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DISCOVERY OF AN UNDISTURBED BED OF 3800 YEAR OLD OYSTERS (CRASSOSTREA VIRGINICA) IN MINAS BASIN, NOVA SCOTIA

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Near Evangeline Beach, Minas Basin, a recent secondary outflow channel of the Gaspereau River has removed the overburden of soft sediments across 3 km of intertidal flats. About 2.2 to 2.3 km from shore it has exposed a 4400 year old forest, and a saltmarsh and oyster bed dated near 3800 yrs B.P. Many of the valves of both the marsh ribbed mussels *Geukensia demissa* and the subtidal oysters *Crassostrea virginica* are erect and paired indicating rapid burial *in situ*. Interpretation of mussel and oyster valves and associated plant, ostracod, foraminiferan, gastropod and pelecypod material entombed in the same deposit indicates that the marine environment at that time was optimal for oysters, that water temperatures exceeded 20°C in summer, that salinity was 20-25°/oo, that there was a sheltered low energy shore, and that both tidal amplitude and turbidity were increasing.

Près de la plage Evangéline, bassin Minas, un recent chenal secondaire d'ecoulement de la rivière Gaspereau a enlevé sur 3 km les sédiments mous qui surchargaient les plaines intertidales. A environ 2.2 à 2.3 km du rivage, une forêt vielle, de 4400 ans a été exposée ainsi qu'un marais salant et un banc d'huîtres datant de près de 3800 ans. Plusieurs des valves des moules striées de marais *Geukensia demissa* et des huîtres infra littorales *Crassostrea virginica* sont érigeés et placeés par paire, Ce qui indique un ensevelissement rapide *in situ*. L'intérprétation des valves de moules et d'huîtres ainsi que les restes de plantes, d'ostracodes, de foramiuifères, de gastropodes et de pélécypodes ensevelis dans le même dépot indiquent que l'environement marin de cette époque était optimal pour les huîtres, que la température de l'eau en été dépassait 20° C, que la Salinité était de 20°/oo à 25°/oo, qu'il y avait un rivage abrité et que l'amplitude des maries ainsi que la turbidité augmentaient.

The complex of submerged forest of pine and hemlock along the southwest shores of the Minas Basin (Fig 1) have been the subject of several studies (Goldthwait 1921; Lyon & Goldthwait 1934; Harrison & Lyon 1963; Grant 1975). These surveys were limited to the "Guzzle" area, a deep channel between Long Island and Boot Island, with the exception of Lyon and Goldthwait (1934) who followed the outflow channel northwards across the intertidal flats for a distance of "half a mile". In 1977, Acadia University students discovered an area of exposed forest, salt marsh, and an oyster bed 2.28 km NNW of Boot Island (Fig 1). The forested area has been carbon dated to over 4400 yrs B.P. and the oyster bed is dated near 3800 yrs B.P.

Results of radiocarbon dating of three individual oysters (*Crassostrea virginica* (Gmelin) were 3750±60 and 3720±60 yrs B.P. (GSC-2598, GSC-3043), and 3615±100 yrs B.P. (DAL-296). Two lots of ribbed mussels (*Geukensia demissa* (Dillwyn) provided C^{14} dates of 3800 80 (GSC-3040) and 3310 125 (DAL-362).

Of particular significance is the undisturbed condition of the entombed fauna. The explanation of why this area is only now being exposed has not been given

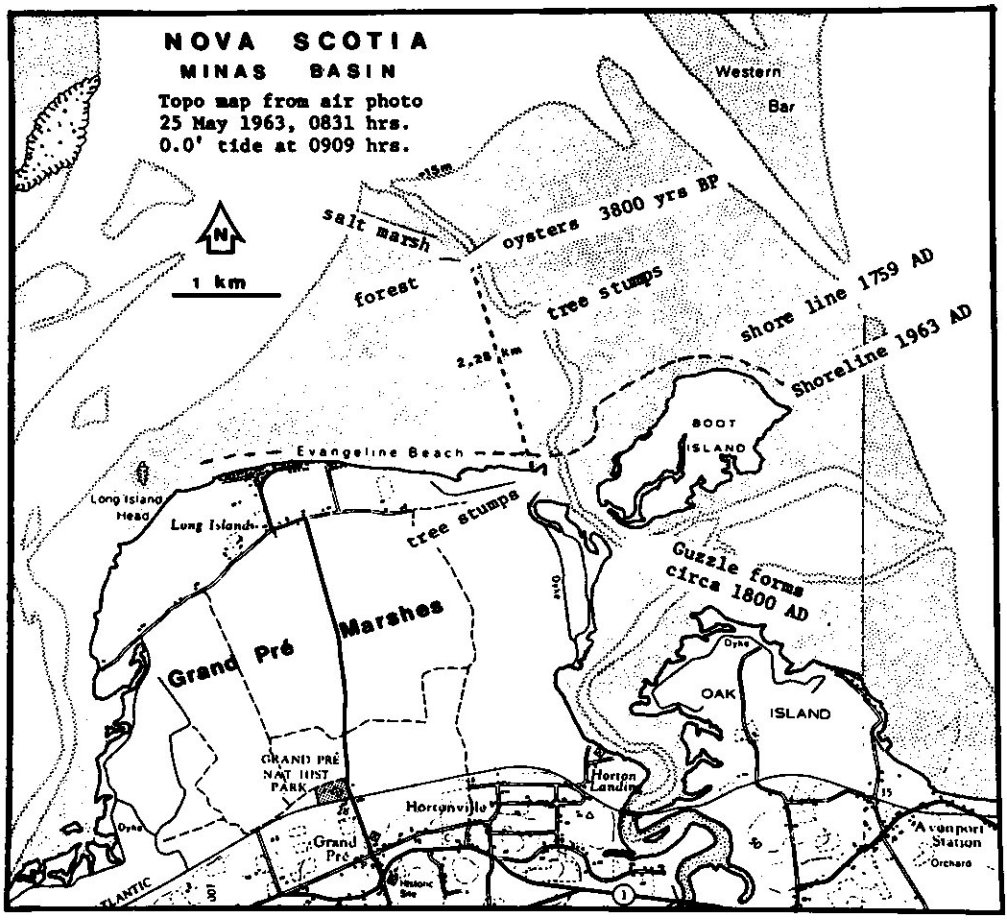

Fig 1. Location of oyster bed and general topographic features mentioned in the text. Note changes in the Guzzle area by comparing with Fig 2 and 3.

due emphasis in the literature. The present Guzzle channel is an early post-glacial valley that became forested and subsequently (over the past 4500 years) submerged and buried beneath marsh and marine sediments. The original forest that blanketed the ridge and valley contours of that period was eventually capped by an immense flat salt marsh, the Grand Pré of Acadian lore. That marsh joined Long Island and Boot Island and the mainland, as the British Land Survey of 1759 so nicely depicts (Fig 2). The map series of 1759, 1911 and 1963 (Figs 2, 3, 1) trace the history of coastal erosion on the north exposure of the marsh, an erosion that eventually opened into a major marsh channel that in turn drained southward into the Gaspereau River. Beneath this marsh channel was the old forested gully. By the 1940's, it had been excavated nearly to its original level revealing on its slope an historic series of tree stumps. The channel scouring is, therefore, very recent and is continuing to erode away the protective cover of deposits across 2.5 km of intertidal flats, apparently following the original post-glacial gully.

The oyster shells are protruding from a gray clay deposit, 1.6 ha of which is exposed. This bed is table-top flat, about 1.5 m above Chart Datum and only 0.3 m

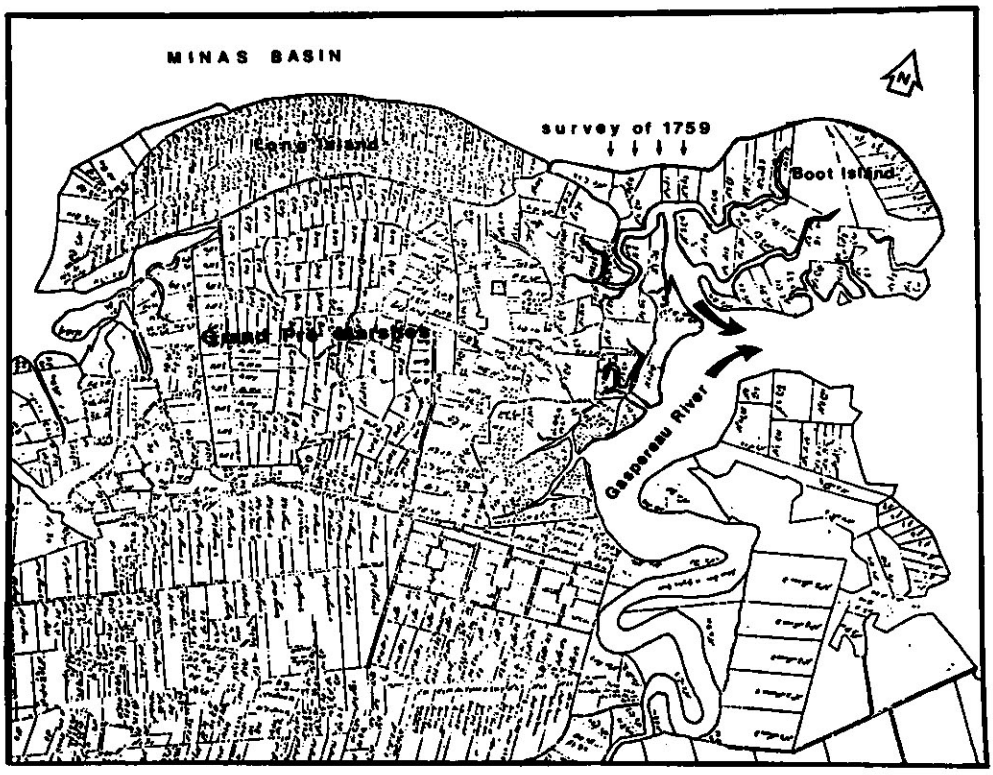

Fig 2. British land survey map of 1759. Note that the configuration of the marsh drainage creeks on Boot Island was still the same in 1963 (Fig 1) but that coastal erosion on the north side of Boot Island had nearly obliterated one of the two major creeks.

below the forested area 120 m to the south in the small gully. By the time the subtidal oyster bed had developed, 3800-3700 yrs B.P., the trees had died, fallen over and been buried by sediments several hundred years previously (C^{14} dates of trees from that elevation: 4470 ±60 (GSC-3105; 4455 ±130 Isotopes Inc.; 4115 ±235 and 3675 ±235 DAL-361). At the time the oysters died, turbidity, sedimentation and rising sea levels must have been accelerating, for, although the growth pattern, shellshape and surface sculpturing indicate a subtidal environment, most of the oysters are attached to ribbed mussels which are usually indicative of salt marshes. Today ribbed mussels are extremely rare in Minas Basin marshes and oyster colonies have not previously been reported nor have their valves been found in shell middens at local archaeological sites. Whatever the circumstances, the process of sedimentation at 3800 yrs B.P. buried the marsh and the oyster communities so quickly and gently that delicate shells, fragile surface sculpturing and even the proteinaceous periostracum remained intact. The fact that so many of the ribbed mussels and oysters occur as paired upright valves also indicates death *in situ*. The wedge-shaped, elongate, upright valves of many of the oysters indicates they were struggling to keep ahead of the rapidly accumulating sediments. Additional indirect evidence of high turbidity and sediment loads is the absence of a successful spat fall over this bed. Only one valve of about 160 examined had other oysters attached: a 7 cm and a 13 cm valve on a 17 cm individual.

As the growth rings on the oysters are wide and evenly spaced and valves of 25 cm in length were but 16 to 18 yrs of age, conditions must have been optimal.

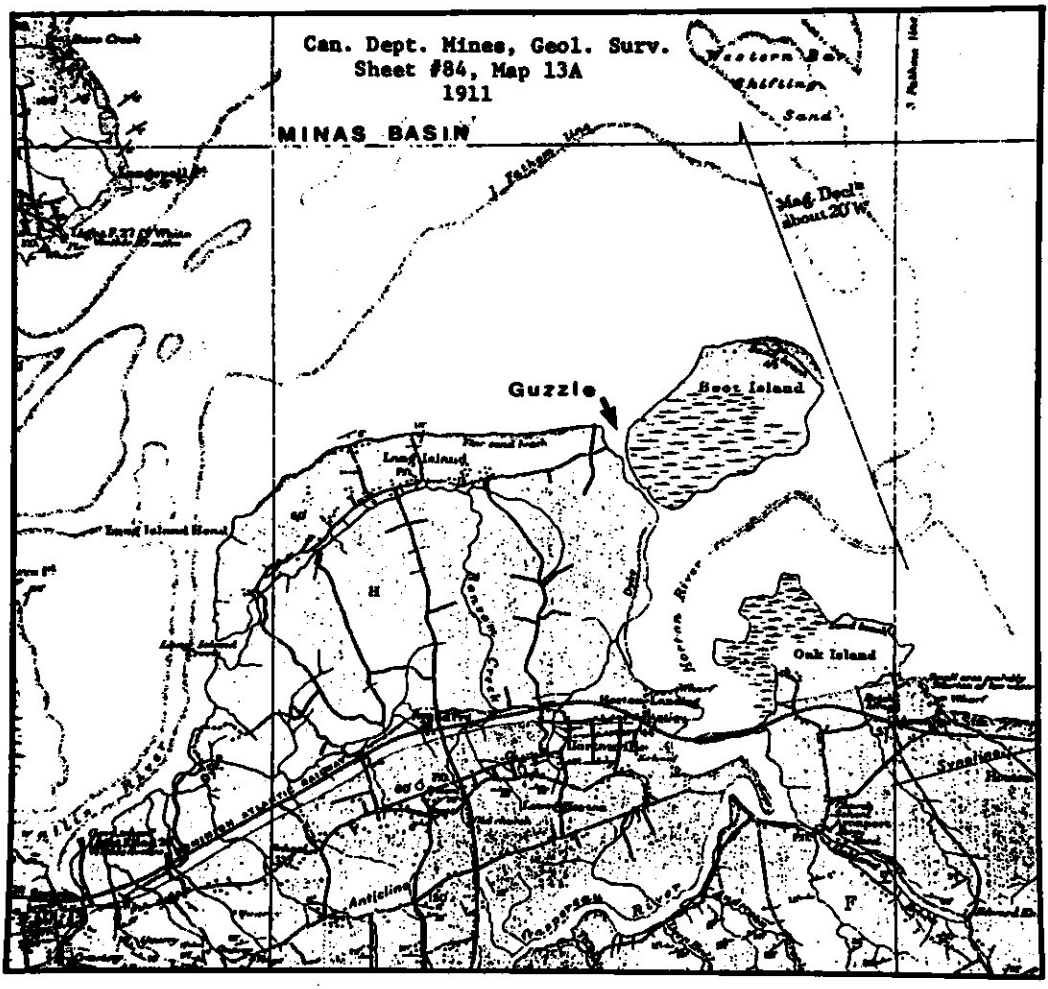

Fig 3. Note the narrow Guzzle of 1911 and absence of any representation of a channel across the broad intertidal flats. The 1928 topographic edition depicts a much wider Guzzle but also lacks the very evident north-south channel of the 1967 map issue (Fig 1).

Summer seawater temperatures would have exceeded 20°C, a requisite for oyster reproduction. The paucity of worm burrows of *Polydora websteri* Hartmann in these thick valves and absence of burrows of the sponge *Cliona celata* Grant indicate salinities of 25°/oo or less and silty conditions (Roy Drinnan, in verb.). These conclusions are substantiated by the foraminiferan assemblage extracted from the clay found on and between valves of the oysters. The six species in order of abundance are: *Elphidium excavatum* (Terquem), *Protelphidium orbiculare* (Brady), *Pateoris hauerinoides* (Rhumbler), *Trochammina inflata* (Montagu), *Ammonia beccarii* (Linne), and *Trochammina macrescens* Brady, a group found in water that is reasonably quiet, warm in summer, and inshore in type. Similar faunas are to be found today in the southern half of the Gulf of St. Lawrence, Northumberland Strait, St. George's Bay and the southern half of Baie des Chaleurs (Fiona E. Cole, in verb.).

Gentle washing and seiving of clay adjacent to and adhering to the oyster valves produce a wealth of well preserved seeds of *Ruppia maritima* L., an aquatic plant of salt marsh pools; stems and leaves of *Spartina* marsh grasses; polychaete jaws; ostracods; foraminiferans; gastropods; and pelecypods. The general assemblage of the ostracod *Cytheormorpha curta* (Edwards) Darby, the gastropods *Littorina rudis* (Maton), *Hydrobia totteni* Morrison, *Ilyanassa obsoleta* (Say), *Odostomia trifida* (Totten), and the pelecypod *Gemma gemma* (Totten) are again indicative of a rather sheltered slightly brackish habitat bordering salt marshes.

Processing of clay trapped between oyster valves yielded two additional gastropod species: the low water *Nassarius trivitattus* (Say) and *Pyramidella (Sayella) fusca* (C.B. Adams). The latter, and *Odostoma trifida,* are typical today of sheltered muddy inlets that harbour oyster beds.

A similar treatment of clay from between paired valves of several ribbed mussels again revealed *Littorina rudis, Hydrobia totteni, Gemma gemma* and four significant specimens of the pulmonate marsh snail *Melampus bidentatus.* The latter is common in coastal marshes along the Atlantic shores of Nova Scotia (Bousfield, 1960) but has not previously been reported in the literature from Minas Basin. Thus *Pyramidella, Crassostrea,* and *Melampus* are recorded from Minas Basin only as sub-fossils.

With rising mean sea levels accompanied by a relatively rapid evolution of megatidal cycles about 4000 to 3500 years B.P., environmental conditions changed in the Minas Basin (Amos, 1978; Amos & Bleakney in preparation). Oysters became extinct probably prior to 2500 yrs B.P. because shell middens in the Minas Basin area contain quantities of soft shell clams (*Mya arenaria* L.) but not oysters, even though the earliest shell cultures were oyster gatherers followed much later by the digging of bivalves (Erskine, n.d.). Indian middens on the Atlantic and Northumberland shores of Nova Scotia are noted for oyster deposits (Smith & Wintemberg 1929; Erskine 1957-58, 1961, n.d.). According to Erskine the Laurentian Culture of hunters and fish eaters avoided shell-fish and first arrived in Nova Scotia about 3000 yrs B.P. Between 2400 and 1900 yrs B.P. several new cultures invaded the Bay of Fundy area and these were the first to introduce utilization of shellfish. It would appear that by then, oysters had been eliminated from Minas Basin waters. Also eliminated from the Basin, but not the rest of Nova Scotia nor the southern Gulf of St. Lawrence were *Pyramidella fusca* and *Melampus bidentatus* and reduced to the status of rare species within the Basin were *Odostomia trifida, Geukensia demissa* and the sponge *Cliona celata* (Bousfield & Leim, 1960; field experience of authors).

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