Ammodiscus* cf. *pennyi* and they are always found together. This would seem to indicate that they are the same species. Owing to the principal of priority of naming species, Eicher's (1960) *Glomospira reata* is synonymous with *A. pennyi*. In addition, due to the predominantly planispiral nature of the specimens, they should be placed in the genus *Ammodiscus*, rather than *Glomospira*.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm., Cumshewa Inlet Stations 2-4; Albian Onward Point Station 3.

Ammodiscus rotalarius Loeblich and Tappan 1949

Plate 1, fig. 4 a-b

Ammodiscus rotalarius LOEBLICH and TAPPAN 1949, p. 247, pl. 46, fig. 1

Ammodiscus rotalarius Loeblich and Tappan TAPPAN 1962, p 131-132, pl. 30, figs. 5-8

Ammodiscus rotalarius Loeblich and Tappan SLITER 1980, P. 372-373, pl. 1, fig. 8

Ammodiscus rotalarius Loeblich and Tappan McNEIL and CALDWELL 1981, p. 136-137, pl. 9, fig. 15

Description: Test free, discoidal, planispiral, with regular coiling; chamber an undivided tube that gradually enlarges, with an even amount of overlap between whorls, about 7-11 whorls per specimen; surface smooth, very finely agglutinated with considerable cement, almost appearing calcareous; aperture at open end of the tube.

Discussion: Distinguished from *A. kiowensis* by relatively smaller size, greater amount of cement, and absence of lateral growth constrictions.

Occurrences: Cenomanian Haida Fm., Beresford Bay Stations 4-6; Albian Haida Fm., Cumshewa Inlet Stations 2-6; Albian Onward Point Stations 1, 3-4.

Other localities: Albian Walnut clay, Oklahoma (Loeblich and Tappan, 1949); Albian Torok Fm. and Albian-Cenomanian Nanushuk Group, northern Alaska (Tappan, 1962); Deep Sea Drilling Project Site 416 (Sliter, 1980); Cenomanian Belle Fourche Member, Ashville Fm., Manitoba (McNeil and Caldwell, 1981).

GENUS *Glomospira* Rzehak 1888

Glomospira corona Cushman and Jarvis 1928

Plate 1, fig. 5 a-d

Glomospira corona CUSHMAN and JARVIS 1928, p. 89, pl. 12, figs. 9-11

Ammodiscus charoides (Jones and Parker) GRZYBOWSKI 1896, p. 61, pl. 8, figs. 39-43

Glomospira corona Cushman and Jarvis TAPPAN 1962, p. 130, pl. 29, figs. 13-16

Glomospira charoides (Jones and Parker 1860) KRASHENINNIKOV 1973, p. 211-212, pl. 3, fig. 5

Glomospira corona Cushman and Jarvis McLEAN and WALL 1981, p. 368-369, pl. 8, figs. 4-5

Glomospira corona Cushman and Jarvis McNEIL and CALDWELL 1981, p. 137, pl. 9, figs.16-17

Glomospira charoides (Jones and Parker 1860) KAMINSKI 1988, p. 185, pl. 3, fig. 15

Description: Test free, tightly wound globular spiral, highly variable morphologically; undivided second chamber, with perhaps a small proloculus at the centre which is masked; end of second chamber less tightly wound at one pole giving the appearance of a crown; sutures distinct and depressed; surface finely agglutinated and smooth; aperture at open end of the tube.

Discussion: Many disparate specimens of the genus Glomospira have been placed in either *G. charoides* (Jones and Parker 1860) or *G. gordialis*. These species, with numerous variations, have been recorded as ranging from the Carboniferous to the Recent. That it is unlikely for a single species to have existed since the Carboniferous until today is an understatement, even for a benthic foraminifer. The many cited variations are probably individual convergent species.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham

Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm., Cumshewa Inlet Stations 2-4.

Other localities: Albian, Wadowice, Poland (Grzybowski 1896); Late Cretaceous well at Lizard Springs, Trinidad (Cushman and Jarvis, 1928); Albian to Campanian Nanushuk and Colville groups, northern Alaska (Tappan, 1962); Late Campanian Millwood and Odanah Members, Pierre Shale, Manitoba (McNeil and Caldwell, 1981);

Family ASTRORHIZIDAE Brady 1881

GENUS *Bathysiphon* Sars 1872

Bathysiphon brosgei Tappan 1957

Plate 1, fig. 6 a-b

Bathysiphon brosgei TAPPAN 1957, p. 202, pl. 65, figs. 1-5

Bathysiphon brosgei Tappan TAPPAN 1962, p. 128, pl. 29, figs. 1-5

Bathysiphon brosgei Tappan HANZLIKOVA 1972, p. 31, pl. 1, fig. 12

Bathysiphon brosgei Tappan McNEIL and CALDWELL 1981, p. 129, pl. 9, fig. 1

Description: Test free, elongate, an uncompressed tubular chamber open at both ends; circular in cross-section; surface finely to coarsely agglutinated and roughly finished; aperture at open end of tubular chamber; other end infilled with detritus.

Discussion: Some of Tappan's (1957) specimens had transverse growth constrictions, but these were not observed in the Queen Charlotte Islands specimens.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida

Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Stations 1-4.

Other localities: Albian Lhoty Member, Cenomanian-Santonian Godula Fm., Moravia (Hanzlikova, 1972); Albian to Campanian Nanushuk and Colville groups, northern Alaska (Tappan, 1957, 1962); Late Albian to Late Cenomanian Ashville Fm., Manitoba (McNeil and Caldwell, 1981).

Bathysiphon vitta Nauss 1947

Plate 1, fig. 7 a-d

Bathysiphon vitta NAUSS 1947, p. 334, pl. 48, fig. 4

Bathysiphon vitta Nauss TAPPAN 1962, p. 128-129, pl. 29, figs. 6-8

Bathysiphon vitta Nauss HANZLIKOVA 1972, p. 32, pl. 2, figs. 4-5

Bathysiphon vitta Nauss McNEIL and CALDWELL 1981, p. 129-130, pl. 9, fig. 2

Description: Test free, large (0.8mm-2.0 mm), elongate, a compressed tubular chamber; elliptical in cross-section, lateral edges rounded; surface finely agglutinated and smooth, with many growth constrictions; aperture at open end of tube, the other end infilled with detritus.

Discussion: Distinguished from B. brosgei by being smoothly finished, much larger in size, and almost always compressed.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm., Cumshewa Inlet Stations 2-7; Albian Onward Point Station 2

Other localities: Campanian Lea Park Fm, Alberta (Nauss, 1947); Late Cretaceous Frydek Fm. And Istebna Member, and Campanian-Maastrichtian, Moravia (Hanzlikova 1972); Albian Grandstand and Topagoruk fms., northern Alaska (Tappan 1962); Santonian to Late Campanian Niobrara Fm. And Pierre Shales, Manitoba (McNeil and Caldwell, 1981).

Family ATAXOPHRAGMIIDAE Schwager, 1877

GENUS *Clavulina* d'Orbigny 1826

Clavulina clavata Cushman 1926

Plate 2, fig. 1

Clavulina clavata CUSHMAN 1926, p. 589, pl. 17, fig. 4

Pseudoclavulina clavata Cushman CUSHMAN 1946, p. 36, pl. 8, figs. 22-31

Clavulina clavata Cushman HANZLIKOVA 1972, p. 59, pl. 13, fig. 12

Description: Test free, initial portion triserial, flaring rapidly and pyramidal, latter section uniserial, rectilineal with parallel sides; resembles a harpoon; sutures distinct and depressed especially in the secondary rectilineal portion; wall finely agglutinated and smooth; aperture obscured, probably an arch on inner margin of final chamber.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4; Albian Haida Fm., Cumshewa Inlet Stations 2-3; Albian Onward Point Station 1.

Other localities: Late Cretaceous Austin Chalk and Velasco Shale, Texas (Cushman, 1926, 1946): Late Cretaceous Frydek Fm., Moravia (Hanzlikova ,1972).

GENUS *Gaudryina* d'Orbigny 1839

Gaudryina cf. *nanushukensis* Tappan 1951

Plate 2, fig. 2 a-c

Gaudryina nanushukensis TAPPAN 1951, p. 2, pl. 1, figs. 8-11

Gaudryina nanushukensis Tappan, TAPPAN 1962, p. 148-149, pl. 34, figs. 11-15

Description: Test free, elongate, triserial, flaring; chambers low and broad, rapidly increasing in size in the initial portion; aperture obscured.

Discussion: Very few specimens of this species were recovered, and those that could be identified to *Gaudryina* cf. *nanushukensis* were poorly preserved, hence the *confare* designation.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4.

Other localities: Albian Grandstand, Topagoruk, and Torok fms., northern Alaska (Tappan, 1951, 1962).

Gaudryina oxycona Reuss 1860

Plate 2, fig. 3 a-d

Gaudryina oxycona REUSS 1860, p. 229, pl. 12, fig. 3

Gaudryina oxycona Reuss CHAPMAN 1892, p. 40, pl. 12, fig. 1

Gaudryina cushmani TAPPAN 1962, p. 147, pl. 34, fig. 10

Dorothia oxycona (Reuss) HANZLIKOVA 1972, p. 57, pl. 11, fig. 10

Dorothia oxycona (Reuss) KAMINSKI ET AL. 1988, p. 195, pl. 9, fig. 9

Dorothia oxycona (Reuss) McGUGAN 1990, p. 32-33, pl. 1, figs. 1-3

Description: Test free, conical with straight sides, biserial, flaring rapidly; 10-12 chambers, broad and low, increasing in size; sutures nearly invisible, horizontal; wall finely agglutinated; aperture obscured.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm., Cumshewa Inlet Stations 3-8; Albian Onward Point Station 1.

Other localities: Campanian-Maastrichtian of Europe, cosmopolitan (Reuss, 1860; Chapman, 1892; Hanzlikova, 1972; Kaminsky *et al.*, 1988); Albian Topagoruk and Torok fms., northern Alaska (Tappan, 1962); Santonian-Early Campanian Trent River Fm., Nanaimo Group, Vancouver Is., British Columbia (McGugan, 1990).

Gaudryinella irregularis Tappan 1943

Plate 2, fig. 5 a-e

Gaudryinella irregularis TAPPAN 1943, p. 490, pl. 78, figs. 31-32

Gaudryinella irregularis Tappan TAPPAN 1962, p. 150-151, pl. 35, figs. 22-24

Description: Test free, straight, loosely bi- or triserial, with alternating chambers; 5-8 spherical chambers; sutures quite distinct as the chambers not very closely appressed; wall finely agglutinated; aperture small, terminal, rounded.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-6; Albian Haida Fm., Cumshewa Inlet Stations 2-8.

Other localities: Albian Washita Group, Texas; Albian Corwin, Grandstand, Kukpowruk, Topagoruk, and Torok fms., Alaska (Tappan, 1943, 1962).

GENUS *Uvigerinammina* Majzon 1943

Uvigerinammina manitobensis (Wickenden 1932)

Plate 2, fig. 4 a-b

Tritaxia manitobensis WICKENDEN 1932, p. 87-88, pl. 1, fig. 10

Tritaxia manitobensis Wickenden CUSHMAN 1946, p. 31, pl. 7, fig. 8

Uvigerinammina manitobensis (Wickenden) TAPPAN 1962, p. 145, pl. 33, figs 18-23

Uvigerinammina manitobensis (Wickenden) McNEIL and CALDWELL 1981, p. 179-180, pl. 14, figs. 15-18

Description: Test free, chamber arrangement irregular tending loosely toward triserial, circular in cross-section, diameter of test increasing rapidly at first as whorls are added; chambers spherical and increasing only slightly in size in the adult portion as they are added; sutures distinct and depressed; wall moderately agglutinated; aperture terminal, round, on a short neck, although absent in less well-preserved specimens.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4, 6; Albian Haida Fm., Cumshewa Inlet Stations 3-8.

Other localities: Albian Tuktu Fm., northern Alaska (Tappan, 1962); Ashville Fm., Manitoba (Wickenden, 1932; McNeil and Caldwell, 1981).

Family EPONIDIDAE Hofker, 1951

GENUS *Eponides* Montfort 1808

Eponides morani Tappan 1957

Plate 2, fig. 8 a-b

Eponides morani TAPPAN 1957, p. 219-220, pl. 70, figs. 1-7

Eponides morani Tappan TAPPAN 1962, p. 191, pl. 51, figs. 1-7

Description: Test free, biconvex, trochospiral, periphery elliptical, last whorl visible, others obscured; 7-10 narrow chambers visible in final whorl; sutures distinct, depressed, curved; wall finely to moderately agglutinated; aperture obscured.

Discussion: The *confare* designation appears because the Tappan (1957, 1962) specimens were not agglutinated , but hyaline. Also, only the sutures of the final whorls of the Queen Charlotte Islands specimens were visible.

Occurrences: Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-2.

Other localities: Albian Grandstand and Topagoruk Fms., northern Alaska (Tappan, 1957, 1962).

Family GAVELINELLIDAE Hofker 1956

GENUS *Gavelinella* Brotzen 1942

Gavelinella sp. A

Plate 2, fig. 6

Description: Test free, trochospiral, 2 whorls visible on the convex spiral umbilical side; prominent spherical proloculus on the umbilical side, chambers increasing rapidly in size as they are added, 6 chambers in the final whorl; sutures distinct, depressed, radial, gently curved away from final chamber; wall calcareous, finely perforate; aperture an arch along the basal margin of the final chamber.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 2.

Gavelinella sp. B

Plate 2, fig. 7 a-b

Description: Test free, trochospiral, convex umbilical side showing only the final whorl, 2 whorls visible on the flattened spiral side; prominent spherical proloculus on the spiral side, chambers increasing rapidly in size as they are added, 6 chambers in the final whorl; sutures distinct, depressed, radial, gently curved away from final chamber, infilled with sediment; wall calcareous, finely perforate; aperture obscured.

Occurrences: Cenomanian Haida Fm., Beresford Bay Stations 4, 6.

Family HORMOSINIDAE Haeckel, 1894

GENUS *Hormosina* Brady 1879

Hormosina sp. A

Plate 3, fig. 1 a-d

Description: Test free, uniserial, rectilinear; chambers subspherical with a tapering neck attached to the next chamber, chambers not appressed as they are only attached at the tip of the neck; wall finely agglutinated with considerable cement; aperture, round, terminal, at the tip of the neck.

Discussion: Chambers almost always found disassociated from the original test due to the weak interchambral connections.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4; Albian Haida Fm., Cumshewa Inlet Station 8.

Hormosina sp. B

Plate 3, fig. 2 a-b

Description: Test free, uniserial, rectilinear; chambers amphora-like with a long tapering neck attached to the next chamber, chambers not appressed as they are only attached at the tip of the neck; wall calcareous, perforate; aperture, round, terminal, at the tip of the neck.

Discussion: Similar to H. ovuloides Grzybowski 1901 except the specimens from the Queen Charlotte Islands are more "amphora" shaped with the long necks of the individual chambers tapering to the fundus as opposed to straight necks. Chambers almost always found disassociated from the original test due to the weak interchambral connections.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4; Albian Haida Fm., Cumshewa Inlet Stations 3-6.

GENUS Reophax Montfort 1808

Reophax cylindracea Chapman 1892

Plate 3, fig. 3 a-d

Reophax cylindracea CHAPMAN 1892, p. 24, pl. 5, fig. 7

Description: Test free, straight, elongate, and uniserial; circular in cross section; chambers low and broad with a width to height ratio in excess of 2:1, gradually increasing in size as added; sutures distinct, horizontal, and depressed; wall coarsely agglutinated; aperture simple, round, and terminal.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4, 6; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Station 1.

Other localities: Gault (Albian) of Folkestone, Great Britain (Chapman, 1892).

Reophax minuta Tappan 1940

Plate 3, fig. 4 a-c

Reophax minuta TAPPAN 1940, p. 94, pl. 14, fig. 4

Reophax minuta Tappan TAPPAN 1962, p. 132-133, pl. 30, fig. 10

Description: Test free, rectinlinear, elongate, uncompressed, and uniserial; circular in cross section; chambers spherical, gradually increasing in size as added; sutures distinct, horizontal, and depressed; wall agglutinated; aperture simple, round, and terminal.

Discussion: These specimens differ somewhat to those of Tappan (1940, 1962) in that they are uncompressed.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-2, 5-6; Albian Haida Fm., Cumshewa Inlet Stations 3-8; Albian Onward Point Station 1.

Other localities: Albian Grayson Fm., Texas; Late Albian-Early Cenomanian, Gulf Coast area, U.S.A.; Albian Torok and Topagoruk Fms., northern Alaska (Tappan, 1940, 1962).

Reophax troyeri Tappan 1960

Plate 3, fig. 5 a-c

Reophax troyeri TAPPAN 1960, p. 291, pl. 1, figs. 10-12

Reophax troyeri Tappan TAPPAN 1962, p. 133, pl. 30, figs. 11-13

Reophax troyeri Tappan McNEIL and CALDWELL 1981, p. 139-140, pl. 10, fig. 1

Description: Test free, elongate, compressed, and uniserial; planar in cross section; chambers round, flat and imbricated, with a small neck extending to next chamber; usually 3 chambers per specimen, gradually increasing in size as added; sutures distinct, horizontal, and depressed; wall finely agglutinated with rough finish; aperture simple, round, and terminal at the end of the neck.

Occurrences: Cenomanian Haida Fm., Beresford Bay Stations 4, 6; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Station 1.

Other localities: Albian Topagoruk Fm., northern Alaska (Tappan, 1960, 1962); Late Albian to Cenomanian Ashville Fm., Manitoba (McNeil and Caldwell, 1981).

Reophax sp. A

Plate 3, fig. 6 a-b

Description: Test free, rectinlinear, elongate, uncompressed, and uniserial; circular in cross section; 4 low and broad chambers, rapidly increasing in size as added; sutures distinct, horizontal, and depressed; wall finely agglutinated; aperture obscured.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4.

Reophax sp. B

Plate 3, fig. 7 a-b

Description: Test free, rectinlinear, elongate, uncompressed, and uniserial; circular in cross section; 2 spherical chambers, rapidly increasing in size as added; sutures distinct, horizontal, and depressed; wall agglutinated; aperture simple, round, terminal, on a short, tapering extension of the final chamber.
Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4.

Family HYPERAMMINIDAE Eimer and Fickert 1899

GENUS *Hyperamminoides* Cushman and Waters 1928

Hyperamminoides barksdalei Tappan 1957

Plate 4, fig. 6 a-b

Hyperamminoides barksdalei TAPPAN 1957, p. 202-203, pl. 65, figs. 6-10
Hyperamminoides barksdalei Tappan TAPPAN 1962, p. 129-130, pl. 29, figs. 21-27

Description: Test free, flat, elongate, highly variable, single tubular chamber, usually widest in the middle of the fundus; wall very finely agglutinated and finely finished; aperture at open, more constricted, end of the chamber.
Occurrences: Albian Haida Fm., Cumshewa Inlet Station 4.
Other localities: Albian Grandstand and Topagoruk fms., northern Alaska (Tappan, 1957, 1962).

Hyperamminoides sp. A

Plate 4, fig. 4 a-b

Description: Test free, elongate, single cylindrical tubular chamber; wall very finely agglutinated with considerable cement, and finely finished; aperture at open end of the tube with a small apertural lip.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4.

Hyperamminoides sp. B

Plate 4, fig. 8

Description: Test free, flat, elongate, single tubular chamber, flask shaped with the widest part at the base; wall moderately agglutinated; aperture at open end of the tube.

Occurrences: Cenomanian Haida Fm., Beresford Bay Stations 4-6.

Family LITUOLIDAE de Blainville, 1825

GENUS *Ammobaculites* Cushman 1910

Ammobaculites fragmentarius Cushman 1927

Plate 4, fig. 1 a-d

Ammobaculites fragmentaria CUSHMAN 1927, p. 130, pl. 1, fig. 8

Ammobaculites fragmentarius Cushman TAPPAN 1962, p. 136-138, pl. 32, figs. 8-11

Ammobaculites fragmentarius Cushman McLEAN and WALL 1981, p. 368-369, pl. 8, figs. 9-10

Ammobaculites fragmentarius Cushman McNEIL and CALDWELL 1981, p. 158-159, pl. 12, figs. 6-7

Ammobaculites fragmentarius Cushman KOKE and STELCK 1984, p. 276-277, pl. 1, fig. 42

Description: Test free, elongate, initial planispiral early portion, rectilinear secondary portion of about 4-6 chambers, with parallel sides; circular in cross section to compressed; sutures dinstinct and depressed; wall coarsely agglutinated; aperture obscured.

Discussion: Due to the preservation of the specimens, and their small size, it was not possible to see the individual chambers on the initial planispiral portion.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4-6; Albian Haida Fm., Cumshewa Inlet Stations 2-8.

Other localities: Albian Grandstand, Kukpowruk, and Topagoruk fms., northern Alaska (Tappan, 1962); Late Albian Ashville Fm., Manitoba (McNeil and Caldwell, 1981); Albian Hasler Fm., British Columbia (Koke and Stelck, 1984).

Ammobaculites wenonahae Tappan 1960

Plate 4, fig. 2 a-d

Ammobaculites wenonahae TAPPAN 1960, p. 291, pl. 1, figs. 3-6

Ammobaculites wenonahae Tappan TAPPAN 1962, p. 138-139, pl. 32, figs. 1-7

Ammobaculites wenonahae Tappan KOKE and STELCK 1984, p. 276-277, pl. 1, figs. 33-35

Description: Test free, elongate, initial planispiral early portion with about 4 chambers, rectilinear secondary portion of about 4-5 chambers, with parallel sides; circular in cross section to compressed; sutures dinstinct and depressed; wall very coarsely agglutinated; aperture obscured.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4; Albian Haida Fm., Cumshewa Inlet Station 4.

Other localities: Albian Grandstand and Topagoruk fms., northern Alaska (Tappan, 1960, 1962); Albian Hasler Fm., British Columbia (Koke and Stelck, 1984).

Ammobaculites sp.

Plate 4, fig. 3 a-b

Description: Test free, elongate, initial planispiral early portion not as tightly coiled as *A. wenonahae*, rectilinear secondary portion, with parallel sides; circular in cross section to compressed; chambers and sutures indinstinct due to coarse agglutination; aperture obscured.

Discussion: The sp. designation is cited as no individual chambers are visible, thus a positive identification is not possible.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 6.

GENUS *Haplophragmoides* Cushman 1910

Haplophragmoides charlottensis n. sp.

Plate 4, fig. 5 a-b

Description: Test free, large, planispiral, always found flattened perpendicular to the coiling axis; about 4-6 chambers slightly inflated; sutures straight and radial, distinct, slightly depressed; surface finely agglutinated and smooth; aperture an arch at the base of the final chamber.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4; Albian Haida Fm., Cumshewa Inlet Stations 2-8.

Haplophragmoides concava (Chapman 1892)

Plate 5, fig. 1 a-b

Trochammina concavus CHAPMAN 1892, p. 30, pl. 6, fig. 14

Haplophragmoides formosus TAKAYANAGI 1960, p. 70, pl. 1, fig. 22

Haplophragmoides concavus (Chapman) SLITER 1980, p. 374-375, pl. 2, figs. 1-3

Description: Test free, planispiral, and biconvex; chambers somewhat inflated in the umbilical region, about 4-6 in the final whorl; sutures distinct, depressed, radial; aperture an interiomarginal arch at the base of the final chamber.

Discussion: The genus *Haplophragmoides* is feminine, thus *concava* for the specific rather than *concavus*.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4, 6; Albian Haida Fm., Cumshewa Inlet Stations 4-7.

Other localities: Gault (Albian) of Folkestone, Great Britain (Chapman, 1892); Aptian-Maastrichtian, Japan (Takayanagi, 1960); Deep Sea Drilling Project Site 416 (Sliter, 1980).

Haplophragmoides cf. *calcula* Cushman and Waters 1927

Plate 4, fig. 7 a-c

Haplophragmoides calcula CUSHMAN and WATERS 1927, p. 83, pl. 10, fig. 5

Haplophragmoides calcula Cushman and Waters McNEIL and CALDWELL 1981, p. 146-147, pl. 11, fig. 1

Description: Test free, planispiral; umbilical areas planar; chambers somewhat inflated in the umbilical region, about 7-9 in the final whorl if they are seen at all; sutures obscure because surface very coarsely agglutinated and roughly finished; aperture obscured, but may be an interiomarginal arch.

Discussion: This is represented by only one specimen , and the sutures are obscured hence the *confare* designation.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4.

Other localities: Maastrichtian Late Navarro Group, Texas (Cushman and Waters, 1927); Campanian Pembina and Millwood Members, Pierre Shale, Manitoba (McNeil and Caldwell, 1981).

Haplophragmoides gigas Cushman 1927

Plate 5, fig. 3 a-b

Haplophragmoides gigas CUSHMAN 1927, p. 129-130, pl. 1, fig. 5

Haplophragmoides gigas Cushman McNEIL and CALDWELL 1981, p. 147-148, pl. 11, figs. 4-5

Description: Test free, large, planispiral, and slightly compressed; chambers somewhat inflated in the umbilical region, about 7-9 in final whorl; sutures sinuate and distinct, slightly depressed, and radial; surface finely agglutinated and smooth; aperture on the final chamber, an interiomarginal arch.

Discussion: H. gigas is an Albian index species.

Occurrences: Late Albian Haida Fm., Beresford Bay Station 1; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Station 3.

Other localities: Middle to Late Albian Lloydminster shale and Joli Fou shale, Alberta, Saskatchewan, and Manitoba (McNeil and Caldwell, 1981).

Haplophragmoides suborbicularis (Grzybowski 1896)

Plate 5, fig. 2 a-f

Cyclammina suborbicularis GRZYBOWSKI 1896, p. 63, pl. 9, figs. 5-6

Haplophragmoides impensus Martin 1964 McNEIL and CALDWELL 1981, p. 151-152, pl. 11, fig. 9

Haplophragmoides suborbicularis (Grzybowski) KAMINSKI ET AL. 1988, p. 189, pl. 5, figs. 12-13

Description: Test free, large, planispiral, occasionally trochospiral, most often globular; chambers slightly inflated, about 5-7 in final whorl; sutures straight and radial, distinct, slightly to moderately depressed; surface finely agglutinated and smooth; aperture on the final chamber an interiomarginal arch.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-6; Albian Haida Fm., Cumshewa Inlet Stations 2-7.

Other localities: Albian, Wadowice, Poland (Grzybowski 1896); Late Campanian Millwood and Odanah members, Pierre Shale, Manitoba (McNeil and Caldwell, 1981).

Haplophragmoides topagorukensis Tappan 1957

Plate 5, fig. 4 a-d

Haplophragmoides topagorukensis TAPPAN 1957, p. 203-204, pl. 65, figs. 15-25
Haplophragmoides topagorukensis Tappan TAPPAN 1962, p. 135-136, pl. 31, figs. 1-15

Description: Test free, planispiral, involute, laterally compressed, biumbilicate, periphery rounded to elliptical, and slightly smaller than H. gigas; chambers flat, about 7-10 in final whorl; sutures distinct in well-preserved specimens, slightly depressed, straight, and radial, although in most specimens sutures are often obscured; surface moderately to finely agglutinated; aperture obscured, but more than likely a low interiomarginal arch.
Discussion: The variability of the test shape, from circular to elliptical is probably due to preservational distortion. Very few specimens had well-preserved sutures.
Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 3; Albian Haida Fm., Cumshewa Inlet Stations 2-6.
Other localities: Albian Topagoruk Fm., northern Alaska (Tappan, 1957, 1962).

Family NODOSARIIDAE Ehrenberg 1839

GENUS *Dentalina* d'Orbigny 1826

Dentalina distincta Reuss 1860

Plate 5, fig. 5 a-d

Dentalina distincta REUSS 1860, p. 184, pl. 2, fig. 5

Dentalina distincta Reuss TAPPAN 1962, p. 175, pl. 45, fig. 18

Dentalina distincta Reuss SLITER 1980, p. 382-383, pl. 6, figs. 23-24

Description: test free, rectilinear, slightly curved; 4-5 ovoid chambers, gradually increasing in size as they are added; sutures distinct, depressed, and oblique; wall calcareous and perforate in some specimens; aperture terminal, usually obscured.

Dicussion: Very few well-preserved specimens were recovered from the Queen Charlotte Islands, but there were many fragments that may have been *D. distincta.*

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4; Albian Haida Fm., Cumshewa Inlet Stations 4-8; Albian Onward Point Station 1.

Other localities: Late Albian (Late Gault), northern Germany (Reuss, 1860); Albian Topagoruk Fm., northern Alaska (Tappan, 1962); Deep Sea Drilling Project Site 416 (Sliter, 1980).

GENUS *Nodosaria* Lamarck 1812

Nodosaria doliiformis Eichenberg 1933

Plate 6, fig. 2 a-b

Nodosaria doliiformis EICHENBERG 1933, p. 7, pl. 7, fig. 6

Nodosaria doliiformis Eichenberg TAPPAN 1962, p. 173, pl. 45, figs. 13-14

Description: Test free, narrow, rectilinear, with straight sides; 4-7 cylindrical chambers gradually increasing in size as they are added, later chambers higher than broad; sutures distinct and slightly depressed; wall calcareous and hyaline; aperture terminal and rounded.

Discussion: The specimens from this study were usually found broken, so there is some doubt about the average number of chambers.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-6; Albian Haida Fm.. Cumshewa Inlet Station 3; Albian Onward Point Station 1.

Other localities: Albian, northern Germany (Eichenberg, 1933); Albian Torok Fm., northern Alaska (Tappan, 1962).

Nodosaria flexocarinata Khan 1950

Plate 6, fig. 3 a-b

Nodosaria fontannesi var. *flexocarinata* KHAN 1950, p. 269, pl. 1, figs. 6-8

Nodosaria flexocarinata Khan TAPPAN 1962, p. 173, pl. 45, figs. 3-4

Description: Test free, rectilinear, with about 20 costae running the length of the test; 6-7 spherical chambers closely appressed; sutures distinct, horizontal, and depressed; wall calcareous; aperture terminal, rounded.

Discussion: Very few well-preserved specimens were recovered from the Queen Charlotte Islands, but there were many fragments that may have been *N. flexocarinata.*

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2-3; Albian Haida Fm., Cumshewa Inlet Station 8.

Other localities: Albian (Gault), Great Britain (Khan, 1950); Albian Grandstand Fm., northern Alaska (Tappan, 1962).

GENUS *Frondicularia* Defrance 1826

Frondicularia extensa Morrow 1934

Plate 6, fig. 4 a-b

Frondicularia extensa MORROW 1934, p. 193, pl. 29, fig. 31

Frondicularia extensa Morrow CUSHMAN 1946, p. 86, pl. 34, figs. 3-4

Frondicularia extensa Morrow (1936 - *sic.*) McNEIL and CALDWELL 1981, p.195-196, pl. 16, fig. 4

Description: Test free, flattened, broad, frond-like, with smooth periphery; prominent spherical proloculus, 8-10 broad chambers of equal height, but increasing width as they are added; sutures oblique, distinct and slightly depressed; wall calcareous and hyaline; aperture terminal, radiate, on a neck.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2.

Other localities: Coniacian Niobrara Fm., Kansas (Morrow,1934); Coniacian-Santonian Austin Chalk, Texas (Cushman, 1946); Santonian Niobrara Fm., Manitoba (McNeil and Caldwell, 1981).

Frondicularia sp. A

Plate 6, fig. 6 a-c

Description: Test free, broad, frond-like, with smooth periphery; prominent spherical proloculus, 10 broad chambers of equal height, each pair intercalated over previous; sutures oblique, distinct and slightly depressed; wall calcareous and hyaline; aperture terminal, radiate, on a neck.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2, 4.

Frondicularia sp. B

Plate 6, fig. 8

Description: Test free, flattened, broad, frond-like, with smooth periphery; prominent spherical proloculus, 4(?) broad chambers of equal height, but increasing width as they are added; sutures obscured; wall calcareous and hyaline; aperture terminal, radiate, on a neck.
Discussion: This is similar to *Flabellina didyma* Berthelin 1880 (in Chapman 1893, p. 73, pl. 6, fig. 7). However, the sutures are obscured, except for the proloculus, in the Queen Charlotte Islands specimen, and the proloculus differs from the Chapman specimen.
Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2; Albian Haida Fm., Cumshewa Inlet Station 4.

GENUS *Lenticulina* Lamarck 1804

Lenticulina cf. *ingenua* (Berthelin 1880)

Plate 6, fig. 9 a-b

Cristellaria ingenua BERTHELIN 1880, p. 54, pl. 3, figs. 20-21
Lenticulina ingenua (Berthelin) TAPPAN 1962, p. 162, pl. 41, figs. 1-2

Description: Test free, lenticular, tending toward planispiral, unravelling later on, periphery keeled; chambers increasing in size gradually as they are added; sutures indistinct and depressed; wall finely agglutinated with considerable cement; aperture radiate at the peripheral angle of the final chamber.
Discussion: Only two specimens were recovered from the Queen Charlotte Islands, and they did not show a large proloculus nor a calcareous hyaline wall structure, and the

sutures were obscured, hence the *confare* designation.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4.

Other localities: Albian, France (Berthelin, 1880); Albian Torok Fm., northern Alaska (Tappan, 1962).

Lenticulina macrodisca (Reuss 1863)

Plate 6, fig. 10 a-b

Cristellaria macrodisca REUSS 1863, p. 78, pl. 9, fig. 5

Lenticulina macrodisca (Reuss) TAPPAN 1962, p. 162-163, pl. 40, figs. 5-8

Description: Test free, lenticular, planispiral, periphery keeled; large spherical proloculus, chambers distinct, about 8-10 in final whorl; sutures gently curved, distinct under optical light, but not depressed; wall calcareous, hyaline, smooth, and translucent under optical light; aperture radiate at periphery angle.

Discussion: The sutures were completely obscured under the scanning electron microscope, hence the inclusion of figures taken through an optical microscope. The specimens were two basic sizes. The larger ones were 0.8-1.2 mm in diameter, and the smaller ones were from 0.2 to 0.35 mm in diameter. There was no gradual spectrum of sizes, one might consider these two distinct species, but as specimens of both sizes were always found together, they probably represent alteration of generations.

*Occurrences:*Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-4; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Stations 1-4.

Other localities: Albian (Late Hils and Middle Gault), northern Germany (Reuss, 1863); Albian, France, Czechoslovakia, and Bavaria; Albian Grandstand, Topagoruk, and Fortress Mountain fms., northern Alaska (Tappan, 1962).

GENUS *Marginulina* d'Orbigny 1826

Marginulina inepta (Reuss 1846)

Plate 6, fig. 1 a-b

Dentalina inepta REUSS 1846, p. 40, pl. 2, fig. 13

Marginulina inepta (Reuss) TAPPAN 1962, p. 169-170, pl. 44, figs. 6-7

Description: Test free, elongate, rectilinear with about 14 surface costae running the length of the test; 3-4 spherical chambers gradually increasing in size; sutures distinct and depressed; wall finely agglutinated; aperture terminal, round, on a short neck.

Discussion: This species could be placed in the genus *Nodosaria* because of its straight axis. Tappan (1962) placed it in *Marginulina* as some of those specimens had slightly curved axes, and because its aperture was not only simple, terminal, and rounded, but on a short neck.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2, 4; Albian Onward Point Stations 1, 4.

Other localities: Gault (Albian), northern Germany (Reuss, 1846); Albian Topagoruk Fm., northern Alaska (Tappan, 1962)

Marginulina planiuscula (Reuss 1862)

Plate 5, fig. 6 a-b

Cristellaria planiuscula REUSS 1862, p. 71, pl. 7, fig. 51

Cristellaria planiuscula Reuss CHAPMAN 1894, p. 97, pl. 10, fig. 14

Marginulina planiuscula (Reuss 1862) TAPPAN 1962, p. 170, pl. 43, figs. 8-11

Description: Test free, small, initial potion slighly coiled, with about 10 very faint surface costae running the length of the test; 4-5 spherical chambers initially rapidly increasing in size; sutures distinct and depressed; wall finely agglutinated; aperture radiate, terminal.
Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2.
Other localities: Neocomian, northern Germany (Reuss, 1862); Albian (Gault), Folkestone, Great Britain (Chapman, 1894); Albian Grandstand Fm., northern Alaska (Tappan, 1962).

GENUS *Saracenaria* Defrance 1824

Saracenaria grandstandensis Tappan 1960
Plate 7, fig. 3 a-b

Saracenaria grandstandensis TAPPAN 1960, p. 292, pl. 2, figs. 8-10
Saracenaria grandstandensis Tappan TAPPAN 1962, p. 164, pl. 41, figs. 3-5
Saracenaria grandstandensis Tappan McLEAN and WALL 1981, p. 370-371, pl. 9, figs. 1-2

Description: Test free, elongate, with parallel sides; initial 2-3 chambers added on a slightly curved axis, last 4-6 chambers rectilinear; chambers low and broad; sutures slighly curved and distinct under optical light; wall calcareous and hyaline; aperture radiate and the peripheral angle, produced on a very short neck.
Discussion: The sutures were completely obscured under the scanning electron microscope, hence the inclusion of figures taken through an optical microscope.
Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4; Albian

Haida Fm., Cumshewa Inlet Station 3; Albian Onward Point Stations 3-4.

Other localities: Albian Grandstand and Topagoruk fms., northern Alaska (Tappan, 1960, 1962)

Saracenaria projectura Stelck and Wall 1956

Plate 7, fig. 1 a-b

Saracenaria projectura STELCK and WALL 1956, p. 50, pl. 3, figs. 22-25

Saracenaria projectura Stelck and Wall TAPPAN 1962, p. 164-165, pl. 41, figs. 9-14

Description: Test free, elongate, initial 3-4 chambers planispiral, last 4-6 chambers large, triangular in cross-section with smooth edges, curving only slightly toward initial half-coil; sutures slighly curved and distinct under optical light; wall calcareous and hyaline; aperture radiate and the peripheral angle, produced on a very short neck.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4; Albian Haida Fm., Cumshewa Inlet Stations 2-8.

Other localities: Early Albian Clearwater Fm., Alberta (Stelck *et al.*, 1956); Albian Fortress Mountain, Grandstand, Topagoruk, and Torok fms., northern Alaska (Tappan, 1962).

Saracenaria valanginiana (Bartenstein and Brand 1951)

Plate 7, fig. 2 a-b

Lenticulina valanginiana BARTENSTEIN and BRAND 1951, p. 291, pl. 13, figs. 364-365

Saracenaria valanginiana (Bartenstein and Brand) TAPPAN 1962, p. 166, pl. 42, figs. 7-8

Description: Test free, initial 3-4 chambers planispiral, final 4-6 chambers elongate, triangular in cross-section with distinct keels at each angle; sutures distinct and elevated; wall calcareous and hyaline; aperture radiate and the peripheral angle, produced on a very short neck

Occurrences: Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-3.

Other localities: Valanginian, northwest Germany (Bartenstein and Brand, 1951); Albian Torok Fm., northern Alaska (Tappan, 1962).

Family ROTALIPORIDAE Sigal 1958

GENUS *Hedbergella* Bronnimann and Brown 1950

Hedbergella delrioensis (Carsey 1926)

Plate 7, fig. 4 a-b

Hedbergella delrioensis (Carsey 1926) McNEIL and CALDWELL 1981, p. 252-253, pl. 20, figs. 5-6

Description: Test free, trochospiral; chambers spherical to ovate, initial chambers tiny, increasing rapidly in size, only final whorl (5-7 chambers) visible on the umbilical side, chambers of the final whorl not very closely appressed; sutures distinct, depressed; walls calcareous, perforate; aperture an interiomarginal arch at the base of the final chamber.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4, 6.

Other localities: Late Cenomanian (?)-Santonian Favel and Niobrara fms., Manitoba (McNeil and Caldwell, 1981).

Hedbergella gorbachikae Longoria 1974

Plate 7, fig. 5 a-b

Hedbergella gorbachikae LONGORIA 1974, p. 56-58, pl. 15, figs. 1-16

Hedbergella gorbachikae Longoria CARON 1985, p. 31-32, fig. 7

Description: Test free, trochospiral; chambers relatively large and spherical, increasing gradually in size, not very closely appressed; sutures distinct, depressed; walls calcareous; aperture an interiomarginal arch at the base of the final chamber.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island.

Other localities: Late Aptian-Early Albian La Pena and Repressa fms., Spain (Longoria, 1974).

Hedbergella planispira (Tappan 1940)

Plate 7, fig. 6 a-b

Globigerina planispira TAPPAN 1940, p. 122, pl. 19, fig. 12

Hedbergella planispira (Tappan) EICHER 1967, p. 186, pl. 19, fig. 3

Hedbergella planispira (Tappan) McNEIL and CALDWELL 1981, p. 255-256, pl. 20, figs. 7-8

Description: Test free, tiny (< 0.4 mm), planispiral; chambers spherical, initial chambers tiny, increasing rapidly in size as they are added, more closely appressed than in *H. delrioensis*; sutures distinct, depressed; walls calcareous, perforate; aperture an interiomarginal arch at the base of the final chamber.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-4; Albian Haida Fm., Cumshewa Inlet Stations 1-5.

Other localities: Albian Grayson Fm., Texas (Tappan, 1940); Cenomanian Belle Fourche Shale, Wyoming and Montana (Eicher, 1967); Late Cenomanian (?)-Santonian Favel and Niobrara fms., Manitoba (McNeil and Caldwell, 1981).

Family RZEHAKINIDAE Cushman 1933

GENUS *Miliammina* Heron-Allen and Earland 1930

Miliammina ischnia Tappan 1957

Plate 7, fig. 8 a-b

Miliammina ischnia TAPPAN 1957, p. 211, pl. 67, figs. 25-26

Miliammina ischnia Tappan TAPPAN 1962, p. 160, pl. 37, figs. 1-5

Description: Test free, planispiral, sides parallel in the middle of the test, gently curved around the poles; chambers long and narrow, a half whorl in length, circular cross-section; sutures distinct and depressed; wall moderately to coarsely agglutinated; aperture at the end of the final chamber.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4; Albian Haida Fm., Cumshewa Inlet Station 2.

Other localities: Albian Grandstand and Topagoruk fms., northern Alaska (Tappan, 1957, 1962).

Miliammina manitobensis Wickenden 1932

Plate 7, fig. 7 a-d

Miliammina manitobensis WICKENDEN 1932, p. 90, pl. 1, fig. 11

Miliammina manitobensis Wickenden CUSHMAN 1946, p. 48, pl. 14, figs. 4-6

Miliammina manitobensis Wickenden McLEAN and WALL 1981, p. 364-365, pl. 7, figs. 2-3

Miliammina manitobensis Wickenden McNEIL and CALDWELL 1981, p. 143-144, pl. 10, figs. 9-14

Description: Test free, ovate, quinqueloculine; chambers long and relatively thick, a half a coil in length, circular cross-section; sutures distinct and depressed; wall finely agglutinated; aperture at the end of the final chamber, on a very short neck parallel to the axis of the test.

Occurrences: Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-4, 6; Albian Onward Point Station 1.

Other localities: Late Albian Ashville Fm., Manitoba; Late Albian of the Lloydminster shale, Alberta; Albian, Joli Fou Fm., Alberta (Cushman, 1946; McNeil and Caldwell, 1981).

GENUS *Psamminopelta* Tappan 1957

Psamminopelta subcircularis Tappan 1957

Plate 7, fig. 9 a-b

Psamminopelta subcircularis TAPPAN 1957, p. 213, pl. 67, figs. 8-10

Psamminopelta subcircularis Tappan TAPPAN 1962, p. 158-159, pl. 37, figs. 7-10

Description: Test free, small, planispiral; chambers curved, long, and narrow, a half whorl in length, circular cross-section; sutures distinct and depressed; wall very finely agglutinated with considerable cement; aperture at the end of the last chamber.
Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 3-4.
Other localities: Albian Corwin, Grandstand, Topagoruk, Torok, and Tuktu fms., Alaska (Tappan, 1957, 1962).

Family SCHACKOINIDAE Pokorny 1958

GENUS *Schackoina* Thalmann 1932

Schackoina cenomana (Schacko 1897)

Plate 8, fig. 1 a-b

Siderolina cenomana SCHACKO 1897, p. 166-168, pl. 4, figs. 3-5

Hantkenina cenomana (Schacko) CUSHMAN and WICKENDEN 1930, p. 40, pl. 6, figs. 1-3

Schackoina cenomana (Schacko) BOLLI, LOEBLICH, and TAPPAN 1957, p. 36, pl. 2, figs. 1-2

Schackoina cenomana (Schacko) McNEIL and CALDWELL 1981, p. 248-249, pl. 19, fig. 17

Description: Test free, planispiral; 4-5 not very closely appressed ovate chambers, each tapering to a short spine; sutures distinct and depressed; wall calcareous and perforate;

aperture obscured.

Discussion: S. cenomana is a Cenomanian index species.

Occurrences: Cenomanian Haida Fm., Beresford Bay Stations 4, 6.

Other localities: Cenomanian, California, Kansas, Texas, northern Germany (Bolli, Loeblich, and Tappan 1957; Schacko, 1897); Late Cenomanian (?) Favel Fm., Manitoba (McNeil and Caldwell, 1981).

Family TEXTULARIIDAE Ehrenberg 1839

GENUS *Textularia* Defrance 1824

Textularia losangica Loeblich and Tappan 1951

Plate 8, fig. 4 a-c

Textularia losangica LOEBLICH and TAPPAN 1951, p. 82, pl. 2, figs. 4-5

Description: Test free, flattened, broad, biserial, with smooth periphery, diamond-shaped in cross-section; 14-16 broad chambers of almost equal height, but increasing width as they are added; sutures straight, distinct and elevated with a central zigzag suture between the two series of chambers; wall moderately agglutinated; aperture obscured.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Station 1.

Other localities: Albian Duck Creek Fm. and Washita Group, Texas (Loeblich and Tappan, 1951).

Textularia topagorukensis Tappan 1957

Plate 8, fig. 6 a-b

Textularia topagorukensis TAPPAN 1957, p. 205-206, pl. 66, figs. 8-9

Spiroplectammina koveri TAPPAN 1957, p. 205, pl. 66, figs. 1-2

Textularia topagorukensis Tappan TAPPAN 1962, p. 141-142, pl. 33, fig. 11

Description: Test free, elongate, early chambers obscured, later chambers biserial and rectilinear, about 5-7 pairs; sutures distinct, depressed, and obliquely angled outward toward proloculus; wall finely agglutinated; aperture obscured.

Discussion: Originally described by Tappan (1957) as two separate species, it was redescribed as *T. topagorukensis* as it was deemed that both *T. topagorukensis* and *Spiroplectammina koveri* represented two different generations as they were always found together (Tappan 1962). The specimens from the Queen Charlotte Islands seem to be *S. koveri* rather than *T. topagorukensis*, and only those specimens appear in the synonymy. Tappan's (1957) specimens of *S. koveri* showed the early chambers in a planispiral coil, which is possible in these specimens but impossible to confirm due to poor preservation.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian-Cenomanian Haida Fm., Beresford Bay Stations 1-6.

Other localities: Albian Topagoruk Fm., northern Alaska (Tappan, 1957, 1962).

Textularia sp.

Plate 6, fig. 5 a-b

Description: Test free, flattened, broad, biserial, with jagged periphery, thin and straight in cross-section; 8-12 broad chambers of equal height, but increasing width as they are added;

sutures straight, distinct and slightly elevated with a central zigzag suture between the two series of chambers; wall calcareous and hyaline; aperture obscured.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2; Albian Haida Fm., Cumshewa Inlet Stations 4-5.

Family TRITAXIIDAE Plotnikova 1979

GENUS *Tritaxia* Reuss 1860

Tritaxia tricarinata (Reuss 1845)

Plate 8, fig. 2 a-b

Textularia tricarinata REUSS 1845, p. 39, pl. 8, fig. 60

Dentalinopsis tricarinatum Reuss REUSS 1863, p. 119, pl. 18, fig. 13

Tritaxia tricarinata Reuss CHAPMAN 1892, p. 34-35 (p. 749), pl. 11, fig. 1

Tritaxia tricarinata Reuss HANZLIKOVA 1972, p. 54, pl. 11, fig. 11

Tritaxia tricarinata Reuss SLITER 1985, p. 347, pl. 1, figs. 19-20

Description: Test free, triserial. Wall coarsely agglutinated. Aperture obscured.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian-Cenomanian Haida Fm., Beresford Bay Station 1-4; Albian Haida Fm., Cumshewa Inlet Stations 2-8; Albian Onward Point Station 1.

Other localities: Gault (Albian) of Folkestone, Great Britain (Chapman, 1892); Santonian Godula Fm., Moravia (Hanzlikova, 1972); Deep Sea Drilling Project Site 585 (Sliter, 1985).

Family TROCHAMMINIDAE Schwager 1877

GENUS *Trochammina* Parker and Jones 1859

Trochammina wetteri Stelck and Wall 1955

Plate 8, fig. 3 a-f

Trochammina wetteri STELCK and WALL 1955, p. 59-60, pl. 2, figs. 1-3, 6

Trochammina wetteri Stelck and Wall McNEIL and CALDWELL 1981, p. 173-174, pl. 13, fig. 10

Description: Test free, planispiral, only one whorl; chambers few, not closely appressed, about 4-5, rapidly expanding as added; sutures distinct and depressed; wall thick, finely to moderately agglutinated, roughly finished; aperture obscured.

Occurrences: Early Albian Longarm Fm., Rennell Sound Road, west-central Graham Island; Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Stations 2-4, 6; Albian Haida Fm., Cumshewa Inlet Stations 3-7; Albian Onward Point Stations 1, 4.

Other localities: Cenomanian-Turonian Kaskapau Fm., (Alberta Stelck and Wall, 1955); Late Albian-Santonian Ashville and Niobrara fms., Manitoba (McNeil and Caldwell, 1981).

Trochammina sp.

Plate 8, fig. 7 a-b

Description: Test free, tiny, pyritized, trochospiral, with two visible whorls on the umbilical side, only the final whorl visible on the other side; chambers globular, not very closely appressed, about 8 per whorl; sutures distinct and depressed; wall structure obscured by pyritization; aperture obscured.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2; Albian Haida Fm., Cumshewa Inlet Stations 2-4.

Family TURRILINIDAE Cushman 1927

GENUS *Praebulimina* Hofker 1953

Praebulimina reussi (Morrow 1934)

Plate 8, fig. 5 a-c

Praebulimina reussi MORROW 1934, p. 195-196, pl. 29, fig. 12

Praebulimina reussi (Morrow) McNEIL and CALDWELL, p. 225-226, pl. 18, fig. 12

Description: Test free, small, ovate, triserial, and circular in transverse section, greatest breadth above the middle; initial end sharply rounded, terminal end obtuse; chambers round, enlarging rapidly as added; early sutures distinct and depressed, later ones become obscure; wall smooth; aperture obscure or terminal.

Occurrences: Late Albian (?)-Cenomanian Haida Fm., Beresford Bay Station 2.

Other localities: Late Cretaceous, Bohemia (Reuss, 1845; Morrow, 1934); Santonian Niobrara Fm., Manitoba (McNeil and Caldwell, 1981).

Incerta

Plate 6, fig. 7 a-b

Description: Test free, rectilinear and curved with 3 chambers, 4-5 costae running the length of the test; sutures highly oblique; wall finely agglutinated with considerable cement; aperture radial, terminal, large, produced on a neck.

Occurrences: Cenomanian Haida Fm., Beresford Bay Station 4.

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PLATE 1

All scale bars are 100 µm unless otherwise stated

Fig. 1 a-b	*Ammodiscus kiowensis* Loeblich and Tappan 1950. a) side; from Beresford Bay Station 6; b) oblique; from Rennell Sound Road. *p. 47-48.*
Fig. 2 a-d	*Ammodiscus pennyi* Cushman and Jarvis 1928. a side, b oblique; from Beresford Bay Station 6. a) side, b) edge; from Beresford Bay Station 3. *p. 48-49.*
Fig. 3 a-b	*Ammodiscus* cf. *pennyi* Cushman and Jarvis 1928. a) side, b) edge; from Beresford Bay Station 6. *p. 49.*
Fig. 4 a-b	*Ammodiscus rotalarius* Loeblich and Tappan 1949. a) side, b) edge; from Beresford Bay Station 3. *p. 50.*
Fig. 5 a-d	*Glomospira corona* Cushman and Jarvis 1928. a) side, b) edge; from Beresford Bay Station 6. c) side; from Beresford Bay Station 4. d) side; from Beresford Bay Station 6. *p. 51-52.*
Fig. 6 a-b	*Bathysiphon brosgei* Tappan 1957. a) side, b) aperture; from Onward Point Station 2. *p. 52-53.*
Fig. 7 a-d	*Bathysiphon vitta* Nauss 1947. a), c) side, b), d) aperture; both from from Beresford Bay Station 3. *p. 53.*

PLATE 2

All scale bars are 100 μm unless otherwise stated

Fig. 1	*Clavulina clavata* Cushman 1926. Side view; from Beresford Bay Station 2. *p. 54.*
Fig. 2 a-c	*Gaudryina* cf. *nanushukensis* Tappan 1951. a) side, b) aperture (?), c. prolocular; from Beresford Bay Station 3. *p. 55.*
Fig. 3 a-d	*Gaudryina oxycona* Reuss 1860. a), c) side, b), d) prolocular; both from Onward Point Station 2. *p. 55-56.*
Fig. 4 a-b	*Uvigerinammina manitobensis* (Wickenden 1932). a) side, b) prolocular; from Beresford Bay Station 4. *p. 57.*
Fig. 5 a-e	*Gaudryinella irregularis* Tappan 1943. a) side, b) prolocular, (cf.) c) side, d) edge; both from Beresford Bay Station 4. e) side; from Beresford Bay Station 3. *p. 56-57.*
Fig. 6	*Gavelinella* sp. A. Umbilical view; from Beresford Bay Station 2. *p. 58-59.*
Fig. 7 a-b	*Gavelinella* sp. B. a) Umbilical, b) bottom; from Beresford Bay Station 4. *p. 59.*
Fig. 8 a-b	*Eponides morani* Tappan 1957. a) umbilical, b) edge; from Beresford Bay Station 3. *p. 58.*

PLATE 3

All scale bars are 100 μm unless otherwise stated

Fig. 1 a-d	*Hormosina* sp. A. a), c) side, b), d), top; from Beresford Bay Station 3. These are single chambers which were part of a uniserial, rectilinear test. *p. 59-60.*
Fig. 2 a-b	*Hormosina* sp. B. a) side, b) top; from Beresford Bay Station 4. These are single chambers which were part of a uniserial, rectilinear test. *p. 60*
Fig. 3 a-d	*Reophax cylindracea* Chapman 1892. a) side, b) prolocular, c) apertural; from Beresford Bay Station 3. d) side; from Rennell Sound Road. *p. 60-61.*
Fig. 4 a-c	*Reophax minuta* Tappan 1940. a) side; from Onward Point Station 1. b) apertural; from Beresford Bay Station 6. c) side; from Rennell Sound Road. *p. 61.*
Fig. 5 a-c	*Reophax troyeri* Tappan 1960. a) side, b) apertural, c) edge; from Onward Point Station 1. *p. 62.*
Fig. 6 a-b	*Reophax* sp. A. a) side, b) prolocular (?); from Beresford Bay Station 4. *p. 62*
Fig. 7 a-b	*Reophax* sp. B. a) side, b) apertural; from Beresford Bay Station 4. *p. 63.*

PLATE 4

All scale bars are 100 μm unless otherwise stated

Fig. 1 a-d	*Ammobaculites fragmentarius* Cushman 1927. a) side, b) edge; from Beresford Bay Station 5. c) side, d) edge; from Cumshewa Inlet Station 8. *p. 64-65.*
Fig. 2 a-d	*Ammobaculites wenonahae* Tappan 1960. a), c), side, b), d), edge; both from Beresford Bay Station 4. *p. 65-66.*
Fig. 3 a-b	*Ammobaculites* sp. Tappan 1960. a) side, b) edge; from Beresford Bay Station 6. *p. 66.*
Fig. 4 a-b	*Hyperamminoides* sp. A. a) side, b) apertural; from Beresford Bay Station 5. *p. 64.*
Fig. 5 a-b	*Haplophragmoides charlottensis* n. sp. a) edge, b) umbilical; from Beresford Bay Station 6. *p. 66-67.*
Fig. 6 a-b	*Hyperamminoides barksdalei* Tappan 1957. a) side, b) edge; from Beresford Bay Station 6. *p. 63*
Fig. 7 a-c	*Haplophragmoides* cf. *calcula* Cushman and Waters 1927. a) umbilical, b) edge, c) other umbilical; from Beresford Bay Station 3. *p. 67-68.*
Fig. 8	*Hyperamminoides* sp. B. Side view; from Beresford Bay Station 5. *p. 64.*

PLATE 5

All scale bars are 100 μm unless otherwise stated

Fig. 1 a-b	*Haplophragmoides concava* (Chapman 1892). a) side/umbilical, b) edge/apertural; from Beresford Bay Station 6. *p. 67.*
Fig. 2 a-f	*Haplophragmoides suborbicularis* (Grzybowski 1896). a) apertural, b) edge, c) umbilical; d) umbilical, e) edge, f) apertural; both from Beresford Bay Station 3. *p. 69.*
Fig. 3 a-b	*Haplophragmoides gigas* Cushman 1927. a) umbilical, b) edge; from Beresford Bay Station 3. *p. 68-69.*
Fig. 4 a-d	*Haplophragmoides topagorukensis* Tappan 1957. a) side, b) apertural/edge; from Beresford Bay Station 3. a) umbilical, b) edge/apertural; from Beresford Bay Station 3. a) umbilical, b) edge/apertural(?); from Beresford Bay Station 2. *p. 70.*
Fig. 5 a-d	*Dentalina distincta* Reuss 1860. a) edge, b) side; from Beresford Bay Station 2. c) side, d) oblique; from Onward Point Station 3. *p. 70-71.*
Fig. 6 a-b	*Marginulina planiuscula* (Reuss 1862). a) side, b) apertural; from Beresford Bay Station 2. *p. 76-77.*

PLATE 5

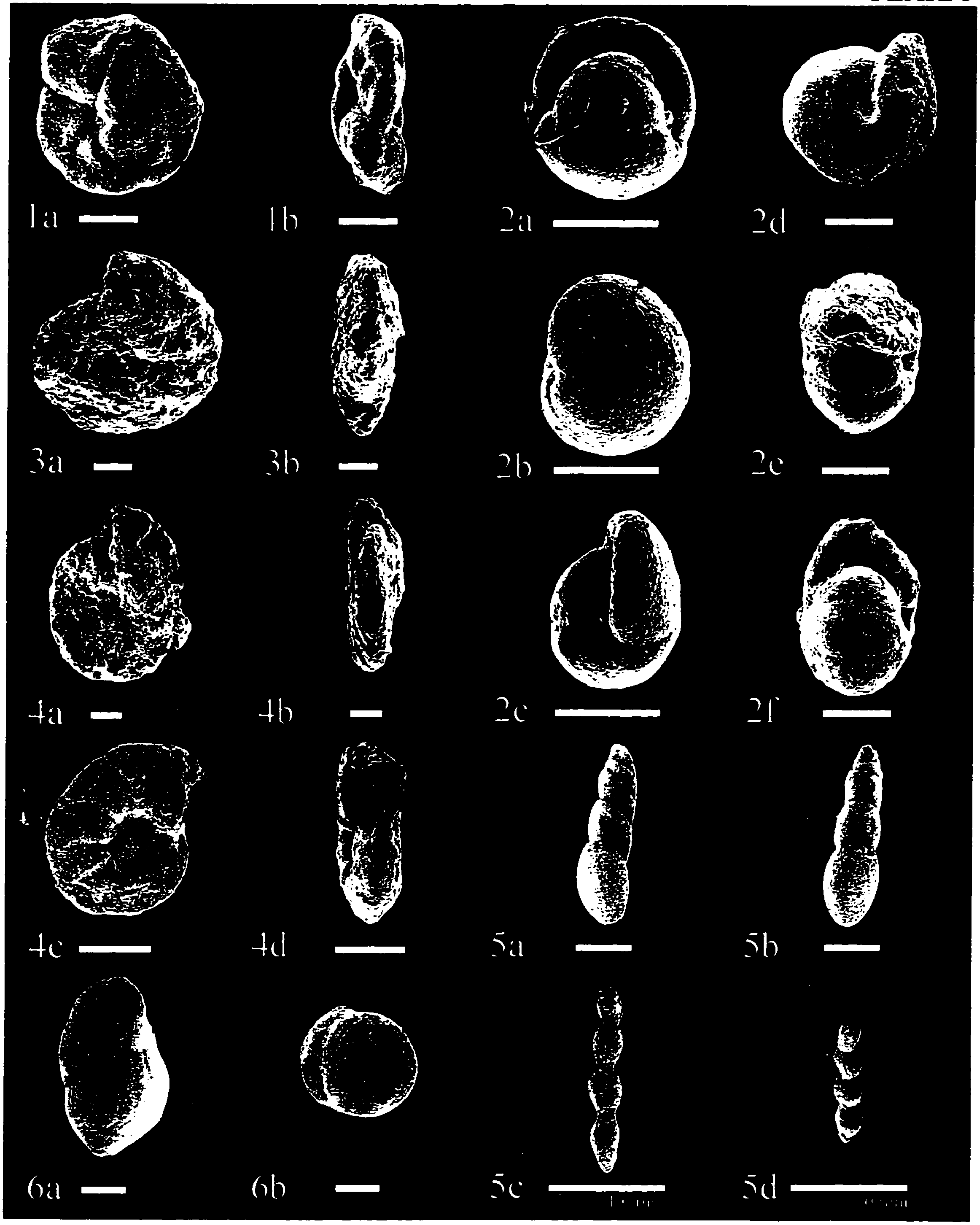


PLATE 6

All scale bars are 100 μm unless otherwise stated

Fig. 1 a-b	*Marginulina inepta* (Reuss 1846). a) side, b) prolocular; from Beresford Bay Station 4. *p. 76.*
Fig. 2 a-b	*Nodosaria doliiformis* Eichenberg 1933. a) side, b) prolocular; from Beresford Bay Station 2. *p. 71-72.*
Fig. 3 a-b	*Nodosaria flexocarinata* Khan 1950. a) side. b) side; both from Beresford Bay Station 2. *p. 72.*
Fig. 4 a-b	*Frondicularia extensa* Morrow 1934. a) side, b) edge; from Beresford Bay Station 2. p. *73.*
Fig. 5 a-b	*Textularia* sp. Taken with a light microscope. a) side, b) edge/apertural(?); from Cumshewa Inlet Station 4.; from Cumshewa Inlet Station 4. *p. 85-86.*
Fig. 6 a-c	*Frondicularia* sp. A. a) side, b) edge; from Beresford Bay Station 2. c) side; from Beresford Bay Station 4. *p. 73.*
Fig. 7 a-b	*Incerta.* a) side, b) edge; from Beresford Bay Station 4. *p. 89.*
Fig. 8	*Frondicularia* sp. B. a) side; from Beresford Bay Station 2. *p. 74.*
Fig. 9 a-b	*Lenticulina* cf. *ingenua* (Berthelin 1880). a) side, b) edge; from Beresford Bay Station 4. *p. 74-75.*
Fig. 10 a-b	*Lenticulina macrodisca* (Reuss 1863). Taken with a light microscope. a) side, b) edge; from Cumshewa Inlet Station 4. *p. 75.*

PLATE 7

All scale bars are 100 μm unless otherwise stated

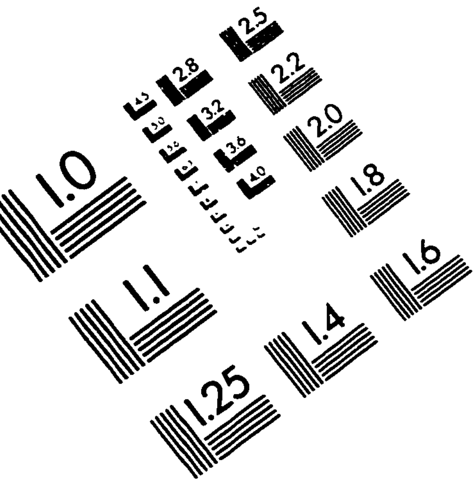
Fig. 1 a-b	*Saracenaria projectura* Stelck and Wall 1956. a) side, b) edge; from Beresford Bay Station 2. *p. 75.*
Fig. 2 a-b	*Saracenaria valanginiana* (Bartenstein and Brand 1951). a) side, b) edge; from Beresford Bay Station 2. *p. 78-79.*
Fig. 3 a-b	*Saracenaria grandstandensis* Tappan 1960. Taken with a light microscope. a) side, b) top; from Cumshewa Inlet Station 3. *p. 77-78.*
Fig. 4 a-b	*Hedbergella delrioensis* (Carsey 1926). a) side. b) side; both from Beresford Bay Station 4. *p. 79.*
Fig. 5 a-b	*Hedbergella gorbachikae* Longoria 1974. a) apertural, b) umbilical; from Rennell Sound Road. *p. 78.*
Fig. 6 a-b	*Hedbergella planispira* (Tappan 1940). a) side, b) edge; from Beresford Bay Station 3. *p. 80-81.*
Fig. 7 a-d	*Miliammina manitobensis* Wickenden 1932. a) side, b) edge; from Beresford Bay Station 2. c) side, d) apertural; from Beresford Bay Station 4. *p. 82.*
Fig. 8 a-b	*Miliammina ischnia* Tappan 1957. a) side, b) edge; from Beresford Bay Station 3. *p. 81.*
Fig. 9 a-b	*Psamminopelta subcircularis* Tappan 1957. a) side, b) edge; from Beresford Bay Station 3. *p. 82-83.*

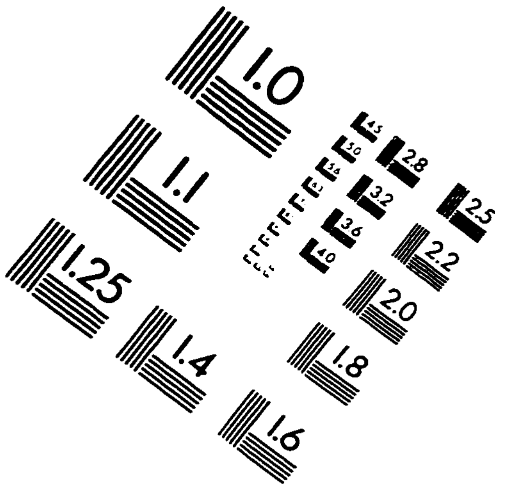
PLATE 8

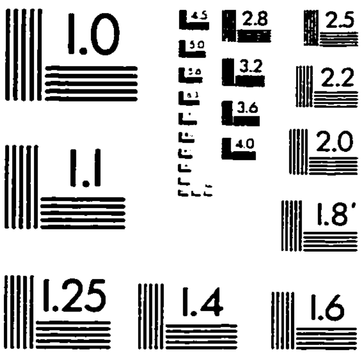
All scale bars are 100 μm unless otherwise stated

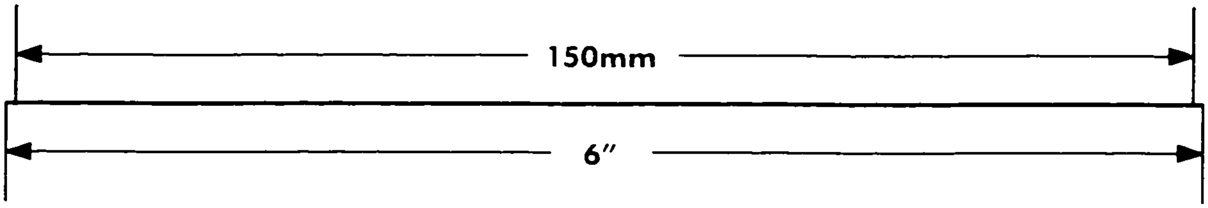
Fig. 1 a-b	*Schackoina cenomana* (Schacko 1897). a) side. b) side; both from Beresford Bay Station 4. *p. 83-84.*
Fig. 2 a-b	*Tritaxia tricarinata* (Reuss 1845). a) side, b) apertural; from Beresford Bay Station 3. *p. 87.*
Fig. 3 a-f	*Trochammina wetteri* Stelck and Wall 1955. a) umbilical, b) bottom. c) umbilical, d) edge. e, f) edge; all three from Beresford Bay Station 3. *p. 87.*
Fig. 4 a-c	*Textularia losangica* Loeblich and Tappan 1951. a) side, b) prolocular, c) apertural; from Onward Point Station 1. *p. 84.*
Fig. 5 a-c	*Praebulimina reussi* (Morrow 1934). a) side, b) prolocular, c) top/apertural(?); from Beresford Bay Station 3. *p. 88.*
Fig. 6 a-b	*Textularia topagorukensis* Tappan 1957. a, b) side ; from Beresford Bay Station 4. *p. 85.*
Fig. 7 a-b	*Trochammina sp.* a) umbilical, b) bottom; from Cumshewa Inlet Station 3. *p. 87-88.*

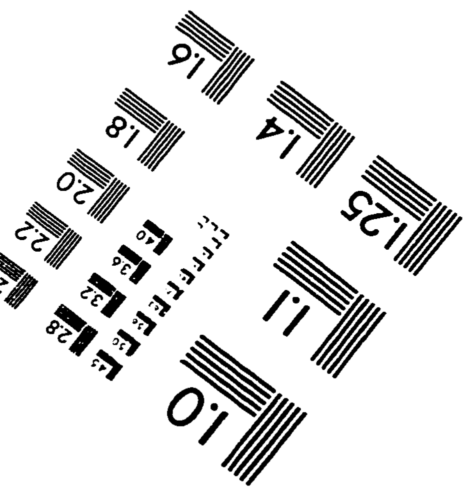
IMAGE EVALUATION TEST TARGET (QA-3)











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