GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

BULLETIN 181

# FAUNAS OF THE PLEISTOCENE CHAMPLAIN SEA

Frances J. E. Wagner

Ottawa
Canada
1970

Price, $3.00

# FAUNAS OF THE PLEISTOCENE CHAMPLAIN SEA

*1,450–1969–233-5885-5*

Technical Editor
R. G. BLACKADAR

Critical Reader
N. R. GADD

Editor
EDNA DASHNEY

Printed on ANCASTER BOOK
Set in Times Roman with
20th Century captions by
CANADIAN GOVERNMENT PRINTING BUREAU

Artwork by CARTOGRAPHIC UNIT, GSC

Collotype by COTSWOLD COLLOTYPE CO.

GEOLOGICAL SURVEY
OF CANADA

*BULLETIN 181*

# FAUNAS OF THE PLEISTOCENE CHAMPLAIN SEA

By
Frances J. E. Wagner

DEPARTMENT OF
ENERGY, MINES AND RESOURCES
CANADA

Available by mail from the Queen's Printer, Ottawa,
from Geological Survey of Canada,
601 Booth St., Ottawa

and at the following Canadian Government bookshops:

HALIFAX
*1735 Barrington Street*

MONTREAL
*Æterna-Vie Building, 1182 St. Catherine St. West*

OTTAWA
*Daly Building, corner Mackenzie and Rideau*

TORONTO
*221 Yonge Street*

WINNIPEG
*Mall Center Building, 499 Portage Avenue*

VANCOUVER
*657 Granville Street*

or through your bookseller

A deposit copy of this publication is also available
for reference in public libraries across Canada

Price $3.00 Catalogue No. M42-181

*Price subject to change without notice*

The Queen's Printer for Canada
Ottawa, Canada
1970

# PREFACE

Withdrawal of the Wisconsin ice sheet from the Ottawa – St. Lawrence Lowland was followed by the inundation of the area with the marine waters of the Champlain Sea. The deposits laid down in the Champlain Sea are of importance for construction aggregates, foundation material, and water supply source, and much of the soil of the area is derived from them.

A clearer understanding of the environment in which these deposits were formed may be gained by a study of the fossils they contain. This report is based on such a study.

Y. O. FORTIER,
*Director, Geological Survey of Canada*

OTTAWA, March 8, 1968

BULLETIN 181 — Die Fauna des Champlain-Meers im Pleistozän

Frances J. E. Wagner

Nach dem Zurückweichen der Wisconsin-Eisdecke überflutete Seewasser das heutige Ottawa- und St.-Lorenz-Tiefland von Ontario und Quebec. Der Artikel beschreibt und erörtert 108 Arten von Organismen aus den Ablagerungen dieses sog. Champlain-Meers.

---

БЮЛЛЕТЕНЬ 181 — Фауны моря Шамплейна плейстоценовой эпохи.

Ф. Й. Вагнер

После отступления висконского материкового ледяного покрова морские воды затопили низменную местность Оттавы — Святого Лаврентия в провинциях Квебек и Онтарио. В настоящей работе описаны и проанализированы 108 видов животных из этих отложений Шамплейнского моря.

# CONTENTS



## Illustrations

# FAUNAS OF THE PLEISTOCENE CHAMPLAIN SEA


## *Abstract*

The Champlain Sea was a body of water of varying salinity that covered parts of the present Ottawa – St.Lawrence Lowland from about 11,500 years B.P. to between 8,000 and 9,000 years B.P. Fossils are widespread throughout the area and have been the subject of numerous studies since 1837. A comprehensive listing of previous records has been issued separately, and this report presents the results of more recent field work. Species examined by the writer are described and illustrated.

The faunal assemblages indicate that the Champlain Sea was shallow, with the salinity of the water ranging from almost fresh in the upper reaches of the Ottawa River and Lake Champlain areas of inundation, to more nearly marine in the Quebec City area. Water temperatures were boreal in the earlier stages of the sea and later became more temperate. An attempt to establish precise temperatures by $O^{18}$ isotope determinations was not successful.



## *Résumé*

La mer de Champlain était une nappe d'eau de salinité inégale qui recouvrait certaines parties des basses-terres actuelles de l'Outaouais et du Saint-Laurent il y a quelque 11,500 à 8,000 ou 9,000 ans. La région est riche en fossiles qui ont fait l'objet de nombreuses études depuis 1837. On a publié séparément une liste complète des travaux antérieurs; le présent rapport donne uniquement les résultats des travaux d'exploration récents. L'auteur décrit les espèces qu'elle a examinées.

La répartition faunique révèle que la mer de Champlain était peu profonde et que l'eau y était presque douce dans les prolongements supérieurs des secteurs inondés de la rivière Outaouais et du lac Champlain, et d'une salinité presque marine aux environs de la ville de Québec. Au début, la température de l'eau était boréale, mais elle s'est élevée graduellement. Une tentative de déterminer les températures exactes au moyen de l'isotope $O^{18}$ n'a produit aucun résultat.

# INTRODUCTION

Champlain Sea is the name applied to a body of marine to brackish water that occupied parts of the Ottawa and St. Lawrence Valleys during late-glacial time. This inundation is believed to have lasted from about 11,500 years B.P. to between 8,000 and 9,000 years B.P. The marine waters extended up the Ottawa Valley to the vicinity of Rapides-des-Joachims, into the St. Lawrence Valley at least as far west as Brockville, and south into the valley now occupied by Lake Champlain. The eastern limit of the Champlain Sea was the constriction of the St. Lawrence Valley just downstream from Quebec City (Gadd, 1964, p. 1,253). Fossils from east of the Quebec City area are not considered in this paper.

Marine organisms reached as far west as an imaginary line extending from Baie Cayien (near Rapides-des-Joachims) through the vicinities of Pembroke, Pakenham, Carleton Place, and Smiths Falls to Brockville. Elevations for these deposits range from 500 feet above present sea level at Baie Cayien to about 300 feet at Brockville. North of the Ottawa and St. Lawrence Rivers, fossils have been discovered at elevations of just over 600 feet in Villeneuve township, 545 feet on Mount Royal, and about 500 feet near St. Raymond (north of Donnacona, Quebec). South of the St. Lawrence River, the sea was bounded by the southwest-trending highlands that parallel the Quebec–Maine boundary, and by the northern limits of the Adirondack Mountains of New York. In this region shells have been found at a height of about 510 feet near Bethany in Shefford county, 425 feet near Kingsey Falls, 350 feet near Drummondville (on top of the Drummondville moraine), 295 feet at Abbotsford, and 260 feet at Hemmingford. These elevations are all below those of the highest marine beaches.

Reconnaissance of the area to determine the extent of the fossiliferous deposits and to make collections began in 1953 and concluded in 1956. Able assistance was given by Miss Mary Muirhead and Mlle Marie-Solange Hone during the 1955 and 1956 field seasons, respectively. The writer is indebted to G. W. Brownell of the Hydro-Electric Power Commission of Ontario who guided her to many fossil localities revealed during construction of the St. Lawrence Seaway and Power Project; and to N. R. Gadd, P. F. Karrow, E. B. Owen, E. I. K. Pollitt, and V. K. Prest of the Geological Survey of Canada for similar assistance within their field project areas. Consultations with A. H. Clarke, Jr. and Mrs. Elizabeth Macpherson, of the National Museum of Canada, on problems related to molluscan taxonomy, with J. E. Hazel, United States Geological Survey, on ostracod identifications, and with G. A. Bartlett, Bedford Institute of Oceanography, regarding identifications of Foraminiferida were most helpful. To all these people, the writer extends sincere thanks.

The earliest known mention of fossil shells from the Champlain Sea was made by Capt. H. W. Bayfield (1837, p. 96) who noted that in raised deposits at Beauport, Quebec, there were shells of species still living in the St. Lawrence estuary. The shells were sent to Sir Charles Lyell for identification, and he reported on them in a paper read before the Geological Society of London in 1839. This list was published in 1841.

Since 1837 the fauna of the Champlain Sea has received continuing attention. Bayfield's collection comprised only pelecypod, gastropod, echinoid, and cirriped remains. In 1845, Lyell added one species each of brachiopod and fish to the list of then-known species. Joseph Leidy (1856) was the first to record seal bones, and J. W. Dawson in 1857 made first mention of worm and ophiuroid fossils. Foraminifers were initially reported in 1859 by Dawson. Results of his

Original MS. submitted by author March 1, 1966.

Final version approved for publication January 17, 1967; subsequent revisions to September, 1969.

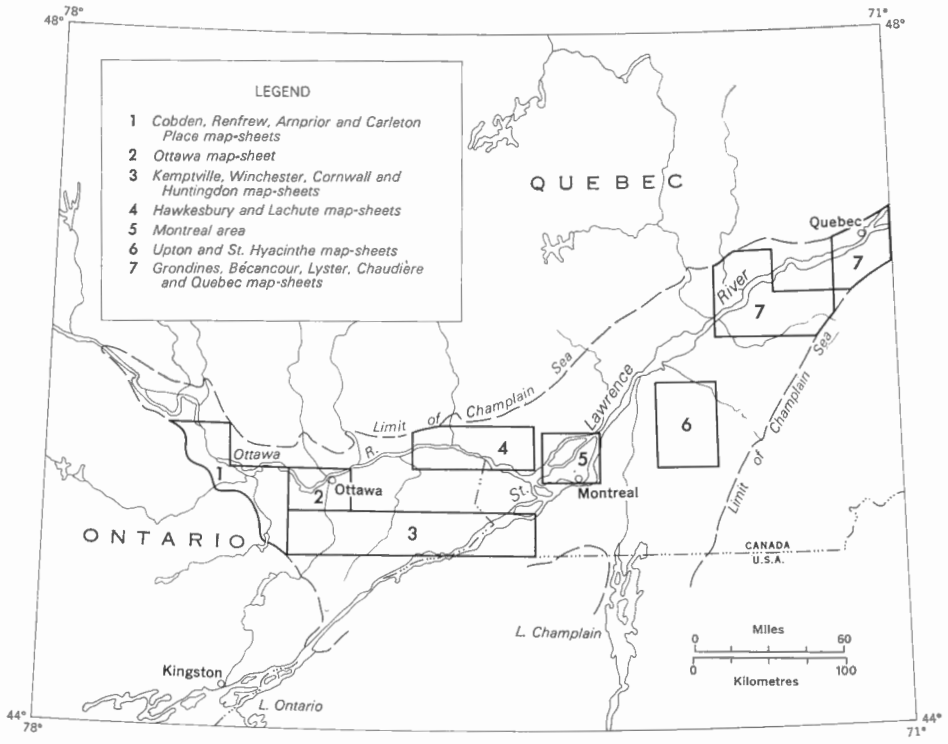



FIGURE 1. Areas selected for comparison of size ranges of certain species.

GSC

further studies, incorporated in Sir William Logan's *Geology of Canada* (1863), included the identification of several species of bryozoa and a species of whale. Thus, in about 25 years, twelve of the fifteen types of organisms eventually recorded from the Champlain Sea had been discovered. Ostracods were added to the list in 1870 with the publication of a paper by G. S. Brady and H. W. Crosskey, and sponges were added with the description of a new species by Dawson in 1871. After 1871, no additional types of organisms were discovered in the Champlain Sea deposits until E. M. Kindle (1928) found an isopod crustacean in a concretion.

All published references to Champlain Sea faunas that the writer has been able to find were compiled and have been issued separately (Wagner, 1967), together with a comparison of the original designation and currently applied names for all species which could be recognized.

## PALEOECOLOGY

Ecological implications of the Champlain Sea faunas were considered by nearly half of those who studied them. Initial observations (Bayfield, 1837 and Lyell, 1841, 1842) were that these faunas comprised species still to be found living in the northern part of the Gulf of St. Lawrence, and that the climate was generally colder than at present. In 1845 Lyell stated that the species were inhabitants of northern seas, and Murray (1852) reiterated this with regard to the species of fish identified from Green Creek, Ontario. J. W. Dawson (1857) concluded that the *Saxicava* sand was a littoral deposit and that the *Leda* clay represented deep-water deposition. He held to this opinion in his publications of 1859, 1863 (*in* Logan, Geology of Canada), 1871, 1872, 1878, and 1883, adding in 1883 that the "lower" *Leda* clay fossils represented Arctic conditions, whereas those species in the "upper" *Leda* clay could still be found in the Gulf of St. Lawrence. He believed (1871, 1872, and 1878) that a collection from Pakenham, Ontario, indicated a climate only slightly more rigorous than that now prevailing in the area. In 1893 Dawson further noted that water depths during deposition of the *Leda* clay were probably less than 100 fathoms. Similar observations were made by Dawson (1895), Wilson (1898), Coleman (1901a, b), Keele and Johnston (1913), Goldthwait (1913), Ardley (1916), Johnston (1916, 1917), Kindle (1918, 1928), Antevs (1925), and Sternberg (1951). Not until 1922 were observations made regarding probable salinity of the Champlain Sea waters and its effects upon the various species; these studies were by Goldring and Whittaker, respectively. Gadd (1960a), Terasmae (1960), and Richards (1962) stated that the Champlain Sea was a shallow body of brackish water.

Whittaker (1922) discussed the faunas and probable ecologic conditions in general terms, whereas Goldring (1922) based her conclusions on a detailed comparison of sizes of Pleistocene and recent representatives of six species of molluscs, namely: *Macoma groenlandica* [=*M. balthica*], *Saxicava rugosa* [=*Hiatella arctica*], *Mytilus edulis, Mya arenaria, Yoldia arctica* [=*Portlandia arctica*], and *Cylicha alba*. Specimens from the Montreal and Ottawa areas were considered, although main emphasis was on the faunas from the Champlain Valley of New York and Vermont. Goldring noted that specimens of *Saxicava rugosa, Macoma groenlandica,* and *Yoldia arctica* from Ottawa and from the Champlain Valley were smaller than those from Montreal, and she deduced, by comparing these with recent representatives in the Baltic Sea where a decrease in salinity towards the east away from the open ocean is accompanied by a decrease in the number of species and a dwarfing of the fauna, that a decrease in salinity was the cause of the dwarfing and impoverishment of the fauna that she had observed.

Considering the above-named species, the writer has measured specimens from seven areas within the region inundated by the Champlain Sea (*see* Fig. 1). Data are presented for each species according to area, and also according to elevation within each area. Measurements of recent east coast specimens from Abbott (1954), Bousfield (1960), and Morris (1957) are included in addition to those given by Goldring (1922).

Goldring regarded specimens of *Macoma balthica* from Montreal as being typically marine and those from Ottawa as being somewhat dwarfed by less saline conditions. According to Zenkevitch (1963, p. 310), however, *Macoma balthica,* unlike *Mytilus edulis* and *Mya arenaria,* is only slightly affected by changes in salinity. At salinities as low as 3.5 to 4 $^{0}/_{00}$, specimens average 19 mm in length. Average length at a salinity of 28 $^{0}/_{00}$ is about 27 mm. He noted that *M. balthica* was more affected by depth, although the table he gave (Table 127)

*Macoma balthica*

| Elevation (feet) | Length (mm) | Width (mm) | Av. length (mm) | Av. width (mm) |
|---|---|---|---|---|
| *Area 1* | | | | |
| 500 | 14 | 12 | | |
| 440 | 11–12 | 9–10 | 11.5 | 9.5 |
| 425 | 14–16 | 12–14 | 15 | 13 |
| 350 | 13–20 | 11–17 | 16 | 13 |
| 315 | 11–18 | 9–16 | 14 | 11 |
| *Area 2* | | | | |
| 380 | 12–23 | 10–19 | 16 | 14 |
| 375 | 12–19 | 10–17 | 16 | 14 |
| 350 | 12–21 | 9–18 | 15 | 13 |
| 300 | 10–18 | 8.5–15 | 16 | 14 |
| Goldring | 15–20 | 12–17.5 | 15–16 | 12–13.7 |
| *Area 3* | | | | |
| 344 | 14–17 | 12.5–15.5 | 16 | 14 |
| 320 | 13–17 | 11–15 | 15 | 13 |
| 300 | 13–14 | 12–13 | 13.5 | 12 |
| 290 | 17–20 | 14–16 | 19 | 15 |
| 275 | 10–15 | 8–13 | 13 | 11 |
| 270 | 15–16 | 14 | 15.5 | 14 |
| 260 | 13.5–15 | 11–12.5 | 14 | 11.5 |
| 210 | 8–18 | 7–15 | 12 | 10 |
| 170 | 9–13 | 7–10 | 11.5 | 9 |
| 165 | 12–15 | 10–13 | 13 | 11 |
| *Area 4* | | | | |
| 335 | 9–25 | 7–22 | 18 | 15 |
| 300 | 12.5–24 | 10.5–21 | 18 | 16 |
| *Area 5* | | | | |
| 310 | 8–17 | 7–15 | 13 | 11.5 |
| 232 | 14–18 | 12–15 | 16 | 13 |
| 205 | 14–23 | 12–19 | 18 | 15 |
| 173 | 10–18 | 9–16 | 14 | 12 |
| 143 | 13–19 | 11–17 | 16 | 14 |
| Goldring | 17–25 | 14–21.5 | 17–18.5 | 14–15.7 |
| *Area 6* | | | | |
| 245 | 7.5 | 6 | | |
| *Area 7* | | | | |
| 390 | 11–15.5 | 9–13 | 13 | 11 |
| 375 | 11 | 9 | | |
| 345 | 17.5–20 | 16–18 | 19 | 17 |
| 211 | 15–20 | 12.5–17 | 17 | 15 |
| 150 | 20–25 | 18–21 | 21 | 18 |
| 35 | 17 | 15 | | |
| *Recent* | | | | |
| East coast of North America: 13–38 mm long [25–33.4 mm (Goldring)] | | | | |
| Baltic Sea: 15–28 mm long | | | | |

covered a range of only 36 metres. Many of the Champlain Sea specimens fall well within the range of size mentioned by Zenkevitch, i.e., 15 to 28 mm, but a considerable number are borderline cases, being slightly less than 15 mm in length.

Goldring noted that the specimens of *Hiatella arctica* from Montreal had very heavy shells. The largest shells, which were in the minority, were as large as recent shells from Greenland. Most shells from Montreal, and those from Ottawa, were definitely dwarfed.

*Hiatella arctica*

| Elevation (feet) | Length (mm) | Width (mm) | Av. length (mm) | Av. width (mm) |
|---|---|---|---|---|
| *Area 2* | | | | |
| 380 | 13–30 | 6–14 | 22 | 12 |
| 350 | 13–23 | 6–11 | 17 | 8.5 |
| 310 | 17–25 | 8–15 | 23 | 13 |
| 300 | 17–29 | 8–15 | 22 | 11 |
| Goldring | 15–25 | 7–13.8 | 15 | 7 |
| *Area 3* | | | | |
| 344 | 15–22 | 8–10 | 18.5 | 9 |
| 320 | 18–20 | 10–11 | 19 | 11 |
| 300 | 18–19 | 10 | 18.5 | 10 |
| 270 | 13–22 | 8–12 | 17 | 9.5 |
| 260 | 19–21 | 9–10 | 20 | 9.5 |
| 210 | 8–21 | 4–10 | 16 | 8 |
| 165 | 25–29 | 14 | 26.5 | 14 |
| *Area 4* | | | | |
| 300 | 17–30 | 9–15 | 23 | 12 |
| *Area 5* | | | | |
| 310 | 18 | 9 | | |
| 232 | 23–28 | 11–14 | 25.5 | 12.5 |
| 205 | 21 | 11–12 | 21 | 11.5 |
| 187 | 15–18 | 8–11 | 17 | 9 |
| 173 | 15–24 | 8–12 | 19 | 10 |
| 143 | 15–27 | 10–13 | 21 | 11 |
| Goldring | 22–37 | 14–21 | 22–27 | 14–16 |
| *Area 6* | | | | |
| 350 | 18–19 | 10–12 | 18.5 | 11 |
| 245 | 19 | 11 | | |
| *Area 7* | | | | |
| 390 | 16–27 | 8–13 | 21 | 10 |
| 375 | 15–29 | 7–13 | 24 | 12 |
| 345 | 20–27 | 10–13 | 24 | 12 |
| 330 | 21–30 | 12–15 | 24 | 12 |
| 197 | 17–21 | 8–10 | 19 | 9 |
| 181 | 15–27 | 7–12 | 20 | 9 |
| 150 | 18 | 10 | | |
| 35 | 19–28 | 9–14 | 22 | 11 |
| *Recent* | | | | |
| East coast of North America: 12–50 mm long | | | | |
| Greenland: 35.6–41 mm long by 18.8–20 mm wide (Goldring, 1922, p. 175) | | | | |
| Hudson Bay: 8–39 mm long | | | | |

*Portlandia arctica* was reported by Goldring to be abundant at Ottawa, but of smaller size, on the average, than at Montreal. As with *Macoma balthica* and *Hiatella arctica,* the Champlain Sea specimens of *Portlandia arctica* were smaller than recent specimens.

Goldring found no unbroken specimens of *Mya arenaria* at Montreal, but she concluded from fragments obtained that the shells were equally as heavy and must have been as large as recent adult specimens.

The figure of *Mytilus edulis* in Geology of Canada, 1863, was regarded by Goldring as being a smaller specimen than would be expected for the Montreal area.

The Pleistocene specimen of *Cylichna alba* figured by Goldring has a length of 9.6 mm. No location, other than "Canada", was given.

*Portlandia arctica*

| Elevation (feet) | Length (mm) | Width (mm) | Av. length (mm) | Av. width (mm) |
|---|---|---|---|---|
| *Area 1* | | | | |
| 440 | (fragments of tiny shells) | | | |
| 315 | 3.5–6 | 2.5–4 | 5 | 3 |
| *Area 2* | | | | |
| Goldring | 13–19 | 8–11 | 13–15 | 8–9 |
| *Area 3* | | | | |
| 320 | 7 | 4.5 | | |
| 270 | 5.5 | 3.5 | | |
| 260 | 10 | 6 | | |
| *Area 5* | | | | |
| 187 | 5–11.5 | 3–7 | 9 | 5 |
| 173 | 4.5–9.5 | 3.5–6 | 8 | 5 |
| 143 | 3.5–12.5 | 2.5–7 | 9 | 6 |
| 55 | 7 | 5 | | |
| Goldring | larger than at Ottawa | | | |
| *Area 7* | | | | |
| 375 | 10.5–13 | 6.5–7.5 | 12 | 7.5 |
| 330 | 10–12 | 6.5–8 | 11 | 7 |
| 150 | 16.5 | 10.5 | | |
| 35 | 19 | 12 | | |

*Recent*

East coast of North America: as long as 25 mm [19.5–20.7 mm (Goldring)]
Hudson Bay: 5–11 mm long
East Greenland: maximum of 28 mm long by 15 mm wide

*Mya arenaria*

| Elevation (feet) | Length (mm) | Width (mm) | Av. length (mm) | Av. width (mm) |
|---|---|---|---|---|
| *Area 3* | | | | |
| 165 | 33–38 | 19–26 | 35.5 | 22.5 |
| *Area 4* | | | | |
| 300 | 28–46 | 18–27 | 39.5 | 23.5 |
| *Area 5* | | | | |
| 232 | 18–44 | 11–27 | 30 | 18 |
| 205 | 42–49 | 26–34 | 45.5 | 30 |
| 173 | 18–40 | 12–27 | 32 | 22 |
| 143 | 36–60 | 21–34 | 45 | 27 |
| Goldring | 85 | 50 | (Fig. from Geol. Can., 1863) | |
| *Area 6* | | | | |
| 245 | 54 | 33 | | |
| 209 | 11–29 | 7–17 | 25 | 15 |
| *Area 7* | | | | |
| 345 | 31–45 | 20–30 | 38 | 25 |
| 35 | 23 | 14 | | |

*Recent*

East coast of North America: 25–150 mm long
Northern United States coast (Goldring, 1922, p. 178): 64.2–89 mm long by 39.5–51.2 mm wide

*Mytilus edulis*

| Elevation (feet) | Length (mm) | Width (mm) | Av. length (mm) | Av. width (mm) |
|---|---|---|---|---|
| *Area 2* | | | | |
| 350 | 27–44 | 15–25 | 40 | 21 |
| *Area 4* | | | | |
| 300 | 15–20 | 9–11.5 | 19 | 10 |
| *Area 5* | | | | |
| 205 | 31 | 18 | | |
| 173 | 45 | 22 (est.) | | |
| Goldring | 40 | 20.5 | (Fig. from Geol. Can., 1863) | |
| *Area 6* | | | | |
| 350 | 44 | 23 | | |
| *Recent* | | | | |
| East coast of North America: 25–75 mm long | | | | |
| Northern United States coast (Goldring, 1922, p. 177): 68–77.5 mm long by 29.7–35.3 mm wide | | | | |

*Cylichna alba*

| | |
|---|---|
| *Area 5* | |
| 187 feet elevation: 4.6–5 mm long | |
| 143 feet elevation: 5.3 mm long | |
| 140 feet elevation: 7 mm long | |
| *Recent* | |
| East coast of North America: 5–6 mm long; a few as long as 10 mm | |

Generally, specimens of *Macoma balthica, Hiatella arctica, Mya arenaria,* and *Mytilus edulis* were found to fall within the lower one-quarter to one-half of the size ranges noted for living east coast representatives of these species. A few individuals of each species were smaller than the east coast minimum sizes; none was larger than, or even approached, the east coast maximum sizes. Collections of *Macoma balthica* with average lengths below the east coast minimum were found at lower elevations (170 to 275 feet above sea level) west of Montreal, and at higher elevations east of Montreal (375 to 390 feet in the region around and just west of Quebec City). One collection from Montreal, with specimens averaging the same length as the smallest east coast individuals, was from an elevation of 310 feet, but the majority of *Macoma balthica* were of small but normal size. Throughout most of the Champlain Sea, specimens of *Macoma balthica* showed very little variation in size, but in the area around Quebec City, specimens were slightly larger than elsewhere. Larger specimens of *Hiatella arctica* occurred at higher elevations along the northern margins of the Champlain Sea, i.e., between 300 and 380 feet from Ottawa, through the Hawkesbury–Lachute area, to the vicinity of Quebec City. In the Cornwall area, the largest specimens were found at about 165 feet, and around Montreal between 140 and 230 feet elevation. *Mya arenaria* and *Mytilus edulis* were not sufficiently abundant for any similar patterns to be detected.

All specimens of *Portlandia arctica* were below the minimum size mentioned for present east coast specimens. Those from all but the extreme eastern part of the Champlain Sea, however, were within the size range observed for recent specimens collected by the writer from Hudson Bay during the Hudson Bay Oceanographic Project, 1965. Near Quebec City, indivi-

duals were larger than the largest taken from Hudson Bay. It was noted for the Quebec City area that the lower the elevation the larger the specimen. The largest were from an elevation of 35 feet.

*Cylichna alba* is omitted from discussion because of its very limited occurrence.

Goldring based her conclusions regarding decreased salinity in the farther reaches of the Champlain Sea, notably the Ottawa area and the Champlain Valley of New York and Vermont, on dwarfing of the species discussed above. She considered specimens from the Montreal area to be indicative of more nearly normal marine conditions. The writer's findings agree in part with Goldring's. A comparison of sizes (average lengths) of these five species with those of Goldring (Pleistocene) and Zenkevitch (recent) is summarized below. Measurements are in millimetres.

| | | *M. balthica* | *H. arctica* | *P. arctica* | *M. arenaria* | *M. edulis* |
|---|---|---|---|---|---|---|
| Ottawa | Goldring | 15–16.5 | 15 | 13–15 | — | — |
| | Wagner | 15–16 | 17–23 | 5.5–10[1] | 35.5[1] | 40 |
| Montreal | Goldring | 17–18.5 | 22–27 | —[2] | 85[3] | 40 |
| | Wagner | 13–18 | 17–25.5 | 8–9 | 30–45.5 | 31–45 |
| North Sea | | 22 | — | — | 100 | 150 |
| Upper reaches of the Baltic | Zenkevitch | 22[4] | — | — | 36.5 | 20–25 |

[1]Area south and east of Ottawa

[2]Larger than at Ottawa

[3]Based on figure in Geology of Canada

[4]Zenkevitch (1963, p. 309) ". . . there are some indications that at the extreme limits of its distribution in the Gulfs of Bothnia and Finland the size of *M. balthica* falls to 15 to 18 mm."

Measurements of the writer's specimens show, on the whole, rather less variation between the Ottawa and Montreal areas than do Goldring's. The small sizes of these indicator species suggest brackish conditions throughout the major part of the Champlain Sea, with the waters being least saline in the farthest extremities of the sea.

Additional evidence for lower salinities is the paucity of species. Zenkevitch (1963, p. 305) shows that the number of species in the Baltic Sea decreases in direct relation to the reduction in salinity. For example, in the Kattegat, with a salinity of 20 $^0/_{00}$, about eight hundred and fifty species have been identified, whereas in the innermost reaches of the Baltic, where the salinity is as low as 5 $^0/_{00}$, approximately twenty-five species have been identified. Also, in a discussion of environmental causes for stunting, Hallam (1965, pp. 142, 150) points out that numerical abundance of specimens of restricted variety is frequently characteristic of waters of low salinity. Stenohaline forms, such as corals, brachiopods, cephalopods, echinoderms, bryozoans, etc., are either rare or absent. Predominant euryhaline forms are pelecypods, gastropods, and ostracods.

The Champlain Sea faunas are also limited with regard to number of species; only ninety-eight have been identified in the writer's collections (Table I, *in pocket*). Additional species cited in the earlier literature are excluded from this discussion because it has not been possible to examine the material. Thirty-eight species have been found in the western reaches of the Champlain Sea (west of 74°W longitude), and of these only fifteen penetrated into the narrow extension of the sea beyond the Ottawa area (*see* Table II)*. Thus some 42 per cent of the species, those indicative of more saline waters, did not extend their ranges into the western part of the sea. Waters of the arm of the Champlain Sea that extended south into the Champlain

*Note: Areas 1–6 in this table cover the whole of the Champlain Sea area and do not correspond to areas 1–7 (Fig. 1) selected for comparison of sizes of species with those recorded by Goldring.

Valley are also shown to have been of low salinity by Goldring who records sixteen species from this area; of these species only *Macoma balthica, Hiatella arctica, Portlandia arctica, Mytilus edulis,* and *Tethya* are common to the writer's list of species for the area of low salinity to the west and north of Ottawa.

According to Zenkevitch (1963, pp. 307, 308), *Macoma balthica* can survive and even thrive with salinity as low as 3.5 to 4 $^0/_{00}$. *Mytilus edulis* has a limit of 4.5 to 5 $^0/_{00}$, and *Mya arenaria* a limit of 5 $^0/_{00}$. In the Baltic Sea he also finds *Cardium edule* and *Macoma calcarea* extending into almost fresh water (salinity $<7$ $^0/_{00}$). Two species of *Astarte* (*A. elliptica* and *A. borealis*) make their appearance where the salinity is greater than 7 $^0/_{00}$. In the transition zone, with salinities between 8 and 20 $^0/_{00}$, the pelecypods *Nucula nucleus, Corbula gibba, Saxicava rugosa,* and *Teredo navalis* appear. The Kattegat, with salinity of more than 20 $^0/_{00}$, supports various representatives of *Leda, Yoldia, Arca, Ostrea,* and *Pecten,* and also offers a more favourable habitat for those species capable of penetrating less saline waters.

A comparison between Baltic Sea and Champlain Sea species suggests the following species to be indicators for corresponding salinity limits in the Champlain Sea.

| | |
|---|---|
| Salinity as low as 3.5–7 $^0/_{00}$ | *Macoma balthica, Mya arenaria, Mytilus edulis, Macoma calcarea* |
| Salinity not lower than 7 $^0/_{00}$ | *Astarte montagui* vars. (?) |
| " " " " 8 $^0/_{00}$ | *Mya truncata, Hiatella arctica, Nucula tenuis* (?) |
| " " " " 20 $^0/_{00}$ | *Portlandia arctica, Nuculana pernula* (?) |

Radiocarbon dates have been determined for a few shell samples from the Champlain Sea deposits (Fig. 2). The three oldest dates obtained fall within a span of about 100 years, from 11,410±150 to 11,320±200 years B.P. The range in elevation covered by the three samples is from 425 and 545 feet above present sea level. The oldest sample is from the lowest elevation, and may record initial marine submergence at a lower level than was obtained later. This would be in line with the ideas of MacClintock and Stewart (1965) on the development of the Champlain Sea. They postulated three stages in the formation of the sea: (1) sea level low because of the water still tied up in glacier ice; (2) sea level rising more rapidly than the isostatic rise of the land, thus giving the highest expression of the marine invasion; (3) isostatic rise of the land more rapid than the eustatic rise of sea level, resulting in a shallowing and final withdrawal of the Champlain Sea. According to the above dates, stage 1 of MacClintock and Stewart would have been compressed into a very short period of time — a few hundreds of years. This, of course, may be feasible in view of the relatively short duration, 3,000 to 4,000 years, of the Champlain Sea, but the range in elevation of the samples dated falls within the natural living depth ranges of the species involved, namely *Hiatella arctica, Macoma balthica, Macoma calcarea,* and *Mya truncata.* It is open to conjecture, therefore, whether the Champlain Sea began at a lower level and became deeper before becoming shallower, as believed by MacClintock and Stewart, or whether the sea was highest initially and then became progressively shallower. The shell collections dated so far do not give the answer. The other shells dated are clustered within a time span of about 350 years (10,850±330 years to 10,590±200 years B.P.) and a range in elevation of 160 feet (450 to 290 feet above sea level), although the several collections of shells from the Ottawa–Hull area are more restricted as to elevation, i.e., between 395 and 290 feet. A single sample of whale bone from an elevation of 300 feet at Ottawa gave a radiocarbon date of 10,470 years B.P. The other shell samples from Pembroke (elevation 450 feet) and from Glennevis (elevation 285 feet) are contemporaneous with the Ottawa–Hull samples. Datings of post-Champlain Sea peats show that the marine waters had withdrawn from the Pembroke area by about 9,540 years B.P., and from the vicinity of Prescott by 9,430±140 years B.P.

Only a few species were involved in the radiocarbon datings. All species are presented in Table III, arranged according to the elevations at which they were found above present sea

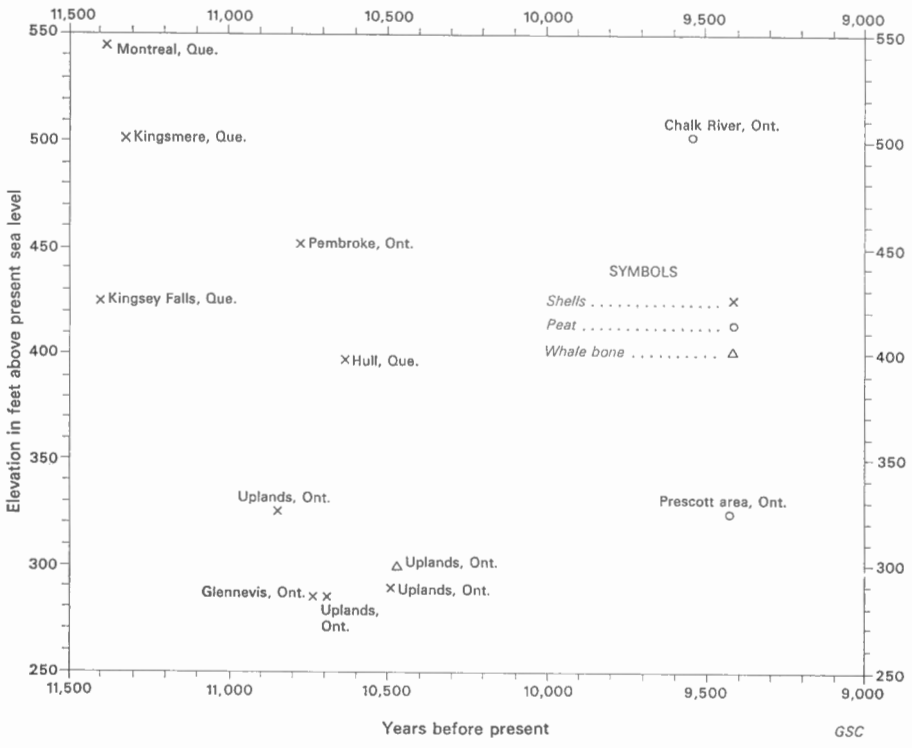



**FIGURE 2. Radiocarbon ages, marine and non-marine samples.**

level. Those at the highest elevations would represent early migrants into the Champlain Sea, although species found in the deeper water clays at lower elevations were probably contemporaneous with those from sands and gravels at higher elevations. Species found at lower elevations are mostly those also found only in the eastern part of the area of marine inundation. Conversely, those species found at the highest elevations are the same ones that penetrated farthest into the Champlain Sea. These latter species, too, show the greatest range in elevation and the widest distribution throughout the extent of the sea. These relationships can be readily seen by comparing Tables II and III.

Between 10 and 15 per cent of the localities had fossil pelecypods in living position, or at least with valves unseparated, indicating little or no transport after death. *Macoma balthica* and *Hiatella arctica* are the species most commonly found intact; *Mya arenaria* ranks third, followed by *Mytilus edulis* and *Portlandia arctica*. The first four species occur primarily in mixed sand and gravel deposits; *Macoma balthica* is also fairly common in sand, both where the sand forms partings in the upper part of the clay and in sand overlying clay or till. *Portlandia arctica* is characteristic of the silts and clays. Thus *Macoma balthica* and *Hiatella arctica* may be regarded as index species for the Champlain Sea sands and gravels, and *Portlandia arctica* for the Champlain Sea silts and clays. *Mya arenaria* and *Mytilus edulis* are of much less common and less widespread occurrence and are not considered to be index species, although their presence, along with *Macoma balthica* and *Hiatella arctica,* contributes to the evidence for the shallow-water origin of the sands and gravels. *Portlandia arctica,* although it has been recorded from depths of as little as 3 metres, is characteristically found in deeper waters.

An attempt to determine precise water temperatures for the Champlain Sea was not successful. Shells were chosen from different elevations to show changes, if any, that might have occurred within the time span of the sea. They were also selected to give as wide an

areal coverage as possible. From the twenty-three samples selected initially, ten were sent to Isotopes, Inc. for oxygen-isotope analysis. Following are the samples tested:

| Sample No. | Species | Locality | Elevation (feet) |
|---|---|---|---|
| 1 | *Macoma balthica* | Lot 18, con. I, Stafford tp., Renfrew co., Ontario | 475 |
| 3 | *M. balthica* | Lot 6, con. VII, Ramsay tp., Lanark co., Ontario | 440 |
| 4 | *Hiatella arctica* | Sand pit at old Uplands Airport, Ottawa, Ontario | 275 |
| 5 | *H. arctica* | Lot 19, con. IV, Cumberland tp., Russell co., Ontario | 225 |
| 6 | *M. balthica* | Cardinal, Ontario | 275 |
| 10a | *H. arctica* | Rivière Beaudet, Quebec, just north of St. Lawrence River | 165 |
| 11 | *H. arctica* | Côte Ste. Catherine Road and St. Joseph Blvd., Montreal, Quebec | 300 |
| 12 | *M. balthica* | Beaugrand and Souligny, Montreal, Quebec | 55 |
| 13 | *M. balthica* | 2.5 miles northwest of St. Narcisse, Quebec | 345 |
| 14a | *M. balthica* | La Carrière, Quebec | 209 |

Results are given as $\delta$ oxygen-18 relative to the PDB standard ($CO_2$ produced from *Belemnitella americana* from the Cretaceous Peedee Formation on the right bank of the Peedee River at Burgess Ferry, near Florence, South Carolina). To calculate the temperature of formation of the carbonate, the following equation is used:

$$t = 16.5 - 4.3(\delta - A) + 0.14(\delta - A)^2$$

where $\delta$ is the value determined and A is the value for the water in which the carbonate formed. For average, present-day sea water, the value of $A = 0\ ^0/_{00}$ is used. A value for fresh water, based on water from Lake Michigan, is $A = -7\ ^0/_{00}$*. J. N. Weber (*Nature*, vol. 203, No. 4948, August 1964, p. 970) gives a value of $A = -8.15\ ^0/_{00}$ for Quaternary freshwater carbonate. Apparently no value has been determined yet for Quaternary marine carbonate.

As a matter of interest, temperatures have been calculated using all three values for A. The two species analyzed gave drastically different results, as can be seen by the following summary.

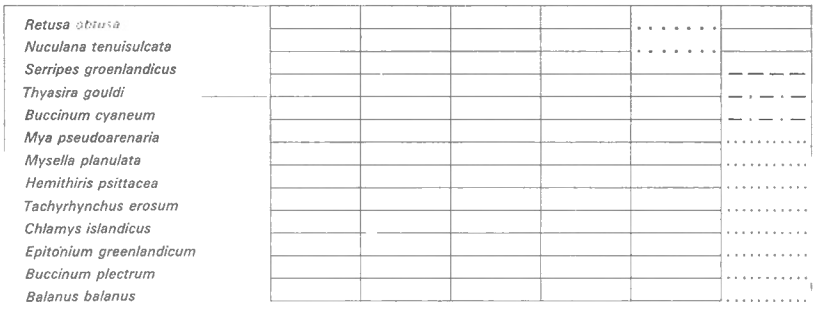
| Species | Sample No. | Elev. | $\delta\ O^{18}$ rel. to PDB | Temperature (°C) Mean sea water $A = 0\ ^0/_{00}$ | Fresh water $A = -7\ ^0/_{00}$ | Quaternary fresh water $A = -8.15\ ^0/_{00}$ |
|---|---|---|---|---|---|---|
| *Macoma balthica* | 1 | 475′ | −10.58 | 77.7 | 33.7 | 27.0 |
| | 3 | 440′ | − 9.77 | 71.9 | 29.5 | 23.8 |
| | 13 | 345′ | −10.07 | 74.0 | 31.0 | 25.3 |
| | 6 | 275′ | − 6.91 | 53.0 | 16.1 | 12.7 |
| | 14a | 209′ | −12.04 | 88.6 | 41.8 | 35.3 |
| | 12 | 55′ | −11.00 | 80.7 | 35.9 | 29.9 |
| *Hiatella arctica* | 11 | 300′ | − 1.56 | 23.6 | −2.8 | −5.8 |
| | 4 | 275′ | − 5.08 | 42.0 | 8.7 | 4.6 |
| | 5 | 225′ | − 2.07 | 26.0 | −1.3 | −4.4 |
| | 10a | 165′ | − 2.32 | 27.2 | −0.7 | −3.9 |

*R. K. Wanless, Geological Survey of Canada, pers. com.

TABLE II | *Geographical Distribution and Abundance of Species*

| SPECIES | NUMBER OF LOCALITIES | | | | | |
|---|---|---|---|---|---|---|
| | 17 | 102 | 8 | 55 | 36 | 13 |
| | AREA | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| *Macoma balthica* | ——— | — — | — — | ——— | — · — | — — |
| *Portlandia arctica* | — — — | — · — | — · — | — · — | — · — | — — — |
| ostracods | — · — · — | — — — | — · — | — · — | — · — | — — — |
| *Elphidium bartletti* | — · — · — | — · — · — | — · — · — | — · — · — | — — — | ..... |
| *Hiatella arctica* | ..... | — — | — — — | — — | — · — | ——— |
| *Mytilus edulis* | ..... | — · — · — | — · — · — | — · — | — — — | — — |
| *Protelphidium orbiculare* | ..... | — · — | — · — | — · — | — · — | — — — |
| *Islandiella teretis* | ..... | ..... | — · — · — | — · — · — | — · — | — · — |
| *Elphidium clavatum* | ..... | ..... | — · — | ..... | — — — | — — — |
| *Islandiella islandica* | ..... | ..... | — — — | ..... | — · — · — | ..... |
| *Tethya logani* | ..... | ..... | — · — · — | ..... | — · — · — | ..... |
| *Elphidium frigidum* | ..... | ..... | — · — · — | ..... | ..... | ——— |
| *Globulina glacialis* | ..... | ..... | ——— | ——— | ——— | ——— |
| *Laryngosigma* sp. | ..... | ..... | ——— | ——— | ——— | ——— |
| *Hyperammina* sp. | ..... | ——— | ——— | ——— | ——— | ——— |
| *Balanus crenatus* | ——— | — — — | — · — | — — — | — · — · — | — · — · — |
| *Mya arenaria* | ——— | ..... | ——— | — — — | ..... | — · — · — |
| *Elphidium incertum* | ——— | ..... | — · — · — | — · — · — | ..... | ..... |
| *Pseudopolymorphina novangliae* | ——— | ..... | — — — | ..... | ——— | ..... |
| *Macoma calcarea* | ——— | ..... | ——— | ..... | — · — · — | — — |
| *Elphidium subarcticum* | ——— | ..... | — · — · — | ..... | ..... | — — — |
| *Pyrulina angusta* | ——— | ..... | ——— | ——— | ——— | ——— |
| *Astarte montagui* vars. | ——— | ..... | ——— | — · — · — | ——— | — · — · — |
| *Mya truncata uddevallensis* | ——— | ..... | ——— | — · — · — | ..... | — · — · — |
| *Balanus hameri* | ——— | ..... | ——— | ..... | ..... | — — — |
| *Quinqueloculina seminulum* | ——— | ..... | ——— | ..... | ——— | ——— |
| *Nucula tenuis* | ——— | ..... | ——— | ..... | ..... | ..... |
| *Islandiella norcrossi* | ——— | ..... | ——— | ..... | ——— | ——— |
| ophiuroid | ——— | ..... | ——— | ..... | ——— | — · — · — |
| *Mallotus villosus* | ——— | ..... | ——— | ——— | ——— | ——— |
| *Margarites* sp. | ——— | ..... | ——— | ——— | ——— | ——— |
| *?Serpula vermicularis* | ——— | ..... | ——— | ——— | ——— | ——— |
| *Haminoea solitaria* | ——— | ..... | ——— | ——— | ——— | ——— |
| *Axinopsida orbiculata* | ——— | ..... | ——— | ——— | ——— | ——— |
| diatoms | ——— | ..... | ——— | ——— | ——— | ——— |
| *Quinqueloculina arctica* | ——— | ..... | ——— | ——— | ——— | ——— |
| *Pseudopolymorphina suboblonga* | ——— | ..... | ——— | ——— | ——— | ——— |
| Polymorphinidae, gen. & sp. indet. | ——— | ——— | — · — · — | ——— | ——— | ——— |
| *? Dentalina* sp. | ——— | ——— | — · — · — | ——— | ——— | ——— |
| *Guttulina dawsoni* | ——— | ——— | — · — · — | ——— | ——— | ——— |
| *Mya truncata* | ——— | ——— | ——— | — · — · — | ..... | — · — · — |
| *Elphidiella arctica* | ——— | ——— | ——— | ..... | ——— | ——— |
| *Cylichna alba* | ——— | ——— | ——— | ..... | ——— | ..... |
| *Neptunea despecta tornata* | ——— | ——— | ——— | ..... | ..... | — · — · — |
| *Nuculana pernula* | ——— | ——— | ——— | ..... | ..... | — — — |
| *Trichotropis borealis* | ——— | ——— | ——— | ..... | ——— | — · — · — |
| *Crassostrea virginica* | ——— | ——— | ——— | ..... | ——— | ——— |
| *Lagena apiopleura* | ——— | ——— | ——— | ..... | ——— | ——— |
| *Cibicides lobatulus* | ——— | ——— | ——— | ..... | ..... | ——— |
| *Buccella frigida* | ——— | ——— | ——— | ..... | ..... | — · — · — |
| *Lepeta caeca* | ——— | ——— | ——— | ..... | ——— | — · — · — |
| *Buccinum* sp. | ——— | ——— | ——— | ..... | ——— | ..... |
| *Pateoris hauerinoides* | ——— | ——— | ——— | ..... | ——— | ——— |
| *Natica pallida* | ——— | ——— | ——— | ——— | ..... | — · — · — |
| *Buccinum undatum* | ——— | ——— | ——— | ——— | ..... | ——— |
| *Natica clausa* | ——— | ——— | ——— | ——— | ..... | — — — |
| *Musculus niger* | ——— | ——— | ——— | ——— | ..... | ..... |
| *Buccinum tenue* | ——— | ——— | ——— | ——— | ..... | ..... |
| *Yoldia limatula* | ——— | ——— | ——— | ——— | ..... | ..... |
| *Lyonsia arenosa* | ——— | ——— | ——— | ——— | ..... | ..... |

Table II continued




Explanation of Areas

*Area 1.* 45 N—46°N, west of 76°W; comprising Chalk River, Pembroke, Fort Coulonge, Cobden, Quyon, Renfrew, Arnprior and Carleton Place map-areas.

*Area 2.* North of 45°N, 74°W—76°W; comprising Low, Wakefield, Thurso, Hawkesbury, Lachute, Ottawa, Russell, Alexandria, Vaudreuil, Kemptville, Winchester, Cornwall and Huntingdon map-areas.

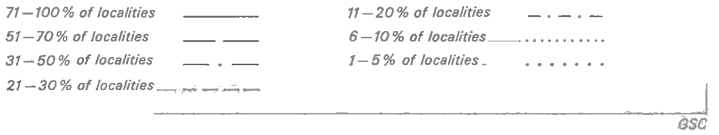
*Area 3.* South of 45°N, east of 76°W; comprising Merrickville, Morrisburg and Massena map-areas.

*Area 4.* 45°N—46°N, 72°W—74° W; comprising Laurentides, Verchères, Upton, Drummondville, Laval, Beloeil, St. Hyacinthe, Lachine, St. Jean, Granby, Chateauguay and Lacolle map-areas.

*Area 5.* 46°N—47°N, 72°W—74°W; comprising Montauban, Shawinigan, Grondines, Trois-Rivières, Bécancour, Sorel, Yamaska and Aston map-areas.

*Area 6.* 46°N—47°N, east of 72°W; comprising St. Raymond, Quebec, Portneuf, Chaudière and Lyster map-areas.

Explanation of Symbols




Why the two species gave such widely differing values is not known. Perhaps some physiologic difference is reflected here. It is interesting to note that the lowest temperature for *Macoma balthica* and the highest for *Hiatella arctica* are for samples from the same elevation, namely 275 feet. It is perhaps not surprising that the results are anomalous when considered in the light of studies carried out by Keith and Parker. They state (1965, p. 115)

> Oxygen isotopic data for modern shells from known environments are interpreted as indicating that $\delta^{18}O$ of fossil shells can not be used as a basis for conclusions regarding paleotemperatures in marginal marine environments of ancient seas, because the temperature effect is masked by larger effects due to river water additions and to evaporation and restricted mixing, which cause local variations in the oxygen isotopic composition of the water.

Waters of the Champlain Sea were probably not truly marine anywhere, and the salinity was certainly variable, being lower in the restricted extremities of the sea where influx of fresh water had a marked effect. The presence of *Portlandia arctica* in the early, deeper water clays suggests higher salinity then than prevailed during later stages of the sea.

A qualitative evaluation of the faunas indicates that the water was colder in the earlier stages of the sea, and later became more moderate. Apparently at no time did strictly Arctic temperatures prevail, unless in the initially relatively deeper waters in which *Portlandia arctica* lived. The near-shore waters of this period were characterized by *Macoma balthica,* a species whose range extends to the Arctic Ocean, but one that does not actually penetrate truly Arctic waters. Lower stages of the Champlain Sea, below about 300 feet above present sea level,

TABLE III | *Distribution and Abundance of Species According to Elevation*

| SPECIES | NUMBER OF LOCALITIES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0 | 3 | 7 | 7 | 10 | 45 | 45 | 38 | 49 | 10 | 10 | 6 |
| | RANGE IN ELEVATION IN FEET | | | | | | | | | | | | |
| | 601-650 | 551-600 | 501-550 | 451-500 | 401-450 | 351-400 | 301-350 | 251-300 | 201-250 | 151-200 | 101-150 | 51-100 | 1-50 |
| *Macoma balthica* | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ |
| *Hiatella arctica* | | | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ |
| *Mytilus edulis* | | | ▬ | | | ▬ | ▬ | ▬ | ▬ | ▬ | ▪ | ▪ | ▬ |
| *Balanus crenatus* | | | ▬ | | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▪ | ▬ | |
| *Mya truncata uddevallensis* | | | ▬ | | | ▪ | | ▪ | ▪ | ▪ | | | |
| ostracods | | | ▬ | | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▪ | ▪ | ▬ |
| *Hyperammina* sp. | | | ▬ | | | | | | | | | | |
| *Elphidium bartletti* | | | | ▬ | | ▬ | ▬ | ▬ | ▬ | ▬ | | | ▬ |
| *Protelphidium orbiculare* | | | | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ |
| *Portlandia arctica* | | | | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ | ▬ |
| *Elphidium clavatum* | | | | | | ▬ | ▪ | ▪ | ▪ | ▬ | ▬ | ▬ | ▬ |
| *Islandiella teretis* | | | | | | ▬ | ▪ | ▪ | ▬ | ▬ | | ▬ | ▬ |
| *Laryngosigma* sp. | | | | | | ▪ | | | ▪ | | | | |
| *Islandiella islandica* | | | | | | ▪ | ▪ | ▪ | ▬ | ▪ | | ▬ | ▬ |
| *Globulina glacialis* | | | | | | ▪ | | ▪ | ▪ | | | | |
| *Elphidium frigidum* | | | | | | ▪ | ▪ | ▪ | ▪ | ▪ | | | |
| *Tethya logani* | | | | | | ▪ | ▪ | ▪ | ▪ | ▪ | | | |
| *Elphidium subarcticum* | | | | | | ▪ | ▪ | | ▪ | ▬ | | | ▬ |
| *Buccella frigida* | | | | | | ▪ | ▪ | | | | | | ▬ |
| *Astarte montagui* vars. | | | | | | ▪ | ▪ | ▪ | ▪ | ▬ | | | |
| *Serripes groenlandicus* | | | | | | ▪ | ▪ | | | ▪ | | | |
| *Macoma calcarea* | | | | | | ▪ | ▪ | ▪ | ▪ | ▬ | | ▬ | ▬ |
| *Mya pseudoarenaria* | | | | | | ▪ | | | | | | | |
| *Natica clausa* | | | | | | ▪ | ▪ | | | ▪ | | | ▬ |
| *Trichotropis borealis* | | | | | | ▪ | ▪ | ▪ | | ▪ | | | |
| *Buccinum cyaneum* | | | | | | ▪ | ▪ | | | | | | |
| ophiuroid | | | | | | ▪ | ▪ | | ▪ | | | ▪ | |
| *Cibicides lobatulus* | | | | | | | ▪ | | | | | | ▬ |
| *Retusa obtusa* | | | | | | | ▪ | | | | | | |
| *Pseudopolymorphina novangliae* | | | | | | | ▪ | ▪ | ▪ | ▪ | ▪ | | |
| *Nuculana minuta* | | | | | | | ▪ | | ▪ | ▪ | ▪ | ▬ | ▬ |
| *Musculus niger* | | | | | | | ▪ | | | | | | ▬ |
| *Lyonsia arenosa* | | | | | | | ▪ | | | | | | ▬ |
| *Mya truncata* | | | | | | | ▪ | ▪ | ▪ | ▪ | | | |
| *Neptunea despecta tornata* | | | | | | | ▪ | ▪ | | ▪ | | | ▬ |
| *Pyrulina angusta* | | | | | | | ▪ | ▪ | ▪ | | | | |
| *Crassostrea virginica* | | | | | | | ▪ | | | ▪ | | | |
| *Elphidium incertum* | | | | | | | | ▪ | ▪ | ▬ | ▬ | | |
| *Mya arenaria* | | | | | | | | ▬ | ▬ | ▬ | ▬ | | ▬ |
| *Haminoea solitaria* | | | | | | | | ▪ | | | | | |
| *Quinqueloculina arctica* | | | | | | | | ▪ | | | | | |
| *Islandiella norcrossi* | | | | | | | | ▪ | | ▪ | | | |
| ? *Dentalina* sp. | | | | | | | | | ▪ | | | | |
| *Guttulina dawsoni* | | | | | | | | | ▪ | | | | |
| *Balanus hameri* | | | | | | | | | ▪ | ▪ | | ▬ | |
| *Quinqueloculina seminulum* | | | | | | | | | ▪ | | | | |
| *Pateoris hauerinoides* | | | | | | | | | ▪ | | | | |
| diatoms | | | | | | | | | ▪ | | | | |
| *Nucula tenuis* | | | | | | | | | ▪ | | ▪ | ▪ | ▬ |
| ? *Serpula vermicularis* | | | | | | | | | ▪ | | | | |
| *Margarites* sp. | | | | | | | | | ▪ | | | | |
| Polymorphinidae, gen. & sp. indet. | | | | | | | | | ▪ | | | | |
| *Axinopsida orbiculata* | | | | | | | | | ▪ | | | | |
| *Lagena apiopleura* | | | | | | | | | ▪ | | | | |
| *Elphidiella arctica* | | | | | | | | | | ▪ | ▪ | ▪ | |
| *Pseudopolymorphina suboblonga* | | | | | | | | | | ▪ | | | |
| *Buccinum* sp. | | | | | | | | | | ▪ | | | |
| *Cylichna alba* | | | | | | | | | | ▪ | ▬ | | |
| *Natica pallida* | | | | | | | | | | ▪ | | | ▬ |
| *Mysella planulata* | | | | | | | | | | ▪ | | | |
| *Hemithiris psittacea* | | | | | | | | | | ▪ | | | |
| *Tachyrhynchus erosum* | | | | | | | | | | ▪ | | | ▬ |
| *Chlamys islandicus* | | | | | | | | | | ▪ | | | |
| *Epitonium greenlandicum* | | | | | | | | | | ▪ | | | |
| *Buccinum plectrum* | | | | | | | | | | ▪ | | | |
| *Buccinum tenue* | | | | | | | | | | ▪ | | | |
| *Balanus balanus* | | | | | | | | | | ▪ | | | |
| *Lepeta caeca* | | | | | | | | | | ▪ | | ▪ | |
| *Yoldia limatula* | | | | | | | | | | ▪ | | | ▬ |
| *Thyasira gouldi* | | | | | | | | | | ▪ | | ▪ | |
| *Mallotus villosus* | | | | | | | | | | | ▪ | | |
| *Buccinum undatum* | | | | | | | | | | | | | ▬ |
| *Nuculana tenuisulcata* | | | | | | | | | | | | | ▬ |

were marked by *Mya arenaria*. *M. arenaria* is a species of the intertidal zone whose present northern limit of range in the western Atlantic is about 57° north latitude. Several species, i.e., *Yoldia limatula, Mysella planulata,* and *Lyonsia hyalina,* which do not range north of the Gulf of St. Lawrence, penetrated only the eastern part of the Champlain Sea, although *Neptunea despecta tornata,* whose northern limit is also Gulf of St. Lawrence, has been reported from as far west as Ottawa (Johnston, 1916, 1917; Antevs, 1939; Richards, 1962), and has been found by the writer at Montreal.

Explanation of Symbols

71–100% of localities ——— ———
51–70% of localities ——— — —
31–50% of localities ——— — . —
21–30% of localities ——— — — —
11–20% of localities — . — . —
6–10% of localities ——— .....
1–5% of localities ——— . . . .

## DESCRIPTION OF SPECIES[1]

## PROTISTA

Phylum **PROTISTA**

Subphylum SARCODINA Schmarda, 1871

Class *RHIZOPODEA* von Siebold, 1845

Subclass *LOBOSIA* Carpenter, 1861

Order **FORAMINIFERIDA** Eichwald, 1830

Suborder TEXTULARIINA Delage and Hérouard, 1896

Superfamily *AMMODISCACEA* Reuss, 1862

Family *ASTRORHIZIDAE* Brady, 1881

Subfamily HIPPOCREPININAE Rhumbler, 1895

Genus *Hyperammina* Brady, 1878

?*Hyperammina* sp.

Plate I, figures 1a, b

*Hyperammina* Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433.

Genus characterized by an elongate test of cemented sand grains, consisting of a bulbous proloculus and long, tubular second chamber; cement either calcareous or ferruginous, sand grains generally angular quartz fragments; aperture terminal and rounded.

*Remarks.* Two fragments of a specimen tentatively referred to this genus were found in the Pembroke area.

*Type and occurrence.* Hypotype, GSC No. 20094. Locality 2: lot 18, con. I, Stafford tp., near Pembroke, Ontario, at an elevation of 475 feet above sea level.

---

[1]Only those species examined and identified by the writer are described.

Suborder MILIOLINA Delage and Hérouard, 1896
Superfamily *MILIOLACEA* Ehrenberg, 1839
Family *MILIOLIDAE* Ehrenberg, 1839
Subfamily QUINQUELOCULININAE Cushman, 1917

Genus *Quinqueloculina* d'Orbigny, 1826

*Quinqueloculina arctica* Cushman, 1933
Plate I, figure 2

*Quinqueloculina arctica* Cushman, Smithsonian Inst. Misc. Collections, vol. 89, No. 9, p. 2, pl. 1, figs. 3a–c; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 40, pl. 5, figs. 11, 12.

Test free, ovate, with chambers angled and showing a quinqueloculine arrangement; wall calcareous, surface smooth; sutures slightly depressed; aperture with a thin, bifid tooth.

*Remarks.* This species may be differentiated from *Q. seminulum* by its more robust shell and by the distinct angulation of the margins of the chambers.

*Type and occurrence.* Hypotype, GSC No. 20095. Locality 95: C.N.R. relocation, lot 21 (?), con. II, Osnabruck tp., Stormont co., Ontario; elevation about 270 feet above sea level.

*Quinqueloculina seminulum* (Linné, 1758)
Plate I, figures 3, 4

*Serpula seminulum* Linné, Systema Nat., ed. 10, tomus 1, 1758, p. 786.
*Quinqueloculina seminulum* (Linné), Cushman, U.S. Natl. Museum, Bull. 104, pt. 6, 1929, p. 24, pl. 2, figs. 1, 2; Weiss, U.S. Geol. Surv., Prof. Paper 254-G, 1954, p. 161, pl. 33, fig. 11; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 251, pl. 6, fig. 1.

Test free, elongate, with chambers added in successive planes 144° apart, so that four chambers may be seen on one side and three on the other; sutures distinct and depressed; wall calcareous–porcellaneous; aperture, at the end of the last chamber, large and provided with a simple tooth, or may be toothless.

*Remarks.* This species is somewhat variable in outline with some specimens being more elongate and slender than others. All specimens found were considerably abraded.

*Occurrence.* Localities 94, 157, and 159.

*Types.* Hypotypes, GSC No. 20097, from a gravel pit 1.4 miles southeast of St. Philomène, Quebec, at an elevation of about 215 feet; GSC No. 20096, from lot 29, con. IV, Cornwall tp., Stormont co., Ontario; elevation 207 feet above sea level.

Genus *Pateoris* Loeblich and Tappan, 1953

*Pateoris hauerinoides* (Rhumbler, 1936)
Plate I, figure 5

*Miliolina seminulum* (Linné) var. *disciformis* (Macgillivray), Williamson, Recent Foraminifera of Great Britain, 1858, p. 86, pl. 7, figs. 188, 189 (not *Vermiculum disciforme* Macgillivray, 1843).
*Miliola (Quinqueloculina) subrotunda* (Montagu), Parker and Jones, Phil. Trans. Roy. Soc. London, vol. 155, 1865, p. 411, pl. 15, figs. 38a, b (not *Vermiculum subrotundum* Montagu, 1803).
*Quinqueloculina subrotunda* (Montagu) forma *hauerinoides* Rhumbler, Foram. der Kieler Bucht, Teil II – Ammodisculinidae bis Textulinidae, vol. 1, No. 1, 1936, pp. 206, 217, 226, text-figs. 167 (p. 205), 208–212 (p. 225).
*Pateoris hauerinoides* (Rhumbler), Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 42, pl. 6, figs. 8–12, text-figs. 1A, B; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 256, pl. 6, fig. 5.

Test free, somewhat compressed, circular to subcircular in outline; early chambers show a quinqueloculine arrangement, later chambers added in a single plane, with 2½ to 3 chambers to a coil; wall calcareous–porcellaneous with a smooth, polished surface, sometimes with transverse wrinkles on later chambers; aperture a low arch in juveniles, opening out later and developing an almost slit-like extension in adults.

*Remarks.* The single specimen found is a young individual.

*Type and occurrence.* Hypotype, GSC No. 20098. Locality 157: pit 1.4 miles southeast of St. Philomène, Quebec; elevation about 215 feet above sea level.

Suborder ROTALIINA Delage and Hérouard, 1896
Superfamily *NODOSARIACEA* Ehrenberg, 1838
Family *NODOSARIIDAE* Ehrenberg, 1838
Subfamily NODOSARIINAE Ehrenberg, 1838

Genus *Dentalina* Risso, 1826

?*Dentalina* sp.
Plate I, figure 6

*Dentalina* d'Orbigny, Ann. Sci. Nat., vol. 7, 1826, p. 254.

Genus comprising forms with an elongate, generally arcuate test, numerous chambers in a linear series; sutures usually oblique; wall calcareous, smooth and opaque; aperture radiate and may be either centrally or eccentrically placed.

*Remarks.* Only the initial chamber was found; its rounded outline suggests a form similar to *Dentalina baggi* Galloway and Wissler.

*Type and occurrence.* Hypotype, GSC No. 20099. Locality 113: eastern edge of Farrans Point, Ontario; elevation about 240 feet above sea level. This locality is now under water, having been flooded by construction of the St. Lawrence Seaway.

Genus *Lagena* Walker and Jacob, 1798

*Lagena apiopleura* Loeblich and Tappan, 1953
Plate I, figure 7

*Lagena apiopleura* Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 59, pl. 10, figs. 14, 15; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 284, pl. 11, fig. 3.

Test free, single chambered, pear-shaped outline, circular in cross-section; surface of the calcareous hyaline wall ornamented with a few longitudinal ribs extending from a ring at the base of the chamber upward to a smooth collar into which they merge just below the apertural neck; aperture round, at end of short, smooth neck.

*Remarks.* This species is rare in the Champlain Sea deposits; a single specimen is known from Montreal. It is a cold-water form, having been previously recognized from the waters off northern Alaska, Greenland, and Ungava Bay.

*Type and occurrence.* Hypotype, GSC No. 20100. Locality 151: corner of Isabella and Décarie Streets, Montreal, Quebec. Elevation about 205 feet above sea level.

Family *POLYMORPHINIDAE* d'Orbigny, 1839
Subfamily POLYMORPHININAE d'Orbigny, 1839

## Genus *Globulina* d'Orbigny *in* de la Sagra, 1839

### *Globulina glacialis* Cushman and Ozawa, 1930

Plate I, figure 9

*Globulina glacialis* Cushman and Ozawa, Proc. U.S. Natl. Museum, vol. 77, No. 2829, art. 6, 1930, p. 71, pl. 15, figs. 6, 7.

Test fusiform, tapering more toward base than at apertural end; chambers arranged in a nearly triserial series, embracing in a clockwise manner, inflated; an additional extra chamber often present higher up on test; sutures distinct, wall smooth and almost transparent; aperture terminal and radiate.

*Remarks.* Only one specimen was found at each of the three localities.

*Occurrence.* Localities 37, 65, and 117.

*Type.* Hypotype, GSC No. 20102, from 2.5 miles south-southeast of Alexandria, Ontario, lot 6, con. I, Kenyon tp., elevation 297 feet above sea level.

### ?*Globulina* sp.

*Globulina* d'Orbigny, *in* de la Sagra, Hist. Phys. Pol. et Nat. de l'Isle de Cuba, 1839, "Foraminifères", p. 134.

Test ovate to globular, chambers overlapping, appearing in a triserial arrangement; sutures distinct but generally not depressed; aperture radiate.

*Remarks.* Because of the fragmentary nature of the material, positive identification is not possible.

*Occurrence.* Locality 16.

## Genus *Guttulina* d'Orbigny, 1839

### *Guttulina dawsoni* Cushman and Ozawa, 1930

Plate I, figure 10

*Guttulina dawsoni* Cushman and Ozawa, Proc. U.S. Natl. Museum, vol. 77, art. 6, 1930, p. 47, pl. 12, figs. 1, 2; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 297, pl. 12, figs. 10, 11.

Test elongate, wider in upper part and tapering toward base; chambers forming a counterclockwise, quinqueloculine series with each succeeding chamber much farther removed from the base; wall smooth with distinct sutures; aperture radiate.

*Remarks.* This is a cold-water species, having been recorded previously from Hudson Bay by Cushman and Ozawa (1930), and from off Spitzbergen and East Greenland by Feyling-Hanssen (1954). The latter has also found it in the Holocene deposits of Spitzbergen and Pleistocene and Holocene deposits of southern Norway.

*Type and occurrence.* Hypotype, GSC No. 20103. Locality 113: eastern edge of the former community of Farrans Point, Ontario (now flooded by the St. Lawrence Seaway); elevation about 240 feet above sea level.

## Genus *Pseudopolymorphina* Cushman and Ozawa, 1928

### *Pseudopolymorphina novangliae* (Cushman, 1923)

Plate I, figures 11, 12

*Polymorphina lactea* (Walker and Jacob) var. *novangliae* Cushman, U.S. Natl. Museum Bull., No. 104, 1923, p. 146, pl. 39, figs. 6–8.

*Pseudopolymorphina novangliae* (Cushman), Weiss, U.S. Geol. Surv., Prof. Paper 254-G, 1954, p. 162, pl. 33, fig. 13; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 300, pl. 13, fig. 3.

Test elongate, tapering at both ends, compressed, early chambers showing a quinqueloculine arrangement, later ones becoming biserial; wall calcareous–hyaline, smooth, with indistinct sutures; aperture terminal, round and radiate.

*Remarks.* *P. novangliae* has been reported from Hudson Bay and from off the western Atlantic coast as far south as Rhode Island. It is also known from Pleistocene deposits of Long Island, New York, and from southern Norway.

*Occurence.* Localities 90, 94, 110, 113, 145, and 175.

*Types.* Hypotypes, GSC No. 20104, lot 2, con. II, Osnabruck tp., Stormont co., Ontario. Elevation about 265 feet above sea level; GSC No. 20105 from Westbury, near Mackenzie, Montreal, Quebec; elevation 171 feet above sea level.

### *Pseudopolymorphina suboblonga* Cushman and Ozawa, 1930

Plate I, figure 13

*Pseudopolymorphina suboblonga* Cushman and Ozawa, Proc. U.S. Natl. Museum, vol. 77, art. 6, 1930, p. 91, pl. 23, figs. 3a–c; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 300, pl. 13, fig. 4.

Test elongate, more acute at apertural end than at base, but with greatest width towards upper part; chambers inflated, slightly overlapping, showing first quinqueloculine and later biserial arrangement; wall smooth, sutures depressed; aperture radiate.

*Remarks.* This species was described from the Pliocene of Japan and is found at present off the Japanese coast. It has also been found in the Pleistocene of southern Norway. A single specimen was found at locality 110.

*Type and occurrence.* Hypotype, GSC No. 20106. Locality 110: lot 15, con. III, Cornwall tp., Stormont co., Ontario, at an elevation of 197 feet above sea level.

### *Pseudopolymorphina* sp.

*Pseudopolymorphina* Cushman and Ozawa, Contrib. Cushman Lab. Foraminiferal Res., vol. 4, pt. 1, 1928, p. 15.

Test elongate, early chambers showing quinqueloculine and later ones biserial arrangement, chambers slightly overlapped with depressed sutures; aperture radiate.

*Remarks.* The specimens from the following localities were broken, and specific determinations were uncertain.

*Occurrence.* Localities 94, 95, 114, 136, 141, and 223.

## Genus *Pyrulina* d'Orbigny *in* de la Sagra, 1839

### *Pyrulina angusta* (Egger, 1857)

Plate I, figure 14

*Polymorphina (Globulina) angusta* Egger, Neues Jahrb. Mineral. Geogn., Geol. Petref.-Kunde, 1857, p. 290, pl. 13, figs. 13–15.
*Polymorphina angusta* Egger, Cushman, U.S. Natl. Museum, Bull. 71, pt. 3, 1913, p. 86, pl. 39, fig. 6.
*Pyrulina angusta* (Egger), Barker, Soc. Econ. Paleontologists, Mineralogists, Spec. Publ. No. 9, 1960, pl. LXXII, figs. 1–3.

Test elongate, subcompressed, cylindrical; apical end acute, apertural end obtuse; chambers few, elongate; sutures distinct; aperture radiate.

*Remarks.* This species also known from only a single locality.

*Type and occurrence.* Hypotype, GSC No. 20107. Locality 94: lot 29, con. IV, Cornwall tp., Stormont co., Ontario, at an elevation of 207 feet above sea level.

*Pyrulina* sp.

*Pyrulina* d'Orbigny *in* de la Sagra, Hist. Phys. Pol. et Nat. de l'Isle de Cuba, 1839, p. 107.

Test fusiform, early chambers arranged spirally, approximately 120° apart, later chambers added biserially; sutures flush; aperture radiate.

*Remarks.* Preservation of these specimens was such that identification to the species level was not possible.

*Occurrence.* Localities 60 and 87.

Family *POLYMORPHINIDAE* d'Orbigny, 1839

Genus and species indet.

Plate I, figure 8

*Polymorphinidae* d'Orbigny, *in* de la Sagra, Hist. Phys. Pol. et Nat. de l'Isle de Cuba, 1839, p. 131.

Test multilocular with chambers arranged spirally or sigmoidally about the longitudinal axis of growth, or biserially, or uniserially, often partly overlapping; aperture terminal, radiate.

*Remarks.* Only the one specimen was found. It bears a superficial resemblance to *Marginulina* (Family Nodosariidae), but some of the lines on the test that appear to be sutures are of secondary origin, probably resulting from pressure.

*Type and occurrence.* Hypotype, GSC No. 20101. Locality 50: bank of St. Lawrence River, just east of creek 7 miles east of Morrisburg, Ontario; elevation 225 feet above sea level.

Family *GLANDULINIDAE* Reuss, 1860
Subfamily GLANDULININAE Reuss, 1860

Genus *Laryngosigma* Loeblich and Tappan, 1953

*Laryngosigma* sp.

*Laryngosigma* Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 83.

Test free, somewhat compressed; chambers biserially arranged in a sigmoid series, each succeeding chamber farther removed from the base; aperture terminal and radiate, with an entosolenian tube.

*Remarks.* A single specimen was found that is probably referable to this genus.

*Occurence.* Locality 16.

Superfamily *BULIMINACEA* Jones, 1875
Family *ISLANDIELLIDAE* Loeblich and Tappan, 1964

Genus *Islandiella* Nørvang, 1958

*Islandiella islandica* (Nørvang, 1945)

Plate I, figures 15, 16

*Cassidulina islandica* Nørvang, Zool. Iceland, vol. 2, pt. 2, 1945, p. 41, fig. on p. 42, tfs. 7, 8d–f.
*Islandiella islandica* (Nørvang), Nørvang, Vid. Medd. Dansk Naturhist. Foren., vol. 120 (1958) 1959, p. 26.

Test free, inflated, rather large, with about four pairs of chambers in the last whorl reaching to the umbilicus on one side and with only a small triangular portion visible on the other side; wall calcareous, radiate-fibrous, smooth, with depressed sutures; aperture elongate with an internal plate-like tooth extending from posterior edge of aperture.

*Remarks.* This is one of the more common species of Foraminifera in the Champlain Sea. It is a widespread species in arctic and boreal waters now.

*Occurrence.* Localities 16, 37, 50, 92, 94, 103, 106, 113, 174, 182, 196, 198, 201, 206, 207, 210, and 218.

*Types.* Hypotypes, GSC No. 20108, from the north bank of St. Lawrence River, just east of the creek 7 miles east of Morrisburg, Ontario, at an elevation of 225 feet above sea level; GSC No. 20109, from the bank of a small stream flowing into the St. Lawrence 3.2 miles southwest of Deschaillons, Quebec; elevation about 100 feet above sea level.

### *Islandiella norcrossi* (Cushman, 1933)

Plate I, figures 17, 18

*Cassidulina norcrossi* Cushman, Smithsonian Inst. Misc. Collections, vol. 89, No. 9, 1933, p. 7, pl. 2, figs. 7a–c.

*Islandiella norcrossi* (Cushman), Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 325, pl. 16, fig. 20; pl. 17, fig. 1.

Test free, biconvex, periphery subacute to slightly keeled; chambers distinct, triangular in side view, alternating from one side to the other, being more nearly equal on the two sides than is usual for the genus; wall calcareous, finely perforate and transluscent, with distinct, limbate sutures; aperture elongate.

*Remarks.* Present distribution of this species is mainly Arctic. It is common in the Pleistocene of southern Norway, but rare in the Pleistocene Champlain Sea deposits.

*Occurrence.* Localities 90 and 159.

*Types.* Hypotypes, GSC No. 20110, from lot 2, con. II, Osnabruck tp., Stormont co., Ontario; elevation about 265 feet above sea level; GSC No. 20111, from the second gravel pit from the southern end of the St. Philomène Ridge, Quebec, at an elevation of 165–170 feet above sea level.

### *Islandiella teretis* (Tappan, 1951)

Plate I, figure 19

*Cassidulina teretis* Tappan, Contrib. Cushman Found. Foraminiferal Res., vol. 2, pt. 1, 1951, p. 7, pl. 1, figs. 30a–c.

*Islandiella teretis* (Tappan), Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 326, pl. 16, fig. 17.

Test free, lenticular, with a clear umbilical boss on either side; chambers alternate on both sides of peripheral keel, each extending from the umbilicus on one side about halfway to umbilical boss on other side; eight to ten chambers visible along periphery; wall smooth, calcareous, with distinct, gently curved sutures; aperture elongate and crescentic.

*Remarks. Islandiella teretis* is widely distributed throughout the Champlain Sea deposits, being next in abundance only to species of the genera *Elphidium* and *Protelphidium*.

*Occurrence.* Localities 16, 65, 90, 92, 94, 95, 102, 106, 113, 118, 123, 136, 140, 150, 151, 157, 161, 163, 174, 177, 178, 180, 182, 194, 195, 198, 199, 201, 204, 206–209, 210, 214, 218–220, 222, and 224.

*Type.* Hypotype, GSC No. 20112, from lot 6, con. I, Kenyon tp., Glengarry co., Ontario; elevation 297 feet above sea level.

Superfamily *DISCORBACEA* Ehrenberg, 1838
Family *DISCORBIDAE* Ehrenberg, 1838
Subfamily DISCORBINAE Ehrenberg, 1838

Genus *Buccella* Anderson, 1952

*Buccella frigida* (Cushman, 1922)
Plate I, figures 20, 21

*Pulvinulina frigida* Cushman, Contrib. Can. Biol., (1921) 1922, No. 9, p. 144.
*Buccella frigida* (Cushman), Anderson, J. Wash. Acad. Sci., vol. 42, No. 5, 1952, p. 144, figs. 4a–c, 5, 6a–c; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 115, pl. 22, figs. 2, 3; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 337, pl. 18, figs. 15–18.

Test free, small, biconvex and trochoid, with a smooth surface; dorsal side has slightly curved, limbate sutures, oblique to peripheral margin; ventral side with curved to radial sutures filled with pustulose material; umbilicus and basal margin of last-formed chamber also pustulose; five to seven chambers in the last whorl, adult tests having two and one-half to three whorls; aperture concealed.

*Remarks.* This is a common species on the Scotian shelf today, but was of limited distribution in the Champlain Sea. It also inhabits most arctic and boreal waters.

*Occurrence.* Localities 141, 209, 223, and 224.

*Types.* Hypotypes, GSC No. 20114, from south shore of St. Lawrence River, 3.2 miles east of Deschaillons, Quebec, elevation about 15 feet above sea level; GSC No. 20113, from east bank of Grande Rivière du Chêne, just south of highway 9, Quebec, at an elevation about 330 feet above sea level.

Superfamily *ROTALIACEA* Ehrenberg, 1839
Family *ELPHIDIIDAE* Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933

Genus *Elphidium* de Montfort, 1808

*Elphidium bartletti* Cushman, 1933
Plate I, figures 22, 23; Plate II, figure 1

*Elphidium bartletti* Cushman, Smithsonian Inst. Misc. Collections, vol. 89, No. 9, 1933, p. 4, pl. 1, fig. 9; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 96, pl. 18, figs. 10-14; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 343, pl. 21, figs. 1, 2.

Test planispiral, involute to slightly evolute, with slightly depressed umbilical regions; peripheral margin rounded and somewhat lobulate; commonly nine or ten chambers in final whorl, but may be as few as seven or as many as twelve; wall calcareous, smooth and glassy, umbilical area filled with granular material; sutures gently curved and depressed with pores and short, broad retral processes; aperture consisting of a row of pores at base of apertural face and scattered pores in apertural face of last chamber.

*Remarks. Elphidium bartletti* is one of the most common foraminiferal species in the Champlain Sea deposits. It penetrated almost to the maximum limits of the marine invasion, and inhabited areas in which brackish conditions prevailed. This species is widely distributed in cold waters today, especially at shallower depths.

*Occurrence.* Localities 2, 16, 42, 47, 53, 60, 89, 91, 94, 95, 102, 104, 106, 110, 117, 118, 120–124, 126, 140, 151, 154, 158, 163, 175, 180, 182, 186, 191, 196, 199, 203, 208, 209, 215, and 224.

*Type.* Hypotypes, GSC Nos. 20115 and 20116, from a pit west of Rivière Beaudet and south of highway 2 in Quebec; elevation about 165 feet above sea level; GSC No. 20117 from site of the Cornwall dyke, in the vicinity of the Hydro-Electric Power Commission of Ontario office, Cornwall, Ontario; elevation about 210 feet above sea level.

### *Elphidium frigidum* Cushman, 1933
Plate II, figure 2

*Elphidium frigidum* Cushman, Smithsonian Inst. Misc. Collections, vol. 89, No. 9, 1933, p. 5, pl. 1, fig. 8; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 99, pl. 18, figs. 4–9.

Test generally involute with rounded periphery and flattened sides; eight or nine chambers in final whorl, earlier ones only slightly inflated and later ones more inflated, final chamber often higher, projecting beyond general contour of test; wall calcareous and coarsely perforate with slightly depressed, curved sutures, each with a row of pores with about ten grooves extending in both directions; aperture a row of pores at base of apertural face with numerous pores scattered over apertural face.

*Remarks.* According to G. A. Bartlett (pers. com.) there is a strong possibility that *Elphidium frigidum* may be the young form of *Elphidiella arctica*. Until this problem has received further study, however, the writer intends to retain the names in current use.

*Occurrence.* Localities 16, 113, 140, 175, and 223.

*Type.* Hypotype, GSC No. 20118, from the corner of Masson and D'Iberville Streets, Montreal, Quebec; elevation 173 feet above sea level.

### *Elphidium incertum* (Williamson, 1858)
and forma *clavatum* Cushman, 1930
Plate II, figures 3–6

*Polystomella umbilicatula* var. *incerta* Williamson, Ray Soc., London, 1858, p. 44, pl. 3, fig. 82a.
*Elphidium incertum* (Williamson) var. *clavatum* Cushman, U.S. Natl. Museum, Bull. 104, pt. 7, 1930, p. 20, pl. 7, fig. 10.
*Elphidium incertum* (Williamson), Macfayden, Geol. Mag., vol. 69, No. 821, 1932, pl. 35, figs. 16a, b; Phleger, Contrib. Cushman Found. Foraminiferal Res., vol. 3, pt. 2, 1952, p. 83, pl. 14, fig. 7; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 100; Barker, Soc. Econ. Paleontologists, Mineralogists, Spec. Publ. No. 9, 1960, pl. CIX, fig. 23.
*Elphidium clavatum* Cushman, Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 98, pl. 19, figs. 8–10.
*Elphidium incertum incertum* (Williamson), Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 344, pl. 19, figs. 16, 17; pl. 20, figs. 9, 10.
*Elphidium incertum clavatum* Cushman, Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 255, 1964, p. 345, pl. 20, figs. 11–15.

Test free, involute, periphery subacute to rounded; biumbonate or with slightly depressed umbilicus, margin entire or with last two or three chambers lobulated, last whorl composed of nine to thirteen chambers; wall calcareous, transluscent, and distinctly perforate to opaque; umbilical area with one or more clear bosses (*clavatum*) to depressed with sutural slits converging at umbilical depression (*incertum*); sutures slightly curved, with pores; retral processes strong to absent, umbilical slits present in both umbonate and umbilically depressed forms; aperture a single row of pores at base of apertural face of last chamber.

*Remarks.* Bartlett (1962, 1965) notes intergradations between *E. clavatum* and *E. incertum,* and the Champlain Sea specimens figured herewith illustrate this point. Figures 3 and 4 show the smaller form with clear central boss referred to forma *clavatum,* and Figure 6 shows typical *E. incertum,* the larger form with depressed umbilicus and grooves radiating from the umbilical area. Figure 5 is of an intermediate form. These intergradations are also recognized by Feyling-Hanssen (1964). Because of stratigraphic considerations he records the two forms as subspecies.

*Elphidium incertum* forma *clavatum* is apparently the young stage of *E. incertum.*

*Occurrence.* Localities 65, 87, 95, 106, 110, 113, 114, 118, 124, 136, 138, 141, 150, 151, 192, 196, and 220 (typical *E. incertum*); localities 16, 30, 37, 47, 50, 94, 103, 104, 110, 114, 120, 141, 143, 151, 154, 158, 189, 195–197, 199, 203, 205, 206, 209, 210, 218, 223, and 224 (*E. incertum* forma *clavatum*).

*Types.* Hypotypes GSC No. 20122, lot 4, con. I, Lochiel tp., Glengarry co., Ontario, at an elevation about 260 feet above sea level, GSC Nos. 20119 and 20120, Beaugrand Street, 100 feet south of Souligny, Montreal, Quebec, elevation about 55 feet above sea level, and GSC No. 20121, southwest corner of Isabella and Décarie Streets, Montreal, Quebec, elevation about 205 feet above sea level.

*Elphidium subarcticum* Cushman, 1944

Plate II, figure 7

*Elphidium subarcticum* Cushman, Cushman Lab. Foraminiferal Res., Spec. Publ. No. 12, 1944, p. 27, pl. 3, figs. 34, 35; Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 105, pl. 19, figs. 5-7; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 347, pl. 20, figs. 17–19.

Test free, planispiral, involute, with broadly rounded periphery and somewhat lobulate margin; eight to nine chambers in final whorl, with later chambers being rather inflated; wall calcareous, smooth and translucent, except for wide opaque band along sutures, with rows of small sutural pores; aperture a row of pores at base of apertural face with scattered pores in face.

*Remarks.* This is a common species in Arctic and north Atlantic waters. It is easily recognized by the wide opaque band along the sutures.

*Occurrence.* Localities 110, 113, 120, 122, 145, 159, 203, 209, 219, 223, and 224.

*Type.* Hypotype, GSC No. 20123, from the second pit from the southern end of St. Philomène Ridge, Quebec, at an elevation of 165–170 feet above sea level.

Genus *Elphidiella* Cushman, 1936

*Elphidiella arctica* (Parker and Jones, 1864)

Plate II, figures 8, 9

*Polystomella arctica* Parker and Jones, *in* Brady, Linnaean Soc. London, vol. 24, pt. 3, 1864, p. 471, pl. 48, fig. 18.

*Elphidiella arctica* (Parker and Jones), Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 106, pl. 20, figs. 1–3.

Test large and planispiral, with broadly rounded periphery and flattened sides; ten to thirteen chambers in final whorl; wall calcareous and smooth except for sutural pores and occasional shallow grooves extending from pores across chamber parallel to outer margin; sutures distinct, with early ones slightly raised and later ones slightly depressed; two rows of pores along each suture; aperture consisting of a row of pores somewhat above base of face of last chamber, and scattered pores above this row.

*Remarks.* As noted previously, *Elphidiella arctica* may be the adult form of *Elphidium frigidum*.

*Occurrence.* Localities 132, 138, and 141.

*Types.* Hypotypes, GSC Nos. 20124 and 20125, southwest corner of McGill University grounds, corner of Sherbrooke and Mansfield Streets, Montreal, Quebec; elevation 143 feet above sea level.

*Elphidiella* sp.

*Elphidiella* Cushman, Contrib. Cushman Lab. Foraminiferal Res., vol. 12, pt. 4, 1936, p. 89.

Test free, involute, bilaterally symmetrical; sutures generally each with a double row of pores; wall calcareous; aperture consisting of scattered pores in apertural face. *Elphidiella* is described as differing from *Elphidium* in lacking retral processes.

*Remarks.* The specimens from these two localities were poorly preserved and could not be identified with certainty as to species.

*Occurrence.* Localities 158 and 159.

Genus *Protelphidium* Haynes, 1956

*Protelphidium orbiculare* (Brady, 1881)

Plate II, figures 10, 11

*Nonionina orbicularis* Brady, Akad. Wiss. Wien, Kl. Math.-Naturw., Denkschr., Bd. 43, Abt. 2, 1881, p. 105, pl. 2, fig. 5.
*Nonion orbiculare* (Brady), Cushman, Cushman Lab. Foraminiferal Res., Spec. Publ. 23, 1948, p. 53, pl. 6, fig. 3.
*Elphidium orbiculare* (Brady), Loeblich and Tappan, Smithsonian Inst. Misc. Collections, vol. 121, No. 7, 1953, p. 102, pl. 19, figs. 1–4.
*Protelphidium orbiculare* (Brady), Todd and Low, Contrib. Cushman Found. Foraminiferal Res., vol. 12, pt. 1, 1961, p. 20, pl. 2, fig. 11; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 349, pl. 21, fig. 3.

Test free, planispiral, involute and robust with a broadly rounded periphery and flat to slightly convex sides, final whorl comprising nine to eleven chambers; wall calcareous, smooth and hyaline with surface of umbilical area granular; sutures distinct, gently curved and slightly thickened and granular in umbilical area; aperture consisting of a row of pores at base of apertural face of last chamber.

*Remarks.* This is the most common foraminiferal species in the Champlain Sea deposits, with wide areal distribution and abundant specimens at many localities.

*Occurrence.* Localities 2, 17, 19, 30, 35, 37, 42–44, 50, 53, 60, 65, 77, 83, 86, 87, 89–95, 101, 102, 104, 106, 110, 113–115, 118, 120–124, 126, 128, 132, 136, 138, 140, 141, 143, 145, 151, 153, 154, 157–159, 161, 163, 165, 167, 182, 186, 192, 194, 198, 199, 203, 204, 206, 209, 214, 215, 218, 219, 222–224.

*Types.* Hypotypes, GSC No. 20126, southwest corner of the McGill University grounds, corner of Sherbrooke and Mansfield Streets, Montreal, Quebec; elevation 143 feet above sea level; GSC No. 20127, from a pit 1.4 miles southeast of St. Philomène, Quebec; elevation about 215 feet above sea level.

Superfamily *ORBITOIDACEA* Schwager, 1876

Family *CIBICIDIDAE* Cushman, 1927

Subfamily CIBICIDINAE Cushman, 1927

Genus *Cibicides* de Montfort, 1808

*Cibicides lobatulus* (Walker and Jacob, 1798)

Plate II, figures 12, 13

*Nautilus lobatulus* Walker and Jacob, *in* Kanmacher, Adam's essays on the microscope, ed. 2, 1798, p. 642, pl. 14, fig. 36.
*Truncatulina lobatula* (Walker and Jacob), Cushman, U.S. Natl. Museum, Bull. 71, pt. 5, 1915, p. 31, pl. 15, fig. 1, fig. 34.
*Cibicides lobatulus* (Walker and Jacob), Cushman, Cushman Lab. Foraminiferal Res., Spec. Publ. 23, 1948, p. 78, pl. 8, fig. 14; Barker, Soc. Econ. Paleontologists, Mineralogists, Spec. Publ. No. 9, 1960, pl. XCII, fig. 10, pl. XCIII, figs. 1, 4, 5; Feyling-Hanssen, Norg. Geol. Undersøkelse, No. 225, 1964, p. 339, pl. 19, figs. 1–3.

Test plano-convex, usually adhering by flattened or concave dorsal side, ventral side convex with periphery acute or rounded, slightly keeled; seven chambers in last whorl; wall calcareous, coarsely perforate and generally smooth, but sometimes has thickenings on ventral side; sutures flush and limbate on dorsal side, somewhat depressed on ventral side; aperture peripheral, extending along inner margin of last chamber on dorsal side.

*Remarks. Cibicides lobatulus* is an extremely variable species. It is widespread in cold waters today and is most common at shallow depths.

*Occurrence.* Localities 182, 208, and 209.

*Types.* Hypotypes, GSC Nos. 20128 and 20129, from the south bank of St. Lawrence River, 3.2 miles east of Deschaillons, Quebec; elevation about 15 feet above sea level.

## PORIFERA

### Phylum **PORIFERA**

Class *DEMOSPONGEA* Sollas, 1875

Order **EPIPOLASIDA** Sollas, 1888

Family *TETHYIDAE* Gray, 1867

Genus *Tethya* Lamarck, 1814

*Tethya logani* Dawson, 1857

Plate II, figures 14a–d

*Tethea logani* Dawson, Can. Nat. Geol., vol. 2, No. 6, 1857, p. 421, pl. VII, fig. 16a–d. [*Tethea* Johnston, 1842 = *Tethya* Lamarck, 1814].

Spicules of this sponge found as isolated individuals, in bundles, or clustered as flattened rosettes; individual spicules acicular, gently curved, tapering at both ends, hollow, some drawn out to very fine points, others more bluntly rounded, many appearing to be truncated and open at each end.

*Remarks.* Dawson gives a length of $\frac{3}{10}$ inch, but the longest measured by the writer were about $\frac{1}{5}$ inch long. Whiteaves (1901, p. 12) regarded *T. logani* as being identical with *Craniella cranium* (Müller), a premise that the writer has so far been unable to confirm or deny.

*Occurrence.* Localities 16, 21, 37, 94, 106, 113, 137, 138, 180, 191, 200, 215, 216, and 223.

*Type.* Hypotype, GSC No. 20130, from First Avenue between Allan and Lacoste, Montreal, Quebec; elevation about 165 feet above sea level.

?*Tethya* sp.

*Tethya* Lamarck, Mem. Museum Hist. Nat. (Paris), vol. 1, No. 1, 1814, p. 69.

Specimen consisting of a small cluster of very fine, hair-like spicules; spicules about $\frac{1}{60}$ inch long.

*Remarks.* This may possibly be the ?*Tethea* sp. recorded by Dawson (1857 and 1893).

*Occurrence.* Locality 208.

## BRYOZOA

### Phylum **BRYOZOA**

Fragments of bryozoan zoaria were found at several stations. Apparently two genera are represented, but the specimens are too incomplete for even generic determinations to be attempted.

*Occurrence.* Localities 75, 117, 140, and 206.

## BRACHIOPODA

### Phylum **BRACHIOPODA**
### Class *ARTICULATA*
### Order **TELOTREMATA**
### Family *RHYNCHONELLIDAE* Gray

Genus *Hemithiris* d'Orbigny, 1847

*Hemithiris* d'Orbigny, Compt. Rend. Acad. Sci. (Paris), vol. 25, 1847, p. 268.
*Hemithyris* (pro *Hemithiris* d'Orbigny, 1847) Bronn, Neues Jahrb. Mineral, 1848, p. 246.

*Hemithiris psittacea* (Gmelin, 1790)

Plate II, figures 15a, b

*Anomia psittacea* Gmelin, *in* Linné, Systema Nat. (ed. 13), vol. 1, pt. 6, 1790, p. 3348.
*Hemithyris psittacea* (Gmelin), Oldroyd, Stanford Univ. Publ., Univ. Ser., Geol. Sci., vol. 1, No. 1, 1924, p. 223, pl. 16, figs. 8–12.
*Hemithiris psittacea* (Gmelin), Hertlein and Gale, Publ. Univ. Calif. (Los Angeles), Math., Phys. Sci., vol. 3, 1944, p. 46, pl. 3, figs. 12, 13, 15, 16; pl. 21, figs. 10, 11, 13; text-figs. 7, 8.
*Hemithyris psittacea* (Chemnitz), Bousfield, Can. Atlantic Sea Shells, 1960, p. 44, pl. 13, fig. 129.

Shell somewhat triangular and globose, dorsal valve with a mesial fold and the less convex ventral valve with a broad flattened mesial sinus; beak sharply pointed and incurved with an incomplete, elongated foramen below beak; surface of shell is usually radiately and finely striated, very seldom strongly ribbed.

*Remarks.* Present western Atlantic range of this species is from the Arctic to the Gulf of St. Lawrence, from near shore to a depth of 60 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20131. Locality 229: 0.2 mile southeast of highway 3, and 0.75 mile due east of St. Nicholas, Quebec; elevation 181 feet above sea level.

## MOLLUSCA

### Phylum **MOLLUSCA**
### Class *GASTROPODA* Cuvier, 1797
### Subclass *PROSOBRANCHIA* Milne-Edwards, 1848
### Order **ARCHAEOGASTROPODA** Thiele, 1925
### Suborder PATELLINA von Ihering, 1876
### Superfamily *PATELLACEA* Rafinesque, 1815
### Family *LEPETIDAE* Dall, 1869

Genus *Lepeta* Gray, 1847

*Lepeta caeca* (Müller, 1776)

Plate II, figures 16a, b

*Patella caeca* Müller, Prodromus Zool. Danicae, 1776, p. 237.
*Lepeta caeca* (Müller), Abbott, Am. Seashells, 1954, p. 107, pl. 17, fig. j, MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 73, pl. 4, figs. 1, 1A.

Shell conical or cap-shaped, with posterior slope usually markedly convex and anterior slope straight; exterior ornamented with fine, crowded, granulose, radial threads. Diameter between ¼ and ½ inch.

*Remarks.* *Lepeta caeca* is a common cold-water species, with a present range from Greenland to Cape Cod, Massachusetts.

*Occurrence.* Localities 159, 218, and 229.

*Type.* Hypotype, GSC No. 20132, 0.2 mile southeast of highway 3, and 0.75 mile due east of St. Nicholas, Quebec (Chaudière map-sheet). Elev. 181 feet. GSC loc. 60759. Coll. F. J. E. Wagner, 1956; N. R. Gadd, 1962.

Suborder TROCHINA Cox and Knight, 1960
Superfamily *TROCHACEA* Rafinesque, 1815
Family *TROCHIDAE* Rafinesque, 1815
Subfamily MARGARITINAE Stoliczka, 1868

Genus *Margarites* Leach, 1847

*Margarites* sp.

*Margarites* Leach MS., Gray, Ann. Mag. Nat. Hist., vol. 20, 1847, p. 271.

Shell, small, thin, turbinate, iridescent within; surface smooth or spirally ribbed; peritreme interrupted by body whorl; umbilicus encircled by a spiral cord.

*Remarks.* A single, very small, broken specimen which may belong to this genus was found at locality 35.

*Occurrence.* Locality 35.

Order **MESOGASTROPODA** Thiele, 1925
Suborder PTENOGLOSSA Gray, 1853
Family *EPITONIIDAE*

Genus *Epitonium* Röding, 1798

*Epitonium greenlandicum* (Perry, 1811)

*Scalaria greenlandica* Perry, Conchology, 1811, pl. 28, fig. 8.
*Epitonium (Boreoscala) greenlandicum* (Perry), Clench and Turner, Johnsonia, vol. 2, No. 31, 1952, p. 320, pl. 154, figs. 1–3.
*Epitonium greenlandicum* (Perry), MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 83, pl. 5, figs. 2, 3.

High-spired shell, as long as 2½ inches, comprising eleven or twelve whorls; aperture subcircular with a thickened lip; sculpture consisting of strong, ridge-like axial costae numbering nine to thirteen on body whorl, and a basal spiral ridge with about nine flattened and regularly spaced spiral cords above it and three to five below it; basal spiral ridge sometimes lacking.

*Remarks.* This species is probably circumpolar in range, and in the western Atlantic extends from Godhavn, Greenland, south to Long Island, New York.

*Occurrence.* Locality 229.

Suborder TAENIOGLOSSA Troschel, 1848
Family *TURRITELLIDAE*

Genus *Tachyrhynchus* Mörch, 1868

*Tachyrhynchus erosum* (Couthouy, 1838)

Plate II, figure 18

*Turritella erosa* Couthouy, Boston J. Nat. Hist., vol. 2, 1838, p. 103.
*Tachyrhynchus erosum* (Couthouy), Abbott, Am. Seashells, 1954, p. 140, pl. 21, fig. 1.

High-spired shell, ¾ – 1 inch long, formed of eight to ten rounded whorls, each whorl decorated with five or six smooth, flattened spiral cords; aperture rounded; columella smooth and somewhat arched.

*Remarks.* This species now has a geographic range south from Greenland to Massachusetts. It is common between 10 and 75 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20133. Locality 229: 0.2 mile southeast of highway 3 and 0.75 mile due east of St. Nicholas, Quebec, at an elevation of 181 feet above sea level.

## Family *TRICHOTROPIDAE*

### Genus *Trichotropis* Broderip and Sowerby, 1829

*Trichotropis borealis* Broderip and Sowerby, 1829

Plate II, figures 17a, b

*Trichotropis borealis* Broderip and Sowerby, Zool. J., vol. 4, No. 15, art. 48, 1829, p. 375; Abbott, Am. Seashells, 1954, p. 167, pl. 24, fig. d.

Shell ½ – ¾ inch long, fairly high-spired, with four to five carinate whorls; if periostracum present (usually lost from fossil shells), it has hairy spicules over region of three major spiral cords; umbilicus chink-like and set off by a large spiral cord; crowded axial threads on whorls; outer lip reflecting the spiral sculpture.

*Remarks.* This is not a common species in the Champlain Sea deposits. Its range now is from the Arctic Archipelago to Massachusetts; also on the west coast of North America.

*Occurrence.* Localities 132, 159, and 220.

*Type.* Hypotype, GSC No. 20134, from the corner of Wiseman and Jean Talon Streets, Montreal, Quebec, at an elevation of 187 feet above sea level.

*Trichotropis* sp.

*Trichotropis* Broderip and Sowerby, Zool. J., vol. 4, No. 15, art. 48, 1829, p. 373.

Shell turbinate; sculpture well developed; aperture less than three-quarters the length of shell, smooth within or merely reflecting external sculpture; outer lip not markedly contracted into an anterior canal; an adherent fibrous periostracum present.

*Remarks.* The two fragmentary specimens are probably referable to this genus.

*Occurrence.* Localities 224 and 227.

## Family *NATICIDAE*

### Genus *Natica* Scopoli, 1777

*Natica clausa* Broderip and Sowerby, 1829

Plate II, figure 19

*Natica clausa* Broderip and Sowerby, Zool. J., vol. 4, No. 15, art. 48, 1829, p. 360; Abbott, Am. Seashells, 1954, p. 191, fig. 43b; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 90, pl. 1, fig. 10, pl. 12, fig. 8; Bousfield, Can. Atlantic Sea Shells, 1960, p. 17, pl. 2, fig. 24.

Shell globose, between 1 inch and 1¼ inches long; surface smooth, with abutting, not channelled, sutures; smooth, flat callus covering umbilicus.

*Remarks.* *Natica clausa* is a circumpolar species that ranges in the western Atlantic as far south as North Carolina. The species is known from deposits as old as Miocene.

*Occurrence.* Localities 205, 223, 224, and 229.

*Type.* Hypotype, GSC No. 20135, west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

*Natica* sp.

*Natica* Scopoli, Introductio ad Historiam Naturalem, 1777, p. 392.

Shell globose; sutures abutting, not channelled; umbilicus covered by a callus; operculum calcareous.

*Remarks.* Damaged specimens from the two localities could not be identified to species.
*Occurrence.* Localities 218 and 229.

## Genus *Lunatia* Gray, 1847

### *Lunatia pallida* (Broderip and Sowerby, 1829)

Plate II, figure 20

*Natica pallida* Broderip and Sowerby, Zool. J., vol. 4, No. 15, art. 48, 1829, p. 372; Clarke, Natl. Museum Can., Bull. No. 181, 1962, p. 21; Fretter and Graham, Ray Soc., No. 144, 1962, p. 675.
*Natica groenlandica* Beck, *in* Möller, Index Moll. Groenl., vol. 7, 1842, p. 7.
*Lunatia pallida* (Broderip and Sowerby), Abbott, Am. Seashells, 1954, p. 190, fig. 43c.
*Polinices pallidus* (Broderip and Sowerby), MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 91, pl. 12, fig. 10.
*Lunatia groenlandica* (Möller), Abbott, Am. Seashells, 1954, p. 189, pl. 22, fig. k; Bousfield, Can. Atlantic Sea Shells, 1960, p. 17, pl. 2, fig. 23.

Shell globose, from less than 1 inch to 1¾ inches long, not quite so wide as long; umbilicus almost closed by white-glazed, moderately thickened parietal wall.

*Remarks.* Abbott (1954) records and describes both *Lunatia groenlandica* and *L. pallida,* although he does state (p. 190) that the former may be synonymous with the latter. Fretter and Graham (1962, p. 675) adhere to the original generic designation of *Natica,* and definitely place *N. groenlandica* in the synonymy of *N. pallida.* The species is found in the north Pacific and in the Atlantic off Europe as well as off the coast of North America. Its western Atlantic range is from Greenland to North Carolina, in depths of 3 to 80 fathoms or more.

*Occurrence.* Localities 205, 209, and 225.

*Type.* Hypotype, GSC No. 20136, from the west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

## Order **NEOGASTROPODA** Wenz, 1938
## Suborder RACHIGLOSSA Gray, 1853
## Family *BUCCINIDAE*

## Genus *Buccinum* Linné, 1758

### *Buccinum hancocki* Mörch, 1877

Plate III, figure 4

*Buccinum groenlandicum* Hancock, Ann. Mag. Nat. Hist., vol. 18, 1846, p. 329, pl. 5, figs. 8, 9 (*non Buccinum groenlandicum* Chemnitz, 1788).

*Buccinum hancocki* Mörch, Mollusca *in* Rink, Danish Greenland, 1877, p. 438; Thorson, Medd. Grønland, vol. 81, pt. 2, 1951, p. 37, fig. 9.

Shell thin, spire elongate, slender, 1¼ to 1¾ inches long; whorls six to seven, somewhat angulated in the centre, with indistinct longitudinal plaits and with two or three strong, distant, noduliferous ridges on centre of body whorl, one of which passes up the spire, whole surface covered by flat spiral striae separated by incised lines and crossed by minute lines of growth; aperture oval, outer lip thin, canal longer than usual for the genus, rather broad; columella with an indistinct plait, anterior extremity sloping to the left.

*Remarks.* This species has been found living in the waters off western Greenland and eastern Baffin Island at depths of 10 to 17 fathoms.

*Occurrence.* Localities 205 and 209.

*Type.* Hypotype, GSC No. 20139, from the west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

### *Buccinum plectrum* Stimpson, 1865

*Buccinum plectrum* Stimpson, Can. Nat. Geol., ser. 2, vol. 2, 1865, p. 374; Abbott, Am. Seashells, 1954, p. 225, fig. 51a; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 105, pl. 9, figs. 11, 12; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 82, pl. 18, fig. 28.

Shell 2 to 3 inches long, with seven to eight whorls; curved axial ribs numbering about nineteen, strongest on upper part of whorl; spiral sculpture consisting of fine, but rough, incised lines, usually grouped into fascicles of four; aperture a little more than one-third of entire length of shell, with outer lip thickened, flaring, and strongly sinuate.

*Remarks.* This species is common in offshore waters today, ranging from the Arctic to the Gulf of St. Lawrence; also eastern Pacific Ocean.

*Occurrence.* Locality 229.

### *Buccinum tenue* Gray, 1839
Plate III, figure 3

*Buccinum tenue* Gray, *in* Beechey, The zoology of Captain Beechey's voyage, 1839, p. 128, pl. 36, fig. 19; Abbott, Am. Seashells, 1954, p. 225, pl. 24, fig. u; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 107, pl. 9, figs. 8, 9; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 82, pl. 19, figs. 5, 6.

Shell composed of six or seven moderately convex whorls; length 1½ to 2½ inches; axial ribs small, numerous, intertwining, and extending from suture to suture; spiral ornamentation of microscopic beaded threads; aperture one-half the length of entire shell; outer lip thin and slightly sinuate.

*Remarks.* Geographic range of *B. tenue* is from Arctic waters (Bernard Harbour, N.W.T.; western Greenland) to Labrador and south to the Gulf of Maine. The optimum depth range is immediately offshore down to 15 to 20 fathoms.

*Occurrence.* Localities 205 and 229.

*Type.* Hypotype, GSC No. 20138, west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

### *Buccinum terrae-novae* (Mörch, 1869, ex Beck MS.)
Plate III, figure 2

*Tritonium Terrae Novae* (Beck MS.) Mörch, Mem. Soc. Malac. Belg., vol. 4, 1869, p. 18.
*Buccinum terrae novae* (Beck) Mörch, Harmer, Pliocene Mollusca of Great Britain, pt. 1, 1914, p. 100, pl. 9, figs. 11, 12.

Shell thin, as much as 1¾ inches long; whorls five to six, inflated but with sloping shoulders below the suture, covered with spiral lines, some more prominent than others, and usually crossed by indistinct and irregular longitudinal plications or lines of growth; aperture wide, angulated above, canal short and open; columella twisted and excavated.

*Remarks.* Recent distribution of this species is from Newfoundland to Greenland, Spitzbergen, Novaya Zemlya, Arctic Ocean north of Siberia to Bering Sea. It has been found as a fossil in Great Britain. The known depth range is from 3 to 330 fathoms.

*Occurrence.* Localities 223 and 224.

*Type.* Hypotype, GSC No. 20137, from a ditch draining into Rivière du Cèdre, 0.3 mile southeast of St. Janvier-de-Joly, Quebec; elevation about 375 feet above sea level.

### *Buccinum* sp.

*Buccinum* Linné, Systema Nat., ed. 10, vol. 1, p. 734.

Shell ovate or oblong with elevated spire and covered with a thin periostracum; aperture rounded, flaring, with inner lip expanded and outer lip generally thin; anterior canal very short and wide.

*Remarks.* The specimens from both localities were badly worn and could not be identified to species.

*Occurrence.* Localities 132 and 225.

## Family *NEPTUNEIDAE*

### Genus *Neptunea* Röding, 1798

### *Neptunea despecta tornata* (Gould, 1839)

Plate III, figure 1

*Murex despecta* Linné, Systema Nat., ed. 10, 1758, p. 754.
*Fusus tornata* Gould, Am. J. Sci., vol. 38, 1839, p. 197.
*Neptunea despecta tornata* (Gould), Morris, Field guide to the shells, 1951, p. 198, pl. 37, fig. 5; Bousfield, Can. Atlantic Sea Shells, 1960, p. 19, pl. 3, fig. 33; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 83, pl. 20, figs. 3, 10, pl. 21, fig. 21.

Shell 3 to 5 inches long, consisting of about eight whorls forming a high, turreted spire; spiral sculpture only, in form of four to six elevated ridges on body whorl and two to three between sutures on other whorls, with smaller, less prominent ridges between the major ones; aperture large and oval, with inner lip reflected on body whorl, and with short, strongly curved canal.

*Remarks.* The range of this species is from Gulf of St. Lawrence to Cape Cod area, Massachusetts, at depths between 5 and 550 fathoms.

*Occurrence.* Localities 145, 159, 205, 209, 223, and 229.

*Type.* Hypotype, GSC No. 20140, from the east bank of Grande Rivière du Chêne, Quebec, just south of highway 9; elevation about 330 feet above sea level.

### *Neptunea* sp.

*Neptunea* Röding, Museum Boltenianum, 1798, p. 115.

Shell ventricose, spire with fewer than eight whorls; sculpture entirely spiral; periostracum thin or wanting; outer lip smooth and markedly contracted into an elongate posterior canal.

*Remarks.* The specimen was incomplete.

*Occurrence.* Locality 191.

## Subclass *OPISTHOBRANCHIA* Milne-Edwards, 1848
### Order **PLEUROCOELA** Thiele, 1925
### Superfamily *ACTEONACEA* d'Orbigny, 1842
### Family *ATYDAE*

Genus *Haminoea* Turton and Kingston, 1830

*Haminoea solitaria* (Say, 1822)

Plate III, figure 5

*Bulla solitaria* Say, J. Acad. Nat. Sci. Philadelphia, vol. 2, 1822, p. 245.
*Haminoea solitaria* (Say), Abbott, Am. Seashells, 1954, p. 279, pl. 26, fig. s; Bousfield, Can. Atlantic Sea Shells, 1960, p. 22, pl. 4, fig. 43.

Shell bulloid, fragile, as long as ½ inch, earlier whorls completely enclosed by body whorl; spire depressed and hidden; outer lip of aperture rising above top of shell; surface of shell sculptured with incised spiral grooves.

*Remarks.* This species is common along the Atlantic coast today between the Gulf of St. Lawrence and Georgia. Dawson (1893, p. 245) states that it is rather common as a fossil at Montreal.

*Type and occurrence.* Hypotype, GSC No. 20141. Locality 77: lot 37, con. I, Kenyon tp., Glengarry co., Ontario; elevation about 295 feet above sea level.

### Family *RETUSIDAE*

Genus *Retusa* Brown, 1827

*Retusa obtusa* (Montagu, 1808)

Plate III, figure 6

*Bulla obtusa* Montagu, Testacea Britannica, vol. 1, 1808, p. 223.
*Retusa obtusa* (Montagu), Abbott, Am. Seashells, 1954, p. 280, fig. 59a; Bousfield, Can. Atlantic Sea Shells, 1960, p. 22, pl. 4, fig. 44.
*Retusa pertenuis* (Mighels), Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 86, pl. 16, fig. 11.

Shell small, cylindrical and stubby, about 1/10 to 1/8 inch long; spire slightly elevated; surface and columella smooth; with a chink-like umbilicus.

*Remarks.* Only a single specimen referable to this species was found. Geographic range of *R. obtusa* is from Arctic seas to North Carolina, and the bathymetric range is from low tide to a depth of about 100 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20142. Locality 200: Rivière des Chutes, 1.5 miles east-northeast of St. Narcisse, Quebec, at an elevation of about 330 feet above sea level.

### Family *SCAPHANDRIDAE*

Genus *Cylichna* Lovén, 1846

*Cylichna alba* Brown, 1827

Plate III, figure 7

*Cylichna alba* Brown, Illustr. Conch. Gt. Brit., 1827, p. 3, pl. 19, figs. 43, 44; Abbott, Am. Seashells, 1954, p. 282, Bousfield, Can. Atlantic Sea Shells, 1960, p. 22, pl. 4, fig. 46; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 86, pl. 21, fig. 18.

Shell about ¼ inch long, fragile, narrowly oblong with flattened sides and with apex slightly depressed; surface ornamented with faint spiral scratches; aperture narrow above and wider below, with slightly raised columella.

*Remarks.* *Cylichna alba* is a circumboreal species, living along the east coast from Greenland to North Carolina, and on the west coast from Bering Sea to San Diego, California. It is common in cold water at depths between 1 fathom and 1,300 fathoms.

*Occurrence.* Localities 132, 138, 141, 144, and 220.

*Type.* Hypotype, GSC No. 20143, from the southwest corner of McGill University grounds, Sherbrooke and Mansfield Streets, Montreal, Quebec; elevation 143 feet above sea level.

Gastropods, indet.

Fragments were found at several localities. These could be recognized as gastropods, but could not be identified as to genus.

*Occurrence.* Localities 2, 90, 114, 153, 175, 198, and 206.

## Class *PELECYPODA*
## Order **PROTOBRANCHIA**
## Superfamily *NUCULACEA*
## Family *NUCULIDAE*

Genus *Nucula* Lamarck, 1799

*Nucula tenuis* (Montagu, 1808)

Plate III, figures 8a, b

*Arca tenuis* Montagu, Testacea Britannica, Suppl., 1808, p. 56, pl. 29, fig. 1.
*Nucula tenuis* (Montagu), Abbott, Am. Seashells, 1954, p. 335, fig. 70c; Bousfield, Can. Atlantic Sea Shells, 1960, p. 25, pl. 5, fig. 58; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 51, pl. 1, figs. 6–9.

Shell ovate, smooth except for irregular growth lines, small, between ⅛ and ¼ inch long; umbones prominent; ventral edge smooth; interior of shell nacreous; a tightly-adhering, olive-green periostracum generally present; thirteen to sixteen anterior teeth and six to eight posterior; teeth chevron-shaped.

*Remarks.* The range for this species is from the Arctic south to North Carolina, at depths of 4 to 110 fathoms; also west coast of North America and Europe. Representatives of this genus are easily recognized by the nacreous lustre.

*Occurrence.* Localities 205 and 218.

*Type.* Hypotype, GSC No. 20144, from the west bank of Lachevrotière River, Quebec, 0.25 mile from the St. Lawrence; elevation 40–65 feet above sea level.

*Nucula* sp.

*Nucula* Lamarck, Mem. Soc. Hist. Nat., Paris, 1799, p. 87.

Shell ovate to trigonal, as much as ⅓ inch in size; taxodont dentition; internal ligament; interior of shell nacreous.

*Remarks.* The specimens recorded here probably belong to *N. tenuis,* but because of the fragmentary nature of the material it is best to note them as *Nucula* sp.

*Occurrence.* Localities 35, 141, and 206.

## Family *NUCULANIDAE*

Genus *Nuculana* Link, 1807
(*Leda* Schumacher, 1817)

*Nuculana pernula* (Müller, 1779)

Plate III, figures 9a, b

*Arca pernula* Müller, Beschäft Naturf. Freunde zu Berlin, vol. 4, 1779, p. 55.
*Nuculana pernula* (Müller), Abbott, Am. Seashells, 1954, p. 336; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 51, pl. 1, figs. 14, 15.

Shell elongate, with anterior end rounded and posterior end truncated; length between ½ and 1 inch; sculpture of raised growth lines; prominent lunule set off by a sharp ridge; interior of posterior end of shell has a strong, low, rounded, radial reinforcing rib; average of nineteen anterior and twenty-one posterior teeth.

*Remarks. Nuculana pernula* is a cold-water species found off the eastern coast of North America between the Arctic Ocean and Massachusetts.

*Occurrence.* Localities 132, 205, 222, and 223.

*Type.* Hypotype, GSC No. 20145, from the west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

*Nuculana tenuisulcata* (Couthouy, 1838)

Plate III, figures 10a, b

*Nucula tenuisulcata* Couthouy, Boston J. Nat. Hist., vol. 2, 1838, p. 64.
*Nuculana tenuisulcata* (Couthouy), Abbott, Am. Seashells, 1954, p. 336, fig. 71a; Bousfield, Can. Atlantic Sea Shells, 1960, p. 26, pl. 5, fig. 61; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 51, pl. 1, fig. 17.

Shell elongate, ½ to ¾ inch long; a sharp, high keel along upper margin of shell from umbo to the truncated posterior end; sculpture consisting of numerous, well-developed, concentric ribs; hinge with about fifteen anterior and thirty or more posterior teeth.

*Remarks.* Only a single valve that would appear to be of this species was found; it occurs at present from the Arctic to Cape Cod, at depths between low tide and 165 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20146. Locality 205: west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec, elevation about 35 feet above sea level.

*Nuculana* sp.

*Nuculana* Link, Beschr. Nat.-Samml. Univ. Rostock, Abth. 3, 1807, p. 155.

Shell with posterior end rostrate, carinate; dentition taxodont; ligament internal; shallow pallial sinus.

*Remarks.* The fragments were recognizable as belonging to the genus *Nuculana,* but could not be identified as to species.

*Occurrence.* Localities 141 and 198.

Genus *Portlandia* Mörch, 1857

*Portlandia arctica* (Gray, 1824)

Plate III, figures 11, 12

*Nucula arctica* Gray, Parry's first voyage, 1819–20, suppl. to appendix, (1824), p. 241.
*Yoldia arctica* (Gray), Morris, Field Guide to the Shells, 1951, p. 9, pl. 41, fig. 11; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 151, pl. 18, fig. 8.
*Yoldia (Portlandia) glacialis* (Wood), Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 52, pl. 1, figs. 18–20, 27, 28.
*Portlandia arctica* (Gray), Clarke, Natl. Museum Can., Bull. No. 185, 1962, p. 100 (footnote).

Shell inflated, oblong oval in shape with prominent umbones, ¾ to 1 inch long; many fossil shells less than ½ inch long; anterior end rounded, posterior end truncate with basal margin sloping upward to a blunt point; thin, greenish periostracum very often present; twelve to seventeen anterior teeth and nine to fourteen posterior teeth.

*Remarks. Portlandia arctica* is a high-Arctic species, found farther south only in deeper waters. To the north it is commonest at depths between 5 and 30 fathoms. As a fossil it is widely distributed throughout the area of the Champlain Sea.

*Occurrence.* Localities 3, 9, 15–17, 19, 33, 37, 50, 53, 78, 91, 92, 94–96, 98, 100, 107, 113, 114, 116, 132, 138–145, 172, 176, 177, 179, 189, 190, 192, 193, 195, 197, 198, 201, 205, 206, 212, 213, 218, 220, 223, and 224.

*Types.* Hypotypes, GSC Nos. 20147 and 20148, west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec; elevation about 35 feet above sea level.

Genus *Yoldia* Möller, 1842

*Yoldia limatula* (Say, 1831)

*Nucula limatula* Say, Am. Conch., vol. 1, 1831, pl. 12.
*Yoldia limatula* (Say), Abbott, Am. Seashells, 1954, p. 340, fig. 71b; Bousfield, Can. Atlantic Sea Shells, 1960, p. 25, pl. 5, fig. 59; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 52, pl. 1, fig. 25.

Shell elongate, flat, narrowing posteriorly, with small, centrally placed umbones; length between 1 inch and 2 inches; growth lines very faint; twenty-two anterior and eighteen posterior teeth.

*Remarks.* The specimen from locality 206 is crushed, but enough of the shape is discernible to place it as *Y. limatula.* The other specimen, from locality 220, is fragmentary but would seem to be of this species. Present range of *Y. limatula* is from the Gulf of St. Lawrence to New Jersey. It is found from just below low water to moderate depths.

*Occurrence.* Localities 206 and 220.

Order **ANISOMYARIA**
Superfamily *MYTILACEA*
Family *MYTILIDAE*

Genus *Mytilus* Linné, 1758

*Mytilus edulis* Linné, 1758
Plate III, figures 13a, b

*Mytilus edulis* Linné, Systema Nat., ed. 10, 1758, p. 705; Abbott, Am. Seashells, 1954, p. 354, pl. 35, fig. m; Bousfield, Can. Atlantic Sea Shells, 1960, p. 26, pl. 6, fig. 62; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 56, pl. 4, figs. 11, 12.

Shell 1 inch to 3 inches long, ovate to elongate, with umbones anterior; surface smooth or with coarse growth lines; colour bluish black, but some specimens, especially young individuals, with radial rays of brownish yellow; interior pearly white with a deep purple-blue border.

*Remarks.* In the western Atlantic this species is known from southern Greenland to South Carolina; elsewhere it is cosmopolitan in temperate to boreal waters. *Mytilus* is an attached form, fastening itself to rocks, wood, other shells, etc., by tough byssal threads.

At locality 39, minute pearls were found associated with shells of *Mytilus* (Wagner, 1958).

*Occurrence.* Localities 15, 22, 28, 38, 39, 51, 53, 54, 62, 64, 102, 106, 108, 114, 116–119, 121, 123, 126, 128, 134, 135, 140, 141, 145, 151, 153, 158, 159, 161, 163, 165, 167, 168, 175, 180, 182–186, 191, 196, 197, 199, 200, 203, 208, 209, 214, 219, 220, 222, 224, 225, 228, 229, and 231.

*Type.* Hypotype, GSC No. 20149, from a pit 2 miles north of St. Joseph-du-Lac, Quebec, at an elevation of 300 feet above sea level.

Genus *Musculus* Röding, 1798

*Musculus niger* (Gray, 1824)

*Modiola nigra* Gray, Parry's first voyage, 1819–20, suppl. to appendix, 1824, p. 244.
*Musculus niger* (Gray), Abbott, Am. Seashells, 1954, p. 355, pl. 28, fig. g; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 157, pl. 18, fig. 6, pl. 21, fig. 6; Bousfield, Can. Atlantic Sea Shells, 1960, p. 27, pl. 6, fig. 67.
*Musculus nigra* (Gray), Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 57, pl. 5, fig. 12.

Shell oblong and fragile, ¾ inch to 1½ inches long, with a brown to black periostracum; anterior and posterior parts of shell bearing numerous axial riblets; central section, separating these two ribbed areas, has microscopic wavy threads; interior of shell pinkish with a silvery sheen.

*Remarks.* A single fragmentary specimen was found at locality 223; locality 205 yielded parts of two, and perhaps three, valves. This species occurs at depths of 1 fathom to 65 fathoms in the western Atlantic Ocean between Greenland and North Carolina.

*Occurrence.* Localities 205 and 223.

Superfamily *PECTINACEA*
Family *PECTINIDAE*

Genus *Chlamys* Röding, 1798

*Chlamys islandicus* (Müller, 1776)

*Pecten islandicus* Müller, Prodromus Zool. Danicae, 1776, p. 248.
*Chlamys islandicus* (Müller), Abbott, Am. Seashells, 1954, p. 365, pl. 27, fig. 1; Bousfield, Can. Atlantic Sea Shells, 1960, p. 29, pl. 7, fig. 75; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 55, pl. 4, fig. 1.

Shell 2 to 4 inches long, not quite so wide as long; one pair of "ears" markedly longer than the other; valves moderately convex to flattish; about fifty scaly ribs that split in two near margin of shell.

*Remarks. Chlamys* is a free-swimming genus common in cold-water areas from extreme low tide to depths of greater than 110 fathoms. Its geographic range is from the Arctic south of Massachusetts. In the Champlain Sea it apparently did not penetrate beyond the easternmost limits of the sea.

*Occurrence.* Locality 229.

Superfamily *OSTREACEA*
Family *OSTREIDAE*

Genus *Crassostrea* Sacco, 1897

*Crassostrea virginica* (Gmelin, 1790)
Plate III, figures 16a, b

*Ostrea virginica* Gmelin, Systema Nat., ed. 13, vol. 1, pt. 6, 1790, p. 3336.
*Crassostrea virginica* (Gmelin), Abbott, Am. Seashells, 1954, p. 375, pl. 28, fig. a; Bousfield, Can. Atlantic Sea Shells, 1960, p. 29, pl. 7, fig. 76; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 55, pl. 4, figs. 5, 7.

Shell heavy, 2 to 6 inches long with size and shape varying greatly with environmental differences; beaks curved; exterior of shell with concentric growth lines and sometimes radial ridges; valve margins either straight or slightly undulating.

*Remarks.* Present range of this species is from the Baie de Chaleur south to the West Indies and the Gulf of Mexico.

The actual presence of *C. virginica* as a fossil in the Champlain Sea area is open to some doubt. Some occurrences observed have been of shells, on or near the surface of the ground, which undoubtedly date from modern times. This is probably the case with the specimen from

locality 134; it was found in the soil layer. The *Crassostrea* from locality 145 (not collected by the writer) unfortunately was not accompanied by stratigraphic data.

Ardley (1912) states positively that oysters lived in the Champlain Sea. Referring to a locality near Montreal he says "... found at a depth of 9 feet below the surface specimens of *Ostrea* associated with *Mya truncata, Macoma calcarea, Astarte laurentiana* and *Saxicava rugosa*, .... This occurrence in the vicinity of Montreal proves definitely that this genus occurs in the Pleistocene Molluscan Fauna in the extreme western portion of the Province of Quebec".

On the basis of Ardley's findings and the possible authenticity of a Pleistocene age for the specimen from locality 145, *Crassostrea virginica* is included in this report.

*Occurrence.* Localities 134 and 145.

*Type.* Hypotypes, GSC No. 20150, Westbury, near Mackenzie, Montreal, Quebec, at an elevation of 171 feet above sea level.

## Order **EULAMELLIBRANCHIA**
## Suborder HETERODONTA
## Superfamily *ASTARTACEA*
## Family *ASTARTIDAE*

### Genus *Astarte* Sowerby, 1816

### *Astarte montagui* (Dillwyn, 1817)
### Plate III, figures 14a, b, 15a, b

*Venus montagui* Dillwyn, Descriptive Catalogue, Recent Shells, pt. I, 1817, p. 167.
*Nicania striata* Leach, Ross's voyage (1819), Appendix 2, p. 62.
*Nicania banksii* Leach, Ross's voyage (1819), Appendix 2, p. 62.
*Astarte laurentiana* Lyell, Travels in North America (Am. ed.), vol. 2, 1845, p. 125, fig. 5; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 59, pl. 6, figs. 17, 18.
*Astarte warhami* Hancock, Ann. Mag. Nat. Hist., ser. 1, vol. 18, 1846, p. 336, pl. 5, figs. 15, 16.
*Astarte montagui* (Dillwyn), vars. *striata* (Leach) and *warhami* Hancock, MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 167, pl. 22, figs. 11–13 (var. *warhami*), 14–16 (var. *striata*).
*Astarte banksii* (Leach), Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 58, pl. 6, figs. 14, 15.
*Astarte striata* (Leach), Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 59, pl. 6, figs. 21, 22.

Shell shape variable, ranging from high and short in typical *montagui* to lower and elongate in var. *warhami;* height to length percentages ranging in the 90's for forma typica, in the 80's for var. *striata,* and in the 70's for var. *warhami,* but with no sharp dividing line, some individuals assignable to either one variety or the other; length between ⅕ inch and 1¼ inches; sculpture variable, from prominent, evenly spaced concentric riblets in umbonal region and less prominent, irregularly spaced riblets on rest of the shell to prominent riblets of equal strength covering entire shell.

*Remarks. Astarte montagui* lives in all Arctic seas, reaching along the east coast of North America as far south as Massachusetts. The species becomes elongated in the same degree as the marine climate becomes more severe. Thus *A. m.* var. *warhami* is found in coldest waters, *A. m.* var. *striata* indicates intermediate conditions, and *A. montagui* forma typica is characteristic of warmest temperatures.

Lyell's figures of *A. laurentiana* (Pl. VII, figs. 7a–c) compare closely with figures of *A. montagui* var. *striata* (Pl. III, fig. 14). His figured specimen shows a height:length ratio of 83 per cent. Therefore the writer considers that *A. laurentiana* should be placed in the synonymy of *A. montagui.*

Most Champlain Sea specimens are *A. m.* var. *striata;* three localities had specimens that might be referred to *A. m.* var. *warhami.*

*Occurrence.* Localities 132, 133, 138, 159, 223, and 224 (var. *striata*); 132, 137, and 146 (var. *warhami*).

*Types.* Hypotypes, GSC No. 20151, from side of a ditch draining into Rivière du Cèdre, 0.3 mile southeast of St. Janvier-de-Joly, Quebec, at an elevation of about 375 feet above sea level (*A. m.* var. *striata*); GSC No. 20152, from the corner of Wiseman and Jean Talon Streets, Montreal, Quebec; elevation 187 feet above sea level (*A. m.* var. *warhami*).

Superfamily *LUCINACEA*
Family *THYASIRIDAE*

Genus *Thyasira* Lamarck, 1818

*Thyasira gouldi* (Philippi, 1845)
Plate III, figures 17a, b

*Lucina gouldii* Philippi, Z. Malak., Jahrg. 2, 1845, p. 74.
*Thyasira gouldi* (Philippi), Abbott, Am. Seashells, 1954, p. 384; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 60, pl. 7, figs. 6, 7.

Shell about ¼ inch long, with length only slightly more than width; beaks inturned; hinge edentulous, conspicuous furrow separating posterior from central slope.

*Remarks.* In the western Atlantic this species ranges from Greenland to Connecticut at depths of 1 fathom to 210 fathoms. It also occurs in the Pacific Ocean.

*Occurrence.* Localities 218 and 220.

*Type.* Hypotype, GSC No. 20153, Grande Rivière du Chêne, opposite mouth of Rivière Bois-Clair, 0.5 mile below Pont Noir, Quebec (Portneuf map-sheet). Elev. 165 feet. GSC loc. 27301. Coll. F. J. E. Wagner, 1953.

Genus *Axinopsida* Keen and Chavan, 1951

*Axinopsida orbiculata* (Sars, 1878)
Plate III, figures 18a, b

*Axinopsis orbiculata* Sars, Mollusca regionis arcticae Norvegiae, 1878, p. 63, pl. 19, figs. 11a–d.
*Axinopsida orbiculata* (Sars), MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 172, pl. 20, fig. 2.

Shell suborbicular in outline, about ⅛ inch long, height slightly more than width; a pronounced concavity in front of beaks; one cardinal tooth in each valve.

*Remarks.* Geographic distribution of *A. orbiculata* is in northern European waters, and from Greenland south to Maine. It is found at depths between 1 fathom and 515 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20154. Locality 92: lot 31, con. V, Cornwall tp., Stormont co., Ontario; elevation 222 feet above sea level.

Superfamily *LEPTONACEA*
Family *LEPTONIDAE*

Genus *Mysella* Angus, 1877

*Mysella planulata* (Stimpson, 1851)
Plate IV, figures 1a, b

*Kellia planulata* Stimpson, Shells of New England, 1851, p. 17.
*Mysella planulata* (Stimpson), Abbott, Am. Seashells, 1954, p. 395; Bousfield, Can. Atlantic Sea Shells, 1960, p. 33, pl. 9, fig. 88.

Shell as much as ⅛ inch long, oval, compressed, fairly fragile; lunule well defined; umbones prominent, touching; two cardinal teeth in left valve, none in right.

*Remarks.* This specimen is apparently a juvenile; it is about 1/16 inch long. Range of the

species is from Prince Edward Island to Texas, in shallow water attached to wharf pilings and eel grass. Earlier authors list this as *Rochefortia planulata*.

*Type and occurrence.* Hypotype, GSC No. 20155. Locality 225: from a ditch 1.5 miles due north of Ancienne Lorette, Quebec, at an elevation of 197 feet above sea level.

Superfamily *CARDIACEA*
Family *CARDIIDAE*

Genus *Serripes*, Gould, 1841

*Serripes groenlandicus* (Bruguière, 1789)
Plate IV, figures 2a, b

*Cardium groenlandicum* Bruguière, Encycl. Méthodique, 1789, p. 222.
*Serripes groenlandicus* (Bruguière), Abbott, Am. Seashells, 1954, p. 401, pl. 32, fig. d; Bousfield, Can. Atlantic Sea Shells, 1960, p. 28, pl. 6, fig. 71; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 63, pl. 8, figs. 12, 13.

Shell approximately equilateral, moderately thin, 2 to 4 inches long; umbones high and inflated; exterior smooth except for very weak radial ribs on posterior and anterior slopes; concentric growth lines.

*Remarks. Serripes groenlandicus* is a widely distributed species; it is circumpolar and extends south along the east coast of North America as far as Cape Cod, Massachusetts. Known bathymetric range is between ½ fathom and 165 fathoms.

*Occurrence.* Localities 223, 224, 229.

*Type.* Hypotype, GSC No. 20156, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9; elevation about 330 feet above sea level.

Superfamily *TELLINACEA*
Family *TELLINIDAE*

Genus *Macoma* Leach, 1819

*Macoma balthica* (Linné, 1758)
Plate IV, figures 3a, b; 4a, b

*Tellina balthica* Linné, Systema Nat., ed. 10, 1758, p. 677.
*Macoma balthica* (Linné), Abbott, Am. Seashells, 1954, p. 431, fig. 88g; Bousfield, Can. Atlantic Sea Shells, 1960, p. 33, pl. 9, fig. 91; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 66, pl. 10, figs. 15, 16.

Shell variable in outline, ovate to rounded subtrigonal, moderately compressed, anterior dorsal margin nearly straight adjacent to prominent beaks, subsequently becoming convex in most specimens (Pl. IV, figs. 3a, b), but remaining straight or becoming slightly concave in others (Pl. IV, figs. 4a, b); as much as 1½ inches long; chalky; two small cardinal teeth in each valve; conspicuous pallial sinus confluent with pallial line along its lower edge, larger in one valve than in the other.

*Remarks.* Specimens from the Champlain Sea deposits are seldom more than ½ inch long. This is a boreal species, not penetrating into Arctic waters; its southern limit in the western Atlantic is off the coast of Georgia. It is common from the mid-tide level to deep water, and is tolerant of a wide variation in salinity. Because of its tolerance to lower salinites, *M. balthica* was able to spread into the farthest reaches of the Champlain Sea where the salinity was greatly reduced by the inflow of fresh water. It is the most common species in the Champlain Sea deposits.

*Occurrence.* Localities 1, 2, 4–8, 10–18, 20, 22–32, 34, 38–42, 44, 46–49, 51–54, 57, 58, 60, 63, 65, 67, 70, 71, 76, 77, 79, 81–85, 90, 91, 93, 95–97, 103–106, 108, 110, 114, 117–121, 123,

125–128, 130, 131, 133–136, 140, 141, 143–156, 158–161, 163–169, 171, 173, 177, 179, 180, 183–188, 191, 192, 195, 196, 199, 200, 202, 205, 208, 211, 214, 219, 221, 222, 224, 226, 228–231. The form characterized by a straight or slightly concave antero-dorsal margin was found only at localities 54, 67, 70, 106, 153, 161, 222, 230, and 231.

*Types.* Hypotypes, GSC No. 20157, from a pit about 2 miles northwest of St. Joseph-du-Lac, Quebec, at an elevation of 300 feet above sea level (figs. 3a, b); GSC No. 20159, from Wilson Avenue, 100 feet north of Notre Dame de Grace, Montreal, Quebec; elevation 232 feet above sea level (figs. 4a, b).

### *Macoma calcarea* (Gmelin, 1792)

Plate IV, figures 5a, b

*Tellina calcarea* Gmelin, Systema Nat., ed. 13, vol. 7, 1792, p. 3236.
*Macoma calcarea* (Gmelin), Abbott, Am. Seashells, 1954, p. 430, fig. 88f; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 181, pl. 24, figs. 5–7, pl. 26, figs. 6–9; Bousfield, Can. Atlantic Sea Shells, 1960, p. 34, pl. 9, fig. 92; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 66, pl. 10, figs. 17–19.

Shell more elongate than *M. balthica*, with anterior end somewhat inflated and posterior end narrowed and slightly twisted; 1 inch to 2 inches long; lower border of pallial sinus fused with the pallial line for only about half its length; sinus much larger in one valve than in the other; teeth as in *M. balthica*.

*Remarks.* This is a characteristically cold-water species of circumboreal distribution. In the western Atlantic, it is found from Greenland to Long Island, New York. Depth range is from low water to about 45 fathoms.

*Occurrence.* Localities 98, 106, 107, 124, 132, 137, 138, 140, 159, 175, 177, 194, 197, 205, 206, 209, 218–220, 222–225, and 229.

*Type.* Hypotype, GSC No. 20158, from a landslide scar 1 mile northeast of St. Maurice, Quebec, at an elevation of about 100 feet above sea level.

## Suborder ADAPEDONTA

## Superfamily *MYACEA*

## Family *MYACIDAE*

### Genus *Mya* Linné, 1758

### *Mya* (*Arenomya*) *arenaria* Linné, 1758

Plate IV, figures 7a–c

*Mya arenaria* Linné, Systema Nat., ed. 10, 1758, p. 670; Foster, Johnsonia, vol. 2, No. 20, 1946, p. 32, pl. 20, figs. 1–3, pl. 21, figs. 1, 2; Abbott, Am. Seashells, 1954, p. 455, pl. 32, fig. x; Bousfield, Can. Atlantic Sea Shells, 1960, p. 37, pl. 10, fig. 104; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 70, pl. 12, fig. 15.
*Mya (Arenomya) arenaria* Linné, MacNeil, U.S. Geol. Surv., Prof. Paper 483-G, p. 33G, pl. 5, figs. 2–12, pl. 6, figs. 1–15, 17, 18.

Shell outline elongately to roundly ovate, gaping at posterior end, 1 inch to 6 inches long; a long, shallow, spoon-shaped chondrophore in left valve; pallial sinus somewhat V-shaped, about twice as long as wide, with upper and lower margins sloping at approximately the same angle.

*Remarks.* Range of *M. arenaria* is from Labrador (about 57°N lat.) to North Carolina. Records from farther north are of incorrectly identified specimens of *M. pseudoarenaria* Schlesch, the Arctic counterpart of *M. arenaria*. *M. arenaria* occurs in the intertidal zone to depths of several fathoms. It is most commonly found in bays and estuaries.

*Occurrence.* Localities 106, 108, 109, 117–121, 123, 126, 133, 140, 141, 144, 151, 153–156, 158, 160, 163–165, 168, 169, 183–186, 191, 205, 214, and 222.

*Type.* Hypotype, GSC No. 20160, from ditch on north side of highway 36, 0.4 mile east of railway crossing in St. Remi, Quebec (Lachine map-sheet). Elev. 208 feet. GSC loc. 60723. Coll. F. J. E. Wagner, 1955.

*Mya (Mya) pseudoarenaria* Schlesch, 1931

Plate V, figures 2a–c

*Mya pseudoarenaria* Schlesch, Arch. Molluskenk., vol. 63, 1931, p. 136, pl. 13, figs. 10–13; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 186, pl. 19, fig. 7, pl. 25, fig. 4.
*Mya (Mya) pseudoarenaria* Schlesch, MacNeil, U.S. Geol. Surv., Prof. Paper 483-G, 1965, p. 37G, pl. 7, figs. 9–11, 13, 14, pl. 9, fig. 4.

Shell oval, similar in outline to *M. arenaria*, about 3 inches long; pallial sinus broadly U-shaped, as in *M. truncata*.

*Remarks.* This species is of Arctic distribution, recorded from Greenland, Iceland, Spitzbergen, Norway, Siberia, and northern Alaska. In contrast with the more temperate *M. arenaria*, it was found at only one Champlain Sea locality.

*Type and occurrence.* Hypotype, GSC No. 20163, 20163a. Locality 224: from a ditch draining into Rivière du Cèdre, 0.3 mile southeast of St. Janvier-de-Joly, Quebec; elevation about 375 feet above sea level.

*Mya (Mya) truncata* Linné, 1758

and var. *uddevallensis* Forbes, 1846

Plate IV, figures 6a, b; Plate V, figures 1a, b.

*Mya truncata* Linné, Systema Nat., ed. 10, 1758, p. 670; Foster, Johnsonia, vol. 2, No. 20, 1946, p. 30, pl. 18, figs. 1–4, pl. 19, figs. 1, 2; Abbott, Am. Seashells, 1954, p. 455, pl. 32, fig. v; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 184, pl. 25, figs. 1–2; Bousfield, Can. Atlantic Sea Shells, 1960, p. 37, pl. 10, fig. 105; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 70, pl. 13, figs. 1, 2.
*Mya (Mya) truncata* Linné, MacNeil, U.S. Geol. Surv., Prof. Paper 483–G, p. 38G, pl. 8, figs. 1–3, 5, 6, 8, 9, 11, 12, pl. 9, figs. 1–3, 5–18.
*Mya truncata* var. *uddevallensis* Forbes, Mem. Geol. Surv. Gt. Brit. and Museum Econ. Geol., vol. 1, 1846, p. 407; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, 1959, p. 184, pl. 25, fig. 3; MacNeil, U.S. Geol. Surv., Prof. Paper 483-G, p. 38G, pl. 8, figs. 4, 7, 10, pl. 9, figs. 19, 20.

Shell similar to that of *M. arenaria* but truncated and more widely gaping posteriorly; length 1 inch to 3 inches; chondrophore in the left valve short, broad, and trigonal; pallial sinus U-shaped, short and broad, with depth equal to or much less than width (Pl. IV, figs. 6a, b).

Variety *uddevallensis* (Pl. V, figs. 1a, b) very obliquely truncated with posterior dorsal margin almost twice as long as posterior ventral margin; complete series of intergradations between typical *M. truncata* and variety *uddevallensis*.

*Remarks.* The geographic range of both the species and variety are essentially the same, except that the variety is not found quite so far south. *M. truncata* is reported from as far south as Massachusetts in western Atlantic waters; the southernmost record for *M. t.* var. *uddevallensis* is the Gulf of St. Lawrence. Depth range is from low water to about 55 fathoms.

*Occurrence.* Localities 132, 133, 137, 140, 145, 215, 223, and 229 (*M. truncata*); 121, 135, 136, 140, 153, 154, 158, 175, 222, and 224 (var. *uddevallensis*).

*Types.* Hypotypes, GSC No. 20161, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9; elevation about 330 feet above sea level (*M. truncata*); GSC No. 20162, from the corner of Masson and D'Iberville Streets, Montreal, Quebec, at an elevation of 173 feet above sea level (*M. truncata* var. *uddevallensis*).

*Mya* sp.

*Mya* Linné, Systema Nat., 10th ed., 1758, p. 670.

Shell variable in shape, rounded anteriorly and gaping posteriorly; valves slightly unequal

in size; internal resilium attached in left valve to horizontally projecting chondrophore; sinupalliate; teeth obsolete.

*Remarks.* Material from these localities was of a fragmentary nature and could be identified only to genus.

*Occurrence.* Localities 148, 149, 152, 161, 181, 184, and 229.

Superfamily *MACTRACEA*
Family *HIATELLIDAE*

Genus *Hiatella* Daudin, *in* Bosc, 1801
(*Saxicava* Fleuriau, 1802)

*Hiatella arctica* (Linné, 1767)
Plate V, figures 5a, b

*Mya arctica* Linné, Systema Nat., ed. 12, 1767, p. 1113.
*Saxicava rugosa* Lamarck (and var. *arctica*), Dawson, Can. Ice Age, 1893, p. 227, pl. V, fig. 6.
*Hiatella arctica* (Linné), Abbott, Am. Seashells, 1954, p. 452, fig. 92a; MacGinitie, Proc. U.S. Natl. Museum, vol. 109, No. 3412, 1959, p. 190, pl. 26, figs. 1–3; Bousfield, Can. Atlantic Sea Shells, 1960, p. 35, pl. 10, fig. 99; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 71, pl. 12, figs. 17–20.

Shell usually heavy and variable in shape — elongate, oblong, or distorted because of animal's burrowing habit; adult shells varying from about ½ inch to 2 inches long; surface chalky, with coarse, irregular lines of growth; hinge thickened, without definite teeth; young specimens having spines in two radial rows on posterior slope.

*Remarks.* This is the *Saxicava arctica* or *Saxicava rugosa* of earlier authors. Its present range in the western Atlantic area is from the Arctic Ocean to deep water off the West Indies. In colder, northern waters it lives close to shore, being found as shallow as the low-tide level. It nestles under stones or among other shells, and also burrows in gravel, sand, mud, clay, and soft rock.

*Occurrence.* Localities 15, 19, 20, 22, 27–29, 35, 36, 38, 40–44, 50, 51, 55, 56, 59–68, 72–77, 80–91, 93–96, 98–102, 111, 112, 114, 115, 118, 120–122, 124–126, 128, 129, 132–136, 138, 140, 141, 145–147, 149–153, 155–159, 164, 166, 170, 171, 175, 182, 184–186, 188, 191, 192, 196, 199, 200, 203–205, 208, 209, 214, 215, 217, 219–231.

*Type.* Hypotype, GSC No. 20164, 1 mile south-southeast of Chevalier, on west side of road to Beauport, Quebec; elevation about 350 feet above sea level.

Order **ANOMALODESMACEA**
Superfamily *PANDORACEA*
Family *LYONSIIDAE*

Genus *Lyonsia* Turton, 1822

*Lyonsia arenosa* (Möller, 1842)
Plate V, figures 3a, b

*Pandorina arenosa* Möller, Index Moll. Groenl., 1842, p. 20.
*Lyonsia arenosa* (Möller), Abbott, Am. Seashells, 1954, p. 468; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 57, pl. 5, fig. 17.

Shell ½ to ¾ inch long, posterior end more oval and higher than anterior end; no posterior gape as in *L. hyalina*; commonly having sand grains adhering to surface.

*Remarks.* This species has a circumboreal distribution. In the western Atlantic it is found from Greenland south to Massachusetts at depths from the low-water level to about 65 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20165. Locality 205: west bank of Batiscan River, 2 miles east-southeast of St. Geneviève, Quebec; elevation about 35 feet above sea level.

*Lyonsia hyalina* (Conrad, 1831)

Plate V, figures 4a, b

*Mya hyalina* Conrad, J. Acad. Nat. Sci., Philadelphia, vol. 6, 1831, p. 261, pl. 11, fig. 12.
*Lyonsia hyalina* (Conrad), Abbott, Am. Seashells, 1959, p. 468, pl. 28, fig. u; Bousfield, Can. Atlantic Sea Shells, 1960, p. 23, pl. 5, fig. 52; Richards, Trans. Am. Phil. Soc., n. ser., vol. 52, pt. 3, 1962, p. 58, pl. 5, fig. 15.

Shell ½ to ¾ inch long; elongate, with posterior end tapering somewhat; thin, fragile, and semi-translucent; exterior ornamented with fine radial ridges, commonly coated with sand grains; gaping posteriorly; hinge weak, without teeth.

*Remarks. Lyonsia hyalina* is of more southern distribution, with a range from the southwestern Gulf of St. Lawrence and western Nova Scotia to Texas. It lives from low tide to a depth of about 33 fathoms.

*Type and occurrence.* Hypotype, GSC No. 20166. Locality 223: east bank of Grande Rivière du Chêne, Quebec, just south of highway 9, at an elevation of about 330 feet above sea level.

## ARTHROPODA

Phylum **ARTHROPODA** Siebold and Stannius, 1845
Supersubphylum EUARTHROPODA Lankester, 1904
Subphylum MANDIBULATA Clairville, 1798
Class *CRUSTACEA* Pennant, 1777
Subclass *OSTRACODA* Latreille, 1806
Order **PODOCOPIDA** Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily *CYTHERACEA* Baird, 1850

Plate VI, figures 1–21;
Plate VII, figures 2, 3

Ostracoda are laterally compressed Crustacea possessed of a bivalved carapace that is hinged along the dorsal margin. The suborder Podocopina is divided into superfamilies on the basis of soft parts, character of the hinge, and the shape and subdivision of certain elements of the muscle scars. All the genera listed below belong to the superfamily Cytheracea.

*Remarks.* The writer is relatively unfamiliar with the Ostracoda, and in addition, a lack of adequate literature dealing with recent forms from Canadian Arctic and Atlantic waters makes identification of the species found in the Champlain Sea deposits very difficult. Representatives of the group from this area seem to have been neglected since about 1870 when Brady worked on material from the Gulf of St. Lawrence and Brady and Crosskey identified fossil ostracods from Montreal. Some new species were described, but illustrations of these and of other species are line drawings only. Dawson (1893) and Whiteaves (1901) merely repeat Brady's list. Some North American records are given by Sars (1928) in his account of the ostracods found off Norway, and Wagner (1957) notes species of the Holocene deposits of the Netherlands that have also been identified from Canadian waters and/or raised marine deposits.

The following genera have been recognized in the Champlain Sea deposits: *Cytheridea* (Pl. VI, fig. 1), *Paracyprideis* (Pl. VI, fig. 2), *Eucytheridea* (Pl. VI, fig. 3), *Heterocyprideis* (Pl. VI, fig. 4), *Cytherura* (Pl. VI, figs. 5, 6), *Cytheropteron* (Pl. VI, figs. 7–9), *Baffinicythere* (Pl. VI, fig. 10), *Hemicytherura* (Pl. VI, fig. 11), *Leptocythere* (Pl. VI, fig. 12), *Limnocythere*

(Pl. VI, fig. 13), *Palmenella* (Pl. VI, fig. 14), *Xestoleberis* (Pl. VI, fig. 15), and *Robertsonites* (Pl. VI, fig. 16). Several specimens of uncertain identity are also illustrated (Pl. VI, figs. 17–21; Pl. VII, figs. 1, 2).

*Occurrence.* Localities 15, 16, 19, 35, 37, 47, 50, 53, 65, 86, 90, 92, 94, 95, 102–104, 106, 110, 113–115, 117, 118, 120–124, 126, 128, 132, 136, 138, 140, 141, 143, 145, 150, 151, 154, 157–159, 163, 165, 175, 177, 182, 191, 192, 199, 200, 203, 205, 208, 209, 214, 215, 220, 223, and 224.

*Types.* Hypotypes, GSC No. 20167, lot 15, con. III, Cornwall tp., Stormont co., Ontario, elevation 197 feet above sea level [*Cytheridea* sp.]; GSC No. 20168, east bank of Batiscan River, Quebec, just below Chute à Jimmy, elevation 386 feet above sea level [*Paracyprideis pseudopunctillata* Swain]; GSC No. 20169, east bank of Batiscan River, Quebec, just below Chute à Jimmy, elevation 386 feet above sea level [*Eucytheridea punctillata* (Brady)]; GSC No. 20170, southwest corner of McGill University grounds, Sherbrooke and Mansfield Streets, Montreal, Quebec, elevation 143 feet above sea level [*Heterocyprideis sorbyana* (Jones)]; GSC No. 20171, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9, elevation about 330 feet above sea level [*Cytherura* sp.]; GSC No. 20172, site of the Cornwall dyke, vicinity of the Hydro-Electric Power Commission of Ontario office, Cornwall, Ontario, elevation about 210 feet above sea level [*Cytherura* sp.]; GSC No. 20173, west bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec, elevation 35 feet above sea level [*Cytheropteron* sp.]; GSC No. 20174, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9, elevation about 330 feet above sea level [*Cytheropteron* sp.]; GSC No. 20175, bank of St. Lawrence River, just east of creek 7 miles east of Morrisburg, Ontario, elevation 225 feet above sea level [*Cytheropteron* sp.]; GSC No. 20176, pit 1.4 miles southeast of St. Philomène, Quebec, elevation about 215 feet above sea level [*Baffinicythere emarginata* (Sars)]; GSC No. 20177, pit 1.4 miles southeast of St. Philomène, Quebec, elevation about 215 feet above sea level [*Hemicytherura* sp.]; GSC No. 20178, corner of Masson and D'Iberville Streets, Montreal, Quebec, elevation 173 feet above sea level [*Leptocythere macchesneyi* (Brady and Crosskey)?]; GSC No. 20179, Morrisburg, Ontario, elevation about 255 feet above sea level [*Limnocythere* sp.]; GSC No. 20180, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9, elevation about 330 feet above sea level [*Palmenella limicola* (Norman)]; GSC No. 20181, bank of St. Lawrence River, just east of creek 7 miles east of Morrisburg, Ontario, elevation 225 feet above sea level [*Xestoleberis* sp.]; GSC No. 20182, east bank of Grande Rivière du Chêne, Quebec, just south of highway 9, elevation about 330 feet above sea level [*Robertsonites logani* (Brady and Crosskey)].

Specimens figured but not named are as follows: GSC No. 20183, southern part of pit 1.4 miles southeast of St. Philomène, Quebec, elevation about 215 feet above sea level; GSC Nos. 20184 and 20185, pit on southeast slope of Mont St. Hilaire, Quebec, elevation 219 feet above sea level; GSC No. 20186, Morrisburg, Ontario, elevation about 255 feet above sea level; GSC No. 20187, pit 1.4 miles southeast of St. Philomène, Quebec, elevation about 215 feet above sea level; GSC No. 20188, east bank of Batiscan River, Quebec, just below Chute à Jimmy, elevation 386 feet above sea level; GSC No. 20189, corner of Masson and D'Iberville Streets, Montreal, Quebec, elevation 173 feet above sea level.

## Subclass *CIRRIPEDIA*
### Order **BALANOMORPHA**
### Family *BALANIDAE*

Genus *Balanus* da Costa, 1778

*Balanus balanus* (Linné, 1758)
Plate VII, figure 3

*Lepas balanus* Linné, Systema Nat., ed. 10, 1758, p. 667.
*Balanus balanus* (Linné), Bousfield, Can. Atlantic Sea Shells, 1960, p. 40, pl. 11, fig. 115.

Shell steep, conical, ½ inch to 1½ inches high; wall plates usually sharply ribbed externally and multi-ribbed internally, with both large and small pores; aperture small, wall plates meeting to form an almost entire margin; curved tips of anterior opercular plates pointing upwards.

*Remarks.* In eastern North American waters this species is found from the Arctic Ocean to Long Island Sound. It occurs from lower low-water level to about 100 fathoms, with optimum depths between 10 and 25 fathoms.

*Occurrence.* Locality 229.

*Type.* Hypotype, GSC No. 20190, from the coast of Nova Scotia. Because of the fragmentary nature of the fossil material, a recent specimen is figured.

### *Balanus crenatus* Bruguière, 1789

Plate VI, figure 4

*Balanus crenatus* Bruguière, Encycl. Méthodique, (Vers), vol. 1, 1789, p. 168; Bousfield, Can. Atlantic Sea Shells, 1960, p. 39, pl. 11, fig. 113.

Shell conical to cylindrical in crowded specimens, ½ to 1 inch high; wall plates generally rough externally, forming a sharp-toothed margin to the aperture, large pores seen at the lower edge; opercular plates flaring away from each other at tips.

*Remarks.* Specimens are usually found in the fossil state as separated plates. The geographic distribution for *B. crenatus* is from the Arctic south to New Jersey at depths between low-water level and 50 fathoms. It is most common between 25 and 50 fathoms, with a second optimum depth at about 6½–7 fathoms.

*Occurrence.* Localities 22, 39, 50, 51, 54, 65, 75, 86–88, 95, 106, 113–115, 120, 135, 136, 140, 143, 166, 175, 199, 214, 219, 229, and 231.

*Type.* Hypotype, GSC No. 20191, from the coast of Nova Scotia.

### *Balanus hameri* (Ascanius, 1767)

Plate VI, figures 5, 6

*Lepas hameri* Ascanius, Icones Rarum Nat., I, ed. 2, 1767.
*Balanus hameri* (Ascanius), Bousfield, Can. Atlantic Sea Shells, 1960, p. 40, pl. 11, fig. 116.

Shell large (1 inch to 2½ inches), cylindrical or somewhat conical; wall plates smooth externally and sharply ribbed internally, coming together to form a wide, diamond-shaped aperture with a low-toothed margin; tips of anterior opercular plates not flared.

*Remarks.* The present range of *B. hameri* is from Hamilton Inlet, Labrador, south to North Carolina. This is a deeper water species than the two preceding ones, being found most commonly at depths greater than 100 fathoms. Some specimens, though, live within 3 fathoms of the surface.

*Occurrence.* Localities 35, 100, 128, 157, 158, 204, 207, 218, 222, and 229.

*Types.* Hypotypes, GSC No. 20192, southern part of pit 1.4 miles southeast of St. Philomène, Quebec, at an elevation of about 215 feet above sea level; GSC No. 20193, from the coast of Nova Scotia.

### *Balanus* sp.

*Balanus* da Costa, Brit. Conch., 1778, p. 249.

Only fragments of plates were found at a number of localities. These are of *Balanus,* but could not be identified to species.

*Occurrence.* Localities 45, 55, 59, 60, 64, 82, 89, 93, 117, 119, 121, 123, 124, 136, 138, 140, 141, 145, 151, 153, 156, 159, 162, 166, 168, 214, and 215.

## ECHINODERMATA

### Phylum **ECHINODERMATA**
### Subphylum ELEUTHEROZOA
### Class *OPHIUROIDEA*

A few ossicles and spines of representatives of this class were found at several localities.

*Occurrence.* Localities 94, 157, 218, and 224.

## ANNELIDA

### Phylum **ANNELIDA** Lamarck, 1809
### Class *POLYCHAETIA* Grube, 1850
Order **SEDENTARIDA** Lamarck, 1818

Family *SERPULIDAE* Burmeister, 1837

Genus *Serpula* Linné, 1768

*?Serpula vermicularis* (Linné, 1767)

*Tubus vermicularis* Linné, Systema Nat., ed. 12, 1767, p. 1267.
*Serpula vermicularis* (Linné), Bousfield, Can. Atlantic Sea Shells, 1960, p. 45, pl. 13, fig. 131.

Tube calcareous, contorted or loosely coiled, lower end attached, remainder of tube more or less erect; surface often with small concentric ridges; length of tubes as much as 4 inches.

*Occurrence.* Locality 35.

## CHORDATA

### Phylum **CHORDATA**
### Subphylum VERTEBRATA
### Class *PISCES*
### Subclass *TELEOSTOMI*
Order **TELEOSTEI**

Family *OSMERIDAE*

Genus *Mallotus* Cuvier, 1829

*Mallotus villosus* (Müller, 1777)

Plate VII, figure 8

*Clupea villosa* Müller, Zool. Prodromus Danicae, 1777, p. 50.
*Mallotus villosus* Cuvier, Dawson, Can. Ice Age, 1893, p. 265, pl. VIII, fig. 1.
*Mallotus villosus* (Müller), Bigelow and Schroeder, Woods Hole Oceanog. Inst., Contrib. No. 1149, 1964, p. 576, figs. 133–136.

Body elongate, moderately compressed, as long as 9 inches but average length about 6 inches; dorsal and ventral profiles of head and trunk slightly convex; caudal fin deeply forked; lower jaw projecting anteriorly to tip of upper jaw.

*Remarks.* Concretions from the clays of the Green Creek – Hiawatha Park area along the Ottawa have yielded numerous specimens of *Mallotus villosus*. The skeletal remains are generally very well preserved. This is a circumboreal species. In the western Atlantic it ranges from southwestern Greenland to northern Nova Scotia and into the Gulf of St. Lawrence.

*Occurrence.* Locality 23.

# BIBLIOGRAPHY[1]


Abbott, R. T.

*1954: American seashells; D. Van Nostrand Company Inc.

Ami, H. M.

1884: List of fossils from Ottawa and vicinity; *Trans. Ottawa Naturalist Club,* vol. 2, No. 1, pp. 54–62.

1887: The great ice age and subsequent formations at Ottawa, Ontario; *Ottawa Naturalist,* vol. 1, pp. 65–74, 81–88.

1892: Additional notes on the geology and palaeontology of Ottawa and its environs; *Ottawa Naturalist,* vol. 6, pp. 73–78.

1897: Contribution to the palaeontology of the post-Pliocene deposits of the Ottawa valley; *Ottawa Naturalist,* vol. 11, pp. 20–26.

1902: List of fossils to accompany report by Dr. R. W. Ells on the City of Ottawa map; *Geol. Surv. Can.,* Ann. Rept. (n.ser.), 1899, vol. 12, pp. 51G–56G.

1906: Report on the geology of a portion of eastern Ontario to accompany map-sheet 119. *Geol. Surv. Can.,* Ann. Rept. 1901, vol. 14, pt. J., Appendix.

Antevs, Ernst

1925: Retreat of the last ice-sheet in eastern Canada; *Geol. Surv. Can.,* Mem. 146.

1939: Late Quaternary upwarpings of northeastern North America; *J. Geol.,* vol. 47, pp. 707–720.

1957: Geological tests of the varve and radiocarbon chronologies; *J. Geol.,* vol. 65, No. 2, pp. 129–148.

1962: Transatlantic climatic agreement versus $C_{14}$ dates; *J. Geol.,* vol. 70, No. 2, pp. 194–205.

Ardley, Edward

1912: Occurrence of *Ostrea* in the Pleistocene deposits of the vicinity of Montreal; *Ottawa Naturalist,* vol. 26, p. 67.

1916: Note on the discovery of a skeleton of *Beluga catodon* (white whale) in the Pleistocene (*Leda* clay) at the town of Montreal East, Quebec; *Can. Record Sci.,* vol. 9, No. 8, pp. 490–493.

Barker, R. W.

*1960: Taxonomic notes on the species figured by H. B. Brady in his report on the Foraminifera dredged by H.M.S. *Challenger* during the years 1873–1876; *Soc. Econ. Paleontologists, Mineralogists,* Spec. Publ. No. 9.

Bartlett, G. A.

*1962: Foraminifera and their relation to bottom sediments on the Scotian Shelf; unpubl. M.S. thesis, Carleton Univ.

*1965: Preliminary notes on recent species of Elphidiidae in shallow waters of Atlantic Provinces; *Bedford Inst. Oceanog.,* Rept. 65–13.

Bayfield, H. W.

1837: Notes on the geology of the north coast of the St. Lawrence; *Trans. Geol. Soc. London,* ser. 2, vol. 5, pp. 89–103.


[1]References marked with an asterisk (*) are the main sources for synonymies.

Bell, Robert

1859a: Catalogue of animals and plants collected and observed on the south-east side of the St. Lawrence from Quebec to Gaspé, and in the counties of Rimouski, Gaspé, and Bonaventure; *Geol. Surv. Can.*, Rept. Prog. 1858, pp. 243–263.

1859b: On the natural history of the Gulf of St. Lawrence and the distribution of the Mollusca of eastern Canada; *Can. Naturalist,* vol. 4, pp. 197–200, 241, 242.

1906: Summary report on the operations of the Geological Survey for the year 1901; *Geol. Surv. Can.*, Ann. Rept. (n.ser.), 1901, vol. 14, pt. A.

Billings, Elkanah

1870: Untitled note; *Can. Naturalist,* vol. 5, pp. 438, 439.

Bousfield, E. L.

1954: The distribution and spawning seasons of barnacles on the Atlantic coast of Canada; *Natl. Museum Can.*, Bull. 132, pp. 112–154.

1955a: Studies on the shore fauna of the St. Lawrence estuary and Gaspé coast; *Natl. Museum Can.*, Bull. 136, pp. 95–101.

1955b: Ecological control of the occurrences of barnacles in the Miramichi estuary; *Natl. Museum Can.*, Bull. 137.

1960: Canadian Atlantic sea shells; *Natl. Museum Can.*

Brady, G. S.

1865: On undescribed fossil Entomostraca from the brick-earth of the Nar; *Ann. Mag. Nat. Hist.*, ser. 3, vol. 16, pp. 189–191, pl. 9.

1868: Contributions to the study of the Entomostraca, Ostracoda from the Arctic and Scandinavian sea; *Ann. Mag. Nat. Hist.*, ser. 4, vol. 2, pp. 30–35, pls. 4, 5.

1870a: Bivalve crustaceans from the Gulf of St. Lawrence; *Can. Naturalist,* n.ser., vol. 5, pp. 378–384.

1870b: Contributions to the study of the Entomostraca. No. 5. Recent Ostracoda from the Gulf of St. Lawrence; *Ann. Mag. Nat. Hist.*, ser. 4, vol. 6, pp. 450–454, pl. 19.

Brady, G. S., and Crosskey, H. W.

1870: Extract from notes on fossil Ostracoda from the post-Tertiary deposits of Canada and New England; *Can. Naturalist,* n.ser., vol. 5, pp. 385–388.

1871: Notes on fossil Ostracoda from the post-Tertiary deposits of Canada and New England; *Geol. Mag.*, vol. 8, pp. 60–65, pl. II.

Brady, G. S., Crosskey, H. W., and Robertson, D.

1874: Post-Tertiary Entomostraca of Scotland, including species from England and Ireland; *Palaeontographical Soc.*, Monograph No. 6.

Brady, G. S., and Robertson, D.

1870: The Ostracoda and Foraminifera of tidal rivers; with an analysis and description of the Foraminifera by H. B. Brady; *Ann. Mag. Nat. Hist.*, ser. 4, vol. 6, pt. I, pp. 1–33, pls. 4–10; pt. II, pp. 273–309, pls. 11, 12.

Brady, H. B.

1870: *See* Brady, G. S., and Robertson, D.

1884: Report on the Foraminifera dredged by H.M.S. *Challenger,* during the years 1873–1876; *Rept. Sci. Results Exploratory Voyage, Challenger 1873–76, Zool.*, vol. 9.

Burt, W. H., and Grossenheider, R. P.

*1956: A field guide to the mammals; Boston, Houghton Mifflin Co.

Bush, K. J.

1883: Catalogue of Mollusca and Echinodermata dredged on the coast of Labrador by the expedition under the direction of Mr. W. A. Stearns in 1882; *Proc. U.S. Natl. Museum,* vol. 6, pp. 236–247, pl. 9.

Chalmers, Robert

1896: Pleistocene marine shore-lines on the south side of the St. Lawrence Valley; *Am. J. Sci.*, ser. 4, vol. 1, pp. 302–308.

1899: Report on the surface geology and auriferous deposits of southeastern Quebec; *Geol. Surv. Can.*, Ann. Rept. 1897, vol. 10, pt. J.

1901: Notes on the Pleistocene marine shore-lines and landslips of the north side of the St. Lawrence Valley. Appendix I to report by R. W. Ells; *Geol. Surv. Can.*, Ann. Rept. 1898, vol. 11, pp. 63J–70J.

1907a: Artesian borings, surface deposits and ancient beaches in Ontario; *Geol. Surv. Can.*, Ann. Rept. (n.ser.), 1902–03, vol. 15, pt. A, pp. 270A–281A.

1907b: Surface geology of eastern Quebec; *Geol. Surv. Can.*, Ann. Rept. 1904, vol. 16, pt. A, pp. 250–263.

Chapman, D. H.

1937: Late-glacial and post-glacial history of the Champlain Valley; *Am. J. Sci.*, ser. 5, vol. 34, pp. 89–124.

Chapman, L. J.

1953: Outlet of Lake Algonquin at Fossmill, Ontario, Canada (abstr.); *Bull. Geol. Soc. Am.*, vol. 64, p. 1407.

Chapman, L. J., and Putnam, D.F.

1951: The physiography of southern Ontario; Univ. Toronto Press.

Clarke, A. H., Jr.

*1963: Arctic archibenthal and abyssal molluscs—II. Molluscs dredged from Drifting Station Charlie (Alpha II); *Natl. Museum Can.*, Bull. 185, pp. 90–109, pls. 1, 2.

Coleman, A. P.

1901a: Marine and freshwater beaches of Ontario; *Bull. Geol. Soc. Am.*, vol. 12, pp. 129–146.

1901b: Sea beaches in eastern Ontario; *Ontario Bur. Mines*, vol. 10, pp. 215–227.

1932: An interglacial Champlain Sea; *Am. J. Sci.*, vol. 24, No. 142, pp. 311–315.

1941: The last million years; Univ. Toronto Press.

Cousineau, J. C.

1953: L'altitude maximum de la mer Champlain dans la région de Sherbrooke; *Ann. Assoc. Can.-Franc. l'Avan. Sci.*, vol. 19, pp. 114–120.

Cushman, J. A.

1918–31: The Foraminifera of the Atlantic Ocean; *U.S. Natl. Museum*, Bull. 104 (pt. 1, 1918; pt. 2, 1920; pt. 3, 1922; pt. 4, 1923; pt. 5, 1924; pt. 6, 1929; pt. 7, 1930; pt. 8, 1931).

1920: Report of the Canadian Arctic Expedition 1913–18; vol. 9, pt. M: Foraminifera.

1933: New Arctic Foraminifera collected by Capt. R. A. Bartlett from Fox Basin and off the northeast coast of Greenland; *Smithsonian Inst. Misc. Collections*, vol. 89, No. 9, pp. 1–8, pls. 1, 2.

1940: Foraminifera, their classification and economic use; 4th ed., Harvard Univ. Press.

1944: Foraminifera from the shallow-water of the New England coast; *Cushman Lab. Foraminiferal Res.*, Spec. Publ. 12.

1948: Arctic Foraminifera; *Cushman Lab. Foraminiferal Res.*, Spec. Publ. 23.

Dawson, G. M.

1870: On Foraminifera from the Gulf and River St. Lawrence; *Can. Naturalist*, n.ser., vol. 5, pp. 172–180.

1871: On Foraminifera from the Gulf and River St. Lawrence; *Ann. Mag. Nat. Hist.*, ser. 4, vol. 7, pp. 83–89, pls. 1–12.

1897: Summary report on the operations of the Geological Survey for the year 1895; *Geol. Surv. Can.*, Ann. Rept. (n.ser.), 1895, vol. 8, pt. A.

Dawson, Sir J. W.

1857: On the newer Pliocene and post-Pliocene deposits of the vicinity of Montreal; *Can. Naturalist,* vol. 2, pp. 401–426, pl. 7.

1859: Additional notes on the post-Pliocene deposits of the St. Lawrence Valley; *Can. Naturalist,* vol. 4, pp. 23–39, 19 text-figs.

1860: Notice of Tertiary fossils from Labrador, Maine, etc., and remarks on the climate of Canada in the New Pliocene or Pleistocene period; *Can. Naturalist,* vol. 5, pp. 188–200.

1865: On the post-Pliocene deposits of Rivière du Loup and Tadoussac; *Can. Naturalist,* n.ser., vol. 2, pp. 81–88.

1871: Notes on the post-Pliocene geology of Canada; *Can. Naturalist,* n.ser., vol. 6, pp. 19–42, 166–187, 241–259, 369–416.

1872: Notes on the post-Pliocene geology of Canada; Montreal, Mitchell & Wilson.

1878: Note on a fossil seal from the *Leda* clay of the Ottawa Valley; *Can. Naturalist,* vol. 8, pp. 340–341.

1883a: On portions of the skeleton of a whale from gravel on the line of the Canada Pacific Railway, near Smith's Falls, Ontario; *Can. Naturalist,* n.ser., vol. 10, pp. 385–387.

1883b: Canadian Pleistocene; *Geol. Mag.,* vol. 10, pp. 111–113.

1889: *Balanus hameri* and varieties of *Mya arenaria* and *M. truncata* in the Pleistocene; *Can. Record Sci.,* vol. 3, pp. 287–292.

1891: Note on a fossil fish and marine worm found in the Pleistocene nodules of Green's Creek on the Ottawa; *Can. Record Sci.,* vol. 4 (1890–1891), pp. 86–88.

1893: The Canadian ice age; William V. Dawson.

1895: Note on a specimen of *Beluga catodon,* from the *Leda* clay, Montreal; *Can. Record Sci.,* vol. 6, pp. 351–354.

Dyck, W., and Fyles, J. G.

1962: Geological Survey of Canada radiocarbon dates I; *Radiocarbon,* vol. 4, pp. 13–26.

1963: Geological Survey of Canada radiocarbon dates II; *Radiocarbon,* vol. 5, pp. 39–55.

1964: Geological Survey of Canada radiocarbon dates III; *Geol. Surv. Can.,* Paper 64-40.

Dyck, W., Fyles, J. G., and Blake, W., Jr.

1965: Geological Survey of Canada radiocarbon dates IV; *Geol. Surv. Can.* Paper 65-4.

Ellis, B. F., and Messina, Angelina

*1940: Catalogue of Foraminifera; *Am. Museum Nat. Hist.* (Supplements post-1940).

Ells, R. W.

1898: Sands and clays of the Ottawa Basin; *Bull. Geol. Soc. Am.,* vol. 9, pp. 211–222.

1901: Report on the geology of the Three Rivers map-sheet, or northwestern sheet of the 'Eastern Townships' map, Quebec; *Geol. Surv. Can.,* Ann. Rept. (n.ser.), 1898, vol. 11, pt. J.

1906: Report on the geology of a portion of eastern Ontario to accompany map-sheet 119; *Geol. Surv. Can.,* Ann. Rept. 1901, vol. 14, pt. J, pp. 5J–89J.

1907: Report on the geology and natural resources of the area included in the northwest quarter-sheet, number 122, of the Ontario and Quebec series, comprising portions of the counties of Pontiac, Carleton and Renfrew; *Geol. Surv. Can.,* Publ. No. 977.

1908: Report on the landslide at Notre-Dame de la Salette, Lièvre River, Quebec; *Geol. Surv. Can.,* Publ. No. 1030.

Elson, J. A.

1960: Littoral mollusks of the Champlain Sea; notes for American Malacological Union excursion to Mount St. Hilaire, Quebec, August 12, 1960.

Elson, J. A., and Elson, J. B.

1959: Phases of the Champlain Sea indicated by littoral mollusks (abstr.); *Bull. Geol. Soc. Am.,* vol. 70, p. 1596.

Elton, C. S., and Baden-Powell, D. F. W.
1931: On a collection of raised beach fossils from Spitzbergen; *Geol. Mag.*, vol. 68, No. 9, pp. 385–405.

Fabricius, Otho
1780: Fauna Groenlandica; J. G. Rothe.

Faessler, Carl
1948: L'extension maximum de la mer Champlain au nord du St-Laurent, de Trois-Rivières à Moisie; *Univ. Laval Fac. Sci. Géol. Minéral.*, Contrib. No. 88, pp. 16–28.

Fairchild, H. L.
1905: "Gilbert Gulf" – marine waters in the Ontario Basin; *Bull. Geol. Soc. Am.*, vol. 17, pp. 712–718.
1918: Pleistocene marine submergence of the Hudson, Champlain and St. Lawrence Valleys; *N.Y. State Museum Bull.*, Nos. 209, 210.

Feyling-Hanssen, R. W.
1954: Late-Pleistocene Foraminifera from the Oslofjord area, southeast Norway; *Norsk Geol. Tidsskr.*, vol. 33, pp. 109–152, pls. 1, 2.
*1964: Foraminifera in late Quaternary deposits from the Oslofjord area; *Norg. Geol. Undersøkelse*, No. 225.

Flint, R. F.
1948: Glacial and Pleistocene geology; John Wiley & Sons, Inc.
1953: Probable Wisconsin substages and late-Wisconsin events in northeastern United States and southeastern Canada; *Bull. Geol. Soc. Am.*, vol. 64, pp. 897–920.
1956: New radiocarbon dates and late-Pleistocene stratigraphy; *Am. J. Sci.*, vol. 254, pp. 265–287.

Forbes, Edward
1846: Catalogue of species of marine animals, the remains of which are found fossil in beds of the glacial epoch; Appendix; *Mem. Geol. Surv. Gt. Brit. and Museum Econ. Geol., London*, vol. 1, pp. 406–432.

Fretter, Vera, and Graham, Alastair
*1962: British prosobranch molluscs; *Ray Soc.*, No. 144.

Gadd, N. R.
1960a: Surficial geology of the Bécancour map-area, Quebec; *Geol. Surv. Can.*, Paper 59-8.
1960b: Surficial geology, Aston, Quebec; *Geol. Surv. Can.*, Map 50-1959.
1961: Surficial geology of the Ottawa area, report of progress; *Geol. Surv. Can.*, Paper 61-19.
1963: Surficial geology of Ottawa map-area, Ontario and Quebec; *Geol. Surv. Can.*, Paper 62-16.
1964: Moraines in the Appalachian region of Quebec; *Bull. Geol. Soc. Am.*, vol. 75, No. 12, pp. 1249–1254.

Gadd, N. R., and Karrow, P. F.
1960: Surficial geology, Trois-Rivières, Quebec; *Geol. Surv. Can.*, Map 54-1959.

Goldring, Winnifred
1922: The Champlain Sea; *N.Y. State Museum Bull.*, No. 239–240, pp. 153–187, pls. 1–3.

Goldthwait, J. W.
1911: Raised beaches of southern Quebec; *Geol. Surv. Can.*, Summ. Rept. 1910, pp. 220–233.
1912: Records of post-glacial changes of level in Quebec and New Brunswick; *Geol. Surv. Can.*, Summ. Rept. 1911, pp. 296–302.
1913a: Rivière du Loup: the post-glacial marine submergence; *Geol. Surv. Can.*, Guide Book No. 1, pt. 1, p. 66.

Goldthwait, J. W. (*cont.*).

1913b: The upper marine limit at Montreal; *Geol. Surv. Can.,* Guide Book No. 3, pp. 119–122.

1913c: The upper marine limit at Covey Hill and vicinity; *Geol. Surv. Can.,* Guide Book No. 3, pp. 122–126.

1914: Marine shore-lines in southeastern Quebec; *Geol. Surv. Can.,* Summ. Rept. 1912, pp. 357–359.

Grant, U. S., IV, and Gale, H. R.

*1931: Catalogue of the marine Pliocene and Pleistocene Mollusca of California; *Mem. San Diego Soc. Nat. Hist.,* vol. 1, 1036 pp., 32 pls.

Hallam, A.

1965: Environmental causes of stunting in living and fossil marine benthonic invertebrates; *Palaeontology,* vol. 8, pt. 1, pp. 132–155.

Hunt, T. S.

1866: Report of Dr. T. Sterry Hunt, L.L.D., F.R.S., chemist and mineralogist, addressed to Sir W. E. Logan, F.R.S., F.G.S.; *Geol. Surv. Can.,* Rept. Prog., 1863–1866, pp. 79–90.

Jensen, A. S.

1905: On the Mollusca of East Greenland. I. Lamellibranchiata; *Medd. Groenland,* vol. 29, pp. 287–362, 5 figs.

1912: Lamellibranchiata, pt. 1; *The Danish Ingolf-Expedition,* vol. 2, pt. 5, pp. 1–119, pls. 1–4.

Johansen, Frits

1929: Echinoderms from the Gulf of St. Lawrence; *Can. Field-Naturalist,* vol. 43, p. 187.

Johnson, C. W.

1934: List of marine Mollusca of the Atlantic coast from Labrador to Texas; *Proc. Boston Soc. Nat. Hist.,* vol. 40, pt. 1, pp. 1–204.

Johnston, W. A.

1916: Late Pleistocene oscillations of sea-level in the Ottawa Valley; *Geol. Surv. Can.,* Museum Bull. 24 (Geol. Ser. 33), pp. 1–14.

1917: Pleistocene and Recent deposits in the vicinity of Ottawa, with a description of the soils; *Geol. Surv. Can.,* Mem. 101.

Karrow, P. F.

1957: Pleistocene geology of the Grondines map-area; Quebec; unpubl. Ph.D. thesis, Univ. Illinois.

1959: Surficial geology, Grondines, Quebec; *Geol. Surv. Can.,* Map. 41-1959.

1961: The Champlain Sea and its sediments; *Roy. Soc. Can.,* Spec. Publ. No. 3, pp. 97–108.

Keele, Joseph, and Johnston, W. A.

1913: The superficial deposits near Ottawa; *Geol. Surv. Can.,* Guide Book No. 3, pp. 126–134.

Keith, M. L., and Parker, R. H.

1965: Local variation of $^{13}C$ and $^{18}O$ content of mollusk shells and the relatively minor temperature effect in marginal marine environment; *Marine Geol.,* vol. 3, No. ½, pp. 115–129.

Kindle, E. M.

1918: An Ottawa beach of the Champlain Sea; *Ottawa Naturalist,* vol. 32, pp. 83–86, 2 text-figs.

1928: A crustacean new to the Pleistocene fauna of Canada; *Can. Field-Naturalist,* vol. 42, No. 9, pp. 211, 212.

Kindle, E. M., and Whittaker, E. J.

1918: Bathymetric check-list of the marine invertebrates of eastern Canada with an index to Whiteaves's catalogue; *Dept. Naval Serv. Fisheries Branch,* Suppl. to 7th Ann. Rept., pp. 229–294.

King, J. E.

*1964: Seals of the world; *Brit. Museum (Nat. Hist.),* London.

Lambe, L. M.

1910: Palaeontology and zoology; *Geol. Surv. Can.,* Summ. Rept. 1909, pp. 269–273.

1914: Report of the vertebrate palaeontologist; *Geol. Surv. Can.,* Summ. Rept. 1913, pp. 293–299.

LaRocque, Aurèle

*1953: Catalogue of the Recent Mollusca of Canada; *Nat. Museum Can.,* Bull. 129.

Laverdière, Camille, and Mailloux, Auguste

1951: Additions à la faune Champlain et post-pléistocène du lac Saint-Jean; *Ann. Assoc. Can.-Franc. l'Avan. Sci.,* vol. 17, pp. 94–95.

Laverdière, J. W.

1950: Baleine fossile de Daveluyville, Quebec; *Nat. Can.,* vol. 77, pp. 271–282.

Lee, H. A.

1962: Surficial geology of Rivière-du-Loup – Trois-Pistoles area; *Geol. Surv. Can.,* Paper 61-32.

Leidy, Joseph

1856: Note on the remains of a species of seal, from the post-Pliocene deposit of the Ottawa River; *Proc. Philadelphia Acad. Nat. Sci.,* vol. 8, pp. 90–91, pl. 3.

Lemche, Henning

1938: Gastropoda Opisthobranchiata; *Zool. Iceland,* vol. 4, pt. 61, pp. 1–54, 3 figs.

1941: Gastropoda Opisthobranchiata. Zoology of East Greenland; *Medd. Groenland,* vol. 121, No. 7, pp. 1–50, 6 figs.

Loeblich, A. R., Jr., and Tappan, Helen

*1953: Studies of Arctic Foraminifera; *Smithsonian Inst. Misc. Collections,* vol. 121, No. 7.

Logan, Sir W. E.

1842: Marine shells on Montreal Mountain; *Proc. Geol. Soc. London,* vol. 3, pp. 769–770.

1847: On the topography and geology of the Ottawa River and some of its tributaries, . . .; *Geol. Surv. Can.,* Rept. Prog. 1845–46.

1863: Geology of Canada; *Geol. Surv. Can.,* Rept. Prog. 1863, pp. 915–930.

Lougee, R. J.

1953: A chronology of postglacial time in eastern North America; *Sci. Monthly,* vol. 76, No. 5, pp. 259–276.

Low, A. P.

1893: Report on the geology and economic minerals of the southern portion of Portneuf, Quebec and Montmorency counties, province of Quebec; *Geol. Surv. Can.,* Ann. Rept. (n.ser.), 1890–91, vol. 5, pt. I, rept. L, pp. 5L–82L.

Lyell, Sir Charles

1841: Remarks on some fossil and Recent shells, collected by Captain Bayfield, R.N., in Canada; *Trans. Geol. Soc. London,* ser. 2, vol. 6, pt. 1, pp. 135–141.

1842: Remarks on some fossil and Recent shells, collected by Capt. Bayfield, R.N., in Canada; *Proc. Geol. Soc. London,* vol. 3, pp. 119–120.

1845: Travels in North America in the years 1841–1842, with geological observations in the United States, Canada, and Nova Scotia; vol. 2; Wiley and Putnam.

MacClintock, Paul

1958: Glacial geology of the St. Lawrence seaway and power projects; *N.Y. State Museum Sci. Serv.*

MacClintock, Paul, and Stewart, D. P.

1965: Pleistocene geology of the St. Lawrence Lowland; *N.Y. State Museum Sci. Serv.*, Bull. No. 394.

MacClintock, Paul, and Terasmae, Jaan

1960: Glacial history of Covey Hill; *J. Geol.*, vol. 68, No. 2, pp. 232–241.

MacGinitie, G. E.

*1955: Distribution and ecology of the marine invertebrates of Point Barrow, Alaska; *Smithsonian Inst. Misc. Collections,* vol. 128, No. 9.

MacGinitie, Nettie

*1959: Marine Mollusca of Point Barrow, Alaska; *Proc. U.S. Natl. Museum,* vol. 109, pp. 59–208, 27 pls.

MacKay, H. H.

*1963: Fishes of Ontario; *Ont. Dept. Lands, Forests.*

MacNeil, F. S.

1965: Evolution and distribution of the genus *Mya,* and Tertiary migrations of Mollusca: *U.S. Geol. Surv.*, Prof. Paper 483-G, pp. G1–G51, pls. 1–11.

Madsen, F. J.

1949: Marine bivalvia; *Zool. Iceland,* vol. 4, pt. 63, pp. 1–116, figs. 1–12.

Mason, R. J.

1960: Early man and the age of the Champlain Sea; *J. Geol.*, vol. 68, No. 4, pp. 366–376.

McAllister, D. E.

*1960: List of the marine fishes of Canada; *Natl. Museum Can.*, Bull. 168.

McGerrigle, H. W.

1936: Lachute map-area. Part II — The lowland area; *Ann. Rept. Quebec Bur. Mines,* pt. C, pp. 41–91.

Möller, H. P. C.

1842: Index molluscorum groenlandiae; C. A. Reitzel.

Moore, R. C. (editor)

*1953–64: Treatise on invertebrate paleontology; pt. C, Protista (1964); pt. E, Archaeocyatha and Porifera (1955); pt. G, Bryozoa (1953); pt. I, Mollusca — chitons, scaphopods, gastropods (1960); pt. Q, Arthropoda — ostracods (1961); *Geol. Soc. Am.* and *Univ. Kansas Press.*

Morris, P. A.

*1957: A field guide to the shells of our Atlantic coast; Houghton Mifflin Co.

Murray, Alexander

1852: On the geology of the region between the Ottawa, the St. Lawrence, and the Rideau Rivers, with notes on economic minerals; *Geol. Surv. Can.*, Rept. Prog. 1851–52, pp. 57–91.

Nørvang, Aksel

1945: Foraminifera; *Zool. Iceland,* vol. 2, pt. 2.

Ockelmann, W. K.

1958: The zoology of east Greenland. Marine lamellibranchiata; *Medd. Groenland,* vol. 122, pt. 4.

Olson, E. A., and Broecker, W. S.

1959: Lamont natural radiocarbon measurements, V; *Am. J. Sci.*, vol. 257, pp 1–28.

1961: Lamont natural radiocarbon measurements, VII; *Radiocarbon,* vol. 3, pp. 141–157.

Osborne, F.F.
1951: Parc des Laurentides ice cap and the Quebec Sea; *Nat. Can.*, vol. 78, pp. 222–251.

Owen, E. B.
1951: Pleistocene and Recent deposits of the Cornwall–Cardinal area, Ontario; *Geol. Surv. Can.*, Paper 51-12.

Parker, F. L.
1952: Foraminifera species off Portsmouth, New Hampshire; *Bull. Museum Comp. Zool. Harvard*, vol. 106, No. 10.

Parker, W. K., and Jones, T. R.
1865: On some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin's Bay; *Phil. Trans. Roy. Soc.*, vol. 155, pp. 325–441, pls. 12–19.

Perkins, G. H.
*1908: Fossil Cetacea of the Pleistocene of the United States and Canada, with special reference to *Delphinapterus vermontanus* Thompson; *Rept. State Geologist, Vermont 1907–1908*, pp. 76–112, pls. 10–20.

Phleger, F. B.
1952: Foraminifera distribution in some sediment samples from the Canadian and Greenland Arctic; *Contrib. Cushman Found. Foraminiferal Res.*, vol. 3, pp. 80–89, pls. 13, 14.

Pilsbry, H. A.
1916: The sessile barnacles (Cirripedia) contained in the collections of the United States National Museum; *U.S. Natl. Museum*, Bull. 93.

Pitt, T. K.
1958: Distribution, spawning and racial studies of the Capelin, *Mallotus villosus* (Müller), in the offshore Newfoundland area; *J. Fisheries Res. Board Can.*, vol. 15, No. 3, pp. 275–293.

Preston, R. S., Person, Elaine, and Deevey, E. S.
1955: Yale natural radiocarbon measurements II; *Science*, vol. 122, No. 3177, pp. 954–960.

Retty, J. A.
1932–33: Reconnaissance along the Coulonge and Black Rivers, Pontiac county; *Rept. Minister Mines, Quebec*, pt. D, pp. 83–107.

Richards, H. G.
*1962: Studies on the marine Pleistocene; *Trans. Am. Phil. Soc.*, n.ser., vol. 52, pt. 3.

Richardson, James
1870: On the country bounded on the northwest by the St. Lawrence and on the southeast by the Quebec Province line, and extending from the Chaudière River to a point beyond Temiscouata Portage road; *Geol. Surv. Can.*, Rept. Prog. 1866–69, pp. 305–311.

Sars, G. O.
*1878: Mollusca regionis Arcticae Norvegiae; Christiania, Trykt Hos A. W. Brøgger.
*1928: An account of the Crustacea of Norway, vol. 9, Ostracoda; Bergen Museum.

Schenck, H. G.
1939: Revised nomenclature for some nuculid pelecypods; *J. Paleontol.*, vol. 13, pp. 21–41, pls. 5–8.

Selwyn, A. R. C.
1872: Summary report of the director; *Geol. Surv. Can.*, Rept. Prog. 1870–71.
1893: Summary report on the operations of the Geological Survey for the year 1890; *Geol. Surv. Can.*, Ann. Rept. (n.ser.), 1890–91, vol. 5, pt. A.

Smith, Burnett

1948: Two marine Quaternary localities; *Paleontographica Americana,* vol. 3, No. 22, pp. 1–16.

Smith, Maxwell

1937: East coast marine shells; Edwards Bros.

Stansfield, John

1912: Certain mica, graphite and apatite deposits of the Ottawa Valley, and an occurrence of *Eozoon canadense; Geol. Surv. Can.,* Summ. Rept. 1911, pp. 280–285.

1915: The Pleistocene and Recent deposits of the island of Montreal; *Geol. Surv. Can.,* Mem. 73.

Sternberg, C. M.

*1951: White whale and other Pleistocene fossils from the Ottawa Valley; *Natl. Museum Can.,* Bull. 123, pp. 259–261.

Stimpson, William

1865: Review of the northern *Buccinum,* and remarks on some other northern mollusks; *Can. Naturalist,* n.ser., vol. 2, pp. 364–389.

Swain, F. M.

*1963: Pleistocene Ostracoda from the Gubik Formation, Arctic coastal plain, Alaska; *J. Paleontol.,* vol. 37, No. 4, pp. 798–833, pls. 95–99, 13 text-figs.

Sylvester-Bradley, P. C.

1941: The shell structure of the Ostracoda and its application to their palaeontological investigation; *Ann. Mag. Nat. Hist.,* ser. 11, vol. 8, pp. 1–33.

Terasmae, Jaan

1959: Notes on the Champlain Sea episode in the St. Lawrence Lowlands; *Science,* vol. 130, pp. 334–335.

1960a: Contributions to Canadian palynology, No. 2, Part I — A palynological study of post-glacial deposits in the St. Lawrence Lowlands; *Geol. Surv. Can.,* Bull. 56.

1960b: Surficial geology of Cornwall map-area, Ontario and Quebec; *Geol. Surv. Can.,* Paper 60-28.

1965: Surficial geology of the Cornwall and St. Lawrence Seaway Project areas, Ontario; *Geol. Surv. Can.,* Bull. 121.

Thorson, Gunnar

1944: The zoology of East Greenland. Marine Gastropoda, Prosobranchiata; *Medd. Groenland,* vol. 121, No. 13, pp. 1–181, figs. 1–26.

Todd, Ruth, and Low, Doris

1961: Near-shore Foraminifera of Martha's Vineyard Island, Massachusetts; *Contrib. Cushman Found. Foraminiferal Res.,* vol. 12, pt. 1, pp. 5–21, pls. 1, 2.

Tolmachoff, I. P.

1927: Note on the discovery of the Champlain Sea fauna on Lake St. John, Quebec, Canada; *Can. Field-Naturalist,* vol. 41, pp. 123–125.

Wagner, C. W.

*1957: Sur les ostracodes du Quaternaire récent des Pays-Bas et leur utilisation dans l'étude géologique des dépôts holocènes; Mouton & Co.

Wagner, F. J. E.

1958: Unusual Pleistocene fossils from southeastern Ontario; *Trans. Roy. Soc. Can.,* ser. 3, vol. 51, sec. 4, 1957, pp. 5–11.

1967: Published references to Pleistocene Champlain Sea faunas 1837–1966 and list of fossils; *Geol. Surv. Can.,* Paper 67-16.

Whiteaves, J. F.

1869: On the marine Mollusca of eastern Canada; *Can. Naturalist,* n.ser., vol. 4, pp. 48–57.

1872: Notes on a deep-sea dredging expedition round the island of Anticosti in the Gulf of St. Lawrence; *Ann. Mag. Nat. Hist.,* ser. 4, vol. 10, pp. 341–354.

*1901: Catalogue of the marine invertebrates of eastern Canada; *Geol. Surv. Can.,* Publ. No. 772.

1907: Palaeontology and zoology; *Geol. Surv. Can.,* Summ. Rept. 1906, pp. 170–177.

Whittaker, E. J.

1922: Pleistocene and Recent fossils of the St. Lawrence Valley from Prescott to Beauharnois. *In* Report of structural material along the St. Lawrence River . . . ; *by* J. Keele and L. H. Cole; *Can. Dept. Mines,* Mines Br. Publ. 549, pp. 103–108.

Wilson, W. J.

1898: Notes on the Pleistocene geology of a few places in the Ottawa Valley; *Ottawa Naturalist,* vol. 11, No. 12, pp. 209–220.

Woodworth, J. B.

1905: Ancient water levels of the Champlain and Hudson Valleys; *N.Y. State Museum.* Bull. 84.

Zenkevitch, L.

1963: Biology of the seas of the U.S.S.R.; London, George Allen & Unwin Ltd.

# APPENDIX I

## Fossil Localities

# APPENDIX I

## Fossil Localities

The stratigraphy of the following localities is described in Appendix II. Elevations are approximate.

1. Approximately 2,000 feet southwest of Baie Cayien, lot 37, con. BA, Rolph tp., Renfrew co., Ontario (Chalk River map-sheet). Elev. 510 feet. GSC loc. 43962. Coll. N. R. Gadd, 1960.
2. Lot 18, con. I, Stafford tp., Renfrew co., Ontario (395694, Pembroke map-sheet)[1]. Elev. 475 feet. GSC loc. 60706. Coll. F. J. E. Wagner, 1955.
3. 1.25 miles east of Bromley Line and 2.5 miles northwest of La Passe, Renfrew co., Ontario (Fort Coulonge map-sheet). Elev. 475 feet. GSC loc. 60761. Coll. F. J. E. Wagner, 1955.
4. Lot 16, con. III, Bromley tp., Renfrew co., Ontario (Cobden map-sheet). Elev. 505 feet. Coll. F. J. E. Wagner, 1955.
5. West side of highway 17, just south of Cobden, lot 6, con. I, Ross tp., Renfrew co., Ontario (Cobden map-sheet). Elev. 450 feet. Coll. F. J. E. Wagner, 1955.
6. East side of highway 17, just south of Cobden, lot 8, con. II, Ross tp., Renfrew co., Ontario (Cobden map-sheet). Elev. 450 feet. Coll. F. J. E. Wagner, 1955.
7. Pit at Tancredia, Calumet Island, lot 6, con. III, Calumet tp., Quebec (Cobden map-sheet). Elev. 500 feet. GSC loc. 60779. Coll. F. J. E. Wagner, 1955.
8. Lot 17, con. I, Horton tp., Renfrew co., Ontario (Renfrew map-sheet). Elev. 500 feet. Coll. E. de Vroome, 1964.
9. Left bank of Quyon River, 2.25 miles northwest of Quyon, lot 7, con. IV, Onslow tp. (partie sud), Pontiac co., Quebec (Quyon map-sheet). Elev. 275 feet. GSC loc. 60760. Coll. F. J. E. Wagner, 1955.
10. Lot 17, con. A. McNab tp., Renfrew co., Ontario (Arnprior map-sheet). Elev. 475 feet. GSC loc. 27334. Coll. F. J. E. Wagner, 1954.
11. Lot 16, con. A. McNab tp., Renfrew co., Ontario (Arnprior map-sheet). Elev. 425 feet. GSC loc. 27335. Coll. F. J. E. Wagner, 1954.
12. Mohr Corners, lot 19, con. VI, Fitzroy tp., Carleton co., Ontario (Arnprior map-sheet). Elev. 350 feet. GSC loc. 27332. Coll. F. J. E. Wagner, 1954.
13. Lot 22, con. I, Torbolton tp., Carleton co., Ontario (Arnprior map-sheet). Elev. 425 feet. Coll. F. J. E. Wagner, 1954.
14. Lot 22, con. VIII, Pakenham tp., Lanark co., Ontario (Arnprior map-sheet). Elev. 460 feet. Coll. F. J. E. Wagner, 1954.
15. Lot 12, con. I, Fitzroy tp., Carleton co., Ontario (Arnprior map-sheet). Elev. 315 feet. GSC loc. 27328. Coll. F. J. E. Wagner, 1954.
16. Sand pit 0.75 mile northwest of crossroads in Carp, lot 20, con. III, Huntley tp., Carleton co., Ontario (Arnprior map-sheet). Elev. 375 feet. Coll. V. K. Prest, 1957.

[1]Where the map-sheet used is provided with the Universal Transverse Mercator Grid, the grid reference is given.

17. Lot 6, con. VII, Ramsay tp., Lanark co., Ontario (077019, Carleton Place map-sheet). Elev. 440 feet. GSC loc. 27337. Coll. F. J. E. Wagner, 1954.
18. Lot 30, con. II, Villeneuve tp., Papineau co., Quebec (Low map-sheet). Elev. 618 feet. Coll. F. J. E. Wagner, 1955.
19. Cut along highway just south of Wakefield, lot 1, con. II, Masham tp., Gatineau co., Quebec (Wakefield map-sheet). Elev. 360 feet. GSC loc. 60762. Coll. F. J. E. Wagner, 1955.
20. Pit on south side of Mountain Road, 1.8 miles due south of Kingsmere, Quebec (343347, Ottawa map-sheet). Elev. 415 feet. GSC loc. 60703. Coll. F. J. E. Wagner, 1955.
21. Department of Public Works hole 85, bounded by Bronson Avenue, Riverside Drive, and C.P.R. tracks, Ottawa, Ontario (461251, Ottawa map-sheet). Elev. 245 feet (at surface). Coll. Dept. of Public Works, 1957.
22. Sand pit near Uplands Airport, Ottawa, Ontario (454203, Ottawa map-sheet). Elev. 275 feet. GSC loc. 27320. Coll. F. J. E. Wagner, 1953.
23. Along Ottawa River at Hiawatha Park, Ontario (571365, Ottawa map-sheet). Elev. 140 feet. Coll. F. J. E. Wagner, 1954.
24. Lot 22, con. VII, Goulburn tp., Carleton co., Ontario (Kemptville map-sheet). Elev. 350 feet. Coll. F. J. E. Wagner, 1954.
25. Lot 13, con. IV, Nepean tp., Carleton co., Ontario (Kemptville map-sheet). Elev. 375 feet. GSC loc. 27338. Coll. F. J. E. Wagner, 1954.
26. Lot 12, con. V, Nepean tp., Carleton co., Ontario (Kemptville map-sheet). Elev. 370 feet. Coll. F. J. E. Wagner, 1954.
27. Campbell Quarry, south of Manotick, lot 8, con. A, North Gower tp., Carleton co., Ontario (Kemptville map-sheet). Elev. 300 feet. GSC loc. 60709. Coll. A. S. MacLaren, 1958.
28. Lot 9, con. I, Osgoode tp., Carleton, co., Ontario (Kemptville map-sheet). Elev. 310 feet. Coll. E. P. Henderson, 1964.
29. Lot 23, con. III, Osgoode tp., Carleton co., Ontario (Kemptville map-sheet). Elev. 310 feet. GSC loc. 27333. Coll. F. J. E. Wagner, 1954.
30. 0.25 mile northwest of railway crossing at Sabourin Station, lot 5, con. IX, South Gower tp., Grenville co., Ontario (Kemptville map-sheet). Elev. 290 feet. GSC loc. 27327. Coll. F. J. E. Wagner, 1954.
31. Lot 7, con. VIII, South Gower tp., Grenville co., Ontario (Kemptville map-sheet). Elev. 305 feet. GSC loc. 27336. Coll. F. J. E. Wagner, 1954.
32. 1.25 miles northwest of Hallville, lot 6, con. X, Mountain tp., Dundas co., Ontario (Kemptville map-sheet). Elev. 275 feet. GSC loc. 27330. Coll. F. J. E. Wagner, 1954.
33. Hoey Road, south of Kemptville, lot 24, con. III, Oxford tp., Grenville co., Ontario (Kemptville map-sheet). Elev. 320 feet. Coll. F. J. E. Wagner, 1954.
34. Lot 22, con. III, Oxford tp., Grenville co., Ontario (Kemptville map-sheet). Elev. 325 feet. Coll. F. J. E. Wagner, 1954.
35. Lot 19, con. IV, Cumberland tp., Russell co., Ontario (739265, Russell map-sheet). Elev. 225 feet. GSC loc. 27329. Coll. F. J. E. Wagner, 1954.
36. Lot 21, con. III, Russell tp., Russell co., Ontario (703171, Russell map-sheet). Elev. 285 feet. GSC loc. 60705. Coll. F. J. E. Wagner, 1954.
37. 1.5 miles east of Russell, lot 8, con. IV, Russell tp., Russell co., Ontario (746113, Russell map-sheet). Elev. 230 feet. GSC loc. 60751. Coll. G. W. Brownell, 1957.
38. 2.5 miles southeast of Glenpayne, lot 37, con. VI, Roxborough tp., Stormont co., Ontario (974055, Winchester map-sheet). Elev. 344 feet. GSC loc. 27339. Coll. F. J. E. Wagner, 1953.

39. Pit on south side of highway 43, 3 miles east of Winchester, lot 11, con. IV, Winchester tp., Dundas co., Ontario (771926, Winchester map-sheet). Elev. 275 feet. Coll. G. W. Brownell, 1956.
40. 2.6 miles due east of Dunbar, lot 9, con. VII, Williamsburg tp., Dundas co., Ontario (862878, Winchester map-sheet). Elev. 300–310 feet. GSC loc. 60805. Coll. F. J. E. Wagner, 1956.
41. Lot 31, con. VI, Osnabruck tp., Dundas co., Ontario (922891, Winchester map-sheet). Elev. 310 feet. Coll. F. J. E. Wagner, 1950.
42. 2.5 miles southwest of Newington, lot 17, con. VII, Osnabruck tp., Dundas co., Ontario (966925, Winchester map-sheet). Elev. 320 feet. GSC loc. 60700. Coll. F. J. E. Wagner, 1956.
43. Pit 2 miles northeast of Gallingertown, lot 26, con. IV, Osnabruck tp., Dundas co., Ontario (962863, Winchester map-sheet). Elev. 310–315 feet. GSC loc. 60801. Coll. F. J. E. Wagner, 1950 and 1956.
44. Pit 1 mile northwest of Osnabruck Centre, lot 21, con. IV, Osnabruck tp., Dundas co., Ontario (980867, Winchester map-sheet). Elev. 310 feet. GSC loc. 60717. Coll. F. J. E. Wagner, 1956.
45. 2 miles west of Cardinal, Ontario, at the intersection of the concession road and the C.N.R. tracks (669591, Morrisburg map-sheet). Elev. 235 feet. GSC loc. 24814. Coll. G. W. Brownell, 1954.
46. Cardinal, Ontario, approximately 400 feet north of highway 2 and 1,000 feet east of Canal Bridge (698596, Morrisburg map-sheet). Elev. 275 feet. GSC loc. 26625. Coll. G. W. Brownell, 1955.
47. Morrisburg, Ontario (849712, Morrisburg map-sheet). Elev. 255 feet. GSC loc. 60727. Coll. G. W. Brownell, 1955.
48. Hoasic Creek, 10,000 feet northeast of the intersection of highway 31 and the C.N.R. tracks (867745, Morrisburg map-sheet). Elev. 250 feet. GSC loc. 24810. Coll. G. W. Brownell, 1954.
49. Lot 34, con. III, Williamsburg tp., Dundas co., Ontario (810767, Morrisburg map-sheet). Elev. 295 feet. Coll. F. J. E. Wagner, 1950.
50. Bank of St. Lawrence River, just east of creek 7 miles east of Morrisburg, Ontario (952762, Morrisburg map-sheet). Elev. 225 feet. GSC loc. 60719. Coll. F. J. E. Wagner, 1955.
51. Secours' gravel pit, 1.5 miles southwest of Vankleek Hill, lot 14, con. VI, W. Hawkesbury tp., Prescott co., Ontario (238370, Alexandria map-sheet). Elev. 335 feet. GSC locs. 27322, 27323, and 27340. Coll. F. J. E. Wagner, 1953.
52. 1 mile west of highway 34 on first crossroad south of Vankleek Hill, lot 14, con. VI, W. Hawkesbury tp., Prescott co., Ontario (Hawkesbury map-sheet). Elev. 350 feet. Coll. F. J. E. Wagner, 1953.
53. Lot 7, con. VI, W. Hawkesbury tp., Prescott co., Ontario (Hawkesbury map-sheet). Elev. 305 feet. GSC loc. 60763. Coll. F. J. E. Wagner, 1955.
54. Pit 1.3 miles east of Hawkesbury, Ontario (Hawkesbury map-sheet). Elev. 180 feet. GSC loc. 27348. Coll. V. K. Prest, 1952; F. J. E. Wagner, 1953.
55. Lot 26, con. VI, Lochiel tp., Glengarry co., Ontario (281273, Alexandria map-sheet). Elev. 290 feet. Coll. F. J. E. Wagner, 1953.
56. Lot 5, con. V, Lochiel tp., Glengarry co., Ontario (356398, Alexandria map-sheet). Elev. 275 feet. Coll. F. J. E. Wagner, 1953.
57. Lot 3, con. VIII, Roxborough tp., Stormont co., Ontario (073156, Alexandria map-sheet). Elev. 300 feet. Coll. F. J. E. Wagner, 1953.

58. Maxville, lot 41, con. VI, Kenyon tp., Glengarry co., Ontario (118145, Alexandria map-sheet). Elev. 382 feet. Coll. F. J. E. Wagner, 1953.
59. Lot 34, con. VI, Kenyon tp., Glengarry co., Ontario (144160, Alexandria map-sheet). Elev. 380 feet. Coll. F. J. E. Wagner, 1953.
60. 0.3 mile southwest of school northwest of Loch Garry, lot 28, con. II, Kenyon tp., Glengarry co., Ontario (197110, Alexandria map-sheet). Elev. 310 feet. GSC locs. 60730, 60806. Coll. F. J. E. Wagner, 1955.
61. Lot 27, con. II, Kenyon tp., Glengarry co., Ontario (205107, Alexandria map-sheet). Elev. 325 feet. Coll. F. J. E. Wagner, 1953.
62. Northeast corner of intersection at Fairview, lot 12, con. VI, Kenyon tp., Glengarry co., Ontario (214199, Alexandria map-sheet). Elev. 311 feet. Coll. F. J. E. Wagner, 1953.
63. Lot 37, con. IV, Lochiel tp., Glengarry co., Ontario (258225, Alexandria map-sheet). Elev. 320 feet. Coll. F. J. E. Wagner, 1953.
64. Lot 6, con. I, Kenyon tp., Glengarry co., Ontario (286126, Alexandria map-sheet). Elev. 310–320 feet. Coll. F. J. E. Wagner, 1953.
65. 2.5 miles south-southwest of Alexandria, lot 6, con. I, Kenyon tp., Glengarry co., Ontario (286125, Alexandria map-sheet). Elev. 297 feet. GSC loc. 27324. Coll. F. J. E. Wagner, 1953.
66. Lot 4, con. I, Kenyon tp., Glengarry co., Ontario (294133, Alexandria map-sheet). Elev. 325 feet. Coll. F. J. E. Wagner, 1953.
67. 2.5 miles southeast of Alexandria and 0.3 mile northeast of highway 34, lot 37, con. VIII, Lancaster tp., Glengarry co., Ontario (314132, Alexandria map-sheet). Elev. 295–304 feet. GSC loc. 27318. Coll. F. J. E. Wagner, 1953.
68. Lot 21, con. IX, Lancaster tp., Glengarry co., Ontario (368165, Alexandria map-sheet). Elev. 240 feet. Coll. F. J. E. Wagner, 1953.
69. Lot 16, con. I, Lochiel tp., Glengarry co., Ontario (373192, Alexandria map-sheet). Elev. 255 feet. Coll. F. J. E. Wagner, 1953.
70. Lot 25, con. VI, Roxborough tp., Stormont co., Ontario (013089, Cornwall map-sheet). Elev. 310–315 feet. Coll. F. J. E. Wagner, 1953.
71. Lot 18, con. VI, Roxborough tp., Stormont co., Ontario (042087, Cornwall map-sheet). Elev. 325 feet. Coll. F. J. E. Wagner, 1953.
72. Lot 12, con. V, Roxborough tp., Stormont co., Ontario (068085, Cornwall map-sheet). Elev. 350 feet. Coll. F. J. E. Wagner, 1953.
73. Lot 6, con. IV, Roxborough tp., Stormont co., Ontario (094088, Cornwall map-sheet). Elev. 325–350 feet. Coll. F. J. E. Wagner, 1953.
74. Pit 1.75 miles northwest of Gravel Hill, lot 7, con. IV, Roxborough tp., Stormont co., Ontario (094087, Cornwall map-sheet). Elev. 325–350 feet. Coll. F. J. E. Wagner, 1955.
75. Just south of highway 43, 0.9 mile southwest of intersection at Monkland Station, lot 16, con. II, Roxborough tp., Stormont co., Ontario (082034, Cornwall map-sheet). Elev. 345 feet. GSC loc. 27331. Coll. F. J. E. Wagner, 1953.
76. Road-cut northeast of McMillan Corners, lot 9, con. I, Roxborough tp., Stormont co., Ontario (125014, Cornwall map-sheet). Elev. 322 feet. GSC loc. 60808. Coll. F. J. E. Wagner, 1953.
77. Apple Hill, lot 37, con. I, Kenyon tp., Glengarry co., Ontario (174069, Cornwall map-sheet). Elev. 295 feet. GSC loc. 60714. Coll. F. J. E. Wagner, 1955.
78. Lot 31, con. I, Roxborough tp., Stormont co., Ontario (051973, Cornwall map-sheet). Elev. 320 feet. GSC loc. 60820. Coll. G. W. Brownell, 1956.
79. Lot 25, con. IX, Cornwall tp., Stormont co., Ontario (074975, Cornwall map-sheet). Elev. 350 feet. Coll. F. J. E. Wagner, 1950.

80. Lot 16, con. IX, Cornwall tp., Stormont co., Ontario (107984, Cornwall map-sheet). Elev. 310 feet. Coll. F. J. E. Wagner, 1950.
81. Lot 12, con. VIII, Cornwall tp., Stormont co., Ontario (131987, Cornwall map-sheet). Elev. 310 feet. Coll. F. J. E. Wagner, 1950.
82. Lot 22, con. VIII, Cornwall tp., Stormont co., Ontario (095956, Cornwall map-sheet). Elev. 310 feet. Coll. F. J. E. Wagner, 1950.
83. Pit about 0.5 mile northwest of Harrisons Corners, lot 30, con. VI, Cornwall tp., Stormont co., Ontario (077933, Cornwall map-sheet). Elev. 305 feet. GSC loc. 60753. Coll. F. J. E. Wagner, 1955.
84. Road between St. Andrews West and Bonville, lot 12, con. VI, Cornwall tp., Stormont co., Ontario (151948, Cornwall map-sheet). Elev. 275 feet. Coll. F. J. E. Wagner, 1950.
85. Lot 25, con. V, Cornwall tp., Stormont co., Ontario (113903, Cornwall map-sheet). Elev. 240 feet. Coll. F. J. E. Wagner, 1950.
86. 3 miles north of Mille Roches, lot 25, con. V, Cornwall tp., Stormont co., Ontario (115903, Cornwall map-sheet). Elev. 272 feet. GSC loc. 60704. Coll. F. J. E. Wagner, 1955.
87. 3 miles northwest of Moulinette, lot 34, con. VI, Cornwall tp., Stormont co., Ontario (082893, Cornwall map-sheet). Elev. 300 feet. GSC loc. 60715. Coll. F. J. E. Wagner, 1955.
88. Lot 34, con. VI, Cornwall tp., Stormont co., Ontario (079863, Cornwall map-sheet). Elev. 300 feet. Coll. F. J. E. Wagner, 1950.
89. Pit 1.5 miles southwest of Lunenburg, lot 13, con. III, Osnabruck tp., Stormont co., Ontario (019867, Cornwall map-sheet). Elev. 275 feet. GSC loc. 60802. Coll. F. J. E. Wagner, 1956.
90. C.N.R. relocation, chainage 559+00, lot 2, con. II, Osnabruck tp., Stormont co., Ontario (068871, Cornwall map-sheet). Elev. about 265 feet. GSC loc. 25744. Coll. G. W. Brownell, 1955.
91. C.N.R. relocation, chainage 542+00, lot 38, con. V, Cornwall tp., Stormont co., Ontario (073874, Cornwall map-sheet). Elev. 260 feet. GSC loc. 60720. Coll. F. J. E. Wagner, 1955.
92. C.N.R. relocation, chainage 443+15, lot 31, con. V, Cornwall tp., Stormont co., Ontario (105875, Cornwall map-sheet). Elev. 222 feet. GSC loc. 60819. Coll. G. W. Brownell, 1956.
93. 2.25 miles northwest of Moulinette, lot 30, con. V, Cornwall tp., Stormont co., Ontario (101888, Cornwall map-sheet). Elev. about 265 feet. GSC loc. 60807. Coll. F. J. E. Wagner, 1955.
94. C.N.R. relocation, chainage 410+00, offset 35′ left, lot 29, con. IV, Cornwall tp., Stormont co., Ontario (114874, Cornwall map-sheet). Elev. 207 feet. GSC locs. 60783, 60822. Coll. G. W. Brownell, 1956.
95. C.N.R. relocation, chainage 1066+100, lot 21?, con. II, Osnabruck tp., Stormont co., Ontario (Cornwall map-sheet). Elev. 270 feet. GSC loc. 60713. Coll. F. J. E. Wagner, 1955.
96. Lot 1, con. II, Osnabruck tp., Stormont co., Ontario (Cornwall map-sheet). Elev. 255 feet. GSC loc. 24811. Coll. G. W. Brownell. 1954.
97. Southeastern point of Sheek Island, Ontario (114834, Cornwall map-sheet). Elev. 190 feet. Coll. F. J. E. Wagner, 1950.
98. Sheek Island, opposite Moulinette, Ontario (118852, Cornwall map-sheet). Elev. 190 feet. Coll. F. J. E. Wagner, 1950.
99. Eastern part of Sheek Island, Ontario (128848, Cornwall map-sheet). Elev. 230 feet. Coll. F. J. E. Wagner, 1955.

100. Extreme eastern point of Sheek Island, Ontario (133845, Cornwall map-sheet). Elev. 190 feet. Coll. F. J. E. Wagner, 1950.

101. Lot 22, con. III, Cornwall tp., Stormont co., Ontario (149865, Cornwall map-sheet). Elev. 210 feet. GSC loc. 60817. Coll. G. W. Brownell, 1953.

102. Maple Grove, lot 24, con. II, Cornwall tp., Stormont co., Ontario (147852, Cornwall map-sheet). Elev. 230–235 feet. GSC loc. 60811. Coll. F. J. E. Wagner, 1955.

103. Maple Grove, lot 22, con. II, Cornwall tp., Stormont co., Ontario (155848, Cornwall map-sheet). Elev. 170 feet. GSC loc. 60803. Coll. F. J. E. Wagner, 1955.

104. Maple Grove, lot 23, con. II, Cornwall tp., Stormont co., Ontario (157850, Cornwall map-sheet). Elev. 198 feet. GSC loc. 26627. Coll. G. W. Brownell, 1955.

105. Maple Grove, lot 22, con. II, Cornwall tp., Stormont co., Ontario (159845, Cornwall map-sheet). Elev. 205 feet. Coll. F. J. E. Wagner, 1956.

106. Cornwall dyke, vicinity of the Hydro-Electric Power Commission of Ontario office, Cornwall, Ontario (Cornwall map-sheet). Elev. about 210 feet. GSC loc. 60821. Coll. G. W. Brownell, 1956.

107. Lot 22, con. I, Cornwall tp., Stormont co., Ontario (165837, Cornwall map-sheet). Elev. 165 feet. GSC locs. 24065, 24066, 24067, 24068, 24069, and 24070. Coll. G. W. Brownell, 1953.

108. Lot 20, con. I, Cornwall tp., Stormont co., Ontario (167847, Cornwall map-sheet). Elev. 185 feet. GSC loc. 24812. Coll. G. W. Brownell, 1954.

109. Lot 20, con. I, Cornwall tp., Stormont co., Ontario (176843, Cornwall map-sheet). Elev. 205 feet. GSC loc. 26626. Coll. G. W. Brownell, 1955.

110. 1,000 feet east of New York Central Railway crossing on Toll Gate Road, Cornwall, lot 15, con. III, Cornwall tp., Stormont co., Ontario (184869, Cornwall map-sheet). Elev. 197 feet. GSC loc. 26628. Coll. G. W. Brownell, 1955.

111. Lot 17, con. I, Kenyon tp., Glengarry co., Ontario (256096, Cornwall map-sheet). Elev. 300 feet. Coll. F. J. E. Wagner, 1953.

112. Lot 11, con. VII, Charlottenburg tp., Glengarry co., Ontario (274036, Cornwall map-sheet). Elev. 275 feet. Coll. F. J. E. Wagner, 1953.

113. Eastern edge of Farrans Point, Ontario (Massena map-sheet). Elev. 240 feet. GSC loc. 60716. Coll. F. J. E. Wagner, 1955.

114. Pit at Sand Bay, at mouth of Hoople Creek, west of Moulinette, Ontario (Massena map-sheet). Elev. 200 feet, GSC loc. 60712. Coll. F. J. E. Wagner, 1955.

115. Pit near Hill Head, Quebec (565593, Lachute map-sheet). Elev. 445 feet. GSC loc. 60726. Coll. F. J. E. Wagner, 1955.

116. 2 miles southwest of Côte Rouge, Quebec (668421, Lachute map-sheet). Elev. at surface 180 feet. Coll. Twin Mountain Uranium Company, 1955.

117. Pit about 2 miles northwest of St. Joseph-du-Lac, Quebec (751443, Lachute map-sheet). Elev. 300 feet. GSC loc. 60756. Coll. F. J. E. Wagner, 1956.

118. 1 mile east-northeast of Glen Robertson, lot 4, con. I, Lochiel tp., Glengarry co., Ontario (408234, Vaudreuil map-sheet). Elev. 260 feet. GSC loc. 27319. Coll. F. J. E. Wagner, 1953.

119. About 2 miles southeast of Glen Robertson, lot 3, con. I, Lochiel tp., Glengarry co., Ontario (422224, Vaudreuil map-sheet). Elev. 275 feet. GSC loc. 27321. Coll. F. J. E. Wagner, 1953.

120. Pit west of Rivière Baudet and south of highway 2 (533065, Huntingdon map-sheet). Elev. 175 feet. GSC loc. 27317. Coll. F. J. E. Wagner, 1953.

121. Pit west of Rivière Baudet and south of highway 2 (533063, Huntingdon map-sheet). Elev. 165 feet. GSC loc. 27316. Coll. F. J. E. Wagner, 1953.

122. St. Agnes-de-Dundee, Quebec (464845, Huntingdon map-sheet). Elev. 200 feet. GSC loc. 60725. Coll. F. J. E. Wagner, 1955.

123. 1.4 miles south-southeast of Cazaville, Quebec (507906, Huntingdon map-sheet). Elev. 211 feet. GSC loc. 60780. Coll. F. J. E. Wagner, 1955.

124. 0.5 mile northeast of Beaver Crossing, Quebec (508853, Huntingdon map-sheet). Elev. 221 feet. GSC loc. 60721. Coll. F. J. E. Wagner, 1955.

125. 1 mile southwest of O'Neil, Quebec (561924, Huntingdon map-sheet). Elev. 222 feet. Coll. F. J. E. Wagner, 1955.

126. About 1 mile northeast of Ste. Julienne, Quebec (014911, Laurentides map-sheet). Elev. 293 feet. GSC loc. 60791. Coll. F. J. E. Wagner, 1956.

127. Road between Mascouche and Mascouche Rapids, Quebec (073676, Laurentides map-sheet). Elev. 130 feet. Coll. F. J. E. Wagner, 1956.

128. Pit 1.75 miles due west of highway 11 at Ste. Thérèse-de-Blainville, Quebec (Laval map-sheet). Elev. 194 feet. GSC loc. 60792. Coll. F. J. E. Wagner, 1956.

129. Pit just off Mascouche Road, 3 miles east-southeast of Le Page Station, Quebec (Laval map-sheet). Elev. 176 feet. Coll. F. J. E. Wagner, 1956.

130. Road between Terrebonne and Terrebonne Heights, 1.5 miles northwest of Terrebonne, Quebec (Laval map-sheet). Elev. 151 feet. GSC loc. 60772. Coll. F. J. E. Wagner, 1965.

131. East side of Bloomfield, 390 feet north of Blair, Montreal, Quebec (Laval map-sheet). Elev. 166 feet. GSC loc. 27350. Coll. V. K. Prest, 1952.

132. Corner of Wiseman and Jean Talon Streets, Montreal, Quebec (Laval map-sheet). Elev. 187 feet. GSC loc. 27345. Coll. V. K. Prest, 1952.

133. Corner of Clyde and Dundee Streets, Montreal, Quebec (Laval map-sheet). Elev. 205 feet. GSC loc. 27362. Coll. V. K. Prest, 1952.

134. North side of Côte Ste. Catherine Road, opposite Brébeuf College, Montreal, Quebec (Laval map-sheet). Elev. 310 feet. GSC loc. 27346. Coll. V. K. Prest, 1952.

135. Notre Dame des Neiges Cemetery, Montreal, Quebec (Laval map-sheet). Elev. 545 feet. GSC loc. 27325. Coll. F. J. E. Wagner, 1953.

136. Côte Ste. Catherine Road and St. Joseph Blvd., Montreal, Quebec (Laval map-sheet). Elev. 300 feet. GSC loc. 27360. Coll. V. K. Prest, 1952.

137. First Avenue, between Allan and Lacoste, Montreal, Quebec (Laval map-sheet). Elev. 165 feet. GSC loc. 27342. Coll. V. K. Prest, 1951.

138. Des Écores and St. Foye, Montreal, Quebec (Laval map-sheet). Elev. 172 feet. GSC loc. 27341. Coll. V. K. Prest, 1951.

139. House No. 5, 23rd Avenue north of Ruskin, Montreal, Quebec (Laval map-sheet). Elev. about 170 feet. Coll. V. K. Prest, 1952.

140. Corner of Masson and D'Iberville Streets, Montreal, Quebec (Laval map-sheet). Elev. 173 feet. GSC loc. 27343. Coll. V. K. Prest, 1952.

141. Sherbrooke and Mansfield Streets, southwest corner of McGill University grounds, Montreal, Quebec (Laval map-sheet). Elev. 143 feet. GSC loc. 27364. Coll. V. K. Prest, 1952.

142. Southeast corner of Sherbrooke and Cuvillier Streets, Montreal, Quebec (Laval map-sheet). Elev. 143 feet. Coll. V. K. Prest, 1952.

143. Beaugrand, 100 feet south of Souligny, Montreal, Quebec (Laval map-sheet). Elev. 55 feet. GSC loc. 27352. Coll. V. K. Prest, 1952.

144. Clay pit at Point Claire, Quebec (Lachine map-sheet). Elev. 140 feet. GSC loc. 27357. Coll. V. K. Prest, 1952.

145. Westbury, near Mackenzie, Montreal, Quebec (Lachine map-sheet). Elev. 171 feet. GSC loc. 27363. Coll. V. K. Prest, 1952.

146. Corner of Carlton and Westbury, Montreal, Quebec (Lachine map-sheet). Elev. 180 feet. GSC loc. 27359. Coll. V. K. Prest, 1952.

147. Victoria, between Plamondon and Barclay, Montreal, Quebec (Lachine map-sheet). Elev. 187 feet. GSC loc. 27351. Coll. V. K. Prest, 1952.

148. Corner of Lavoie and Kent Streets, Montreal, Quebec (Lachine map-sheet). Elev. 235 feet. GSC loc. 27349. Coll. V. K. Prest, 1952.

149. Dupuis Avenue, east of Lavoie, Montreal, Quebec (Lachine map-sheet). Elev. 250 feet. GSC loc. 27355. Coll. V. K. Prest, 1952.

150. Corner of Bourret and Lemieux Streets, Montreal, Quebec (Lachine map-sheet). Elev. 200 feet. GSC loc. 27358. Coll. V. K. Prest, 1952.

151. Southwest corner of Isabella and Décarie Streets, Montreal, Quebec (Lachine map-sheet). Elev. 205 feet. GSC loc. 27347. Coll. V. K. Prest, 1952.

152. Corner of Somerled and Bessborough Streets, Montreal, Quebec (Lachine map-sheet). Elev. 190 feet. Coll. V. K. Prest, 1952.

153. Wilson Ave., 100 feet north of Notre Dame de Grace, Montreal, Quebec (Lachine map-sheet). Elev. 232 feet. GSC loc. 27344. Coll. V. K. Prest, 1952.

154. South side of Sherbrooke Street, between Benny Lane and Cavendish, Montreal, Quebec (Lachine map-sheet). Elev. 163 feet. GSC loc. 27354. Coll. V. K. Prest, 1952.

155. East side of West Hill, about 300 feet south of Sherbrooke, Montreal, Quebec (Lachine map-sheet). Elev. 192 feet. GSC loc. 27353. Coll. V. K. Prest, 1952.

156. Upper Lachine Road, 200 feet east of Grand Blvd., Montreal, Quebec (Lachine map-sheet). Elev. 173 feet. GSC loc. 27361. Coll. V. K. Prest, 1952.

157. Pit 1.4 miles southeast of St. Philomène, Quebec (Lachine map-sheet). Elev. 215 feet. GSC loc. 27313. Coll. F. J. E. Wagner, 1953.

158. Southern part of pit 1.4 miles southeast of St. Philomène, Quebec (Lachine map-sheet). Elev. 215 feet. GSC loc. 27314. Coll. F. J. E. Wagner, 1953.

159. Second pit from southern end of St. Philomène Ridge, Quebec (Lachine map-sheet). Elev. 165–170 feet. GSC locs. 27312, 27326. Coll. V. K. Prest, 1952; F. J. E. Wagner, 1953.

160. Southernmost pit, St. Philomène Ridge, Quebec (Lachine map-sheet). Elev. 175–200 feet. GSC loc. 60708. Coll. F. J. E. Wagner, 1953; E. P. Henderson, 1963.

161. Ditch on north side of highway 36, 0.4 mile east of railway crossing in St. Remi, Quebec (Lachine map-sheet). Elev. 208 feet. GSC loc. 60723. Coll. F. J. E. Wagner, 1955.

162. Northwest slope of Mont St. Hilaire, Quebec (Beloeil map-sheet). Elev. 270 feet. Coll. F. J. E. Wagner, 1956.

163. Pit on southeast slope of Mont St. Hilaire, Quebec (Beloeil map-sheet). Elev. 219 feet. GSC loc. 60702. Coll. F. J. E. Wagner, 1956.

164. Ditch on east side of St. André Road, 1.7 miles west-southwest of St. Jacques-le-Mineur, Quebec (215137, St. Jean map-sheet). Elev. 143 feet. GSC loc. 60789. Coll. F. J. E. Wagner, 1956.

165. 0.5 mile south of Menardville, Quebec (518154, St. Jean map-sheet). Elev. 160 feet. GSC loc. 60790. Coll. F. J. E. Wagner, 1956.

166. Southeast slope of Mount Johnson, 1.2 miles northeast of Mont St. Gregoire, Quebec (454234, St. Jean map-sheet). Elev. 195–242 feet. GSC loc. 60757. Coll. F. J. E. Wagner, 1956.

167. Ditch, 0.3 mile south of highway 40, due east of southern end of Mount Johnson, Quebec (484230, St. Jean map-sheet). Elev. 163 feet. GSC loc. 60746. Coll. F. J. E. Wagner, 1956.

168. 1 mile west-northwest of railway crossing at Girard, Quebec (Lacolle map-sheet). Elev. 174 feet. Coll. F. J. E. Wagner, 1956.

169. Bridge 2.2 miles north of St. Valentin, Quebec (Lacolle map-sheet). Elev. 166 feet. GSC loc. 60765. Coll. F. J. E. Wagner, 1956.

170. 1.4 miles north of International Boundary and 3.5 miles west of Richelieu River, Quebec (Lacolle map-sheet). Elev. 277 feet. Coll. F. J. E. Wagner, 1956.

171. 2.6 miles north of International Boundary and 2.5 miles west of Richelieu River, Quebec (Lacolle map-sheet). Elev. 209 feet. GSC loc. 60758. Coll. F. J. E. Wagner, 1956.

172. Bridge over Rivière au Lard, 1.5 miles southwest of St. Narcisse Station, Quebec (Shawinigan map-sheet). Elev. 350 feet. GSC loc. 60769. Coll. F. J. E. Wagner, 1956.

173. Highway bridge over Rivière la Fourche, 2.5 miles northwest of St. Narcisse, Quebec (Shawinigan map-sheet). Elev. 345 feet. GSC loc. 60749. Coll. F. J. E. Wagner, 1956.

174. Rivière au Lard, about 1 mile southwest of St. Narcisse Station, Quebec (Shawinigan map-sheet). Elev. 340 feet. GSC locs. 60707, 60781. Coll. P. F. Karrow, 1956.

175. 2.5 miles due south of St. Boniface-de-Shawinigan, Quebec, on north side of Rivière Yamachiche (Trois-Rivières map-sheet). Elev. 290 feet. GSC loc. 60735. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1955.

176. Bank beside railway along St. Maurice River, just south of Les Grès Station, Quebec (Trois-Rivières map-sheet). Elev. 200 feet. GSC loc. 60793. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1956.

177. Slide scar 1 mile northeast of St. Maurice, Quebec (Trois-Rivières map-sheet). Elev. 100 feet. GSC loc. 60740. Coll. F. J. E. Wagner, 1956.

178. West bank of St. Francis River at mouth of Rivière aux Vaches, Quebec (Yamaska map-sheet). Elev. 175 feet. GSC loc. 60764. Coll. F. J. E. Wagner, 1956.

179. West bank of Rivière St. Zéphirin, 1.5 miles north of St. Zéphirin, Quebec (Yamaska map-sheet). Elev. 138 feet. GSC loc. 60786. Coll. F. J. E. Wagner, 1956.

180. Creek bank 0.8 mile southeast of St. Edmond-de-Grantham, Quebec (Upton map-sheet). Elev. 215 feet. GSC loc. 60711. Coll. F. J. E. Wagner, 1956.

181. Pit near Chibouet River, 3 miles southwest of St. Eugene-de-Grantham, Quebec (Upton map-sheet). Elev. 210 feet. Coll. F. J. E. Wagner, 1956.

182. 2.1 miles southeast of railway crossing at Duncan Station, Quebec (Upton map-sheet). Elev. 350 feet. GSC loc. 60766. Coll. F. J. E. Wagner, 1956.

183. Just north of highway 9, 1.5 miles west of St. Germain-de-Grantham, Quebec (Upton map-sheet). Elev. 290 feet. GSC loc. 60785. Coll. F. J. E. Wagner, 1956.

184. 1.25 miles northwest of St. Liboire, Quebec (732594, St. Hyacinthe map-sheet). Elev. 245 feet. GSC loc. 60788. Coll. F. J. E. Wagner, 1956.

185. 0.9 mile northwest of St. Liboire, on road between St. Liboire and St. Edward Station, Quebec (736589, St. Hyacinthe map-sheet). Elev. 236 feet. GSC loc. 60778. Coll. F. J. E. Wagner, 1956.

186. Ditch on south side of main road through La Carrière, Quebec (664487, St. Hyacinthe map-sheet). Elev. 209 feet. GSC loc. 60747. Coll. F. J. E. Wagner, 1956.

187. West bank of Black River, 1.9 miles west of St. Valérien, Quebec (753480, St. Hyacinthe map-sheet). Elev. 150 feet. GSC loc. 60718. Coll. F. J. E. Wagner, 1956.

188. Highway 1, about 2 miles east of the centre of Abbotsford, Quebec (691328, Granby map-sheet). Elev. 294 feet. GSC loc. 60776. Coll. F. J. E. Wagner, 1956.

189. 0.5 mile east of St. Ubald, Quebec (Montauban map-sheet). Elev. 300 feet. GSC loc. 60752. Coll. P. F. Karrow, 1956.

190. West bank of Batiscan River, just south of bridge at St. Adelphe, Quebec (Grondines map-sheet). Elev. 340 feet. Coll. P. F. Karrow, 1956.

191. West bank of Charest River, 3 miles south-southwest of Laganière and 3.5 miles northeast

of St. Prosper, Quebec (Grondines map-sheet). Elev. 345 feet. GSC loc. 60796. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.

192. West bank of tributary flowing into Ste. Anne River from the northwest, 1.5 miles northeast of St. Prosper, Quebec (Grondines map-sheet). Elev. 150 feet. GSC loc. 60742. Coll. F. J. E. Wagner, 1956.
193. West side of Rivière Blanche, 0.6 mile northeast of St. Thuribe, Quebec (Grondines map-sheet). Elev. 150 feet. GSC loc. 60794. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
194. East bank of Rivière Blanche, 0.75 mile northeast of St. Thuribe, Quebec (Grondines map-sheet). Elev. 180 feet. GSC loc. 60745. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
195. West bank of Ste. Anne River, 1 mile northeast of St. Alban, Quebec (Grondines map-sheet). Elev. 190 feet. GSC loc. 60750. Coll. F. J. E. Wagner, 1956.
196. Southeast corner of dam on Ste. Anne River at St. Alban, Quebec (Grondines map-sheet). Elev. 220 feet. GSC loc. 60741. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
197. Ditch south of bridge at dam on the Ste. Anne River, at St. Alban, Quebec (Grondines map-sheet). Elev. 200 feet. GSC loc. 60797. Coll. F. J. E. Wagner, 1956.
198. East bank of Ste. Anne River, 2.5 miles northeast of St. Casimir, Quebec (Grondines map-sheet). Elev. 100 feet. GSC loc. 60771. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
199. Pit 1 mile south of St. Narcisse, Quebec (Grondines map-sheet). Elev. 390 feet. GSC loc. 60743. Coll. F. J. E. Wagner, 1956.
200. Rivière des Chutes, 1.5 miles east-northeast of St. Narcisse, Quebec (Grondines map-sheet). Elev. 330 feet. GSC loc. 60733. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1955.
201. Just below Chute des Ailes, west bank of Batiscan River, Quebec (Grondines map-sheet). Elev. 300 feet. GSC loc. 27315. Coll. F. J. E. Wagner, 1953.
202. Section at Shawinigan Water Power Company dam, east of St. Narcisse, Quebec (Grondines map-sheet). Elev. 225 feet. GSC loc. 60731. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1955.
203. East bank of Batiscan River, Quebec, just below Chute à Jimmy (Grondines map-sheet). Elev. 386 feet. GSC loc. 60748. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
204. 3 miles due north of Ste. Geneviève, Quebec (Grondines map-sheet). Elev. 75 feet. GSC loc. 60737. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1955.
205. West bank of Batiscan River, 2 miles east-southeast of Ste. Geneviève, Quebec (Grondines map-sheet). Elev. 35 feet. GSC loc. 60732. Coll. P. F. Karrow, 1955; F. J. E. Wagner, 1955.
206. South shore of St. Lawrence River, 2.25 miles northeast of St. Pierre-les-Becquets, Quebec (Grondines map-sheet). Elev. 30 feet. GSC loc. 60744. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
207. Bank of small stream flowing into St. Lawrence River, 3.2 miles southwest of Deschaillons, Quebec (Grondines map-sheet). Elev. 100 feet. GSC loc. 60734. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
208. South shore of St. Lawrence River, 3.3 miles east of Deschaillons, Quebec (Grondines map-sheet). Elev. 90 feet. GSC loc. 60736. Coll. F. J. E. Wagner, 1956.
209. South shore of St. Lawrence River, 3.2 miles east of Deschaillons, Quebec (Grondines map-sheet). Elev. 15 feet. GSC loc. 60738. Coll. P. F. Karrow, 1956; F. J. E. Wagner, 1956.
210. East bank of Petite Rivière du Chêne, near the southern boundary of the Grondines map-sheet (Grondines map-sheet). Elev. 100 feet. GSC loc. 60728. Coll. P. F. Karrow, 1956.
211. West bank of Ruisseau l'Espérance, 1.7 miles due east of Parisville, Quebec (Grondines map-sheet). Elev. 190 feet. Coll. P. F. Karrow, 1956.

212. West bank of Champlain River, 1.8 miles northwest of Champlain, Quebec (Bécancour map-sheet). Elev. 25 feet. Coll. F. J. E. Wagner, 1953.

213. North shore of St. Lawrence River, at Champlain, Quebec (Bécancour map-sheet). Elev. 20 feet. Coll. F. J. E. Wagner, 1953.

214. Bécancour River, 2.5 miles northeast of St. Wenceslas, Quebec (Aston map-sheet). Elev. 235 feet. GSC loc. 27311. Coll. F. J. E. Wagner, 1953.

215. North bank of Bécancour River, 1.75 miles northeast of Aston Station, Quebec (Aston map-sheet). Elev. 253 feet. GSC loc. 60754. Coll. F. J. E. Wagner, 1956.

216. 0.4 mile west of highway 9, 3.75 miles northwest of Maddington Falls, Quebec (Aston map-sheet). Elev. 290 feet. Coll. F. J. E. Wagner, 1953.

217. 1.5 miles southeast of St. Raymond, Quebec (St. Raymond map-sheet). Elev. 500 feet. GSC loc. 60770. Coll. F. J. E. Wagner, 1956.

218. West bank of Lachevrotière River, 0.25 mile from the St. Lawrence, Quebec (Portneuf map-sheet). Elev. 40–65 feet. GSC loc. 60795. Coll. F. J. E. Wagner, 1956.

219. West side of Portneuf River, 0.8 mile north of St. Lawrence River, Quebec (Portneuf map-sheet). Elev. 100 feet. GSC loc. 60773. Coll. F. J. E. Wagner, 1956.

220. Grande Rivière du Chêne, opposite mouth of Rivière Bois-Clair, 0.5 mile below Pont Noir, Quebec (Portneuf map-sheet). Elev. 165 feet. GSC loc. 27310. Coll. F. J. E. Wagner, 1953.

221. East bank of Methot Brook at St. Antoine-de-Tilly-les-Fonds, Quebec (Portneuf map-sheet). Elev. 50 feet. GSC loc. 60787. Coll. F. J. E. Wagner, 1956.

222. 0.4 mile southwest of Potvin, Quebec (Portneuf map-sheet). Elev. 236 feet. GSC loc. 60774. Coll. F. J. E. Wagner, 1956.

223. East bank of Grande Rivière du Chêne, just south of highway 9, Quebec (Lyster map-sheet). Elev. 330 feet. GSC loc. 60767. Coll. F. J. E. Wagner, 1956.

224. Ditch draining into Rivière du Cèdre, 0.3 mile southeast of St. Janvier-de-Joly, Quebec (Lyster map-sheet). Elev. 375 feet. GSC loc. 60768. Coll. F. J. E. Wagner, 1956.

225. 1.5 miles due north of Ancienne Lorette, Quebec (198880, Quebec map-sheet). Elev. 197 feet. GSC loc. 60701. Coll. F. J. E. Wagner, 1956.

226. 1 mile south-southeast of Chevalier, on west side of road to Beauport, Quebec (322939, Quebec map-sheet). Elev. 350 feet. GSC loc. 60777. Coll. F. J. E. Wagner, 1956.

227. East side of Montmorency Falls, Quebec (365953, Quebec map-sheet). Elev. 300 feet. GSC loc. 60775. Coll. F. J. E. Wagner, 1956.

228. Culvert under highway 3, 0.1 mile east of St. Nicholas, Quebec (Chaudière map-sheet). Elev. 211 feet. GSC loc. 60755. Coll. F. J. E. Wagner, 1956.

229. 0.2 mile southeast of highway 3, and 0.75 mile due east of St. Nicholas, Quebec (Chaudière map-sheet). Elev. 181 feet. GSC loc. 60759. Coll. F. J. E. Wagner, 1956; N. R. Gadd, 1962.

230. Johnston Corners, Ontario (524146, Ottawa map-sheet). Elev. 380 feet. GSC loc. 69165. Coll. F. J. E. Wagner, 1965.

231. About 1 mile southwest of South Gloucester, Ontario (543127, Ottawa map-sheet). Elev. 350 feet. GSC loc. 69166. Coll. F. J. E. Wagner, 1965.

NOTE: Localities 47, 48, 50, 97–100, 102–107, 113, and 114 are no longer accessible because of the flooding of the St. Lawrence valley above Cornwall, Ontario by the St. Lawrence Seaway and Power Project.

# APPENDIX II

## Stratigraphic Data

## APPENDIX II

### Stratigraphic data for fossil localities

Descriptions of sections read from the top of the section down

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 1 | 510 | |
| 2 | 475 (bottom of section) | 2–3 feet weathered zone; 3 feet stratified medium to coarse sand and very fine pebbles, fragments of marine shells |
| 3 | 475 (top of section) | 1 foot weathered silt; undeterminable thickness of subangular to subrounded pebbles; minor cobbles, shell fragments |
| 4 | 505 (bottom of section) | 2–3 feet stratified medium sand; minor small pebbles, shell fragments; 2–5 feet obscured by slumped material |
| 5 | 450 (bottom of section) | 6–8 feet stratified sand and silty sand, shell fragments |
| 6 | 450 (bottom of section) | 3–4 feet silty sand; 3–4 feet stratified medium-grained sand, fossiliferous, 10–12 feet obscured by slumped material. Some pelecypod shells have the valves unseparated |
| 7 | 500 (bottom of section) | 2–3 feet extremely fine sand or silt with subangular to subrounded pebbles scattered and in patches throughout; fossiliferous 5–6 feet obscured by slumped material. Some pelecypod shells with valves unseparated |
| 8 | 505 (fossil horizon) | Shells from sand about 80 feet above road level |
| 9 | 275 (top of section) | 10–12 feet medium sand, mainly quartz; 8–10 feet horizontally bedded *"Leda"* clay fossiliferous; 2 inches fine silty sand; 5½ feet horizontally bedded *"Leda"* clay, fossiliferous |
| 10 | 475 (bottom of section) | 4 feet horizontally bedded pebbles (mainly flat plates of Ordovician limestone), some cobbles, fossiliferous; Ordovician bedrock. Some pelecypod shells have valves unseparated |
| 11 | 425 (bottom of section) | 5–6 feet unstratified, weathered sand and pebble, gravel, shell fragments throughout; till? |
| 12 | 350 (bottom of section) | 2–3 feet stratified sands and silts, shells in bands and sparsely distributed throughout the section |
| 13 | 425 (bottom of section) | 10–15 feet well sorted, stratified, pebble gravel, some cobbles and boulders, shell fragments; bedrock |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 14 | 460 (bottom of section) | 8–10 feet subangular to subrounded pebble gravel, little stratification, shell fragments |
| 15 | 315 (top of section) | 2 feet sandy silt, several coquina beds |
| 16 | 375 | Clay, fossiliferous; sand; clay, fossiliferous; till |
| 17 | 440 (top of section) | 2–3 feet sandy silt, fossiliferous |
| 18 | 618 (bottom of section) | 3–4 feet silty clay; 7–8 feet stratified sand and pebble gravel, fossiliferous. Shells about 2 feet from bottom of section; one specimen with valves unseparated |
| 19 | 360 (bottom of section) | 10–12 feet marine clay, more finely bedded at the top, fossiliferous; 4–5 feet stratified fine sand; 6 inches clay; 1 foot (plus) sand |
| 20 | 415 (bottom of section) | 6–8 feet sand with pebbles and cobbles, fossiliferous |
| 21 | 245 (at ground surface) | 4½ feet loam, silt and sand; 7½ feet grey clay; 40 feet soft blue clay; 43 feet almost black silty clay, with *Tethya;* 9 feet grey silty clay; 2 feet medium sand; 17 feet sand and gravel; bedrock |
| 22 | 340 (top of section) | 30 feet crossbedded sand with some fine gravel, fossiliferous; 4 feet horizontally bedded sand, fossiliferous; 10 feet horizontally bedded clay with sand partings, fossiliferous; 22 feet stratified sand with shells; 20 feet silty clay, fossiliferous; 10 feet covered |
| 23 | 150 (top of section) | 10–15 feet brownish grey clay with concretions |
| 24 | 355 | Beach gravels, fossiliferous |
| 25 | 375 (bottom of section) | 10 feet (approx.) sand and gravel, fossiliferous. Section mainly obscured by slumping |
| 26 | 370 | Gravels; marine sand, fossiliferous |
| 27 | 300 | No data |
| 28 | 310 | No data |
| 29 | 310 (bottom of section) | 1 foot – 2 feet unsorted cobbles and pebbles in a sandy matrix, fossiliferous; 1 foot – 2 feet finely bedded, medium sand; 10–11 feet obscured by slumped material |
| 30 | 290 (top of section) | 2–3 feet silty sand, fossiliferous |
| 31 | 305 (bottom of section) | 2–3 feet weathered sand; 6–7 feet stratified, medium-grained sand; 1½ feet subangular pebbles and small cobbles, fossiliferous |
| 32 | 275 (bottom of pit) | 4–6 feet poorly sorted, roughly stratified gravel, fossiliferous; 4–5 feet sand, some crossbedding noted |
| 33 | 320 (bottom of pit) | 5–6 feet cobbles with some pebble gravel and sand, roughly stratified and dipping slightly toward the north, fossiliferous; 6–7 feet obscured by slumped material |
| 34 | 325 | Gravels high on ridge, grading into sand on the flanks of the ridge. Fossils in sands and gravels |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 35 | 225 | 2–2½ feet clay; 3–4 feet coarse gravel, fossiliferous; 5 feet covered |
| 36 | 285 | 4–7 feet coarse sand to large pebbles, some cobbles, shell fragments; 3–6 feet obscured by slumped material |
| 37 | 230 (at ground surface) | No data |
| 38 | 344 | 5–6 feet stratified sand, pebbles and cobbles, some boulders, fossiliferous; 5 feet (approx.) obscured by slumped material |
| 39 | 275 | No data |
| 40 | 310 | 5 feet roughly sorted and stratified pebbles and small cobbles in sand matrix, shell fragments |
| 41 | 310 | Gravel with shell fragments |
| 42 | 320 (top of section) | 2½ feet angular to subangular pebble and cobble gravel with medium to coarse sand matrix, shell fragments plus unbroken pelecypod valves |
| 43 | 310–315 | 2–3 feet unsorted, unstratified sand, pebbles and cobbles, fossiliferous; 3–4 feet covered with slumped material. Some shells in living position |
| 44 | 310 | Pebbles and cobbles at ground surface |
| 45 | 235 (top of section) | 5 feet silty sand; about 15 feet silty clay with *Balanus* |
| 46 | 315 (surface of ground) | Shells found 40 feet below ground surface |
| 47 | 255 | No data |
| 48 | 250 | No data |
| 49 | 295 | Coarse gravels on northwest flank of clay–till ridge |
| 50 | 225 | 10 feet silt; 4 feet (approx.) clay, fossiliferous |
| 51 | 335 | Cobbles and boulders, with sandy matrix, shell fragments; stratified fine gravel and sand, fossiliferous |
| 52 | 350 | 7 feet (approx.) bedded cobbles and pebbles with some sand, fossiliferous; 5 feet covered by slumped material |
| 53 | 305 | 2½–3 feet silt and sand, shells in upper 1 foot – 2 feet of section. Some shells with valves intact |
| 54 | 180 | 2½ feet coarse gravel with sand; 1½–2 feet red clay; 3–4 inches buff clay; 3½–4 feet stratified silt, sand and gravel, fossiliferous |
| 55 | 290 | 10–15 feet deltaic(?) sand and gravels, fossiliferous |
| 56 | 275 | Pebble and cobble gravel with minor amount of sand |
| 57 | 300 | 2–3 feet marine beach sand and gravel. Some unbroken pelecypod valves |
| 58 | 382 (top of section) | 5–6 feet pebbles with some cobbles, shell fragments |
| 59 | 380 | 4–6 feet roughly stratified pebbles and cobbles, some boulders |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 60 | 310 | 6–7 feet unsorted mixture of medium to coarse sand, small to large pebbles, and cobbles. At least 4 distinct fossil horizons |
| 61 | 325 | 3–3½ feet stratified pebbles and cobbles, shell fragments plus some unbroken valves; 2½–3 feet obscured by slumped material |
| 62 | 311 | 1 foot – 2 feet soil; 3–4 feet dipping stratified coarse to fine sand and pebble to cobble gravel, larger material rounded, shell fragments |
| 63 | 320 | 4 feet (approx.) roughly stratified cobbles and boulders with matrix of sand and pebbles, shell fragments |
| 64 | 310–320 | 20 feet (approx.) pebbles, cobbles, and boulders, with the coarser material toward top of section. Fossils in living position from 5 feet to 12 feet above bottom of section |
| 65 | 297 | 1 foot – 2 feet pebbles and cobbles in sandy matrix with unfossiliferous sand wedges. Shells in coarse material are in living position |
| 66 | 325 | 4–5 feet pebbles and cobbles in matrix of fine gravel, shell fragments; 4–5 feet obscured by slumped material |
| 67 | 295–304 | 1 foot – 2 feet fine gravel or gravelly sand, fossiliferous; 1 foot – 3 feet pebbles and cobbles |
| 68 | 240 | 2½ feet pebble and cobble gravel, shell fragments |
| 69 | 255 | Angular pebbles and cobbles, shell fragments |
| 70 | 310–315 | 2–3 feet gravel, small pebbles at top grading down to coarser pebbles and then small cobbles, more sand in relation to number of pebbles in the top 8–10 inches. Shells present in living position |
| 71 | 325 | 2–2½ feet small pebbles in sand matrix; 2 feet (approx.) roughly bedded large and small pebbles with some cobbles; 2 feet (approx.) stratified pebbles and cobbles. Shell fragments throughout |
| 72 | 350 | 2–3 feet sand; pebble gravel, fossiliferous |
| 73 | 325–350 | 7–8 feet roughly stratified pebbles and cobbles, shell fragments with some unbroken valves |
| 74 | 325–350 | 8–9 feet stratified, roughly sorted, small to large pebbles, minor amount of sand, shell fragments throughout |
| 75 | 345 | 6–7 feet unsorted pebbles and cobbles with sand matrix, shell fragments scattered throughout exposure |
| 76 | 322 | 4½–5 feet pebbles and cobbles with very coarse sand matrix, shell fragments plus some complete specimens |
| 77 | 295 | 3 feet sand exposed in ditch |
| 78 | 320 | No data |
| 79 | 350 | Bedded sand and coarse gravel |
| 80 | 310 | Gravel on northwest side of ridge |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 81 | 310 | Gravel; sand, fossiliferous; gravel; till |
| 82 | 310 | Sand |
| 83 | 305 | 7–8 feet interbedded cobbles and pebbles, shell fragments in upper part of section |
| 84 | 275 | No data |
| 85 | 240 | Gravel, sand |
| 86 | 272 (top of section) | 5–6 feet roughly sorted, subrounded cobbles in sand and pebble matrix, boulders, shell fragments throughout; 8–9 feet obscured by slumped material |
| 87 | 300 | 16–18 feet poorly sorted, angular limestone cobbles and boulders, some pebbles and sand. Shells 5–6 feet from top of section, some complete specimens but mostly single valves |
| 88 | 300 | Stratified sand and gravel, shells in sandier beds |
| 89 | 275 | 3–4 feet pebbles and cobbles (reworked till?), fossiliferous; 4 feet obscured by slumped material |
| 90 | 265 | No data |
| 91 | 260 | 3 feet peat with jelly-like, lignitiferous material at bottom; 1 foot – 2 feet fine sand with clay intermixed. Shells occur along the top of the sand |
| 92 | 222 | No data |
| 93 | 265 | 12 feet poorly stratified medium to fine sand and roughly sorted pebble to cobble gravels. Several fossiliferous horizons with shells in living position |
| 94 | 207 | No data |
| 95 | 270 (top of section) | 4–5 feet very sandy gravel (reworked till). Shells occur 4 feet below ground surface |
| 96 | 255 (fossil horizon) | Peat; silty clay, fossiliferous |
| 97 | 190 | 4–5 feet sand; 20–21 feet clay, fossiliferous; till |
| 98 | 190 | No data |
| 99 | 230 (top of section) | Pocket of richly fossiliferous coarse sand on top of till knob. Some complete shells |
| 100 | 190 | Sand with pebbles, fossiliferous; varved clay |
| 101 | 210 | 2 feet fine gravel; till |
| 102 | 230–235 | 9–10 feet relatively unsorted and unstratified pebble, cobble, and boulder gravel; floor of pit is coarse sand and fine gravel with shell fragments plus some unbroken valves |
| 103 | 170 (top of section) | 2–3 feet fine sand; 4–5 feet obscured by slumped material; 3 feet silty clay, fossiliferous; clay (just below water level of canal) |
| 104 | 198 | No data |
| 105 | 205 | 1½ feet medium sand; 5 feet stratified sandy silt and clay, several fossiliferous horizons with some shells with valves intact |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 106 | 210 | 5½ feet sand; 6½ feet silty sand, fossiliferous; ½ foot gravel, fossiliferous; 5 feet clay; till |
| 107 | 165 | No data |
| 108 | 185 | 2 feet sand; 5 feet silty clay; sand, fossiliferous |
| 109 | 205 | About 3 feet sand with boulders |
| 110 | 200 (ground surface) | 3 feet or more sand |
| 111 | 300 | Shells observed on surface of ground |
| 112 | 275 | 2 feet fine gravel; 2–3 feet interbedded pebbles and cobbles. Shell fragments scattered throughout |
| 113 | 240 | Crossbedded sand; fissured clay with occasional bands of fossils |
| 114 | 200 | 1 foot – 2 feet fine sand |
| 115 | 445 | 1 foot – 1½ feet sand with lenses of pebbles; 1 foot – 1½ feet roughly stratified coarse sand, pebbles, and cobbles; 2–2½ feet sand with single bed of pebbles and cobbles; 2–2½ feet silty clay with scattered pebbles, cobbles, and boulders, fossiliferous; ½ foot sand; 3 feet unsorted pebbles and cobbles in silty clay matrix; 10–12 feet obscured by slumped material. Shells are scattered throughout the silty clay, many with valves unseparated but not in living position |
| 116 | 180 (ground surface) | 41½ feet fine sand; 199½ feet clay, shells between 125 and 145 feet below ground level; 74 feet coarse gravel, cobbles, and boulders; 12 feet till; bedrock |
| 117 | 300 (bottom of section) | 3–4 feet sand with pebbles and cobbles, slumped; 10 feet interbedded medium to coarse sand and pebbles, fossiliferous. Shells occur in narrow bands, single valves mainly convex side up. *Mya arenaria* found in living position |
| 118 | 260 | 0–3 feet interbedded pebbles and cobbles; 2–5 feet unsorted mixture of pebbles and cobbles in silty matrix, roughly stratified toward the top; 1 foot small angular pebbles with sand matrix, fossiliferous; 1 foot very small angular pebbles in a more clayey matrix than above, fossiliferous. Shells mainly fragments, but some unbroken valves, and several pelecypods with valves unseparated |
| 119 | 275 | 0–1 foot sand with pebbles; 1 inch – 2 inches fine gravel with freshwater gastropods; 5–6 feet roughly bedded pebbles and cobbles with thin sand layer, dip 25°, fossiliferous; 2–3 feet obscured by slumped material |
| 120 | 175 | 3 feet stratified pebbles and cobbles, prominent shell bed at the base; 12–18 feet very fine sand and pebble gravel; 2–10 feet obscured by slumped material. Many shells in living position |
| 121 | 165 | 10 feet roughly stratified cobbles and boulders among which fossils are interspersed with some tendency |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| | | toward bedding; 5–6 feet finer gravel, very compact and till-like; 3–4 feet sand, 5–7 feet obscured by slumped material |
| 122 | 200 (top of section) | 2–3 inches compact grey clay, fossiliferous; 10 inches semi-consolidated peaty material; 6 inches medium-grained quartz sand |
| 123 | 211 (top of section) | 4–5 feet sharp, medium-grained sand on top of a small ridge. Shell fragments in place about 5 feet below ground surface |
| 124 | 221 (top of fossil horizon) | 10–12 inches stony soil; 6–12 inches medium-grained sand, very fossiliferous; 4–6 inches fine sand; 1 foot – 1½ feet stratified clay, large pebbles and small cobbles along upper contact; 2½–3 feet reworked sandy till; 6–7 feet obscured by slumped material |
| 125 | 222 | 2–3 feet very coarse sand to fine gravel, unstratified and relatively unsorted, shell fragments |
| 126 | 293 (base of exposure) | Medium-grained grey sand; clay; shells in the sand |
| 127 | 130 (bottom of section) | 8–10 feet obscured by slumped material; about 7 feet clay with sandy partings at intervals of 4–5 inches; 3 feet obscured by slumped material. Shells occur along sandy partings in the clay |
| 128 | 194 | 1 foot clayey soil; 2 feet stratified pebbles and cobbles with interbedded medium to coarse sand in lower part and clay in upper part, fossiliferous; 10 feet obscured by slumped material |
| 129 | 176 (top of section) | 1 foot – 4 feet blocky weathering, buff clay, ½–1 foot pebbles and cobbles in clay matrix, disconformable contact with overlying clay; about 13 feet roughly stratified pebbles and cobbles, some interbedded coarse sand. Shell fragments in lower part of section |
| 130 | 151 | 15 feet sand, finely crossbedded; about 5 feet interbedded grey silt and fine grey sand, fossiliferous |
| 131 | 166 | Sand and gravel, fossiliferous; clay |
| 132 | 187 | No data |
| 133 | 205 | Sand |
| 134 | 310 | Sand and gravel |
| 135 | 545 (top of section) | 3 feet fine- to medium-grained sand. Shells in upper part are fragmentary, in living position in lower part |
| 136 | 300 | Clayey gravel with coquina beds |
| 137 | 165 | Clay; till |
| 138 | 172 | 5 feet sand and clay, fossiliferous; till |
| 139 | 170 | No data |
| 140 | 173 | Sand and clay |
| 141 | 143 | Sand; clay, fossiliferous |
| 142 | 143 | Clay |
| 143 | 55 | 8 feet oxidized clays; 1 foot pink and grey clay, fossiliferous; 3 feet clay with sandy interlayers |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 144 | 140 | Clay |
| 145 | 171 | Clay |
| 146 | 180 | 1 foot – 2 feet soil, sand and gravel; till |
| 147 | 187 | Sand; till |
| 148 | 235 | Sand and gravel; till |
| 149 | 250 | 2–3 feet soil and gravel; till |
| 150 | 200 | No data |
| 151 | 205 | Sand, fossiliferous; sandy clay |
| 152 | 190 | Sand |
| 153 | 232 | Gravel, sand; silt. Shells occur in both the gravel and sand |
| 154 | 163 | Sand |
| 155 | 192 | Sand |
| 156 | 173 | Sand |
| 157 | 215 (top of section) | Sand with pebbles, silt, fossiliferous; pebbles and cobbles with sand |
| 158 | 215 | 5 feet horizontally bedded sand; 20–25 feet stratified coarse sand to large rounded cobbles, dipping about 22° eastward, fossiliferous beds at 2- to 3-foot intervals, shells in living position |
| 159 | 165–170 | Sand; interbedded coarse and fine gravel. Shells in silty clay lenses in the sand |
| 160 | 175–200 | 1 foot – 4 feet unsorted subrounded pebbles and cobbles, lower foot of unit shows rough imbrication of the pebbles and less intermixed sand than above; 7 feet stratified reddish silty clay with interbedded fine sand and silt, freshwater pelecypods; 6 feet roughly stratified pebbles, cobbles, and boulders, marine shells in living position at upper contact; 15 feet obscured by slumped material |
| 161 | 208 (bottom of exposure) | 2½ feet fine- to medium-grained sand; 2½ feet pebble and cobble gravel in sandy matrix. Shells in living position in the sand |
| 162 | 270 (base of fossiliferous beds) | 25 feet stratified sand; 20 feet interbedded sand and pebble to boulder gravel, shell fragments in the sand beds; 30 feet obscured by slumped material |
| 163 | 219 (fossil horizon) | 3–3½ feet obscured; 3 feet gravel, mainly subangular to subrounded pebbles; 2 feet fine- to medium-grained sand, shells in living position; 3–4 feet obscured; 1 foot – 1½ feet sand; 8½ feet obscured by slumped material |
| 164 | 143 (top of section) | 6 feet clay |
| 165 | 160 (top of coquina bed) | 1 foot – 1½ feet black organic soil, peaty in lower part; 5–6 inches grey silt; 2 feet fine brown sand; 1 foot coquina; 1 foot covered |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 166 | 182 (floor of pit) | 20–25 feet poorly sorted cobbles and pebbles with abundant boulders; 10–15 feet obscured by slumped material; 2 feet clay; 10 feet sand with shells in lower 4 feet; 33 feet covered by slumped material; 10 feet sand, fossiliferous; 10 feet slumped material |
| 167 | 163 (top of section) | 3 feet medium sand; 6 inches coquina; 2 feet red clay |
| 168 | 174 (bottom of section) | 8–10 feet reworked till |
| 169 | 166 (top of section) | Whole section obscured by slumped material; shells scattered on surface with heaviest concentration about 2 feet from top of bank |
| 170 | 277 | 3½–4 feet stratified coarse sand and pebble gravel, shell fragments scattered throughout; 2½–3 feet obscured by slumped material |
| 171 | 209 (top of section) | Beach deposit developed on crest of till ridge |
| 172 | 350 | 4–6 feet sand; about 6 feet marine clay, fossiliferous |
| 173 | 345 (top of section) | 25 feet marine clay, many shells in living position |
| 174 | 340 (bottom of section) | 5 feet beach gravel; 12 feet stratified brown silty sand; 3 feet grey marine stony silt with shell casts; 4 feet sand; 13 feet sticky sandy till, shell casts; 18 feet grey sandy till; 42 feet stratified stony silt, fossils in upper 10 feet |
| 175 | 290 (bottom of section) | 60 feet stratified marine silt with thin beds of sand throughout; fossil horizon 15 feet from top of section |
| 176 | 200 (bottom of section) | 8 feet covered; 2 feet medium-grained weathered sand; 30 feet marine silt with shells; 5 feet grey till with large amount of sand and boulders; 20 feet massive medium-grained weathered sand; 30 feet grey till |
| 177 | 100 | Marine clay (recent slide scar) |
| 178 | 175 (bottom of section) | ½ foot alluvial sand; 21 feet light grey marine stony silt, fossiliferous; 2½ feet brownish sandy silt, fossiliferous; 1½ feet stratified silt and sand; 8 feet sandy till; 3 feet crossbedded sand; 30 feet varved silts; 16 feet sandy till |
| 179 | 138 (top of section) | 9 feet brown clay, 2-foot fossiliferous band about 9 feet from top; 39 feet grey clay, fossil horizon 7 feet above the base; 6 inches silt; 7 feet till |
| 180 | 215 (bottom of section) | 2–2½ feet medium-grained brown sand, 1 foot fine-grained grey sand, fossiliferous; 1 foot very fine grained grey sand |
| 181 | 210 | 3–3½ feet medium-grained sand with scattered pebbles and cobbles; 5 feet stratified coarse sand and fine to coarse pebbles, shell fragments throughout |
| 182 | 350 | Shells concentrated in gravel within 2 feet of surface of till on top of Drummondville moraine |
| 183 | 290 (fossil horizon) | ½–1 foot sand, shells in a bed 4 or 5 inches thick |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 184 | 245 (bottom of section) | 3 feet medium-grained sand with several indistinct beds of cobbles; 1 foot roughly stratified coarse sand and fine gravel; 5 feet poorly sorted, stratified coarse sand at fine to coarse pebble gravel, some shells in living position |
| 185 | 236 (bottom of section) | 5 feet medium-grained sand, shell horizon 2½–3 feet from the top |
| 186 | 209 (top of section) | 1½ feet sandy soil; 1 foot jelly-like lignitiferous material; 1½–2 feet medium-grained quartz sand, some scattered cobbles. Shells in bottom foot of section, some in living position |
| 187 | 150 (bottom of section) | 8 feet fine sand grading down into silt; 3 feet brown clay; 8–10 feet grey clay. Casts of shells near top of grey clay |
| 188 | 300 (top of section) | 2 feet coarse sand grading down into fine gravel; 3½–4 feet fine to coarse pebble gravel, fairly well sorted; sand fossiliferous |
| 189 | 300 (bottom of section) | 75–100 feet clay, fossiliferous at base |
| 190 | 340 (fossil horizon) | About 30 feet marine clay |
| 191 | 345 (top of section) | 18 feet weathered stratified buff sand; 18 feet stratified contorted grey silty sand; 6 feet slightly stratified clayey silt, fossiliferous; 6 feet clayey silt; 12 feet stratified silt and sand, coquina bed at top; 6 feet stratified grey sand and silt, fossiliferous; 30 feet stratified grey sand and silt |
| 192 | 150 | 5 feet marine clay |
| 193 | 150 (base of section) | 10 feet till; 2 feet silt; 2–3 feet till(?); 5 feet sand; 5 feet till; 8 feet compact stony silt, fossiliferous |
| 194 | 180 (top of section) | 24 feet poorly stratified grey silt, fossiliferous, 2 feet stratified sand and silt; 7 feet buff grading down to grey sandy till |
| 195 | 190 (top of section) | 15 feet covered; 7–8 feet sand, some gravel in upper part; 25 feet marine clay, stratified with sandy partings in the upper part, more massive toward the bottom. Shells along sandy partings in the clay |
| 196 | 220 (top of section) | 15–20 feet sand; 1 foot "varved" weathered sand and silty sand; 10 feet stratified grey silts and sands, fossiliferous |
| 197 | 200 | Silts exposed along bottom of ditch |
| 198 | 100 | No data |
| 199 | 390 | Shells from below gravel forming floor of pit |
| 200 | 330 | 2 feet marine silt, very fossiliferous; 2–3 feet sandy gravel |
| 201 | 300 | No data |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 202 | 225 (bottom of section) | 75 feet stratified weathered sand; 21 feet stratified grey marine sand and silt, fossiliferous; 33 feet covered by slumped material; 19 feet stratified grey silt, becoming more sandy toward the bottom; 60 feet grey bouldery and sandy till |
| 203 | 386 (top of section) | 32 feet stratified gravelly sand; 8 feet stratified grey silty sand, some pebble layers, fossiliferous; 4 feet buff sandy till |
| 204 | 75 | 6 feet clay; 2 feet sand and boulders. Fossils occur at the contact between the clay and the underlying sand and boulders |
| 205 | 35 | 10 feet marine silt, several fossil horizons in lower part |
| 206 | 30 (bottom of section) | 80 feet stratified weathered sand; 0–3 feet marine sand, fossiliferous; 6–8 feet red till; 10 feet red and green varved clay, severely contorted and tilted |
| 207 | 100 (bottom of section) | 0–8 feet stratified weathered sand and silt, fossils at the base; 17 feet grey silty till; 25 feet grey varved clay |
| 208 | 90 (top of section) | 6–8 feet sand, shells in place in thin layers to a depth of at least 2½ feet below floor of pit |
| 209 | 15 (bottom of section) | 70–80 feet stratified weathered sand; 8–10 feet marine sand, fossiliferous; 5–10 feet red till |
| 210 | 100 (top of section) | 2–3 feet alluvial sand; 40 feet marine sediments, fossiliferous; 12 feet sandy till; 4 feet varved (?) silt |
| 211 | 190 | Glacio-marine sands and gravels |
| 212 | 25 | 5 feet sand; 5–6 feet silt; 4–5 feet clay, fossiliferous |
| 213 | 21 | 3–4 feet crossbedded sand; 4–5 feet clay, fossiliferous |
| 214 | 235 (top of section) | 12 feet silty sand, fossiliferous at top; 1 foot buff sand, fossiliferous; 1 foot – 1½ feet blue silt, fossiliferous; 3–4 feet covered by slumped material; bedrock |
| 215 | 253 (top of section) | 5½ feet medium alluvial sand; 23 feet stratified fine sand and silt; fossiliferous; 2½ feet coarse gravel; 5 feet sandy till; 14 feet contorted sand; 55 feet crossbedded sand and fine gravel; 20 feet covered |
| 216 | 290 | 1 foot – 2 feet sand; ½ foot silt; ½–1 foot sand with stones. Sponges at contact between upper sand and silt |
| 217 | 500 | Sand; stratified silt. Single cast of *Hiatella* found in silt |
| 218 | 70 (top of section) | 6 feet alluvial sand; 1½ feet medium-grained sand with weathered limestone blocks; 10 feet marine silt, fossiliferous; 6 inches weathered sand with cobbles; 1 foot clayey silt; 6 feet grey stratified silty sand |
| 219 | 175 (top of section) | 80 feet sand; 22 feet sandy till. Shells found throughout lower 60 feet of sand, generally outlining bedding planes, and in upper part of till |
| 220 | 165 (top of section) | 10 feet (approx.) stratified sand; 20–30 feet silt, fossiliferous in the upper part |
| 221 | 50 (top of section) | 2-3 feet unstratified, poorly sorted pebble gravel |

| Locality No. | Elevation (feet) | Description |
|---|---|---|
| 222 | 236 (fossil horizon) | 6 feet fine- to medium-grained brown sand; 3 feet very fine grained grey sand. Shells are concentrated at the contact between the two sands |
| 223 | 330 (top of section) | 15 feet sand, medium grained at the top becoming very fine grained at the bottom; 1 foot grey silt; 5 feet black organic silt; 5 feet clay with sandy partings, shells along the sandy partings |
| 224 | 375 | 4 feet coarse-grained brown sand; 2 feet fine- to medium-grained grey sand, shells in the upper 1 foot |
| 225 | 197 (bottom of section) | 2½ feet medium-grained sand, shells in lower 6 inches |
| 226 | 350 (top of section) | 0–5 feet gravel, abundant shell fragments; 0–30 feet sandy grey till; 60 feet yellow, fine- to coarse-grained stratified alluvial sand |
| 227 | 300 | Gravel; bedrock |
| 228 | 211 (top of section) | Fine clayey sand; bedrock |
| 229 | 181 (bottom of section) | 1 foot red sandy clay with stones; 6 feet crossbedded, medium-grained sand to fine gravel, fossiliferous; till |
| 230 | 380 (top of section) | 8–10 feet sand with pebbles and some cobbles, shells throughout; 15 feet slumped. Most shells intact and some in living position |
| 231 | 350 (top of section) | 3 feet roughly stratified pebbles and cobbles in sandy matrix; 3 feet stratified sand with a few pebbles, fossiliferous; 5 feet slumped. Shells in living position |

PLATES I to VII

## Plate I

Figure 1. *?Hyperammina* sp. (Page 16)
Two fragments of a single specimen, x40, locality 2; hypotype, GSC No. 20094.

Figure 2. *Quinqueloculina arctica* Cushman (Page 17)
Side view, x50, locality 95; hypotype, GSC No. 20095.

Figure 3. *Quinqueloculina seminulum* (Linné) (Page 17)
Side view, x70, locality 94; hypotype, GSC No. 20096.

Figure 4. *Quinqueloculina seminulum* (Linné) (Page 17)
Side view, x55, locality 157; hypotype, GSC No. 20097.

Figure 5. *Pateoris hauerinoides* (Rhumbler) (Page 17)
Side view, x50, locality 157; hypotype, GSC No. 20098.

Figure 6. *?Dentalina* sp. (Page 18)
Side view, x45, locality 113; hypotype, GSC No. 20099.

Figure 7. *Lagena apiopleura* Loeblich and Tappan (Page 18)
Side view, x40, locality 151; hypotype, GSC No. 20100.

Figure 8. Polymorphinidae, genus and species indet. (Page 21)
Side view, x45, locality 50; hypotype, GSC No. 20101.

Figure 9. *Globulina glacialis* Cushman and Ozawa (Page 19)
Side view, x50, locality 65; hypotype, GSC No. 20102.

Figure 10. *Guttulina dawsoni* Cushman and Ozawa (Page 19)
Side view, x50, locality 113; hypotype, GSC No. 20103.

Figure 11. *Pseudopolymorphina novangliae* (Cushman) (Page 19)
Side view, x50, locality 145; hypotype, GSC No. 20105.

Figure 12. *Pseudopolymorphina novangliae* (Cushman) (Page 19)
Side view, opposite side to that shown on figure 11, x35, locality 90; hypotype, GSC No. 20104.

Figure 13. *Pseudopolymorphina suboblonga* Cushman and Ozawa (Page 20)
Side view, x40, locality 110; hypotype, GSC No. 20106.

Figure 14. *Pyrulina angusta* (Egger) (Page 20)
Side view, x50, locality 94; hypotype, GSC No. 20107.

Figure 15. *Islandiella islandica* (Nørvang) (Page 21)
Side view, x70, locality 207; hypotype, GSC No. 20109.

Figure 16. *Islandiella islandica* (Nørvang) (Page 21)
Side view, showing aperture, x75, locality 50; hypotype, GSC No. 20108.

Figure 17. *Islandiella norcrossi* (Cushman) (Page 22)
Side view, showing aperture, x25, locality 90; hypotype, GSC No. 20110.

Figure 18. *Islandiella norcrossi* (Cushman) (Page 22)
Side view, x50, locality 159; hypotype, GSC No. 20111.

Figure 19. *Islandiella teretis* (Tappan) (Page 22)
Side view, showing aperture, x45, locality 65; hypotype, GSC No. 20112.

Figure 20. *Buccella frigida* (Cushman) (Page 23)
Ventral view, x70, locality 223; hypotype, GSC No. 20113.

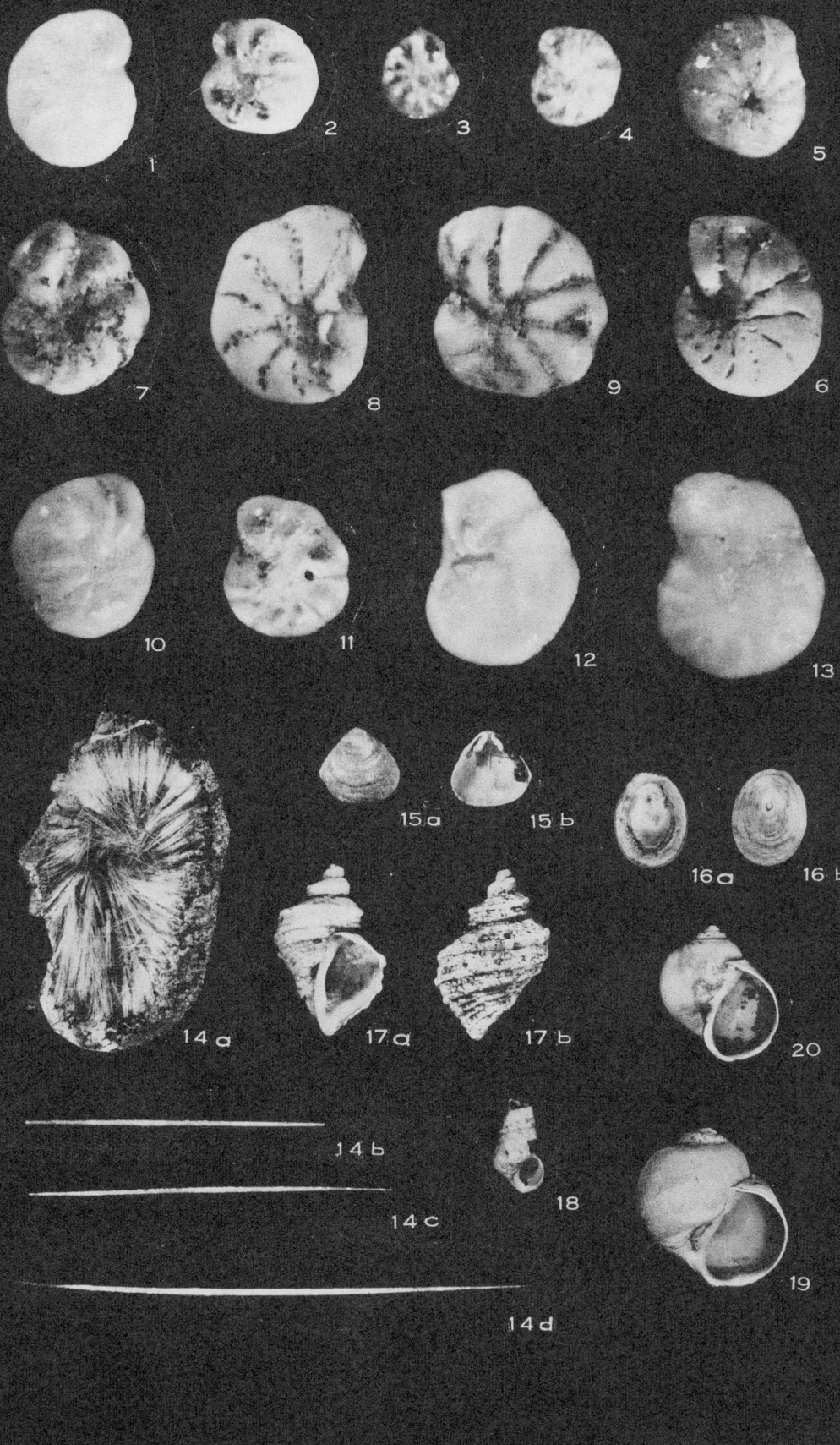
Figure 21. *Buccella frigida* (Cushman) (Page 23)
Dorsal view, x75, locality 209; hypotype, GSC No. 20114.

Figure 22. *Elphidium bartletti* Cushman (Page 23)
Side view of small specimen, x40, locality 121; hypotype, GSC No. 20115.

Figure 23. *Elphidium bartletti* Cushman (Page 23)
Side view of large specimen, showing sutural pores, x40, locality 121; hypotype, GSC No. 20116.

PLATE I

PLATE II


1
2
3
4
5
7
8
9
6
10
11
12
13
14 a
15 a
15 b
16 a
16 b
17 a
17 b
20
14 b
18
14 c
19
14 d

## PLATE II

Figure 1. *Elphidium bartletti* Cushman (Page 23)
Side view, showing granular material in umbilical area, x75, locality 106; hypotype, GSC No. 20117.

Figure 2. *Elphidium frigidum* Cushman (Page 24)
Side view, x45, locality 140; hypotype, GSC No. 20118.

Figure 3. *Elphidium incertum* (Williamson) forma *clavatum* Cushman (Page 24)
Side view, showing clear central boss, x55, locality 143; hypotype, GSC No. 20119.

Figure 4. *Elphidium incertum* (Williamson) forma *clavatum* Cushman (Page 24)
Side view, x55, locality 143; hypotype, GSC No. 20120.

Figure 5. *Elphidium incertum* (Williamson) (Page 24)
Side view of a specimen intermediate between typical *E. incertum* and forma *clavatum,* x50, locality 151; hypotype, GSC No. 20121.

Figure 6. *Elphidium incertum* (Williamson) (Page 24)
Side view of larger form with depressed umbilicus and grooves radiating from the umbilical area, x35, locality 118; hypotype, GSC No. 20122.

Figure 7. *Elphidium subarcticum* Cushman (Page 25)
Side view, showing wide opaque bands along the sutures, x45, locality 159; hypotype, GSC No. 20123.

Figure 8. *Elphidiella arctica* (Parker and Jones) (Page 25)
Side view, showing double rows of sutural pores, x35, locality 141; hypotype, GSC No. 20124.

Figure 9. *Elphidiella arctica* (Parker and Jones) (Page 25)
Side view, x35, locality 141; hypotype, GSC No. 20125.

Figure 10. *Protelphidium orbiculare* (Brady) (Page 26)
Side view, x60, locality 141; hypotype, GSC No. 20126.

Figure 11. *Protelphidium orbiculare* (Brady) (Page 26)
Side view, x55, locality 157; hypotype, GSC No. 20127.

Figure 12. *Cibicides lobatulus* (Walker and Jacob) (Page 26)
Ventral view, x65, locality 209; hypotype, GSC No. 20128.

Figure 13. *Cibicides lobatulus* (Walker and Jacob) (Page 26)
Dorsal view, x65, locality 209; hypotype, GSC No. 20129.

Figure 14. *Tethya logani* Dawson (Page 27)
14a, view of a complete specimen, x2; 14b, c, d, individual spicules, x16, locality 137; hypotype, GSC No. 20130.

Figure 15. *Hemithiris psittacea* (Gmelin) (Page 28)
15a, exterior of brachial valve; 15b, interior of brachial valve, x1, locality 229; hypotype, GSC No. 20131.

Figure 16. *Lepeta caeca* Müller (Page 28)
16a, interior of shell showing muscle scar; 16b, dorsal view, x1, locality 229; hypotype, GSC No. 20132.

Figure 17. *Trichotropis borealis* Broderip and Sowerby (Page 30)
17a, oral view; 17b, aboral view to show sculpture on body whorl, x2, locality 132; hypotype, GSC No. 20134.

Figure 18. *Tachyrhynchus erosum* (Couthouy) (Page 30)
Incomplete specimen with apical whorls missing, x1, locality 229; hypotype, GSC No. 20133.

Figure 19. *Natica clausa* Broderip and Sowerby (Page 30)
Oral view, x1, locality 205; hypotype, GSC No. 20135.

Figure 20. *Lunatia pallida* (Broderip and Sowerby) (Page 31)
Oral view, x1, locality 205; hypotype, GSC No. 20136.

PLATE III

Figure 1. *Neptunea despecta tornata* (Gould) (Page 33)
Oral view, x1, locality 223; hypotype, GSC No. 20140.

Figure 2. *Buccinum terrae-novae* (Mörch, ex Beck MS.) (Page 32)
Oral view of a rather squat specimen, x1, locality 224; hypotype, GSC No. 20137.

Figure 3. *Buccinum tenue* Gray (Page 32)
Oral view, x1, locality 205; hypotype, GSC No. 20138.

Figure 4. *Buccinum hancocki* Mörch (Page 31)
Oral view, x1, locality 205; hypotype, GSC No. 20139.

Figure 5. *Haminoea solitaria* (Say) (Page 34)
Oral view, x6, locality 77; hypotype, GSC No. 20141.

Figure 6. *Retusa obtusa* (Montagu) (Page 34)
Oral view of damaged specimen, x13, locality 200; hypotype, GSC No. 20142.

Figure 7. *Cylichna alba* Brown (Page 34)
Oral view, x2, locality 141; hypotype, GSC No. 20143.

Figure 8. *Nucula tenuis* (Montagu) (Page 35)
8a, interior of shell showing hinge, the right side of which has been broken; 8b, exterior of shell, x2, locality 218; hypotype, GSC No. 20144.

Figure 9. *Nuculana pernula* (Müller) (Page 36)
9a, exterior of right valve; 9b, interior of right valve, x1, locality 205; hypotype, GSC No. 20145.

Figure 10. *Nuculana tenuisulcata* (Couthouy) (Page 36)
10a, interior of left valve; 10b, exterior of left valve, x1, locality 205; hypotype, GSC No. 20146.

Figure 11. *Portlandia arctica* (Gray) (Page 36)
Interior of right valve, x1, locality 205; hypotype, GSC No. 20147.

Figure 12. *Portlandia arctica* (Gray) (Page 36)
Exterior of right valve, x1, locality 205; hypotype, GSC No. 20148.

Figure 13. *Mytilus edulis* Linné (Page 37)
13a, exterior of worn specimen; 13b, interior of worn specimen with tip of hinge lacking, x1, locality 117; hypotype, GSC No. 20149.

Figure 14. *Astarte montagui striata* (Leach) (Page 39)
14a, interior of left valve; 14b, exterior of left valve, x1, locality 224; hypotype, GSC No. 20151.

Figure 15. *Astarte montagui warhami* Hancock (Page 39)
15a, exterior of right valve; 15b, interior of right valve, x1, locality 132; hypotype, GSC No. 20152.

Figure 16. *Crassostrea virginica* (Gmelin) (Page 38)
16a, exterior of worn specimen; 16b, interior of valve, x1, locality 145; hypotype, GSC No. 20150.

Figure 17. *Thyasira gouldi* (Philippi) (Page 40)
17a, exterior of left valve; 17b, interior of right valve, x5, locality 220; hypotype, GSC No. 20153.

Figure 18. *Axinopsida orbiculata* (Sars) (Page 40)
18a, interior of right valve; 18b, exterior of left valve, x4, locality 92; hypotype, GSC No. 20154.

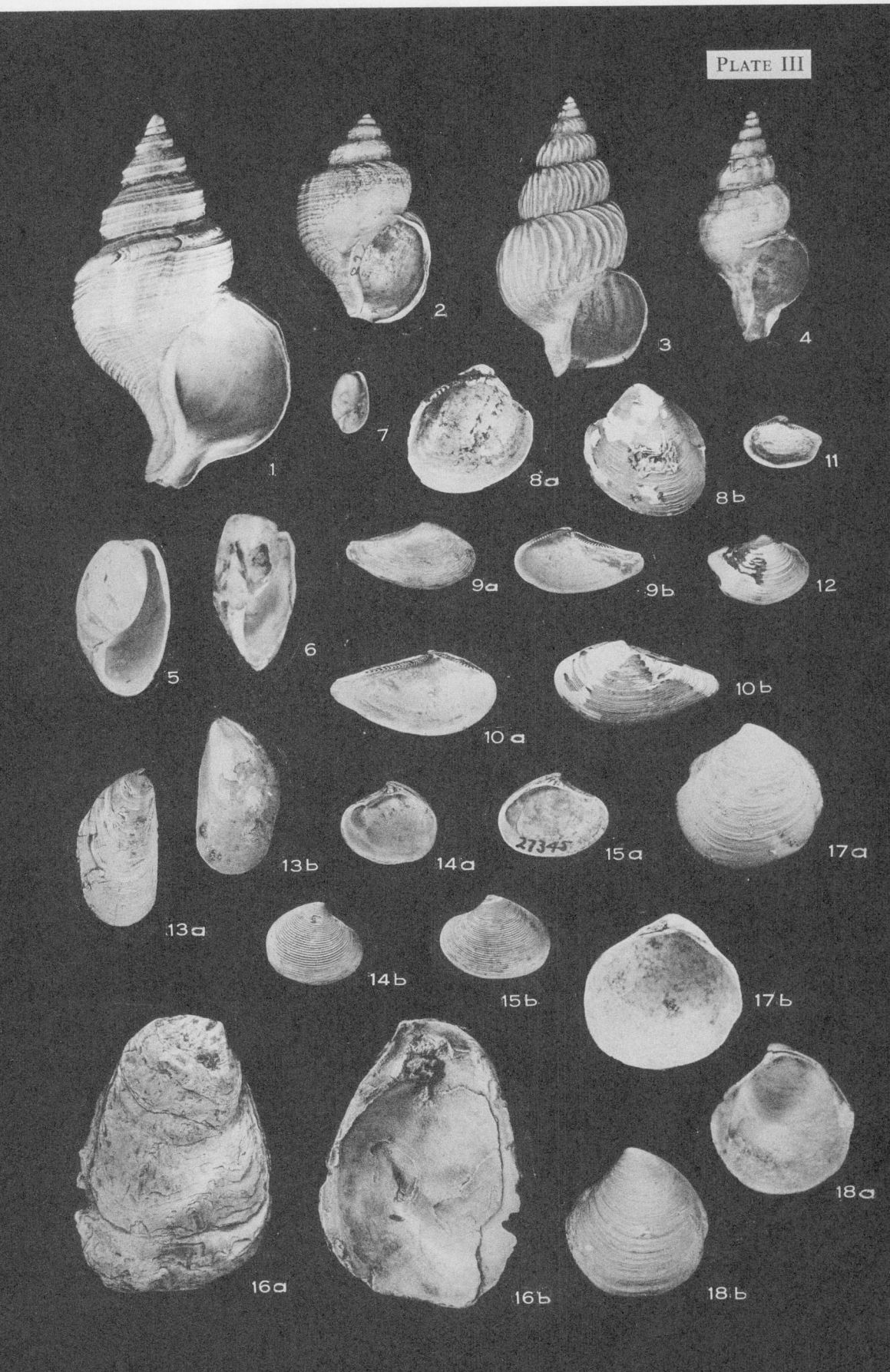


PLATE III
1
2
3
4
5
6
7
8a
8b
9a
9b
10a
10b
11
12
13a
13b
14a
14b
15a
15b
16a
16b
17a
17b
18a
18b
27345

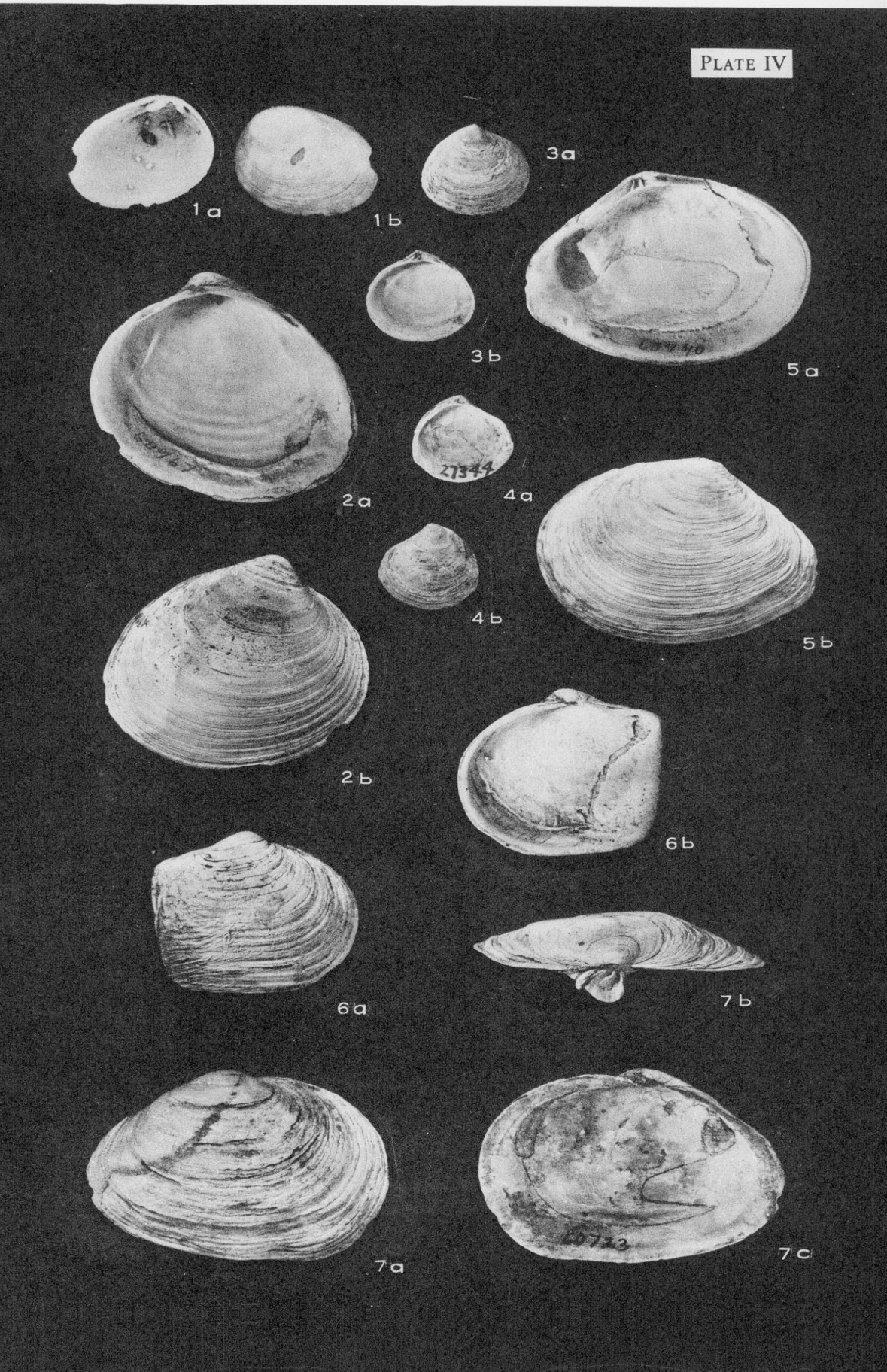


PLATE IV
1a
1b
3a
3b
5a
2a
4a
27344
4b
5b
2b
6b
6a
7b
7a
7c

PLATE IV

Figure 1. *Mysella planulata* (Stimpson) (Page 40)
1a, interior of shell; 1b, exterior of shell, x20, locality 225; hypotype, GSC No. 20155.

Figure 2. *Serripes groenlandicus* (Bruguière) (Page 41)
2a, interior of shell; 2b, exterior of shell, x1, locality 223; hypotype, GSC No. 20156.

Figure 3. *Macoma balthica* (Linné) (Page 41)
3a, exterior of right valve; 3b, interior of right valve, x1, locality 117; hypotype, GSC No. 20157.

Figure 4. *Macoma balthica* (Linné) (Page 41)
4a, interior of left valve; 4b, exterior of left valve, x1, locality 153; hypotype, GSC No. 20159.

Figure 5. *Macoma calcarea* (Gmelin) (Page 42)
5a, interior of left valve; 5b, exterior of left valve, x1, locality 177; hypotype, GSC No. 20158.

Figure 6. *Mya* (*Mya*) *truncata* Linné (Page 43)
6a, exterior of right valve; 6b, interior of right valve, x1, locality 223; hypotype, GSC No. 20161.

Figure 7. *Mya* (*Arenomya*) *arenaria* Linné (Page 42)
7a, exterior of right valve; 7b, chondrophore of left valve viewed from the top; 7c, interior of right valve with pallial line inked, x1, locality 161; hypotype, GSC No. 20160.

PLATE V

Figure 1. *Mya* (*Mya*) *truncata uddevallensis* Forbes (Page 43)
1a, interior of left valve; 1b, exterior of left valve, x1, locality 140; hypotype, GSC No. 20162.

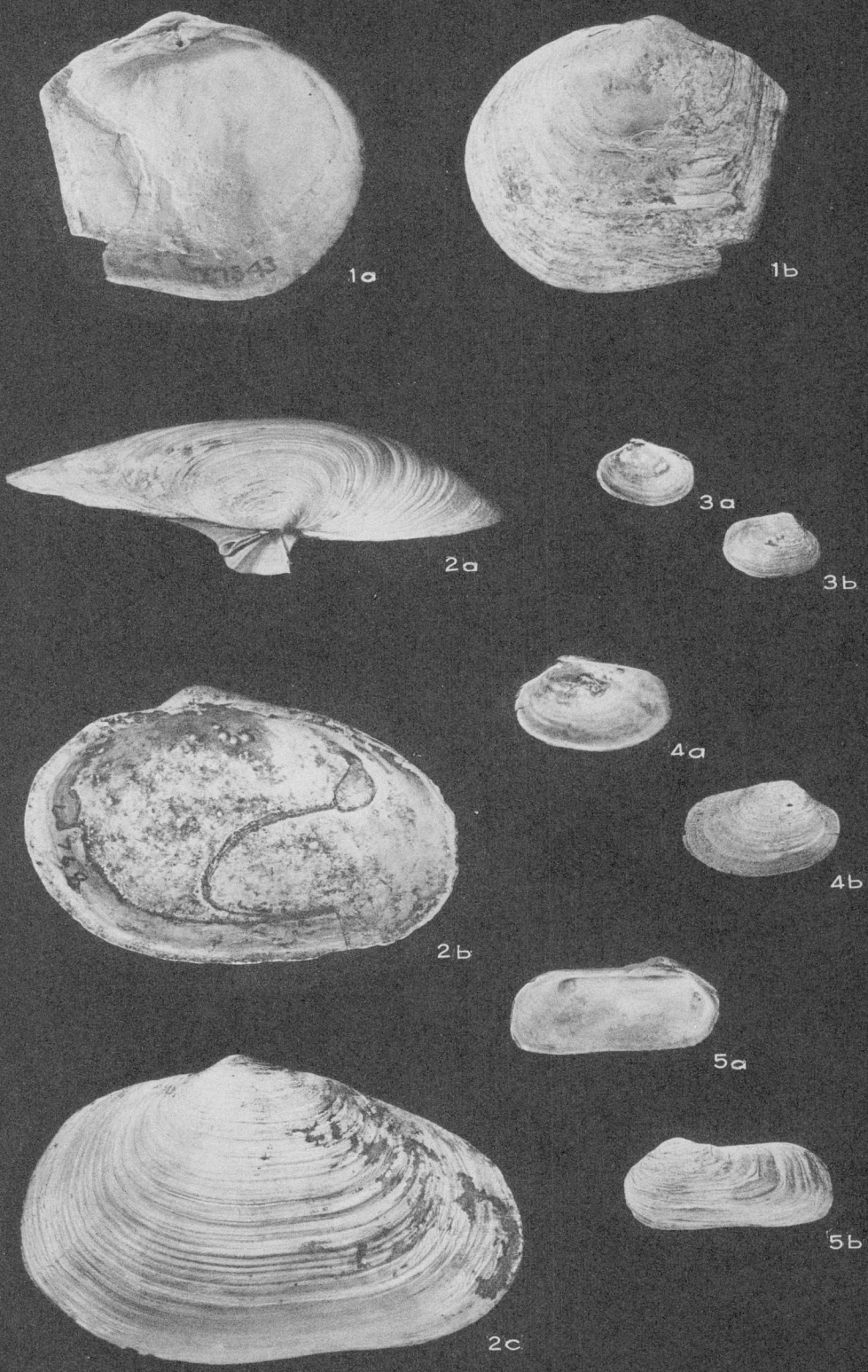
Figure 2. *Mya* (*Mya*) *pseudoarenaria* Schlesch (Page 43)
2a, chondrophore of left valve viewed from the top; 2b, interior of right valve, 2c, exterior of left valve, x1, locality 224; hypotypes, GSC Nos. 20163 (figs. 2a, c), 20163a (fig. 2b).

Figure 3. *Lyonsia arenosa* (Möller) (Page 44)
3a, interior of right valve; 3b, exterior of right valve, x1, locality 205; hypotype, GSC No. 20165.

Figure 4. *Lyonsia hyalina* (Conrad) (Page 45)
4a, interior of right valve of large specimen; 4b, exterior of right valve, x2, locality 223; hypotype, GSC No. 20166.

Figure 5. *Hiatella arctica* (Linné) (Page 44)
5a, interior of left valve; 5b, exterior of left valve, x1, locality 226; hypotype, GSC No. 20164.

PLATE V



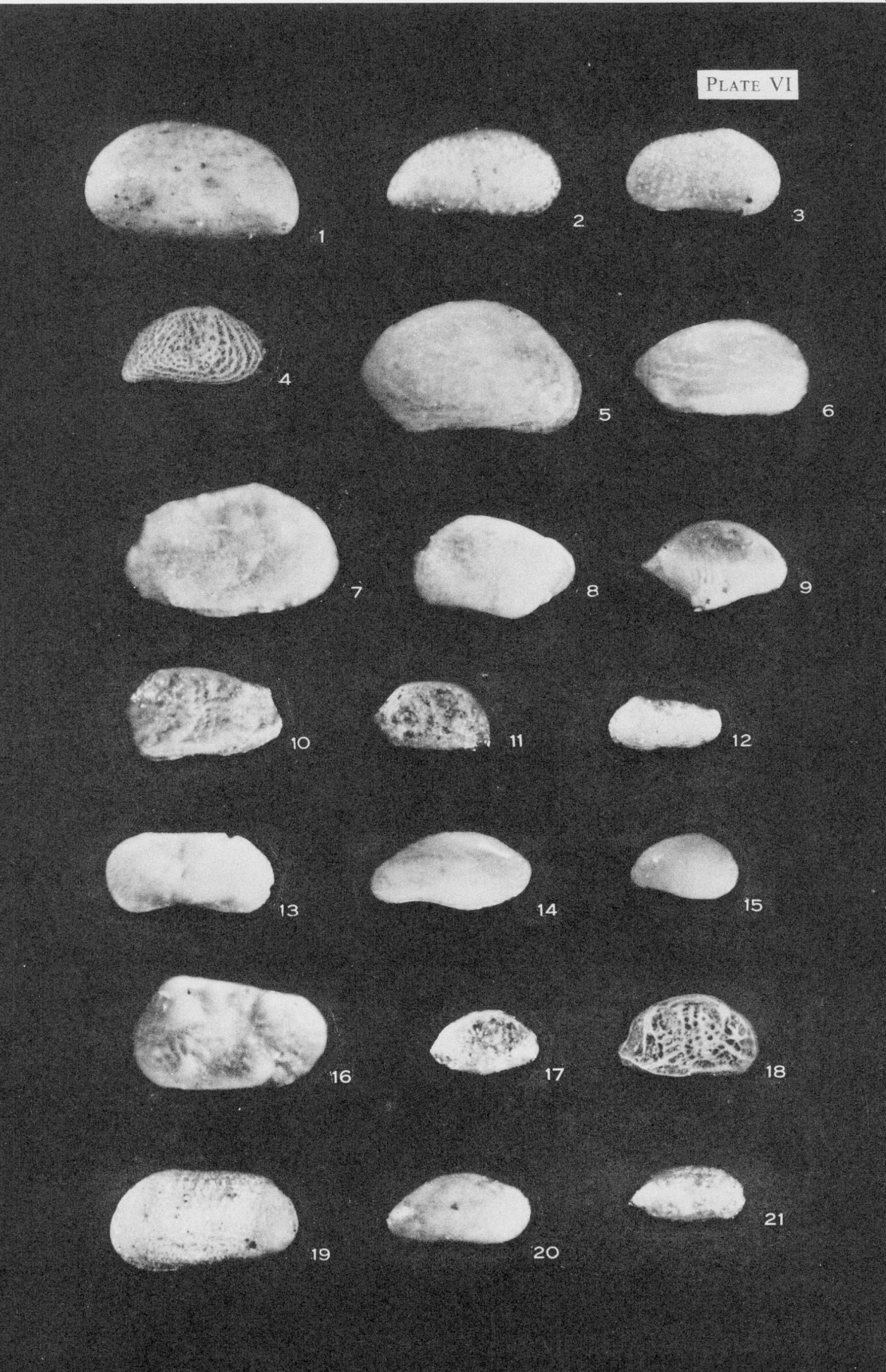


PLATE VI
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

PLATE VI

Figure 1. *Cytheridea* sp. (Page 45)
Exterior of left valve, x40, locality 110; hypotype, GSC No. 20167.

Figure 2. *Paracyprideis pseudopunctillata* Swain (Page 45)
Exterior of right valve, x45, locality 203; hypotype, GSC No. 20168.

Figure 3. *Eucytheridea punctillata* (Brady) (Page 45)
Exterior of right valve, x35, locality 203; hypotype, GSC No. 20169.

Figure 4. *Heterocyprideis sorbyana* (Jones) (Page 45)
Exterior of right valve, x25, locality 141; hypotype, GSC No. 20170.

Figure 5. *Cytherura* sp. (Page 45)
Exterior of right valve, x85, locality 223; hypotype, GSC No. 20171.

Figure 6. *Cytherura* sp. (Page 45)
Exterior of right valve, x90, locality 106; hypotype, GSC No. 20172.

Figure 7. *Cytheropteron* sp. (Page 45)
Exterior of right valve, x65, locality 205; hypotype, GSC No. 20173.

Figure 8. *Cytheropteron* sp. (Page 45)
Exterior of left valve, x65, locality 223; hypotype, GSC No. 20174.

Figure 9. *Cytheropteron* sp. (Page 45)
Exterior of right valve, x40, locality 50; hypotype, GSC No. 20175.

Figure 10. *Baffinicythere emarginata* (Sars) (Page 45)
Exterior of left valve, x45, locality 157; hypotype, GSC No. 20176.

Figure 11. *Hemicytherura* sp. (Page 45)
Exterior of right valve, x45, locality 157; hypotype, GSC No. 20177.

Figure 12. *Leptocythere macchesneyi* (Brady and Crosskey)? (Page 45)
Exterior of left valve, x45, locality 140; hypotype, GSC No. 20178.

Figure 13. *Limnocythere* sp. (Page 45)
Exterior of left valve, x35, locality 47; hypotype, GSC No. 20179.

Figure 14. *Palmenella limicola* (Norman) (Page 46)
Exterior of left valve, x35, locality 223; hypotype, GSC No. 20180.

Figure 15. *Xestoleberis* sp. (Page 46)
Exterior of left valve, x35, locality 50; hypotype, GSC No. 20181.

Figure 16. *Robertsonites logani* (Brady and Crosskey) (Page 46)
Exterior of left valve, x65, locality 223; hypotype, GSC No. 20182.

Figure 17. Ostracod indet. (Page 46)
View of exterior, x40, locality 158; hypotype, GSC No. 20183.

Figure 18. Ostracod indet. (Page 46)
View of exterior, x30, locality 163; hypotype, GSC No. 20184.

Figure 19. Ostracod indet. (Page 46)
View of exterior, x40, locality 163; hypotype, GSC No. 20185.

Figure 20. Ostracod indet. (Page 46)
View of exterior, x45, locality 47; hypotype, GSC No. 20186.

Figure 21. Ostracod indet. (Page 46)
View of exterior, x45, locality 157; hypotype, GSC No. 20187.

## PLATE VII

Figure 1. Ostracod indet. (Page 46)
View of exterior, x40, locality 203; hypotype, GSC No. 20188.

Figure 2. Ostracod indet. (Page 46)
View of exterior, x40, locality 140; hypotype, GSC No. 20189.

Figure 3. *Balanus balanus* (Linné) (Page 46)
3a, top view of adult specimen; 3b, side view of the same, x1. Recent, Atlantic Coast; hypotype, GSC No. 20190.

Figure 4. *Balanus crenatus* Bruguière (Page 47)
4a, top view of cluster of three adult individuals; 4b, side view of the same, x1. Recent, Atlantic Coast; hypotype, GSC No. 20191.

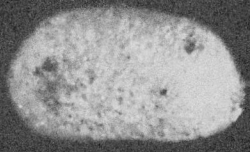
Figure 5. *Balanus hameri* (Ascanius) (Page 47)
5a, side view of adult individual attached to shell of *Placopecten magellanicus* (Gmelin) and reflecting the ribbing of the scallop shell; 5b, top view of the same, x1. Recent, Atlantic Coast; hypotype, GSC No. 20193.

Figure 6. *Balanus hameri* (Ascanius) (Page 47)
6a, side view of adult specimen showing effects of narrow base of attachment on the shell development; 6b, two of the opercular plates (scuta) from 6a, x1, locality 158; hypotype, GSC No. 20192.

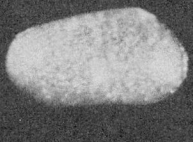
Figure 7. *Astarte laurentiana* Lyell (Page 39)
7a–c, reproductions of Lyell's original figures of *A. laurentiana* (*from* Lyell, Travels in North America, vol. 2, 1845, p. 125).

Figure 8. *Mallotus villosus* (Müller) (Page 48)
Drawing of skeleton preserved in a concretion (*from* Dawson, The Canadian ice age, 1893, p. 266).

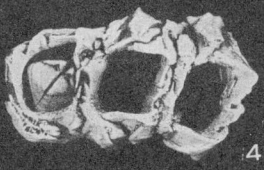
PLATE VII



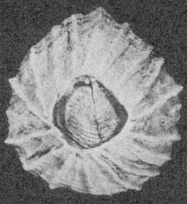
1



2

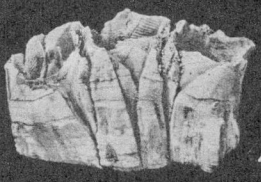


4a

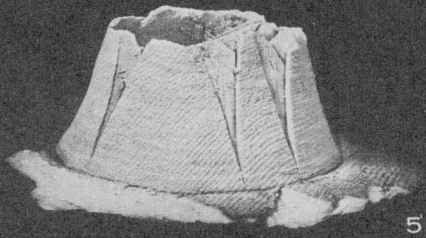


3a

3b



4b

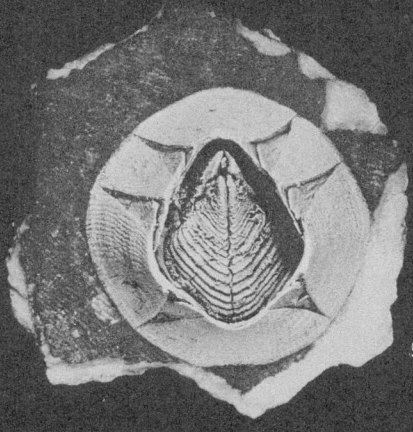


5a

7a

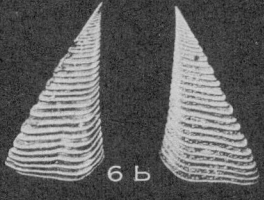
6a

7b

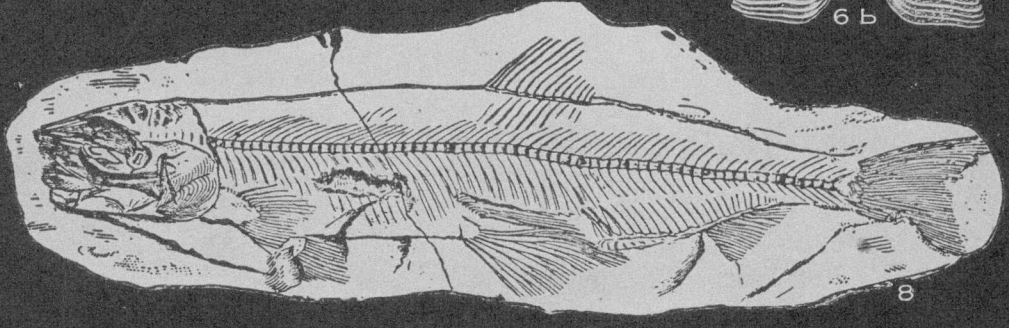


5b

7c



6b



8

# INDEX

Numbers in **bold face** type indicate pages where species are described

## BULLETINS

### Geological Survey of Canada

**Bulletins present the results of detailed scientific studies on geological or related subjects. Some recent titles are listed below (Queen's Printer Cat. No. in brackets):**

155 Middle and Upper Triassic spiriferinid brachiopods from the Canadian Arctic Archipelago, *by* A. Logan, $2.00 (M42-155)

156 A standard for Triassic time, *by* E. T. Tozer, $4.00 (M42-156)

157 Lower Palaeozoic sediments of northwestern Baffin Island, *by* H. P. Trettin, $2.00 (M42-157)

158 Hettangian ammonite faunas of the Taseko Lakes area, B.C., *by* Hans Frebold, $2.00 (M42-158)

159 Study of pegmatite bodies and enclosing rocks, Yellowknife-Beaulieu region, District of Mackenzie, *by* R. Kretz, $3.00 (M42-159)

160 The geochemistry of silver and its deposits, *by* R. W. Boyle, $6.50 (M42-160)

161 Petrology and structure of Nakusp map-area, British Columbia, *by* D. W. Hyndman, $2.75 (M42-161)

162 The pyroxene granulites of the Mount Wright map-area, Quebec–Newfoundland, *by* R. A. Roach and Stanley Duffell, $2.50 (M42-162)

163 Contributions to Canadian palaeontology: Lower Cambrian faunas from Ellesmere Island, District of Franklin, *by* J. W. Cowie; a Middle Cambrian *Plagiura–Poliella* faunule from southwest District of Mackenzie, *by* B. S. Norford, $1.75 (M42-163)

164 Silurian cephalopods of James Bay lowland, with a revision of the Family Narthecoceratidae, *by* R. H. Flower, $5.00 (M42-164)

165 Contributions to Canadian palaeontology, *by* J. A. Legault, D. L. Dineley, and H. Jessen, $2.50 (M42-165)

167 Magnetization direction in the Muskox Intrusion and associated dykes and lavas, *by* W. A. Robertson, $1.50 (M42-167)

168 Structure of the Northern Foothills and Eastern Mountain ranges, Alberta and B.C., *by* E. J. W. Irish, $2.00 (M42-168)

169 Late upper Devonian (Famennian) rhynchonellid brachiopods from western Canada, *by* Paul Sartenaer, $8.00 (M42-169)

170 Middle Triassic (Anisian) ammonoids from northeastern B.C. and Ellesmere Island, *by* F. H. McLearn, $3.00 (M42-170)

171 Pre-Mississippian geology of northern Axel Heiberg and northwestern Ellesmere Islands, Arctic Archipelago, *by* H. P. Trettin, $2.00 (M42-171)

172 The contact metasomatic magnetite deposits of southwestern British Columbia, *by* D. F. Sangster, $2.00 (M42-172)

173 Heavy mineral studies in the Klondike area, Yukon Territory, *by* C. F. Gleeson, $2.00 (M42-173)

176 Ordovician and Silurian stratigraphy of the southern Rocky Mountains, *by* B. S. Norford, $2.75 (M42-176)

177 Geochemical prospecting for petroleum and natural gas in Canada, *by* A. H. Debnam, $1.00 (M42-177)

178 The Clearwater Complex, New Quebec, *by* H. H. Bostock, $2.00 (M42-178)

180 Stratigraphy and structure of the "Keno Hill Quartzite" in Tombstone River – Upper Klondike River map-areas, Yukon Territory, *by* D. J. Tempelman-Kluit, $3.00 (M42-180)

181 Faunas of the Pleistocene Champlain Sea, *by* Frances J. E. Wagner, $3.00 (M42-181)

182 Contribution to Canadian paleontology, *by* B. S. Norford, *et al.*, $6.00 (M42-182)

183 Geology of Ordovician to Pennsylvanian rocks, M'Clintock Inlet, north coast of Ellesmere Island, Canadian Arctic Archipelago, *by* H. P. Trettin, $2.00 (M42-183)

184 Stratigraphy of the Devonian Southesk Cairn carbonate complex and associated strata, eastern Jasper National Park, Alberta, *by* W. S. MacKenzie, $2.00 (M42-184)

185 Barremian Textulariina, Foraminiferida from Lower Cretaceous beds, Mount Goodenough section, Aklavik Range, District of Mackenzie, *by* T. P. Chamney, $2.50 (M42-185)