

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

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ABSTRACT

A systematic treatment of 57 species of Late Albian-Cenomanian (Cretaceous) foraminifera obtained from 267 samples collected from 20 localities throughout the Queen Charlotte Islands of British Columbia is presented to provide a reference aid for future researchers in the area. The benthic fauna is comprised of 35 agglutinated and 19 calcareous foraminiferal species. In addition three planktic foraminiferal species are recognized.

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INTRODUCTION

The Cretaceous strata of the Queen Charlotte Islands, British Columbia, Canada, are well known for their rich molluscan faunas (e.g., Whiteaves 1876, 1884, 1900; McLearn 1972; Jeletzky 1977; Haggart 1986), which have served as the standard Cretaceous biostratigraphic reference tool for the region. As these molluscan faunas are primarily restricted to coarser clastic nearshore facies, the regional biostratigraphic control for deeper marine, offshore facies is poor. Preliminary biostratigraphic research on the Cretaceous offshore facies has been carried out utilizing radiolarians (Haggart and Carter 1993; Carter and Haggart 2006) and nannofossils (Haggart et al. 1994). Although some

research has been carried out on well preserved Jurassic foraminiferal faunas in the region (e.g., Kottachchi et al. 2002, 2003) little work has been conducted on Cretaceous foraminifera.

Geological Survey of Canada field parties collected the sedimentary rock samples used for this foraminiferal study from throughout the Queen Charlotte Islands (Figure 1). We subsequently undertook a micropaleontological survey of the foraminifera from a subset of these samples to determine their faunal content and to establish a foraminiferal biostratigraphic framework, which dated the study sections as Albian-Cenomanian in age (Dalby et al. 2009). As the Cretaceous foraminifera of this large area are virtually unknown, the purpose of the research presented here is to

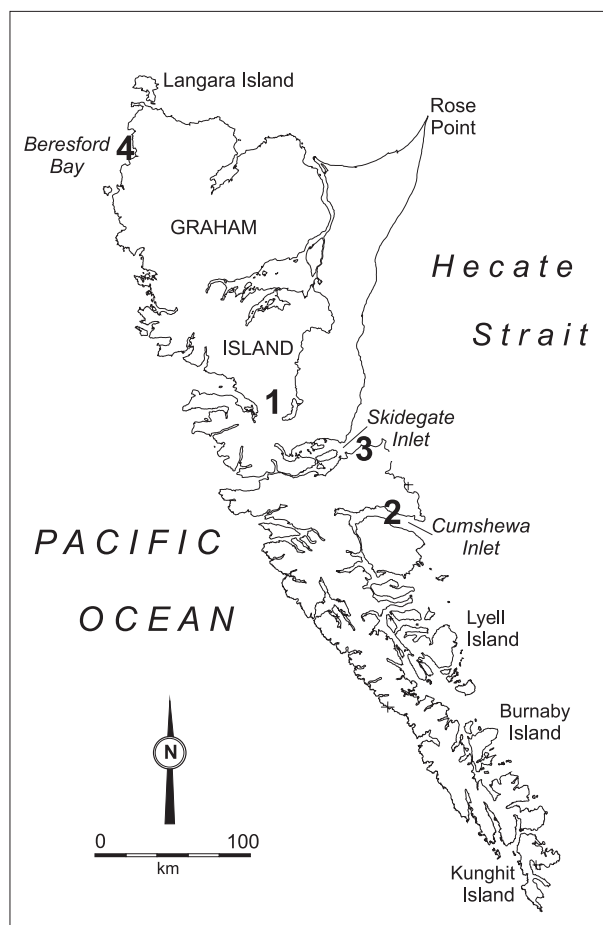


FIGURE 1. Locality map of Queen Charlotte Islands, British Columbia, showing localities discussed in text. 1 = Rennell Sound road, southern Graham Island; 2 = north shore of Cumshewa Inlet; 3 = Onward Point, Moresby Island; 4 = Beresford Bay area, northwestern Graham Island.

fully document the foraminiferal fauna identified in these samples, which will provide baseline data for use by future researchers to interpret foraminiferal fossil assemblages in Albian and Cenomanian aged sediments from the Queen Charlotte Islands and elsewhere along the Pacific Northwest coast.

REGIONAL GEOLOGICAL SETTING

The Upper Triassic through Cretaceous succession of the Queen Charlotte Islands is probably the most complete Mesozoic biostratigraphic reference section for the northeast Pacific region. The Triassic-Lower Jurassic portion of this sequence encompasses the Wrangellia terrane succession (Jones et al. 1977), which is a thick accumulation of Upper Triassic massive oceanic basalts (Karmutsen Formation) conformably overlain by deep-

water clastic facies and fringing reef carbonates (Sadler Limestone), with local latest Triassic to earliest Jurassic age tuffaceous beds (Peril and Sandilands formations). The overlying Lower Jurassic strata (Maude Group) are comprised of continentally-derived clastic detritus. These rocks are in turn overlain by Middle to lower Upper Jurassic volcanic and volcanoclastic strata (Yakoun and Moresby groups) that provide evidence of the initiation of proximal andesitic arc volcanism (see detailed summaries in Sutherland-Brown 1968; Cameron and Hamilton 1988; Woodsworth and Tercier 1991; Haggart 1987; Haggart et al. 1995).

The bulk of Cretaceous strata on the Queen Charlotte Islands are assigned to the Queen Charlotte Group (Sutherland Brown 1968; Haggart 1991, 2004) (Figure 2). The Longarm Formation ranges from Valanginian to Aptian in age while the Haida Formation ranges from Albian to Turonian. Longarm Formation strata accumulated in the western parts of the basin while Haida Formation rocks were deposited in more easterly parts of the basin. Both of these units are characterized by basal conglomerate and coarse-grained sandstone and represent basal transgressive sequences, which fine up-section into deeper water facies. Longarm Formation strata grade upward into outer-shelf mudstone and shale, locally with calcareous concretions, assigned to the informal Hotspring Island formation, of Barremian-Aptian age. Haida Formation strata grade upward into siltstone, mudstone, and shale, previously named the Haida Shale Member but now assigned to the informal Bearskin Bay formation of Albian-Cenomanian age. Localized distal turbidite deposits assigned to the Skidegate Formation represent outer-shelf and distal fan facies that accumulated in deeper parts of the basin during Cenomanian to early Turonian time. Coarse-grained fan-delta and submarine-fan complexes of the Honna Formation prograded into the basin from the east during later Turonian to Coniacian time (Higgs 1990, 1991; Haggart 1991). Latest Cretaceous deposits include upper Santonian to upper Campanian shelf muds of the informally named Tarundl formation (Haggart 2004; Haggart et al. 2009). Deep-basin Cretaceous facies are apparently absent on the islands and may have been truncated by late Neogene strike-slip movement (Haggart 1991).

The principal biostratigraphic groups utilized in correlation of the Cretaceous strata of the islands are the ammonites and bivalves, including the work of McLearn (1972), Jeletzky (1977), Ricciardi (1981), and Haggart (1995); the succession

		STAGE	LITHOSTRAT		MOLLUSC ZONE
CRETACEOUS	UPPER	MAASTRICHTIAN	QUEEN CHARLOTTE GROUP	No Deposits Known	No Fossils Known
		CAMPANIAN		Tarundl formation	<i>Pachydiscus suciaensis</i> No Fossils Known
		SANTONIAN		Honna Formation	<i>Eupachydiscus haradai</i> <i>Sphenoceras</i> cf. <i>orientalis</i> <i>Plesiotexanites</i> sp.
		CONIACIAN			<i>Peroniceras</i> sp.
		TURONIAN			No Fossils Known
		CENOMANIAN		Bearskin Bay fm	<i>Mytiloides</i> ex gr. <i>labiatus</i> <i>I.</i> aff. <i>incelebratus</i>
	LOWER	ALBIAN		Haida Formation	<i>D. (P.) japonicum</i> <i>Turrilites</i> sp. <i>Mortoniceras-D. (P.) dawsoni</i> <i>C. (Grycia?) perezianum</i> <i>Brewericeras hulenense</i> <i>Leconteites</i> sp.
		APTIAN		Hotspring Island fm	<i>Tropaeum</i> sp. <i>Lytoceras (Gabbioceras)</i> sp. <i>Shasticrioceras</i> sp. <i>Shastoceras</i> sp. <i>Inoceramus colonicus</i>
		BARREMIAN		Longarm Formation	<i>I.</i> cf. <i>paraketzovi</i> <i>Simbirskites</i> spp. <i>Buchia crassicollis</i>
		HAUTERIVIAN			
		VALANGINIAN			
		BERRIASIAN		'White Point Beds'	No Fossils Known

FIGURE 2. General Cretaceous lithostratigraphic column of Queen Charlotte Islands, adapted from Haggart (1991, 2004) and Haggart et al. (1995).

of established faunal zones is summarized in Figure 2. Recent work with radiolarians (Haggart and Carter 1993; Carter and Haggart 2006) has shown that this group also holds promise as a potential biostratigraphic correlation tool for Cretaceous deposits. Planktic foraminifera are also valuable

biostratigraphic tools in these strata (Patterson and Fowler 1996; Prokoph et al. 2000, 2001; Patterson et al. 2004, 2005; Dalby et al. 2009).

Cretaceous strata of Queen Charlotte Islands accumulated in a forearc basin west of an active magmatic arc and deposition was essentially con-

TABLE 1. Sample station location information for Cretaceous foraminiferal collections, Queen Charlotte Islands, British Columbia.

Area	Station	NTS Map-Area	UTM Zone	Coordinates *		Stratigraphic Unit
				Latitude	Longitude	
Rennell Sound Road	1	103F/08	8	53–22.10'	132–18.67'	Bearskin Bay fm
Cumshewa Inlet	8	103G/04	9	53–03.56'	131–53.21'	Bearskin Bay fm
	7	103G/04	9	53–04.25'	131–50.07'	Bearskin Bay fm
	6	103G/04	9	53–03.99'	131–49.79'	Bearskin Bay fm
	5	103G/04	9	53–03.51'	131–48.41'	Bearskin Bay fm
	4	103G/04	9	53–03.81'	131–47.87'	Bearskin Bay fm
	3	103G/04	9	53–03.30'	131–46.70'	Bearskin Bay fm
	2	103G/04	9	53–03.16'	131–46.06'	Bearskin Bay fm
	1	103G/04	9	53–02.69'	131–45.14'	Bearskin Bay fm
Onward Point	5	103G/04	9	53–13.49'	131–56.33'	Haida Fm
	4	103G/04	9	53–14.44'	131–55.15'	Haida Fm
	3	103G/04	9	53–14.33'	131–55.05'	Haida Fm
	2	103G/04	9	53–14.43'	131–55.06'	Haida Fm
	1	103G/04	9	53–14.40'	131–54.80'	Haida Fm
Beresford Bay	5	103K/03	8	54–00.98'	133–05.67'	Bearskin Bay fm
	4	103K/03	8	54–01.40'	133–04.10'	Bearskin Bay fm
	3	103K/03	8	54–02.13'	133–03.62'	Bearskin Bay fm
	2	103K/03	8	54–01.80'	133–03.16'	Bearskin Bay fm
	1	103K/03	8	54–02.95'	133–03.26'	Haida Fm

* NAD27 coordinate system; coordinate data from Geological Survey of Canada paleontology database

tinuous within the basin from at least Valanginian through Campanian time (Haggart 1991). The basin appears to have been open to the proto-Pacific Ocean on the west (Haggart 1991, 1993), resulting in generally open-marine conditions. Given its position west of the active arc, and assuming an onshore westerly wind pattern, volcanic strata and tuffs are rare within the succession. The overall stratigraphic succession reflects continuous basin subsidence for much of Cretaceous time, with an eastward-migrating shoreline (Haggart 1991). Earlier studies (Yorath and Chase 1981; Fogarassy and Barnes 1991) suggested that the Aptian represented a time of uplift and erosion in the Queen Charlotte Islands region, but subsequent detailed stratigraphic studies have demonstrated that deposition was continuous within the basin during this interval (Haggart 1991; Haggart and Carter 1993).

A second pulse of plutonism in the Queen Charlotte Islands region occurred during Paleo-

gene and possibly persisted through earliest Neogene time (Anderson and Reichenbach 1991; Hickson 1991; Hamilton and Dostal 1993). Thermal metamorphism associated with the Jurassic and Paleogene plutonism has detrimentally impacted the quality of fossil preservation in many areas (see Orchard and Forster 1991). In addition, the region is structurally complex (see Thompson et al. 1991; Lewis et al. 1991) making geologic correlation difficult in these intensely-deformed geological units. When available, biostratigraphic control is thus of great value in helping to unravel the original stratigraphic relationships of rocks and interpret the geological history.

METHODS AND MATERIALS

B.E.B. Cameron, J.W. Haggart, and assistants of the Geological Survey of Canada (GSC) collected samples used in this study through several field seasons (1980-1993). Station numbers were assigned to all localities and recorded along with

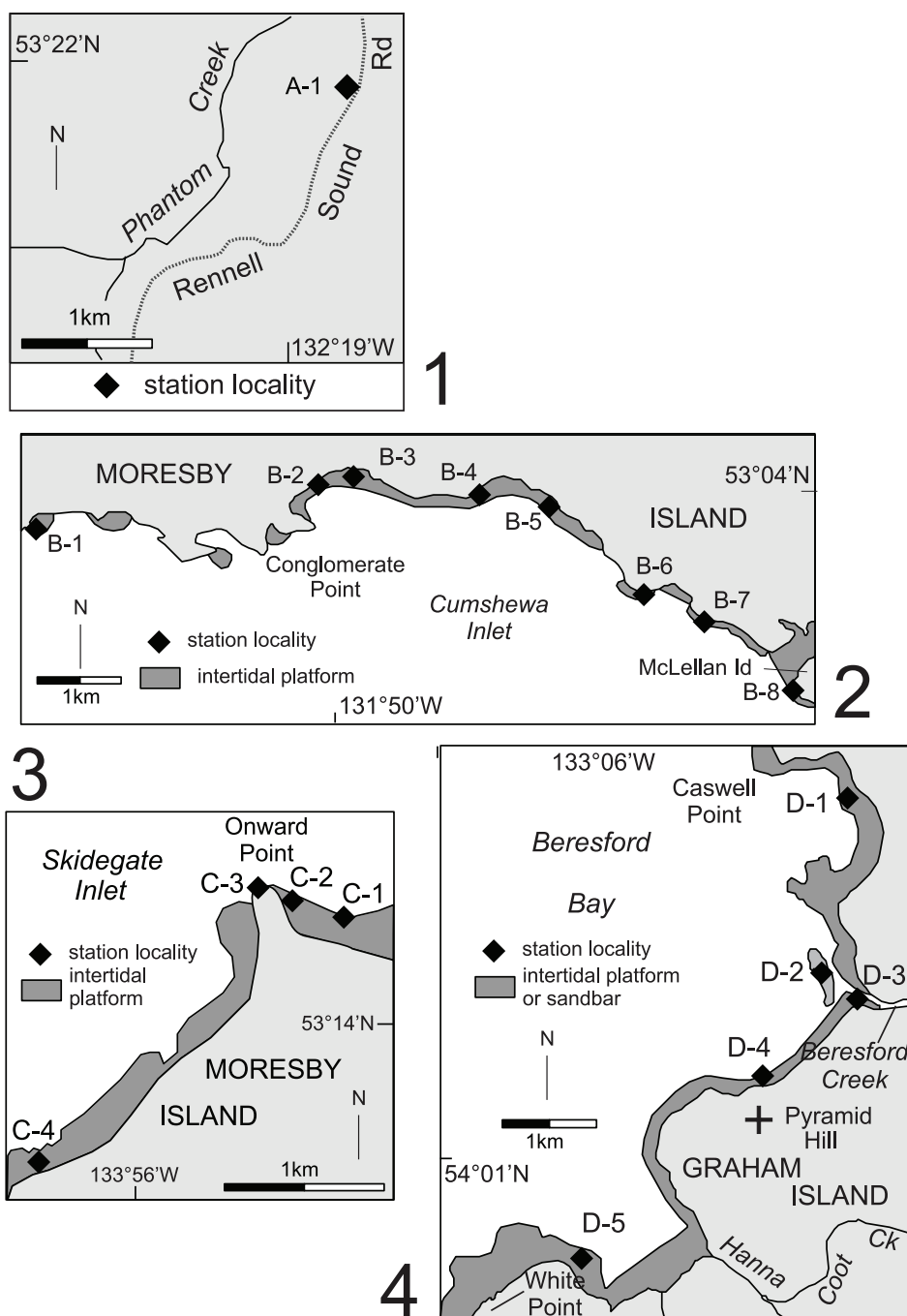


FIGURE 3. Locality map of Cretaceous foraminiferal-bearing exposures, Queen Charlotte Islands: (1) along Rennell Sound Road, south-central Graham Island; (2) along north shore of Cumshewa Inlet; (3) in the vicinity of Onward Point, northeastern Moresby Island; and (4) in vicinity of Beresford Bay, northwest coast of Queen Charlotte Islands.

processed at the GSC's Pacific Geoscience Centre Paleontology Laboratory at Sidney, British Columbia, using techniques developed at the Geological Survey of Canada (see Johns et al. 2006). Samples were then picked for microfossils at the GSC-Pacific office in Vancouver and isolated specimens mounted on slides. Slides were then delivered to Carleton University for identification and analysis.

Specimens were photographed using a JEOL 6400 scanning electron microscope at the Carleton University Research Facility for Electron Microscopy (CURFEM). For specimens whose chamber arrangements were difficult to discern under the SEM, a Javelin video camera mounted on an Olympus SZH stereo-microscope was used to produce a light photograph. Coarsely agglutinated

specimens were embedded in a Lakeside 70 epoxy resin and carefully ground on 15µm wet/dry abrasive paper to expose diagnostic internal test structures.

SYSTEMATIC PALEONTOLOGY

Suprageneric classification follows that of Loeblich and Tappan (1987). Illustrated specimens are housed in the micropaleontological collections of the Geological Survey of Canada. Detailed locations of sample localities described in the occurrence section of each description are found in Table 1.

ORDER FORAMINIFERIDA Eichwald 1830

Superfamily ASTORRHIZACEA Brady 1881

Family BATHYSIPHONIDAE Avnimelech 1952

GENUS *Bathysiphon* Sars 1872

Bathysiphon brosgiei Tappan 1957

Figures 4.1-4.2

1957 *Bathysiphon brosgiei* Tappan, p. 202, pl. 65, figs. 1-5.

1962 *Bathysiphon brosgiei* Tappan; Tappan, p. 128, pl. 29, figs. 1-5.

1972 *Bathysiphon brosgiei* Tappan; Hanzlíková, p. 31, pl. 1, fig. 12.

1981 *Bathysiphon brosgiei* Tappan; McNeil and Caldwell, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island; Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2); Albian, Onward Point Stations 1-4 (Figure 3.3).

Bathysiphon vitta Nauss 1947

Figures 4.3-4.6

1947 *Bathysiphon vitta* Nauss, p. 334, pl. 48, fig. 4.

1962 *Bathysiphon vitta* Nauss; Tappan, p. 128-129, pl. 29, figs. 6-8.

1972 *Bathysiphon vitta* Nauss; Hanzlíková, p. 32, pl. 2, figs. 4-5.

1981 *Bathysiphon vitta* Nauss; McNeil and Caldwell, p. 129-130, pl. 9, fig. 2.

Description: Test free, large (0.8 mm-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. brosgiei* by being smoothly finished, much larger in size, and almost always compressed.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 2-7 (Figure 3.2); Albian, Onward Point Station 2 (Figure 3.3).

Superfamily HYPERAMMINACEA Eimer and Fickert 1899

Family HYPERAMMINOIDIDAE Loeblich and Tappan 1984

GENUS *Hippocrepina* Parker, in Dawson 1870

Hippocrepina barksdalei (Tappan 1957)

Figures 4.7-4.8

1957 *Hyperamminoides barksdalei* Tappan, p. 202-203, pl. 65, figs. 6-10.

1962 *Hyperamminoides barksdalei* Tappan; Tappan, p. 129-130, pl. 29, figs. 21-27.

1999 *Hippocrepina barksdalei* (Tappan); Stritch and Schröder-Adams, p. 1622, pl. 1, figs. 12, 15.

Description: Test free, flat, elongate, highly variable, single tubular chamber, usually widest in the middle of the chamber; wall very finely agglutinated and finely finished; aperture at open, more constricted end of the chamber.

Occurrence: Albian, Cumshewa Inlet Station 5 (Figure 3.2).

Suborder TEXTULARIINA Delage and Hérouard 1896

Superfamily AMMODISCACEA Reuss 1862

Family AMMODISCIDAE Reuss 1862

Subfamily AMMODISCIDAE Reuss 1862

GENUS *Ammodiscus* Reuss 1862

Ammodiscus kiowensis Loeblich and Tappan 1950

Figures 4.9 – 4.10

1950 *Ammodiscus kiowensis* Loeblich and Tappan, p. 5-6, pl. 1, fig. 3.

1975 *Ammodiscus kiowensis* Loeblich and Tappan; North and Caldwell, pl. 1, fig. 7.

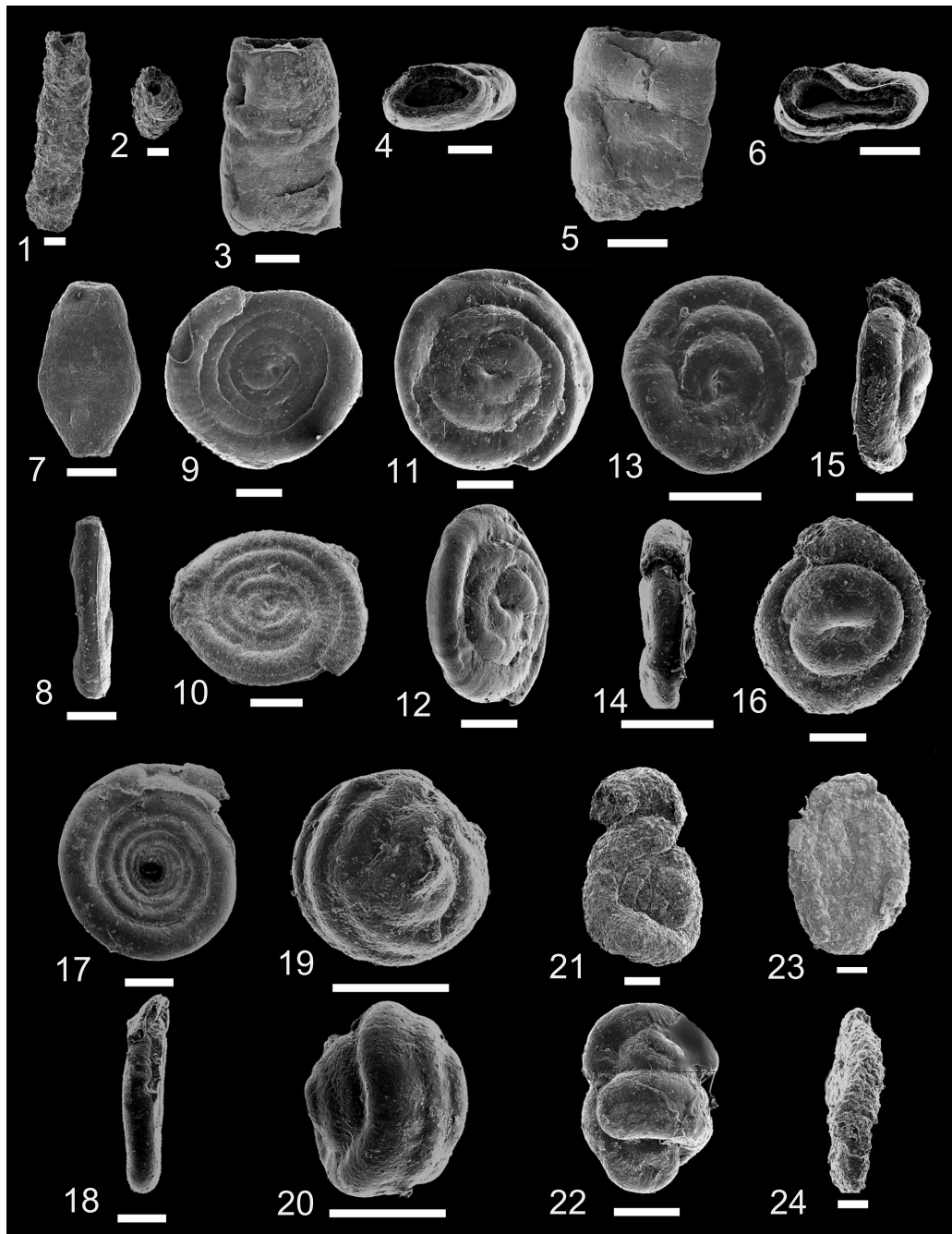


FIGURE 4. All scale bars = 100 μ m, unless otherwise indicated. **1, 2**, *Bathysiphon brosgiei* Tappan 1957, GSC No. 126538, from Onward Point Station 2 (GSC Loc. C-302078). **3-6**, *Bathysiphon vitta* Nauss 1947, GSC No. 126539, from Beresford Bay Station 3 (GSC Loc. C-173016). **7, 8**, *Hippicrepina barksdalei* (Tappan 1957), GSC No. 126569, from Cumshewa Inlet Station 4 (GSC Loc. C-301954). **9, 10**, *Ammodiscus kiowensis* Loeblich and Tappan 1950. a. GSC No. 126530, side view, from Beresford Bay Station 6 (GSC Loc. C-301756); b. GSC No. 126531, oblique view, from Rennell Sound Road (GSC Loc. C-172862). **11, 12**, *Ammodiscus pennyi* Cushman and Jarvis 1928, GSC No. 126532, from Beresford Bay Station 6 (GSC Loc. C-301762). **13, 14**, GSC No. 126533, from Beresford Bay Station 3 (GSC Loc. C-173011). **15, 16**, *Ammodiscus pennyi* Cushman and Jarvis 1928, GSC No. 126534, from Beresford Bay Station 6 (GSC Loc. C-301748). **17, 18**, *Ammodiscus rotarius* Loeblich and Tappan 1949, GSC No. 126535, from Beresford Bay Station 4 (GSC Loc. C-173132). **19, 20**, *Glomospira charoides* Cushman and Jarvis 1928, GSC No. 126536, from Beresford Bay Station 6 (GSC Loc. C-301762). **21, 22**, GSC No. 126537, from Beresford Bay Station 4 (GSC Loc. C-173138). **23, 24**, *Miliammina ischnia* Tappan 1957, GSC No. 126601, from Beresford Bay Station 4 (GSC Loc. C-173132).

- 1981 *Ammodiscus kiowensis* Loeblich and Tappan; McNeil and Caldwell, p. 136, pl. 9, fig. 14.

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; terminal aperture.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Albian, Beresford Bay Station 5 (Figure 3.4); Albian, Cumshewa Inlet Station 6 (Figure 3.2).

Ammodiscus pennyi Cushman and Jarvis 1928
Figures 4.11-4.16

- 1928 *Ammodiscus pennyi* Cushman and Jarvis, p. 87, pl. 12, figs. 4-5.

- 1960 *Glomospira reata* Eicher, p. 56-57, pl. 3, 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 with the previous; approximately three whorls per specimen; surface finely agglutinated and smooth; wall thick; terminal aperture semicircular.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)—Cenomanian, Beresford Bay Stations 2-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 5-7 (Figure 3.2); Albian, Onward Point Station 2 (Figure 3.3).

Ammodiscus rotalarius Loeblich and Tappan 1949
Figures 4.17-4.18

- 1949 *Ammodiscus rotalarius* Loeblich and Tappan, p. 247, pl. 46, fig. 1.

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

- 1980 *Ammodiscus rotalarius* Loeblich and Tappan; Sliter, p. 372-373, pl. 1, fig. 8.

- 1981 *Ammodiscus rotalarius* Loeblich and Tappan; McNeil and Caldwell, p. 136-137, pl. 9, fig. 15.

Description: Test free, discoidal, planispiral, with regular coiling; chamber an undivided tube that gradually enlarges in width and in thickness, 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; terminal aperture.

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

Occurrence: Cenomanian, Beresford Bay Stations 4-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 3-7 (Figure 3.2); Albian, Onward Point Stations 1-4 (Figure 3.3).

Subfamily AMMOVERTELLININAE Saidova 1981

GENUS *Glomospira* Rzehak 1885

Glomospira charoides (Jones and Parker 1860)
Figures 4.19-4.22

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

- 1928 *Glomospira corona* Cushman and Jarvis, p. 89, pl. 12, figs. 9-11.

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

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

- 1981 *Glomospira corona* Cushman and Jarvis; McLean and Wall, p. 368-369, pl. 8, figs. 4-5.

- 1981 *Glomospira corona* Cushman and Jarvis; McNeil and Caldwell, p. 137, pl. 9, figs. 16-17.

- 1987 *Repmanina squamata* (Jones and Parker 1860) Loeblich and Tappan, p. 52, pl. 39, figs. 24-26.

- 1988 *Glomospira charoides* (Jones and Parker 1860); Kaminski and others, 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), *G. corona*, or *G. gordialis*. These species, with numerous variations, have been recorded as ranging from the Carboniferous to the Recent (see references listed in the synonymy above). 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 thus probably individual convergent species.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 2–5 (Figure 3.4); Albian, Cumshewa Inlet Stations 3–7 (Figure 3.2).

Superfamily RZEHAKINACEA Cushman 1933

Family RZEHAKINIDAE Cushman 1933

GENUS *Miliammina* Heron-Allen and Earland 1930

Miliammina ischnia Tappan 1957

Figures 4.23–4.24

1957 *Miliammina ischnia* Tappan, p. 211, pl. 67, figs. 25–26.

1962 *Miliammina ischnia* Tappan; Tappan, 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.

Occurrence: Cenomanian, Beresford Bay Station 4 (Figure 3.4); Albian, Cumshewa Inlet Station 7 (Figure 3.2).

Miliammina manitobensis Wickenden 1932

Figures 5.1–5.4

1932 *Miliammina manitobensis* Wickenden, p. 90, pl. 1, fig. 11.

1946 *Miliammina manitobensis* Wickenden 1932; Cushman, p. 48, pl. 14, figs. 4–6.

1981 *Miliammina manitobensis* Wickenden; McLean and Wall, p. 364–365, pl. 7, figs. 2–3.

1981 *Miliammina manitobensis* Wickenden 1932; McNeil and Caldwell, 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.

Occurrence: Upper Albian–Cenomanian, Beresford Bay Stations 1–4, 5 (Figure 3.4); Albian, Onward Point Station 3 (Figure 3.3).

GENUS *Psamminopelta* Tappan 1957

Psamminopelta subcircularis Tappan 1957

Figures 5.5–5.6

1957 *Psamminopelta subcircularis* Tappan, p. 213, pl. 67, figs. 8–10.

1962 *Psamminopelta subcircularis* Tappan; Tappan, 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; aperture at the end of the last chamber.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 3–4 (Figure 3.4).

Superfamily HORMOSINACEA Haeckel 1894

Family ASCHEMOCELLIDAE Vyalov 1966

GENUS *Kalamopsis* de Folin 1883

Kalamopsis sp. A

Figures 5.7–5.8

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

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 3–4 (Figure 3.4).

Kalamopsis sp. B

Figures 5.9

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

Occurrence: Cenomanian, Beresford Bay Stations 4, 5 (Figure 3.4).

Family HORMOSINIDAE Haeckel 1894

Subfamily REOPHACINAE Cushman 1910

GENUS *Reophax* Montfort 1808

Reophax sp. A

Figures 5.10–5.11

Description: Test free, rectilinear, 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.

Occurrence: Cenomanian, Beresford Bay Station 4 (Figure 3.4).

Reophax sp. B

Figures 5.12–5.13

Description: Test free, rectilinear, elongate, uncompressed, and uniserial; circular in cross section; two spherical chambers, rapidly increasing in size as added; sutures distinct, horizontal, and depressed; wall agglutinated; aperture simple,



FIGURE 5. All scale bars = 100 μ m, unless otherwise indicated. **1, 2**, *Miliammina manitobensis* Wickenden 1932, GSC No. 126599, from Beresford Bay Station 2 (GSC Loc. C-172907). **3, 4**, GSC No. 126600, from Beresford Bay Station 4 (GSC Loc. C-173137). **5, 6**, *Psammimopelta subcircularis* Tappan 1957, GSC No. 126602, from Beresford Bay Station 3 (GSC Loc. C-173006). **7, 8**, *Kalamopsis* sp. A, GSC No. 126567, from Beresford Bay Station 4 (GSC Loc. C-173133). **9**, *Kalamopsis* sp. B, GSC No. 126571, from Beresford Bay Station 5 (GSC Loc. C-301740). **10, 11**, *Reophax* sp. A, GSC No. 126560, from Beresford Bay Station 4 (GSC Loc. C-173135). **12, 13**, *Reophax* sp. B, GSC No. 126561, from Beresford Bay Station 4 (GSC Loc. C-173130). **14-16**, *Reophax* sp. C. Tappan 1960, GSC No. 126559, from Onward Point Station 1 (GSC Loc. C-302118). **17-19**, *Scherochorella cylindracea* Chapman 1892, GSC No. 126554, from Beresford Bay Station 3 (GSC Loc. C-173006). **20**, GSC No. 126555, from Rennell Sound Road (GSC Loc. C-172846). **21**, *Scherochorella minuta* Tappan 1940, GSC No. 126556, from Onward Point Station 1 (GSC Loc. C-302112). **22**, GSC No. 126558, from Rennell Sound Road (GSC Loc. C-172846). **23**, GSC No. 126557, from Beresford Bay Station 6 (GSC Loc. C-301759). **24, 25**, *Caudammina* sp., GSC No. 126551, from Beresford Bay Station 3 (GSC Loc. C-173013). **26, 27**, GSC No. 126552, from Beresford Bay Station 3 (GSC Loc. C-173013). **28, 29**, *Haplophragmoides concavus* (Chapman 1892), GSC No. 126572, from Beresford Bay Station 6 (GSC Loc. C-301757).

round, terminal, on a short, tapering extension of the final chamber.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 3–4 (Figure 3.4).

Reophax sp. C Tappan 1960
Figures 5.14–5.16

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 three 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.

Occurrence: Cenomanian, Beresford Bay Stations 4, 5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1–7 (Figure 3.2); Albian, Onward Point Station 4 (Figure 3.3).

GENUS *Scherochorella* Loeblich and Tappan 1984
Scherochorella cylindracea Chapman 1892
Figures 5.17–5.20

1892 *Reophax cylindracea* Chapman, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 2–4 (Figure 3.4); Albian, Cumshewa Inlet Stations 1–7 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

Scherochorella minuta Tappan 1940
Figures 5.21–5.23

1940 *Reophax minuta* Tappan, p. 94, pl. 14, fig. 4.

1962 *Reophax minuta* Tappan; Tappan, p. 132–133, pl. 30, fig. 10.

1987 *Scherochorella minuta* (Tappan), p. 58, pl. 44, figs. 15–16.

1995 *Scherochorella minuta* (Tappan) Geroch and Kaminski, p. 117–122, pl. 1, fig. 3.

Description: Test free, rectilinear, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian–Cenomanian, Beresford Bay Stations 1–2, 5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1–6 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

Subfamily HORMOSININAE Haeckel 1894
GENUS *Caudammina* Montanaro–Gallitelli 1955
Caudammina sp.
Figures 5.24–5.27

Description: Test free, uniserial, rectilinear; chambers sub-spherical 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; aperture, round, terminal, at the tip of the neck.

Discussion: Chambers almost always found disassociated from the original test due to the fragile stolons connecting the chambers.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 3–4 (Figure 3.4); Albian, Cumshewa Inlet Station 1 (Figure 3.2).

Superfamily LITUOLACEA de Blainville 1827
Family HAPLOPHRAGMOIDIDAE Maync 1952
GENUS *Haplophragmoides* Cushman 1910
Haplophragmoides concavus (Chapman 1892)
Figures 5.28–5.29

1892 *Trochammina concavus* Chapman, p. 30, pl. 6, fig. 14.

1960 *Haplophragmoides formosus* Takayanagi, p. 70, pl. 1, fig. 22.

1980 *Haplophragmoides concavus* (Chapman); Sliter, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 2–4, 5 (Figure 3.4); Albian, Cumshewa Inlet Stations 2–5 (Figure 3.2).

Haplophragmoides cf. *H. calcula* Cushman and Waters 1927
Figures 6.1-6.3

1927 *Haplophragmoides calcula* Cushman and Waters, p. 83, pl. 10, fig. 5.

1981 *Haplophragmoides calcula* Cushman and Waters; McNeil and Caldwell, 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 cf. designation.

Occurrence: Cenomanian, Beresford Bay Station 3 (Figure 3.4).

Haplophragmoides cf. *suborbicularis* (Grzybowski 1896)
Figures 6.4-6.9

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

1981 *Haplophragmoides impensus* Martin 1964; McNeil and Caldwell, p. 151-152, pl. 11, fig. 9.

1988 *Haplophragmoides suborbicularis* (Grzybowski); Kaminski and others, 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 3-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 2-7 (Figure 3.2).

Haplophragmoides topagorukensis Tappan 1957
Figures 6.10-6.13

1957 *Haplophragmoides topagorukensis* Tappan, p. 203-204, pl. 65, figs. 15-25.

1962 *Haplophragmoides topagorukensis* Tappan; Tappan, 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*; cham-

bers 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Station 3 (Figure 3.4); Albian, Cumshewa Inlet Stations 3-7 (Figure 3.2).

Family LITUOLIDAE de Blainville 1825
Subfamily AMMOMARGINULININAE Pobonina 1978

GENUS *Ammobaculites* Cushman 1910
Ammobaculites fragmentarius Cushman 1927
Figures 6.14-6.17

1927 *Ammobaculites fragmentaria* Cushman, p. 130, pl. 1, fig. 8.

1962 *Ammobaculites fragmentarius* Cushman; Tappan, p. 136-138, pl. 32, figs. 8-11.

1981 *Ammobaculites fragmentarius* Cushman; McLean and Wall, p. 368-369, pl. 8, figs. 9-10.

1981 *Ammobaculites fragmentarius* Cushman; McNeil and Caldwell, p. 158-159, pl. 12, figs. 6-7.

1984 *Ammobaculites fragmentarius* Cushman; Koke and Stelck, 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 to compressed in cross section; sutures distinct 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2, 4-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2).

Ammobaculites wenonahae Tappan 1960
Figures 6.18-6.21

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

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

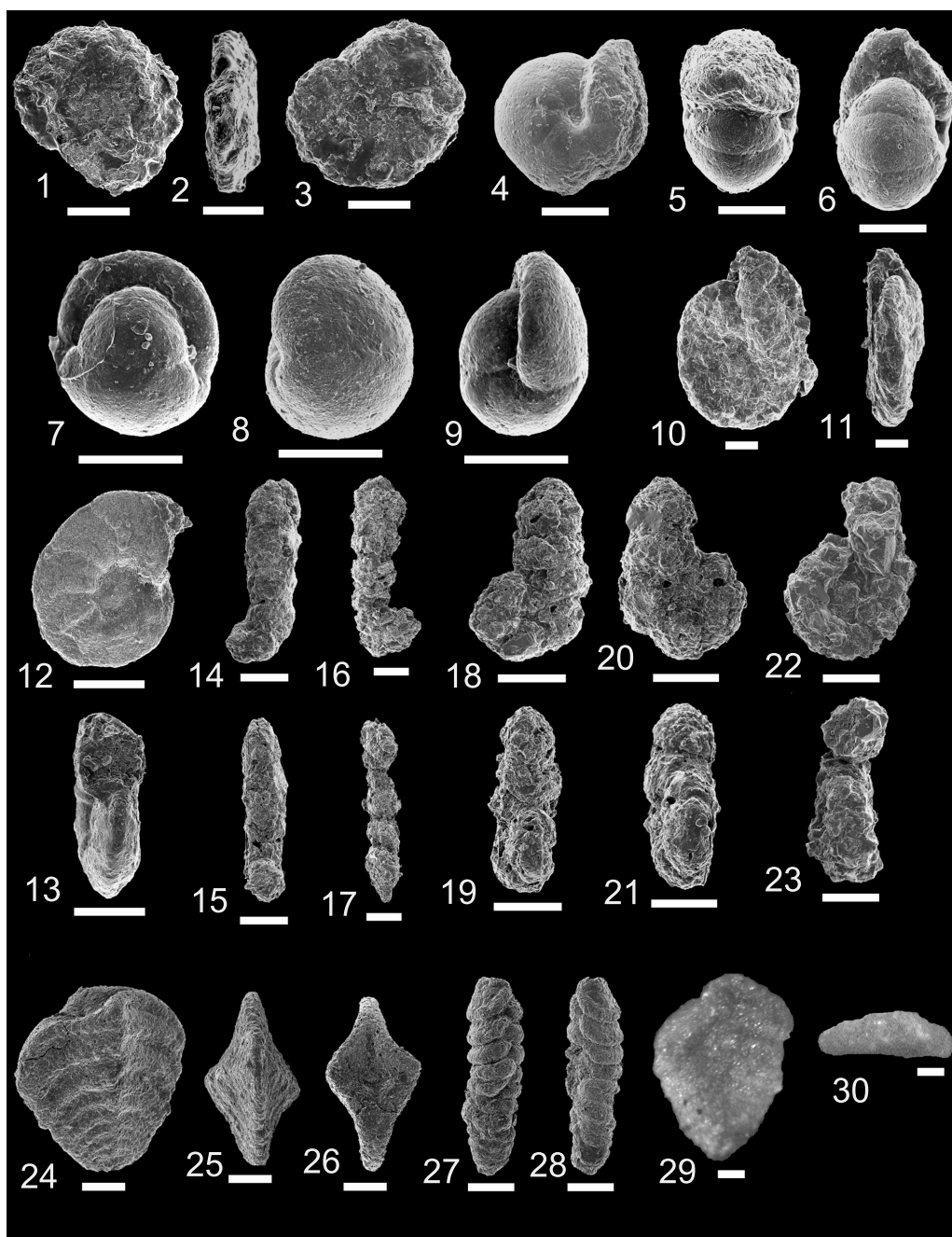


FIGURE 6. All scale bars = 100 μ m, unless otherwise indicated. **1-3**, *Haplophragmoides* cf. *H. calcula* Cushman and Waters 1927, GSC No. 126570, from Beresford Bay Station 3 (GSC Loc. C-164993). **4-6**, *Haplophragmoides* cf. *suborbicularis* (Grzybowski 1896), GSC No. 126574, from Beresford Bay Station 3 (GSC Loc. C-173016). **7-9**, GSC No. 126573, from Beresford Bay Station 3 (GSC Loc. C-173016). **10, 11**, *Haplophragmoides topagorukensis* Tappan 1957, GSC No. 126576, from Beresford Bay Station 3 (GSC Loc. C-165000). **12, 13**, GSC No. 126577, from Beresford Bay Station 3 (GSC Loc. C-165000). **14, 15**, *Ammobaculites fragmentarius* Cushman 1927, GSC No. 126562, from Beresford Bay Station 5 (GSC Loc. C-301740). **16, 17** GSC No. 126563, from Cumshewa Inlet Station 8 (GSC Loc. C-301991). **18, 19**, *Ammobaculites wenonahae* Tappan 1960, GSC No. 126564, from Beresford Bay Station 4 (GSC Loc. C-173112). **20, 21**, GSC No. 126565, from Beresford Bay Station 4 (GSC Loc. C-173112). **22, 23**, *Ammobaculites* sp. Tappan 1960, GSC No. 126566, from Beresford Bay Station 6 (GSC Loc. C-301762). **24-26**, *Textulariopsis losangica* Loeblich and Tappan 1951, GSC No. 126608, from Onward Point Station 1 (GSC Loc. C-302108). **27, 28**, *Textulariopsis topagorukensis* Tappan 1957, GSC No. 126610, from Beresford Bay Station 4 (GSC Loc. C-173138). **29, 30**, *Textulariopsis* sp., GSC No. 126585, from Cumshewa Inlet Station 4 (GSC Loc. C-301953).

- 1984 *Ammobaculites wenonahae* Tappan; Koke and Stelck, 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 distinct and depressed; wall very coarsely agglutinated; aperture obscured.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2, 4 (Figure 3.4); Albian, Cumshewa Inlet Station 5 (Figure 3.2).

Ammobaculites sp.
Figures 6.22-6.23

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 indistinct 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.

Occurrence: Cenomanian, Beresford Bay Station 5 (Figure 3.4).

Superfamily TEXTULARIACEA Ehrenberg 1838
Family TEXTULARIIDAE Ehrenberg 1839
GENUS *Textulariopsis* Banner and Pereira 1981
Textulariopsis losangica (Loeblich and Tappan 1951)
Figures 6.24-6.26

- 1951 *Textularia losangica* Loeblich and Tappan, p. 82, pl. 2, figs. 4-5.
1982 *Textulariopsis losangica* (Loeblich and Tappan); Loeblich and Tappan, p. 67, pl. 2, figs. 8-10.

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, noncanaliculate; aperture obscured.

Occurrence: Cenomanian, Beresford Bay Station 5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

Textulariopsis topagorukensis Tappan 1957
Figures 6.27-6.28

- 1957 *Textulariopsis topagorukensis* Tappan, p. 205-206, pl. 66, figs. 8-9.

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

- 1962 *Textulariopsis topagorukensis* Tappan; Tappan, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian-Cenomanian, Beresford Bay Stations 1-5 (Figure 3.4).

Textulariopsis sp.
Figures 6.29-6.30

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 agglutinated; aperture obscured.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2 (Figure 3.4); Albian, Cumshewa Inlet Stations 4, 5 (Figure 3.2).

Superfamily TROCHAMMINACEA Schwager 1877
Family TROCHAMMINIDAE Schwager 1877
GENUS *Trochammina* Parker and Jones 1859
Trochammina wetteri Stelck and Wall 1955
Figures 7.1-7.6

- 1955 *Trochammina wetteri* Stelck and Wall, p. 59-60, pl. 2, figs. 1-3, 6.

- 1981 *Trochammina wetteri* Stelck and Wall; McNeil and Caldwell, 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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-4, 5 (Figure 3.4); Albian, Cumshewa Inlet Stations 2-6 (Figure 3.2); Albian, Onward Point Stations 3, 4 (Figure 3.3).

Trochammina sp.
Figures 7.7-7.8

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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2 (Figure 3.4); Albian, Cumshewa Inlet Stations 5-7 (Figure 3.2).

Superfamily VERNEULINACEA Cushman 1911
Family VERNEULINIDAE Cushman 1911
Subfamily VERNEULININAE Cushman 1911
GENUS *Gaudryina* d'Orbigny 1839
Gaudryina cf. *G. nanushukensis* Tappan 1951
Figures 7.9-7.11

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

1962 *Gaudryina nanushukensis* Tappan; Tappan, 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. *G. nanushukensis* were poorly preserved, hence the cf. designation.

Occurrence: Cenomanian, Beresford Bay Station 3 (Figure 3.4).

Gaudryinella irregularis Tappan 1943
Figures 7.12-7.16

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

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

Description: Test free, straight, loosely biserial, with alternating chambers; 5-8 spherical chambers; sutures quite distinct as the chambers not very

closely appressed; wall finely agglutinated; aperture small, terminal, rounded.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian (?)–Cenomanian, Beresford Bay Stations 3-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2).

Family TRITAXIIDAE Plotnikova 1979
GENUS *Tritaxia* Reuss 1860
Tritaxia tricarinata (Reuss 1845)
Figures 7.17-7.18

1845 *Textularia tricarinata* Reuss, p. 39, pl. 8, fig. 60.

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

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

1972 *Tritaxia tricarinata* Reuss; Hanzlíková, p. 54, pl. 11, fig. 11.

1985 *Tritaxia tricarinata* Reuss; Sliter, p. 347, pl. 1, figs. 19-20.

Description: Test free, triserial. Wall calcareous. Aperture obscured.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian–Cenomanian, Beresford Bay Station 1-4 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

Family EGGERELLIDAE Cushman 1937
GENUS *Protomarssonella* Desai and Banner 1987
Protomarssonella sp.
Figures 7.19-7.22

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

Discussion: Wall structure places this species in *Protomarssonella*, a genus commonly found in the Jurassic (Desai and Banner 1987; Kaminski 1996).

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-5 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-6 (Figure 3.2); Albian, Onward Point Station 4 (Figure 3.3).

Superfamily TEXTULARIACEA Ehrenberg 1839
Family VALVULINIDAE
Subfamily VALVULININAE Berthelin 1880
GENUS *Clavulinoides* Cushman 1936
Clavulinoides sp.
Figures 7.23

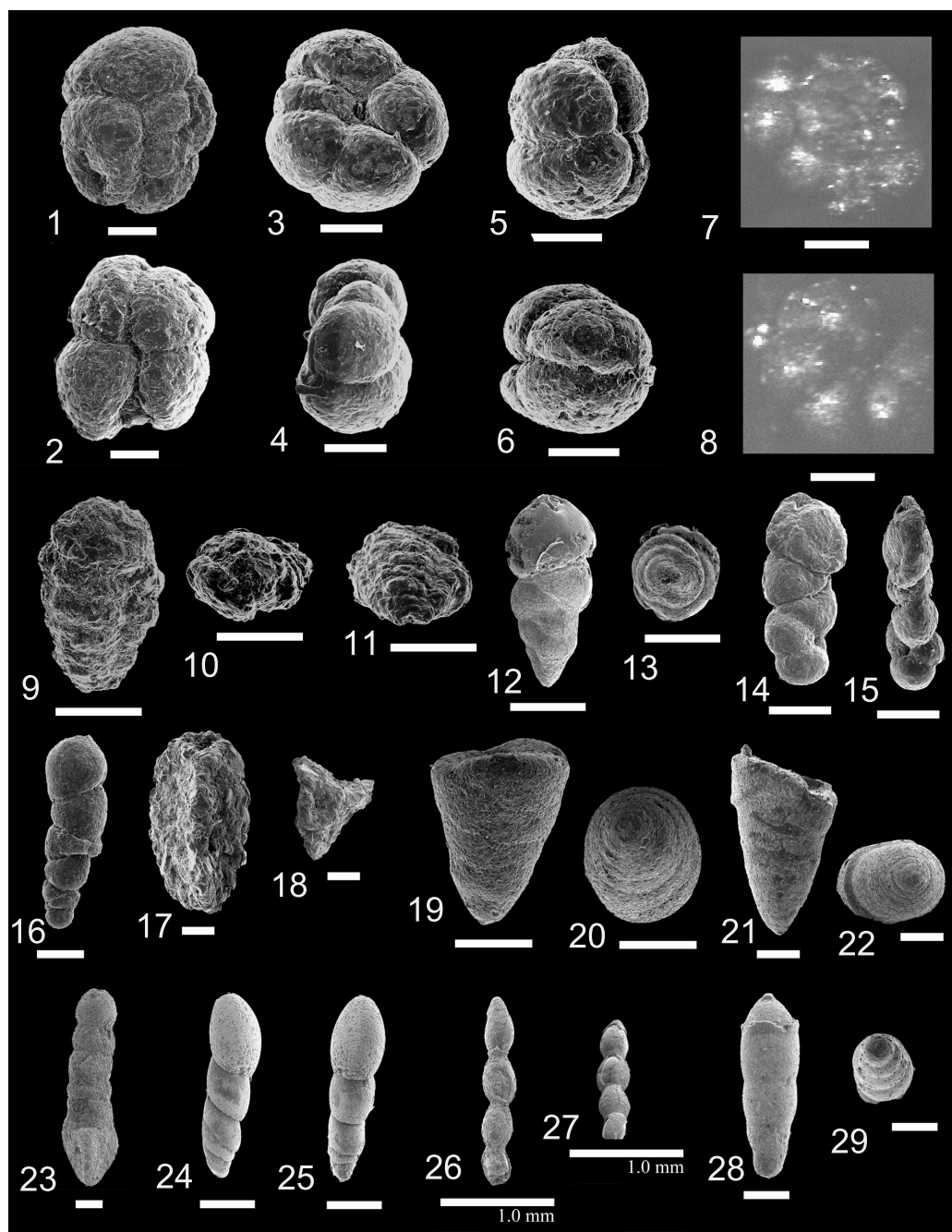


FIGURE 7. All scale bars = 100 μ m, unless otherwise indicated. **1, 2**, *Trochammina wetteri* Stelck and Wall 1955, GSC No. 126605, from Beresford Bay Station 3 (GSC Loc. C-164991). **3, 4**, GSC No. 126606, from Beresford Bay Station 3 (GSC Loc. C-164992). **5, 6**, GSC No. 126607, from Beresford Bay Station 3 (GSC Loc. C-164991). **7, 8**, *Trochammina* sp., GSC No. 126611, from Cumshewa Inlet Station 3 (GSC Loc. C-302007). **9-11**, *Gaudryina* cf. *G. nanushukensis* Tappan 1951, GSC No. 126541, from Beresford Bay Station 3 (GSC Loc. C-164996). **12, 13**, *Gaudryinella irregularis* Tappan 1943, GSC No. 126545, from Beresford Bay Station 4 (GSC Loc. C-173138). **14, 15**, GSC No. 126546, from Beresford Bay Station 4 (GSC Loc. C-173100). **16**, GSC No. 126547, from Beresford Bay Station 3 (GSC Loc. C-164991). **17, 18**, *Tritaxia tricarinata* (Reuss 1845), GSC No. 126604, from Beresford Bay Station 3 (GSC Loc. C-164992). **19, 20**, *Protomarssonella* sp., GSC No. 126542, from Onward Point Station 4 (GSC Loc. C-301789). **21, 22**, GSC No. 126543, from Onward Point Station 4 (GSC Loc. C-301789). **23**, *Clavulinoides* sp., GSC No. 126540, from Beresford Bay Station 2 (GSC Loc. C-172913). **24, 25**, *Laevidentalina distincta* Reuss 1860, GSC No. 126578, from Beresford Bay Station 2 (GSC Loc. C-172908). **26, 27**, GSC No. 126579, from Onward Point Station 1 (GSC Loc. C-302108). **28, 29**, *Nodosaria doliiformis* Eichenberg 1933, GSC No. 126582, from Beresford Bay Station 2 (GSC Loc. C-172914).

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

Occurrence: Late Albian (?)–Cenomanian, Beresford Bay Stations 2, 4 (Figure 3.4); Albian, Cumshewa Inlet Stations 2–3 (Figure 3.2); Albian, Onward Point Station 1 (Figure 3.3).

Suborder LAGENINA Delage and Hérourard 1896
Superfamily NODOSARIACEA Ehrenberg 1838
Family NODOSARIIDAE Ehrenberg 1838
GENUS *Laevidentalina* Loeblich and Tappan 1986
Laevidentalina distincta (Reuss 1860)
Figures 7.24–7.27

- 1860 *Dentalina distincta* Reuss, p. 184, pl. 2, fig. 5.
1962 *Dentalina distincta* Reuss; Tappan, p. 175, pl. 45, fig. 18.
1980 *Dentalina distincta* Reuss; Sliter, 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 smooth; aperture terminal, usually obscured.

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

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2, 4 (Figure 3.4); Albian, Cumshewa Inlet Stations 1–5 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

GENUS *Nodosaria* Lamarck 1812
Nodosaria doliiformis Eichenberg 1933
Figures 7.28–7.29

- 1933 *Nodosaria doliiformis* Eichenberg, p. 7, pl. 7, fig. 6.
1962 *Nodosaria doliiformis* Eichenberg; Tappan, 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2–5 (Figure 3.4); Albian, Cumshewa Inlet Station 6 (Figure 3.2); Albian, Onward Point Station 3 (Figure 3.3).

Nodosaria flexocarinata Khan 1950
Figures 8.1–8.2

- 1950 *Nodosaria fontannesii* var. *flexocarinata* Khan, p. 269, pl. 1, figs. 6–8.
1962 *Nodosaria flexocarinata* Khan; Tappan, 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*.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2–3 (Figure 3.4); Albian, Cumshewa Inlet Station 1 (Figure 3.2).

Nodosaria sp. A
Figures 8.3–8.4

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 in outline to *H. ovuloides* Grzybowski 1901 except that 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 fragile stolons connecting the chambers.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 3–4 (Figure 3.4); Albian, Cumshewa Inlet Stations 3–6 (Figure 3.2).

Subfamily FRONDICULARIINAE Reuss 1860
GENUS *Fronicularia* Defrance 1826 (in d’Orbigny 1826)

Fronicularia extensa Morrow 1934
Figures 8.5–8.6

- 1934 *Fronidularia extensa* Morrow, p. 193, pl. 29, fig. 31.
 1946 *Fronidularia extensa* Morrow; Cushman, p. 86, pl. 34, figs. 3-4.
 1981 *Fronidularia extensa* Morrow (1936 - sic) McNeil and Caldwell, 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2 (Figure 3.4).

Fronidularia sp. A
 Figures 8.7-8.9

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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2, 4 (Figure 3.4).

Fronidularia sp. B
 Figure 8.10

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. However, the sutures are obscured, except for the proloculus, in the Queen Charlotte Islands specimen, and the proloculus differs from the Chapman specimen.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2 (Figure 3.4); Albian, Cumshewa Inlet Station 5 (Figure 3.2).

Family VAGINULINIDAE Reuss 1860
 Subfamily LENTICULININAE Chapman, Parr, and Collins 1934

GENUS *Lenticulina* Lamarck 1804
Lenticulina cf. *L. ingenua* (Berthelin 1880)
 Figures 8.11-8.12

- 1880 *Cristellaria ingenua* Berthelin, p. 54, pl. 3, figs. 20-21.

- 1962 *Lenticulina ingenua* (Berthelin); Tappan, p. 162, pl. 41, figs. 1-2.

Description: Test free, lenticular, tending toward planispiral, unraveling later on, periphery keeled; chambers increasing in size gradually as they are added; sutures indistinct and depressed; wall calcareous; 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 cf. designation.

Occurrence: Cenomanian, Beresford Bay Station 4 (Figure 3.4).

Lenticulina macrodisca (Reuss 1863)
 Figures 8.13-8.14

- 1863 *Cristellaria macrodisca* Reuss, p. 78, pl. 9, fig. 5.
 1962 *Lenticulina macrodisca* (Reuss); Tappan, 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. As there was size gradation, one might consider these two distinct species, but as specimens of both sizes were always found together, they probably represent alteration of generations.

Occurrence: Upper Albian–Cenomanian, Beresford Bay Stations 1-4 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2); Albian, Onward Point Stations 1-4 (Figure 3.3).

GENUS *Saracenaria* Defrance 1824
Saracenaria grandstandensis Tappan 1960
 Figures 8.15-8.16

- 1960 *Saracenaria grandstandensis* Tappan, p. 292, pl. 2, figs. 8-10.
 1962 *Saracenaria grandstandensis* Tappan; Tappan p. 164, pl. 41, figs. 3-5.

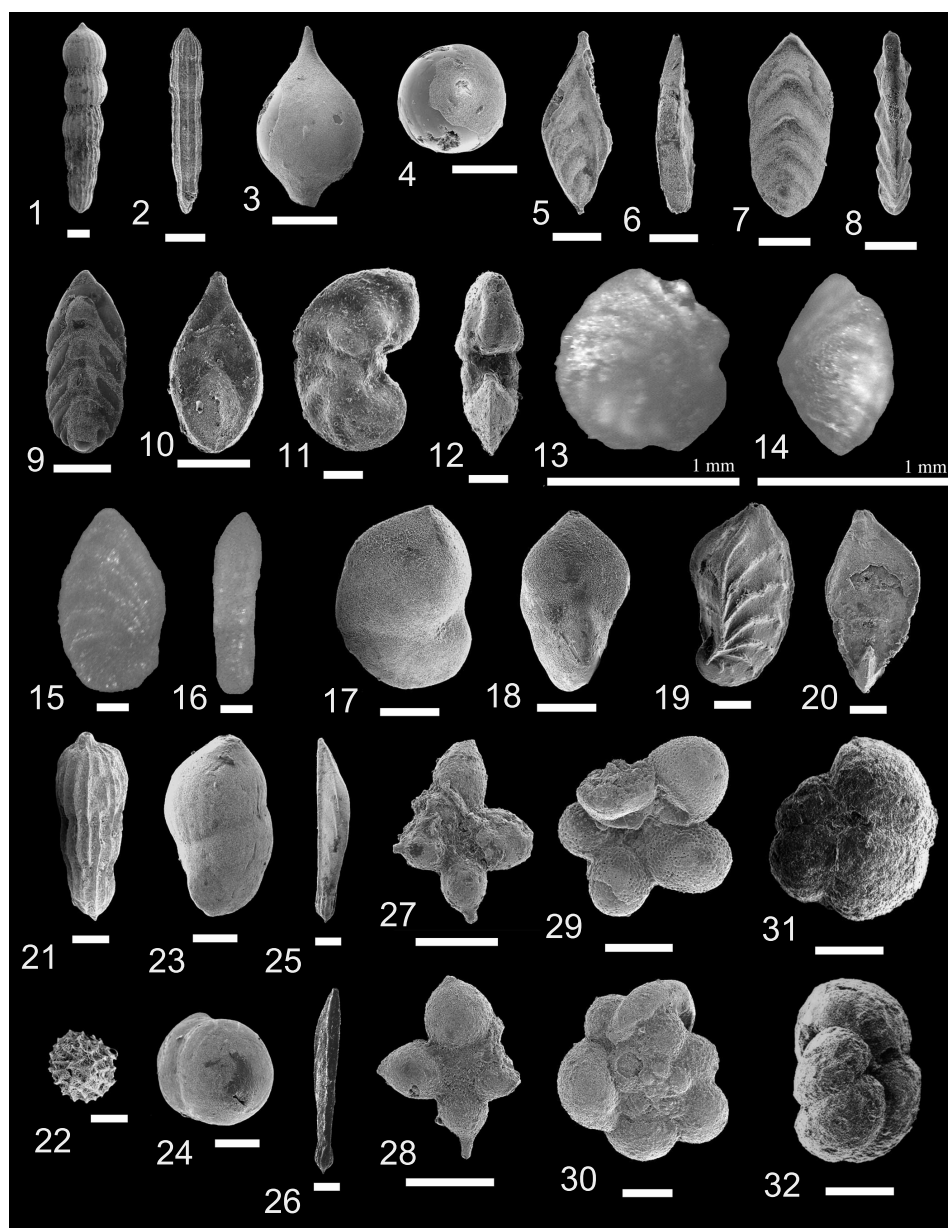


FIGURE 8. All scale bars = 100 µm, unless otherwise indicated. **1, 2**, *Nodosaria flexocarinata* Khan 1950, GSC No. 126583, from Beresford Bay Station 2 (GSC Loc. C-172913). **3, 4**, *Nodosaria* sp. A, GSC No. 126553, from Beresford Bay Station 4 (GSC Loc. C-173138). **5, 6**, *Fronidularia extensa* Morrow 1934, GSC No. 126584, from Beresford Bay Station 2 (GSC Loc. C-172907). **7, 8**, *Fronidularia* sp. A., GSC No. 126586, from Beresford Bay Station 2 (GSC Loc. C-172902). **9**, GSC No. 126587, from Beresford Bay Station 4 (GSC Loc. C-173133). **10**, *Fronidularia* sp. B., GSC No. 126589, from Beresford Bay Station 2 (GSC Loc. C-172908). **11, 12**, *Lenticulina* cf. *L. ingenua* (Berthelin 1880), GSC No. 126590, from Beresford Bay Station 4 (GSC Loc. C-173130). **13, 14**, *Lenticulina macrodisca* (Reuss 1863), GSC No. 126591, from Cumshewa Inlet Station 4 (GSC Loc. C-301953). **15, 16**, *Saracenaria grandstandensis* Tappan 1960, GSC No. 126594, from Cumshewa Inlet Station 3 (GSC Loc. C-302007). **17, 18**, *Saracenaria projectura* Stelck and Wall 1956, GSC No. 126592, from Beresford Bay Station 2 (GSC Loc. C-172909). **19, 20**, *Saracenaria valanginiana* (Bartenstein and Brand 1951), GSC No. 126593, from Beresford Bay Station 2 (GSC Loc. C-172901). **21, 22**, *Marginulina* cf. *inepta* (Reuss 1846), GSC No. 126581, from Beresford Bay Station 4 (GSC Loc. C-173085). **23, 24**, *Marginulina planiuscula* (Reuss 1862), GSC No. 126580, from Beresford Bay Station 2 (GSC Loc. C-172901). **25, 26**, *Citharina* sp., GSC No. 126588, from Beresford Bay Station 4 (GSC Loc. C-173129). **27, 28**, *Schackoina cenomana* (Schacko 1897), GSC No. 126603, from Beresford Bay Station 4 (GSC Loc. C-173137). **29, 30**, *Hedbergella planispira* (Tappan 1962), GSC No. 126595, from Beresford Bay Station 4 (GSC Loc. C-173138). **31, 32**, *Hedbergella* sp., GSC No. 126597, from Rennell Sound Road (GSC Loc. C-172855).

- 1981 *Saracenaria grandstandensis* Tappan;
McLean and Wall, 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 slightly 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-4 (Figure 3.4); Albian, Cumshewa Inlet Station 6 (Figure 3.2); Albian, Onward Point Stations 3, 4 (Figure 3.3).

Saracenaria projectura Stelck and Wall 1956 in
Stelck et al. 1956
Figures 8.17-8.18

- 1956 *Saracenaria projectura* Stelck and Wall, p. 50, pl. 3, figs. 22-25.
1962 *Saracenaria projectura* Stelck and Wall;
Tappan, 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 slightly curved and distinct under optical light; wall calcareous and hyaline; aperture radiate and the peripheral angle, produced on a very short neck.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2-4 (Figure 3.4); Albian, Cumshewa Inlet Stations 1-7 (Figure 3.2).

Saracenaria valanginiana (Bartenstein and Brand 1951)
Figures 8.19-8.20

- 1951 *Lenticulina valanginiana* Bartenstein and Brand, p. 291, pl. 13, figs. 364-365.
1962 *Saracenaria valanginiana* (Bartenstein and Brand); Tappan, 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.

Occurrence: Upper Albian–Cenomanian, Beresford Bay Stations 1-3 (Figure 3.4).

Subfamily MARGINULININAE Wedekind 1937
GENUS *Marginulina* d'Orbigny 1826
Marginulina cf. *inepta* (Reuss 1863)
Figures 8.21-8.22

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, not centrally positioned.

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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Stations 2, 4 (Figure 3.4); Albian, Onward Point Stations 1, 4 (Figure 3.3).

Marginulina planiuscula (Reuss 1862)
Figures 8.23-8.24

- 1862 *Cristellaria planiuscula* Reuss, p. 71, pl. 7, fig. 51.
1894 *Cristellaria planiuscula* Reuss; Chapman, p. 97, pl. 10, fig. 14.
1962 *Marginulina planiuscula* (Reuss 1862); Tappan, p. 170, pl. 43, figs. 8-11.

Description: Test free, small, initial portion slightly 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.

Occurrence: Upper Albian (?)–Cenomanian, Beresford Bay Station 2 (Figure 3.4).

Subfamily VAGINULININAE Reuss 1860
GENUS *Citharina* d'Orbigny 1839
Citharina sp.
Figures 8.25-8.26

Description: Test free, sub-triangular, flattened, proloculus globular with later changes broad, low, uniserial, increasing in breadth and strongly angled back toward the base from the nearly straight dorsal margin, sutures oblique, slightly curved and depressed, 4-5 costae running the length of the test; wall calcareous, perforate; aperture radial, terminal, large, produced on a short neck.

Occurrence: Cenomanian, Beresford Bay Station 4 (Figure 3.4).

Suborder GLOBIGERININA Delage and Hérourard
1896

Superfamily PLANOMALINACEA Bolli, Loeblich
and Tappan 1957

Family SCHACKOINIDAE Pokorny 1958

GENUS *Schackoina* Thalmann 1932

Schackoina cenomana (Schacko 1897)

Figures 8.27-8.28

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

1957 *Schackoina cenomana* (Schacko); Bolli, Loeblich, and Tappan, p. 36, pl. 2, figs. 1-2.

1981 *Schackoina cenomana* (Schacko); McNeil and Caldwell, 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 latest Albian-Cenomanian index fossil. Based on association with several benthic index fossils the strata where this species is found is late Albian.

Occurrence: Latest Albian, Beresford Bay Stations 4, 5 (Figure 3.4).

Suborder ROTALIINA Delage and Hérourard 1896

Superfamily ROTALIPOACEA Sigal 1958

Family HEDBERGELLIDAE Loeblich and Tappan
1961

Subfamily HEDBERGELLINAE Loeblich and Tappan
1961

GENUS *Hedbergella* Brönnimann and Brown 1958

Hedbergella planispira (Tappan 1940)

Figures 8.29-8.30

1940 *Globigerina planispira* Tappan; Tappan p. 122, pl. 19, fig. 12.

1957 *Praeglobotruncana planispira* (Tappan); Bolli, Loeblich and Tappan, p. 40, pl. 9, fig. 3.

1961 *Hedbergella planispira* (Tappan); Loeblich and Tappan, p. 276-277, pl. 5, fig. 4-11.

1967 *Hedbergella planispira* (Tappan); Eicher, p. 186, pl. 19, fig. 3.

1981 *Hedbergella planispira* (Tappan); McNeil and Caldwell, p. 255-256, pl. 20, figs. 7-8.

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.

Occurrence: Upper Albian (?) - Cenomanian, Beresford Bay Stations 2-4, 5 (Figure 3.4).

Hedbergella sp.

Figures 8.31-8.32

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.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1).

Hedbergella delrioensis (Carsey 1926)

Figures 9.1-9.2

1926 *Globigerina cretacea* d'Orbigny var. *delrioensis* Carsey, p. 43.

1981 *Hedbergella delrioensis* (Carsey 1926); McNeil and Caldwell, p. 252-253, pl. 20, figs. 5-6.

Description: Test free, planispiral; chambers spherical, initial chambers tiny, increasing rapidly in size as they are added; sutures distinct, depressed; walls calcareous, perforate; aperture an interiomarginal arch at the base of the final chamber.

Occurrence: Lower Albian, Rennell Sound Road, west-central Graham Island (Figure 3.1); Upper Albian-Cenomanian, Beresford Bay Stations 1-4 (Figure 3.4); Albian, Cumshewa Inlet Stations 4-8 (Figure 3.2).

Superfamily TURRILINACEA Cushman 1927

Family TURRILINIDAE Cushman 1927

GENUS *Praebulimina* Hofker 1953

Praebulimina reussi (Morrow 1934)

Figures 9.3-9.5

1934 *Bulimina reussi* Morrow p. 195, pl. 29, fig. 12.

1981 *Praebulimina reussi* (Morrow); McNeil and Caldwell p. 225, pl. 18, fig. 12.

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

Occurrence: Upper Albian-Cenomanian, Beresford Bay Station 2 (Figure 3.4).

Superfamily CHILOSTOMELLACEA Brady 1881

Family GAVELINELLIDAE Hofker 1956



FIGURE 9. All scale bars = 100 μ m, unless otherwise indicated. **1, 2**, *Hedbergella delrioensis* (Carsey 1926), GSC No. 126598, from Beresford Bay Station 3 (GSC Loc. C-164991). **3-5**, *Præbulimina reussi* (Morrow 1934), GSC No. 126609, from Beresford Bay Station 3 (GSC Loc. C-164992). **6**, *Gavelinella* sp. A, GSC No. 126548, from Beresford Bay Station 2 (GSC Loc. C-172909). **7, 8**, *Gavelinella* sp. B, GSC No. 126549, from Beresford Bay Station 4 (GSC Loc. C-173123).

Subfamily GAVELINELLINAE Hofker 1956

GENUS *Gavelinella* Brotzen 1942

Gavelinella sp. A

Figure 9.6

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.

Occurrence: Cenomanian, Beresford Bay Station 2 (Figure 3.4).

Gavelinella sp. B

Figures 9.7-9.8

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.

Occurrence: Cenomanian, Beresford Bay Stations 4, 5 (Figure 3.4).

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