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An Introduction to the Cenozoic Ostracoda (Crustacea) of Arctic and Eastern Canada

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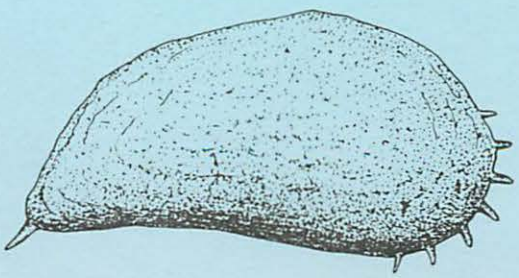

NOVA SCOTIA MUSEUM

Curatorial Reports

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Abstract

This report provides an introduction to the study of Ostracoda (Crustacea) in Eastern and Arctic Canada, with a historical review of research in Nova Scotia. Although no full species list exists as yet, a list of genera and species is provided as a basis for further research.

INTRODUCTION

Ostracods, sometimes called seed shrimps, are minute aquatic crustaceans with a fossil record 600 million years long. Their carapaces provide some of the most useful and beautiful of the microfossils. Different species are found in all natural waters including acid bogs and streams. They inhabit glacier lakes, hot springs, subterranean waters, bromeliad cups, ponds, lakes including salt lakes, estuaries, all marine environments from planktonic to abyssal benthic, and also swamps and wet litter on the floors of some tropical forests. Their fossil carapaces occur in rocks of all ages back to the Cambrian-Precambrian boundary (600 million years); some, which have fossilized in extraordinary circumstances, even include appendages.

WHAT ARE OSTRACODS?

Being crustacea, the ostracods have segmented bodies and jointed appendages covered with an impermeable integument of chitin. However, the segments have been reduced and coalesced to form a corpus slightly constricted in the region of the mouth, and the chitinous exoskeleton has been extended to enclose the whole animal in a bivalved carapace. The carapace is usually calcified and is the part most often fossilised. The valves are hinged along the back, under the layer of chitin, and are held in place in relation to one another by more or less complex arrangements of teeth or bars, and sockets. The carapace provides anchorage for the limb muscles, and also has a group of adductor muscles which close the valves. The free edges are equipped for sensory and other functions and often have a set of lists (ridges) which interlock to keep the valves shut. Traces of all these functions can be seen on the carapace, and are of taxonomic importance. The outside is often beautifully sculptured, displaying all variations from polished surfaces to complex ridges, reticulae or spines. The carapace may be translucent or opaque, but nearly always has a translucent area or tubercle near the front of the hinge, where the single eye is located. The planktonic species have translucent leathery carapaces usually with an eye in the middle of each side.

The biramous, jointed limbs of crustacea tend to be numerous and serially uniform at least behind the mouth. In ostracods, the limbs have been reduced to a remarkably stable total of seven pairs. These are completely enclosed by the carapace, together with the reproductive structures and the caudal furcae which always terminate the body posteriorly and may be quite large. The male reproductive organ is bulky and the female in some families includes a brood pouch inside her carapace. Since most ostracods are less than 1mm long and .5mm high as adults, this is one of the most elegant packing jobs in nature.

Typically the sexes are separate, fertilization is internal and females lay eggs which hatch into crustacean nauplii. These grow by a series of moults, and there are eight instars, including the hatchling and the adult. In some freshwater species, males are very scarce or absent, and the females reproduce parthenogenetically. In most species sexual dimorphism is apparent in the carapaces.

Ostracods are almost all free living; some are planktonic, but the majority live on or around the bottom, walking in mud, climbing plants and other objects or swimming for short distances. Some of the climbers let themselves down again by threads spun from glands in their antennae. Feeding habits differ widely, many ostracods being detritus or perhaps bacterial feeders. Some will eat carrion and can be attracted to pieces of meat, and some have sucking mandibles and feed on plant juices. At least one local species preys on smaller crustacea.

The crustacea are an ancient group, already established by the beginning of the Cambrian. As those with uncalcified exoskeletons are very seldom found as fossils, the relationships between the various classes are not at all clear. The ostracods, which show affinities with the cirripedes (barnacles) and the Cladocera (water fleas, Daphnia), are known to be among the oldest, and are informally classified with six other classes as the Entomostraca. These are usually small animals which are often very abundant (e.g., copepods, cladocerans and cirripedes) and may be specially adapted to marginal environments such as temporary waters and supersaline lakes (e.g., brine, tadpole and clam shrimps). The ostracods are both abundant and versatile; they are the most abundant planktonic crustacea in the Indian Ocean, and they may be the only crustacea present in marginal habitats. The ostracod blueprint is obviously an adaptable and successful one.

ECONOMIC USE

Throughout geological time, the ostracods have had many evolutionary radiations, some local, some worldwide, the resulting species often being associated with very specific habitats. Ostracods appear to be particularly affected by changes in salinity and by temperature. Consequently, their fossil remains can be used to interpret past history, especially the alternations of marine and freshwater conditions and alterations in climatic temperature. In this they support the Foraminifera (Protozoa) which are nearly all marine; though the forams are much more abundant in marine deposits than the ostracods, there are occasions when they do not give such precise information. Ostracod fossils can also be used in elucidating the past histories of lakes, and are utilized in the correlation of geological horizons disclosed by drilling and coring activities.

RESEARCH ON THE NORTH ATLANTIC OSTRACODS

The history of ostracod research in the western North Atlantic and adjacent Arctic seas began with European scientists about the middle of the nineteenth century. T. R. Jones, a geologist, described a number of microfossil species from the Tertiary deposits of England. One of these was Heterocyprideis sorbyana (Jones 1857), a beautifully ornamented animal which seems to have continued unchanged for more than 5 million years. It is a circumpolar species found in marine waters from estuaries to the upper continental slope, and its southern boundary in the Western North Atlantic is probably close to Nova Scotia's south shore. It is one of our commonest marine species.

The most eminent ostracodologists were the Scot, David Robertson (1806-1896, Founder of the Marine Biological Station at Milport in the Firth of Clyde) and the North Britons G. S. Brady (1832-1921) and A. M. Norman (1831-1918). These three men explored and described the ostracod fauna of the British Isles. The ostracods collected on the oceanographic voyages of the day were referred to them and they had a worldwide circle of correspondents with whom they exchanged material. Brady reported on the ostracods of the Challenger Expedition (1873-1876) and the British Arctic Expedition (1875-1876); he and Robertson were correspondents of J. F. Whiteaves, who collected ostracods in the course of his explorations of Eastern Canadian waters (1871-1873). G. O. Sars (1837-1927), the Norwegian scientist who is famous for his thorough and beautiful drawings of crustacea, summarised his knowledge at the end of his life in the monographic series titled "An Account of the Crustacea of Norway". He was working on the ostracod volume at the time of his death a few days short of his ninetieth birthday; the volume was finished by his colleagues from his notes. Because of his excellent drawings, one is seldom in doubt as to the characteristics of species discussed by Sars. The other naturalists were not so gifted, and often made very small drawings of valves only, which were inadequate for identification purposes. Although most Arctic species are also found in Europe, the number of species common to both sides of the Atlantic decreases with distance southward; before this was realised, many misidentifications had been made by persons who had no resources other than the old European literature.

From about 1920 on, ostracods were ignored by most biologists but because of their importance as fossils, description and taxonomy were carried on by geologists, the work often being financed by oil companies. As a result, geologists having only the carapaces to examine, taxonomic assignments ignored the appendages completely. In the 1960's, a group of scientists, mostly geologists, founded the International Symposia on Ostracoda, which holds meetings every two or three years in different places where live or fossil ostracods are common. This provides a focus for research

on ostracods and also gives participants a chance to increase their knowledge through field collecting. Since the inception of the Symposia, a great deal of work on anatomy and systematics has been published, and taxonomy and biogeography are being revised. In addition, the specimens and notes left by the nineteenth century naturalists are being found and re-examined.

The concept of faunal provinces is another legacy from the mid-nineteenth century. A faunal province is a geographic area in which the species composition of the animal assemblage differs considerably from those of neighbouring areas. This was a useful concept in the early days of marine research but as information accumulated it became obvious that all boundaries overlapped; the "provinces" tended to vary according to the interest of the user, or perhaps were controlled by the boundaries of shifting water currents. The Nova Scotian Marine Faunal Province has been used as a unit in distribution studies on benthic invertebrates including ostracods, and is defined as the coastal, shelf and slope region between Cape Cod, Massachusetts, in the south, and Cape North, Cape Breton Island (or mid-Cabot Strait!) in the north. It is an overlap area between arctic and southern water masses, but it is in fact an area where the northern and southern ranges of many warm and cold-water species respectively end. It is mentioned here because of its historical interest, and because it is the reason why ostracod records from outside Canada have been included. J. E. Hazel discussed the Western North Atlantic Provinces in his 1970 paper.

The compilation of records specifically on post-Tertiary ostracod species and their distribution in the Maritimes began when Dr. Q. A. Siddiqui came to Saint Mary's University Geology Department as Lecturer in Paleontology in 1968. In 1970 J. E. Hazel (USGS) had published a list of offshore species from the N.W. Atlantic including those from the nineteenth century collections, but mostly from series of explorations carried out by the U. S. Government. He also revised the important families Trachyleberidae and Hemicytheridae (Hazel,1967). In 1975, a preliminary list of inshore species was published by Q. A. Siddiqui in collaboration (Siddiqui and Grigg, 1975); a list of ostracods from the Strait of Canso was published the same year by Carolyn Ferguson (Dalhousie University: Cole & Ferguson, 1975). Recently R. H. Benson, R. M. Del Grosso and P. L. Steineck (1984) published a paper on the distribution and ecology of ostracods on the continental slope and rise east of Newfoundland. Most of these papers are illustrated with scanning electron micrographs of the species mentioned.

All of this work has indicated that the marine ostracod fauna of Atlantic Canada is derived partly from Arctic and Northern European assemblages, partly from further south, and that it probably contains an endemic element. This agrees with what has been found in other living invertebrates, such as the molluscs and the polychaete worms.

There is considerable interest in North America in our local ostracods as fossils. They are being used in investigations to establish the geological history and ancient climates of the Scotian and Labrador Shelves. Many of them occur in cores and drillholes being sampled in the Beaufort Sea and in Alberta, also living in surface samples from the Arctic Shelf. Two parties from USGS are working on similar material, one in Alaska and one on the east coast of the United States: there are also at least two U.S. University Geology Departments doing research on the benthic ostracods of Arctic seas. On the European side, similar research is being carried out by Russian, English, German and Scandinavian scientists among others. The work being done here in Nova Scotia therefore is of international significance.

The total ostracod collection of the Nova Scotia Museum consists of one named species, deposited by the author. There must be others, buried in various accumulations, and probably deteriorating, as they disintegrate if stored wet, and lose their appendages if stored dry. A properly preserved reference collection for the N.S.M. should be made up as soon as possible.

THE COLLECTION AND STUDY OF OSTRACODS

There are several reasons why the study of ostracods has been neglected. Their benthic habits result in a great deal of tedious picking through sediment and organic debris which has to be done under a microscope. One then has to dissect out the minute appendages from inside the opaque carapace for examination of taxonomically important details - dissection often results in broken valves, which are consequently useless for dry mounts.

Ostracod valves and carapaces can be found by sieving fine sediment obtained from quiet reaches of such aquatic habitats as lake margins, rock pools, saltmarsh pools and hollows in deep water. Sediments for sieving can also be obtained by sampling cores or by collecting at exposed fossiliferous sites on land. The mesh sizes used are 1/4" (1 cm), to remove sticks and stones, 1 mm to remove small molluscs, grit and other items, and either .25 mm or .063 mm, which yields most of the ostracods. The finer the mesh the more tedious the sorting becomes; however, the .25 mm mesh loses some species and many of the juveniles. If only dead material is present, the sediment is then dried on filter paper and examined under a microscope at 6-80X magnification. The valves are picked out with the tip of a damp, fine paintbrush, and stuck on a cardboard microscope slide with gum tragacanth.

If some of the ostracods are living, they can be seen moving about in a shallow dish of water and picked out with a Pasteur pipette. Living ostracods can also be collected by washing seaweed or waterplants briskly in a bucket of water and then pouring the water through the sieves. Planktonic species are caught with a standard plankton net; they are not common, however, near the coast.

Some of the fresh-water species lay eggs which can be dried, frozen, freeze-dried or stored in brine without affecting their viability. For this reason, naturalists used to exchange samples of dried mud or mud recently thawed for the purpose of hatching ostracods and other Entomostraca; the habit has been resumed among ostracod workers recently. The mud sample is put in a jar with distilled or deionized water and aerated with a gentle stream of bubbles. The jar must be examined daily for nauplii, as some of the species hatch, grow, lay eggs and die all within a fortnight. The jar must also be kept in a bright but not sunny place so that small organisms will grow for the nauplii to feed on.

Collecting equipment can easily be improvised; a wire coat-hanger and a leg of nylon hosiery make a useful plankton net. A camp-stove fuel tin can be converted to a small dredge by having its ends cut off; a tow bar is then formed by nailing a dowel between ears cut from the short sides, and a bag is tied on to the curled up bottom edges. For a handy sieve series, a kitchen sieve (mesh size usually about 1 mm), a "soft" aquarium net from a petshop (mesh varies but is very fine) and a plastic mixing bowl serve very well: the sample is washed in the kitchen sieve,ostracods go through into the mixing bowl, and the fraction is then freed of mud by being poured into the aquarium net. Samples need not be large: some famous collections have been made from lumps of mud brought up on ships' anchors and other equipment.

Recently collected ostracods survive well if there are no violent temperature changes: this usually means storing them in a refrigerator. If it is not possible to keep the temperature stable, or if the sample cannot be examined within a day or so, the catch should be frozen.

Once picked out, whole ostracods are preserved in 70% ethyl alcohol, and carapaces and valves are stored dry, usually in special cardboard microscope slides. Dissected limbs can be mounted on glass microscope slides using any biological mounting medium suitable for crustacea (polyvinyl lactophenol, CMC-S). When set, the slides should be sealed with lacquer (nail varnish).

ACKNOWLEDGEMENTS

Many ostracod specimens have been contributed by scientists who have collected benthic material for other purposes; these donors include Dr Gus Vilks, Dr Peta Mudie, Iris Hardy and Tony Cole from the Atlantic Geoscience Centre, and Dr David Scott of Dalhousie University Geology Department. Industrial clients of Scotia Biological Services Ltd. have also allowed me to keep the ostracods from their samples.

Dr Q. A. Siddiqui, who first introduced me to these fascinating animals, helped me with the taxonomy and systematics.

The scientific staff of the Nova Scotia Museum, especially Dr Derek Davis and Barry Wright, have provided advice, encouragement, and editorial help. Fred Scott drew Heterocyprideis sorbyana for the cover. Gloria Jewers and Doris Cruikshank typed the drafts and final copy.

REFERENCES

Benson, R. H., DelGrosso, R. M., and Steineck, P. L. 1984. Ostracode distribution and biofacies, Newfoundland continental slope and rise. Micropaleontology Vol. 29, no. 4, pp 430-453.

Cole, F. E., and Ferguson, C. 1975. An Illustrated Catalogue of Foraminifera and Ostracoda from Canso Strait and Chedabucto Bay, Nova Scotia. Report Series/Bl-R/75-5.March 1975.

Cronin, T. M. 1981. Paleoclimatic implications of Late Pleistocene marine ostracodes from the St. Lawrence lowlands. Micropaleontology Vol.27, no.4, pp 384-418.

Hartman, G., and Puri, H. S. 1974. Summary of Neontological and Paleontological classification of Ostracoda. Mitt. Hamburg. Zool. Mus. Inst. Bd. 70, s. 7-73.

Hazel, J. E. 1967. Classification and Distribution of the Recent Hemicytheridae and Trachyleberididae (Ostracoda) off North eastern North America. U.S. Geological Survey Professional Paper 564.

_____ 1970. Atlantic Continental Shelf and Slope of the United States: Ostracode Zoogeography in the Southern Nova Scotian and Northern Virginian Faunal Provinces. U. S. Geological Survey Professional Paper 529-E.

Joy, J. A. and Clark, D. L. 1977. The distribution, ecology and systematics of the benthic ostracoda of the Central Arctic Ocean. Micropaleontology Vol.23, pt.2, pp 129-154.

Siddiqui, Q. A. and Grigg, U. M. 1975. A Preliminary survey of the Ostracodes of Halifax Inlet. Bull. Amer. Paleontology Vol. 65, no.282, pp 369-379.

CHECKLIST OF OSTRACODS

The following is a working list of ostracod species which have been reliably reported from eastern and northern Canada or just outside its boundaries. The names are taken from three sources, of which the first is the pioneering work of the English ostracodologists, G. S. Brady, D. Robertson and A. M. Norman, who included species from the North Atlantic coast in some of their publications. The second source is the group of recent papers already mentioned: references to these are given on page seven of this report and earlier literature can be reached through them. The third source is the material accumulated by Siddiqui and Grigg. Identifications from general fauna surveys have been left out for the time being, and so have identifications made by Siddiqui and Grigg but not yet verified. The last category includes most of the fresh water species.

The list comprises species found between Cape Cod, Massachusetts, and the Canadian boundary with Alaska, outwards to the Continental slope, and from adjacent coastal areas. The species listed by Joy and Clark (1977) from the region of the Chukchi Sea have been included because they are likely to be found around the Canadian Archipelago. All species listed are Cenozoic; most are still living. There are more than 165 species.

The systematic placement follows Hartmann and Puri (1974) as far as the Suborders, but Families, Genera and Species are arranged alphabetically.

This list undoubtedly contains some synonyms and errors and is presented here as a basis for further research.

CHECKLIST OF THE OSTRACODA

Order Myodocopida (marine, including planktonic species)

Family Cylindroleberididae
Parasterope pollex Kornicker 1967

Family Cypridinidae
Cypridina excisa Stimpson
norvegica Baird 1860
Philomedes globosus (Lilljeborg 1853)
interpuncta Baird

Family Halocypridae
Conchoecia borealis Sars 1865
elegans Sars 1865
haddoni Brady & Norman 1896
obtusata Sars 1865
spp.
Halocypris globosa (Claus 1874)

Family Polycopidae
Polycope arcys Joy & Clark 1977
bireticulata Joy & Clark 1977
bispinosa Joy & Clark 1977
horrida Joy & Clark 1977
inornata Joy & Clark 1977
moenia Joy & Clark 1977
orbicularis Sars 1865
punctata Sars 1870
semipunctata Joy & Clark 1977
spp.

Family Sarsiellidae
Sarsiella zostericola Cushman 1906

Order Podocopida
Suborder Platycopa (marine)

Family Cytherellidae
Cytherella luster
ovata? (Roemer 1841)

Suborder Podocopa (marine, brackish, freshwater)
Superfamily Cytheracea (all marine or brackish except for one family)

Family Bythocytheridae
Bythoceratina spp.
Bythocythere spp.
Jonesia simplex (Norman 1865)
Pseudocythere caudata Sars 1866

Family Cushmanideidae
Cushmanidea seminuda (Cushman 1906)
spp.
Hulingsina spp.

Family Cytherettidae
Cytheretta edwardsi (Cushman 1906)
teshekpukensis Swain 1963

Family Cytheridae
Cythere lutea Müller 1785
Cytheromorpha curta Edwards 1944
fuscata (Brady 1868)
macchesneyi Brady & Crosskey 1871
spp.
Microcytherura sp.A Siddiqui & Grigg 1975
Munseyella atlantica Hazel & Valentine 1969
mananensis Hazel & Valentine 1969
Palmenella limicola (Norman 1865)
Perissocytheridea sp.A
Neolophocythere subquadrata Grossman 1966
Tetracytherura spp.

Family Cytherideidae
Cytheridea elongata? Brady
papillosa Bosquet
Cytherideis foveolata Brady 1870
Heterocyprideis sorbyana (Jones 1856)
Sarsicytheridea bradii (Norman 1865)
punctillata (Brady 1865)
macrolaminata (Elofson 1939)

Family Cytheruridae
Cytheropteron alatum Sars 1866
cf. *alatoides* Blake 1929
angulatum Brady & Robertson
arcuatum Brady, Crosskey & Robertson 1874
champlainum Cronin 1981
inflatum Brady, Crosskey & Robertson 1874
latissimum (Norman 1865)
montrosiense Brady, Crosskey & Robertson 1874
nealei Cronin 1981
nodosum Brady 1868
parallatissimum Swain 1963
pyramidale (Brady 1868)
subcircinatum Sars 1865
sulense Lev 1972
testudo Sars 1869
tumefactum Lev 1972
vespertilio? Reuss
spp.

Cytherura atra Sars 1865
concentrica Crosskey, Brady & Robertson
cristata Brady & Crosskey
elongata Edwards 1944
gibba (O.F.Müller 1785)
granulosa Brady & Crosskey 1871
C.? mainensis Hazel & Valentine 1969
pumila Crosskey, Brady & Robertson
C.? rudis Brady
C.? similis Sars 1865
C.? undata Sars 1866
spp.
Hemicytherura clathrata (Sars 1866)
Semicytherura wardensis (Howe & Brown 1935)
nigrescens (Baird 1838)

Family Eucytheridae
Eucythere argus (Sars 1865)
declivis (Norman 1865)
spp.

Family Hemicytheridae
Aurila aff. A. amygdala (Stephenson)
Baffinicythere emarginata (Sars 1865)
howei Hazel 1967
Elofsonella concinna (Jones 1857)
Finmarchinella angulata (Sars 1865)
finmarchica (Sars 1865)
logani (Brady & Crosskey 1871)
Hemicythere angulata (Sars 1865)
borealis (Brady)
concinna (Jones 1896)
latimarginata (Speyer)
pulchella (Brady)
villosa (Sars 1865)
Muellerina abyssicola (Sars)
canadensis (Brady 1870)
lienenklausi (Ulrich & Bassler 1904)
Normanicythere leioderma (Norman 1869)
Patagonacythere dubia Brady
Thaerocythere crenulata (Sars)
sp.

Family Krithidae
Krithe glacialis Brady, Crosskey & Robertson 1874
sp.D Peypouquet 1979
spp.
Paracyprideis pseudopunctillata Swain 1963

Family Leptocytheridae
Cluthia clathae (Brady, Crosskey & Robertson 1874)
Leptocythere angusta Blake 1929
crispata Brady

darbyi Keyser 1976
nikraveshae Morales 1966
pellucida Baird
quebecensis Cronin 1981
spp.

Family Limocytheridae (freshwater)
Limnocythere sp.

Family Loxoconchidae
Hirschmannia viridis (Müller 1785)
Loxoconcha sp.A
granulata Sars 1866
impressa (Baird 1850)
sperata Williams 1966
spp.
Roundstonia globulifera Brady 1868

Family Neocytherideidae
Sahnicythere faveolata (Brady 1880)
spp.

Family Paradoxostomatidae
Acetabulostoma arcticum Shornikov 1970
Cytherois fischeri (Sars 1866)
Paradoxostoma obliquum Sars 1865
variabile (Baird 1835)
spp.
Schlerochilus contortus (Norman 1835)
spp.
Xiphichilus sp.

Family Pontocyprididae
Argilloecia cf. conoidea Sars 1866
aff. sp.7 Maddocks 1969
spp.
Propontocypris edwardsi (Cushman 1906)

Family Trachyleberidae
"Acanthocythereis" cuspidata (Brady & Crosskey 1871)
Acanthocythereis dunelmensis (Norman 1865)
Actinocythereis dawsoni (Brady 1870)
aff. gomillionensis (Howe & Ellis)
vineyardensis (Cushman 1906)
spp.
Bensonocythere americana Hazel 1967
arenicola (Cushman 1906)
spp.
"Cythere whitei" Baird
Echinocythereis dasyderma Brady 1880
echinata (Sars 1866)
planibasalis procteri (Blake 1933)

Pterygocythereis inexpectata (Blake 1933)
Puriana rugipunctata (Ulrich & Bassler)
Rabilimis mirabilis (Brady 1868)
paramirabilis (Swain 1963)
septentrionalis (Brady 1866)
Robertsonites tuberculatus (Sars 1865)

Family Xestoleberidae
Xestoleberis aurantia Baird 1838
depressa (Sars 1865)

Superfamily Cypridacea (freshwater)
Family Cyprididae
Cyprinotus glaucus Furtos 1933

Family Candonidae
Cypria sp.
Candona subtriangulata Benson & MacDonald 1963
spp.

Family Cypridopsidae
Cypridopsis vidua Müller 1776

Family Ilyocyprididae
Ilyocypris gibba (Ramdohr 1808)
sp.