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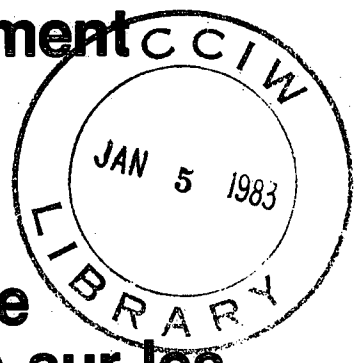


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**DISTRIBUTION OF AN ARCTIC OSTRACODE FAUNA
IN SPACE AND TIME**

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DISTRIBUTION OF AN ARCTIC OSTRACODE FAUNA IN SPACE AND TIME

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ABSTRACT

If one finds a particular type of fossil organism which as present is restricted to a certain geographic locality several hundred or thousand kilometers away from its modern counterpart, what can be said about the paleoenvironment of the fossil locality? Can a chronology of events be established for the fossil locality?

A fossil locality on the Pembina Upland, in southern Manitoba (Delorme, 1971), contains three or four ostracode species (seed shrimp) near the base of the deposit. Two of these ostracodes, Candona rectangulata and Cyclocypris globosa are found alive only in the northern parts of the Northwest and Yukon Territories of Canada. Both species are indicative of subarctic forest tundra and alpine tundra. Their position in the lower 69 cm of the deposit indicates that, as the glacial ice thinned over the upland and retreated from the Agassiz basin, a tundra-like environment could have existed with the potential for tundra vegetation to develop.

A reverse situation occurred in the Northwest Territories based on ostracode fossils from a peaty marl deposit at the east end of Jiggle Lake. Seven species were found in the deposit. As reported by Delorme et al. (1977) for other similar sites, the striking element is the absence of true Arctic ostracodes. The majority of the species live very successfully further south in Manitoba and Saskatchewan at the present time.

FOSSIL COLD WATER FAUNA AT A PRESENT DAY WARM WATER SITE

In a survey of freshwater ostracodes in Canada, a total of 6720 biological freshwater samples were collected. The lakes, ponds, and streams sampled were in the provinces of British Columbia to the Ontario/Quebec border, and north into the Northwest and Yukon Territories. The area sampled in the north was along the Mackenzie Valley Transportation corridor. From the total samples collected, the species Candona rectangulata and Cyclocypris globosa occur only in the Canadian Territories. The species Cytherissa lacustris occurs south of latitude 60°, and is restricted in the provinces to large, cold water lakes. Cyclocypris globosa has been recovered south to about a latitude of 65° and Candona rectangulata as far south as latitude 62°.

The climatic zones in which these species live are taiga and alpine (forest-tundra). Between 62° and 65° latitude, there is the entry of the sub-boreal (Burns, 1973) climatic zone. Within the area referred to, the mean annual temperature varies between -11.95 to 6.9°C, annual precipitation varies from 12.1 to 47.6 cm, and the potential evapotranspiration is from 34.4 to 56.2 cm. According to Brown (1970), the area lies within both the continuous and discontinuous permafrost zones.

The three species listed above are found in these climatic zones. All but Cytherissa lacustris are restricted to it. Table 1 indicates the

ranges for the climatic parameters for each species according to the number of times they have been found in the environment.

The chemical characteristics of the habits in which these species live are given in table 2.

In general it can be seen that the three species are truly fresh-water forms. Candona rectangulata has a broad tolerance range to sodium chloride, as it is found in some coastal ponds which receive sea spray. The other two species do not have this tolerance to sodium chloride.

Somerset Site

In 1971, Delorme enumerated the ostracode fauna obtained from a core near Somerset, Manitoba. The core was obtained from a pond on the Pembina Upland, some 24 km west of the eastern edge of the Glacial Lake Agassiz basin. Three ostracode species, Candona rectangulata (noted as C. willmani in the paper, now is synonymy with C. rectangulata), Cyclocypris globosa, and Cytherissa lacustris, identified what Delorme referred to as zone 1, subzone A.

The lacustrine sediments of subzone A are in juxtaposition to the glacial till and overlain by 2.53 m of additional lacustrine sediments. The

sediments of subzone A therefore represent the first deposited sediments in the lake as the glacial ice melted around it, about 12,500 years B.P. It is not unexpected that the first faunal elements to colonize the lake were those with a preference for cold water and a cold climate. The climatic ranges interpreted for this subzone are given in table 3.

The method used to interpret the paleoclimate is the same as that used by Delorme et al. (1977). The interpreted chemical parameters are given in table 4. Determination of these ranges was done using the same method as used in interpreting the paleoclimate.

The interpreted climatic environment based on fossil ostracodes clearly reflects the modern climatic conditions of where the three species currently live. As previously mentioned, the three species are not found in the area of the fossiliferous site today. The present climate at the Somerset site is much different with a mean annual temperature of 2.6°C, annual precipitation of 73.9 cm, and potential evapotranspiration of 54.0 cm. This means the temperature of subzone A was about 11°C colder than present, that there was a decrease of precipitation by 38 cm and the potential evapotranspiration was smaller by 11 cm.

Based on the subzone A paleoclimatic interpretation, it is reasonable to assume that during this time period the landscape could have supported a subarctic forest (open woodland) tundra. The modern analogue is

located at latitude 67.39°, longitude 134.39°, a distance of some 2600 km (figure 1) northward.

FOSSIL WARM WATER FAUNA AT A PRESENT DAY COLD WATER SITE

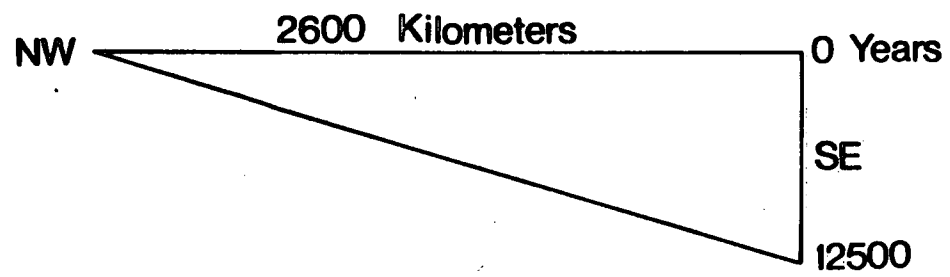
Seven ostracode species (table 5) are also known from the ostracode survey. The modern representatives of these species have been found in lakes, ponds, and streams in the Canadian provinces and territories. The ranges for the climatic parameters for each species (table 5) are very broad. The modern analogues for the species range from latitude 41° to 69° which explains the broad ranges. It is entirely possible that these species exist in similar habitats south of the Canada/United States border.

Jiggle Lake Site

In 1977, Delorme et al. identified ostracodes and molluscs from several fossiliferous sites north of latitude 65°. Another such site, Jiggle Lake, occurs at latitude 67°41', longitude 132°07' (Zoltai, 1975, personal comm.). The site has exposed 282 cm of sediments containing 22 cm of peaty marl. The fossil bearing segment (sampled every centimetre) contains the seven ostracode species listed above. The paleoclimatic interpretation (table 6) agrees very well with the interpretation given by

Modern Analogue

Somerset Site



Delorme et al. (1977) for the nearby sites. The mean annual temperature is interpreted as 1.2°C, the annual precipitation at 51.3 cm, and the potential evapotranspiration at 52.6 cm. The only major discrepancy is in the annual precipitation with values ranging from 44.2 to 48.0 cm for sites 1 to 4 of the 1977 study. The higher precipitation values for the Jiggle Lake site may be the result of a slightly different ostracode fauna. The Jiggle Lake site provides considerably more detail during the 250 to 300-year deposition period than did the other sites described by Delorme et al. (1977). Zoltai (1975, personal comm.) has indicated that the peaty marl is bracketed by two dates (7200 ± 60 yrs - BGS148 and 8610 ± 100 yrs - BGS149). Based on the paleoclimatology, the area immediately surrounding the site had the potential for supporting a forested vegetation association, the major elements being either closed coniferous or a mixed coniferous-deciduous forest.

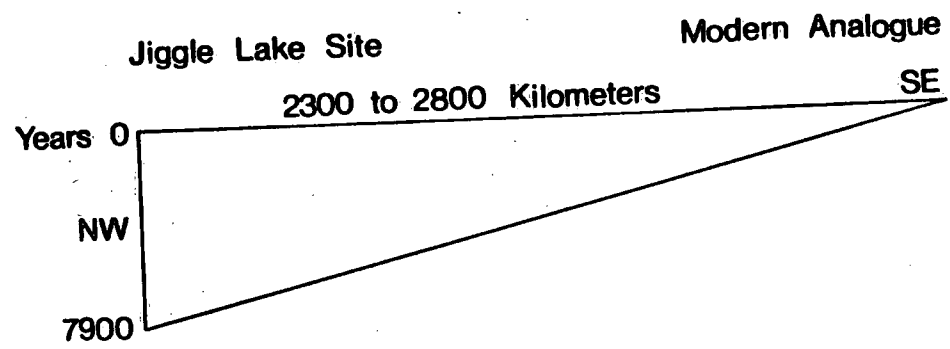
There are two modern analogues for the fossiliferous deposit. The interval 206 to 191 cm has a modern equivalent of the habitat at latitude 52.57°, longitude 104.17°. The mean annual temperature of this analogue is 1.3°C, annual precipitation of 45.9 cm and potential evapotranspiration of 52.7 cm. The upper portion of the deposit, 191 to 185 cm, has a modern analogue located at 49.54°, longitude 95.56°. The mean annual temperature of this analogue is 1.7°C, annual precipitation of 61.5 cm and potential evapotranspiration of 52.7 cm. As the ranges for the climatic parameters on which the interpretation is based are rather broad, the selection of modern analogues becomes more difficult. The would-be modern analogues, from north

of latitude 65°, have the ostracode species Candona protzi which is missing from the fossil assemblages. This absence disqualified the sites as modern representatives. Would-be modern analogues from each of longitude 96° and south of latitude 49° have the following species which are not found in the fossil assemblage:

<u>Candona crogmaniana</u>	<u>Physocypria globula</u>
<u>Darwinula stevensoni</u>	<u>Physocypria pustulosa</u>

The absence of these species from the fossil assemblage eliminated the sites as modern analogues. This leaves the modern samples in the intervening area as prospective modern analogues.

The Jiggle Lake site provides more detailed paleoenvironmental interpretation than the other four sites previously interpreted by Delorme et al. (1977), however, the interpretation remains essentially unchanged. The mean annual temperature at the time of deposition of the peaty marl was about 11°C warmer than at present, annual precipitation 21.5 cm more and the evapotranspiration 13 cm more than at present. Based on the paleoclimatic interpretation, the landscape surrounding the site could have supported a mixed-deciduous transitional forest. The modern analogues (latitude 52.57°, longitude 104.17° and latitude 49.54° and longitude 95.56°) are located 2300 and 2800 km south of the site (figure 2).



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Table 1. Mean annual temperature, annual precipitation, and potential evapotranspiration ranges for Candona rectangulata, Cyclocypris globosa and Cytherissa lacustris.

Ostracode Species	Mean Annual Temperature °C	Annual Precipitation cm	Potential Evapotranspiration cm
<u>Candona rectangulata</u>	-11.9 - (-7.4)	12.1 - 41.1	34.4 - 43.7
<u>Cyclocypris globosa</u>	-9.9 - (-7.1)	30.1 - 47.6	41.2 - 45.1
<u>Cytherissa lacustris</u>	-10.1 - (+9.5)	20.0 - 99.8	39.0 - 66.3

Table 2. Chemical range for Candona rectangulata, Cyclocypris globosa and Cytherissa lacustris.

Species	Calcium mg/L	Magnesium mg/L	Sodium mg/L
<u>Candona rectangulata</u>	2 - 118	0.7 - 95	0.3 - 1080
<u>Cyclocypris globosa</u>	10 - 20	1.2 - 6.2	0.4 - 3.4
<u>Cytherissa lacustris</u>	2 - 50	0.0 - 16.8	0.3 - 30.7

Species	Bicarbonate mg/L	Sulphate mg/L	Chloride mg/L
<u>Candona rectangulata</u>	3.7 - 366	3.0 - 300	2.0 - 1900
<u>Cyclocypris globosa</u>	24.4 - 73.2	5.0 - 14.0	3.0 - 5.0
<u>Cytherissa lacustris</u>	3.7 - 183	1.0 - 55.0	1.6 - 33.0

Species	TDS mg/L	Conductivity micromhos	pH
<u>Candona rectangulata</u>	11.2 - 3526	25 - 6590	6.5 - 8.5
<u>Cyclocypris globosa</u>	45.2 - 81.9	76 - 145	6.7 - 7.6
<u>Cytherissa lacustris</u>	11.2 - 215	25 - 370	6.4 - 8.8

Table 3. Paleoclimatic interpretation of subzone A.

Subzone	Mean Annual Temperature °C	Annual Precipitation cm	Potential Evapotranspiration cm
A	-9.9 - (-7.1)	30.1 - 41.1	41.2 - 43.7

Table 4. Paleolimnologic interpretation of subzone A.

Parameter	Range	Parameter	Range
Calcium (mg/L)	10.4 - 20.0	Chloride (mg/L)	3.0 - 5.0
Magnesium (mg/L)	1.2 - 6.2	Total Solids (mg/L)	45.2 - 81.9
Sodium (mg/L)	0.4 - 3.4	Conductivity (micromhos)	76.0 - 145.0
Bicarbonate (mg/L)	24.4 - 73.2	pH	6.7 - 7.6
Sulphate (mg/L)	5.0 - 14.0		

Table 5. Mean annual temperature, annual precipitation, and potential evapotranspiration ranges for seven ostracode species.

Ostracode Species	Mean Annual Temperature °C	Annual Precipitation cm	Potential Evapotranspiration cm
<u>Candona candida</u>	-11.5 - (9.6)	13.8 - 118.4	34.8 - 66.5
<u>Candona decora</u>	-9.5 - (8.9)	20.7 - 90.3	43.3 - 65.4
<u>Candona paraohioensis</u>	-10.1 - (8.5)	25.2 - 100.3	40.0 - 62.7
<u>Cyclocypris ampla</u>	-10.1 - (9.1)	17.7 - 124.8	40.0 - 64.5
<u>Cyclocypris sharpei</u>	-9.7 - (9.3)	17.8 - 117.6	39.8 - 65.0
<u>Cypridopsis vidua</u>	-9.7 - (9.9)	17.7 - 128.0	40.1 - 68.2
<u>Limnocythere itasca</u>	-10.1 - (8.0)	22.8 - 126.6	40.0 - 61.6

Table 6. Distribution of ostracodes and paleoclimatic interpretation of the Jiggle Lake site.

Depth cm	<u>Candona</u> <u>candida</u>	<u>Candona</u> <u>decora</u>	<u>Candona</u> <u>paraohioensis</u>	<u>Cyclocypris</u> <u>ampla</u>	<u>Cyclocypris</u> <u>sharpei</u>	<u>Cypridopsis</u> <u>vidua</u>	<u>Limnocythere</u> <u>itasca</u>	Mean Annual Temperature °C	Annual Precipitation cm	Potential Evapotranspiration cm
184-185	2							-11.5(-0.4)9.6	13.8(50.8)118.4	34.8(50.9)68.5
185-186	12		3	27		12		-9.7 (1.5)8.5	25.2(54.5)100.4	40.1(52.9)62.7
186-187	58		66	91	6	50	25	-9.7 (1.2)8.0	25.2(52.2)100.4	40.1(52.7)61.6
187-188	179		71	136	28	89	104	-9.7 (1.2)8.0	25.2(51.3)100.4	40.1(52.6)61.6
188-190	225		101	136		30	15	-9.7 (0.9)8.0	25.2(51.9)100.4	40.1(52.4)61.6
190-191	118		137	110	7	92	114	-9.7 (1.2)8.0	25.2(51.7)100.4	40.1(52.7)61.6
191-192	194		57	128	19	109	99	-9.7 (1.2)8.0	25.2(51.3)100.4	40.1(52.6)61.6
192-193	266		77	171	24	183	218	-9.7 (1.2)8.0	25.2(51.0)100.4	40.1(52.8)61.6
193-194	406		154	245	28	210	294	-9.7 (1.1)8.0	25.2(51.1)100.4	40.1(52.6)61.6
194-195	226		87	202	19	183	120	-9.7 (1.2)8.0	25.2(51.6)100.4	40.1(52.7)61.6
195-196	313		23	205	9	201	168	-9.7 (1.2)8.0	25.2(51.0)100.4	40.1(52.7)61.6
196-197	258	5	62	210	33	186	134	-9.5 (1.3)8.0	25.2(48.9) 90.3	43.3(52.7)61.6
197-198	429	15	62	315	10	253	155	-9.5 (1.3)8.0	25.2(48.9) 90.3	43.3(52.7)61.6
198-199	224		42	262	28	164	84	-9.7 (1.3)8.0	25.2(51.5)100.4	40.1(52.7)61.6
199-200	253	5	32	272	18	106	42	-9.5 (1.2)8.0	25.2(49.1) 90.3	43.3(52.7)61.6
200-201	113		50	207	27	94	39	-9.7 (1.3)8.0	25.2(51.8)100.4	40.1(52.8)61.6
201-202	185		45	405	45	115	30	-9.7 (1.3)8.0	25.2(51.7)100.4	40.1(52.8)61.6
202-203	130			189	17	46	21	-9.7 (1.3)8.0	22.8(50.7)117.6	40.1(52.7)61.6
203-204	135	7	15	120	7	22	7	-9.5 (1.1)8.0	25.2(48.9) 90.3	43.3(52.5)61.6
204-205	95		13	76		23	16	-9.7 (1.1)8.0	25.2(51.3)100.4	40.1(52.5)61.6
205-206				12		4		-9.7 (2.1)9.1	17.7(54.8)124.8	40.1(53.6)64.5

TABLE LEGENDS

Table 1. Mean annual temperature, annual precipitation, and potential evapotranspiration ranges for Candona rectangulata, Cyclocypris globosa and Cytherissa lacustris.

Table 2. Chemical range for Candona rectangulata, Cyclocypris globosa and Cytherissa lacustris.

Table 3. Paleoclimatic interpretation of subzone A.

Table 4. Paleolimnologic interpretation of subzone A.

Table 5. Mean annual temperature, annual precipitation, and potential evapotranspiration ranges for seven ostracode species.

Table 6. Distribution of ostracodes and paleoclimatic interpretation of the Jiggle Lake site.

FIGURE LEGENDS

Figure 1. Time difference of about 12,500 years and spacial difference of about 2600 km between the Somerset site and the modern analogue site.

Figure 2. Time difference of about 7900 years and spacial differences of 2300 and 2800 km between the Jiggle Lake site and the modern analogue sites.

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