

Late-glacial (Allerød) Coleoptera from Joggins, Lantz and Blomidon, central Nova Scotia, Canada

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Three late-glacial sites in central Nova Scotia, Canada, have produced small Coleoptera assemblages that add to the palaeoenvironmental interpretation during the interval 11,800 to 10,800 years B.P. in the Maritimes region. During this time, beetle assemblages are boreal in nature, in contrast to older sites which contain tundra to tree-line species and later, Younger Dryas age sites, containing northern boreo-montane species. Palaeontological interpretations from buried organic sites near Joggins, Lantz and Blomidon are consistent with palynological results from the region and support evidence derived from lake sediments for regional steep climatic gradients during the late-glacial period in the Maritimes.

Trois emplacements tardiglaciaires du centre de la Nouvelle-Écosse, au Canada, ont produit des assemblages de petits coléoptères qui ajoutent à l'interprétation du contexte paléoenvironnemental existant pendant l'intervalle de 11 800 à 10 800 ans BP dans la région des Maritimes. Au cours de cette période, les assemblages de coléoptères présents étaient de nature boréale, par contraste avec les emplacements plus anciens abritant des végétaux variant de la toundra à la limite de végétation des arbres, ainsi qu'avec les sites plus récents de l'époque des dryades ultérieurs renfermant des espèces boréales subalpines septentrionales. Les interprétations paléontologiques des emplacements organiques enfouis près de Joggins, Lantz et Blomidon correspondent aux constatations palynologiques de la région et appuient les indications tirées des sédiments lacustres témoignant de gradients climatiques régionaux élevés pendant la période tardiglaciaire dans les Maritimes.

[Traduit par la rédaction]

INTRODUCTION

Studies of fossil beetles from late-glacial buried organic deposits in Atlantic Canada (Miller and Morgan, 1991; Miller, 1995, 1996, 1997a, 1997b) have suggested a three phase framework for understanding changes in Coleoptera assemblages from about 12,600 to 10,600 years B.P. This paper presents details of the Coleoptera fauna from three late-glacial sites of Allerød age from central, mainland Nova Scotia in eastern Canada (Fig. 1). Fossil representation is relatively poor in these sites. However, in the context of an overall picture of late-glacial beetle assemblages in the region, they provide valuable information for the period 11,800 years B.P. to the onset of the Younger Dryas around 10,800 years B.P.

Over the past decade a number of papers have discussed the late-glacial environment of Atlantic Canada. Mott *et al.* (1986a), Stea and Mott (1989), Mott and Stea (1993) and Mott (1994) summarized information gathered from a number of buried organic sites in New Brunswick and Nova Scotia and provided stratigraphic interpretation, radiocarbon chronology and pollen records that have been used to piece together a picture of late-glacial environments from about 14,000 to 10,000 years B.P. The work has resulted in a detailed analysis of deglaciated environments and evidence for active glaciers of Younger Dryas age in Nova Scotia. Additional work has provided detail of the timing of the

Younger Dryas in Atlantic Canada (Mayle *et al.*, 1993a) and about late-glacial vegetation patterns (Mayle *et al.*, 1993b; Mayle and Cwynar, 1995). Published studies have also included chironomid and diatom analyses (Walker *et al.*, 1991; Wilson *et al.*, 1993).

METHODS

Samples of peat and organic-rich sediment were taken in thicknesses of 5 to 10 cm and submitted to standard palaeontological analysis using a kerosene floatation technique to isolate chitinous fragments (Elias, 1994). Untreated samples and processed residues were retained for other possible analyses. Identified Coleoptera specimens were mounted on micropalaeontology slides or stored in alcohol and were catalogued and counted. All specimens and samples, including residues, are stored in the palaeontology collections of the New Brunswick Museum.

SITE DESCRIPTIONS AND PALAEOENTOMOLOGY

Joggins

The site is located north of Joggins, Nova Scotia on the road to Lower Cove (45°42.85'N, 64°26.10'W; Fig. 1). It was described by Mott (1985) and in radiocarbon report notes

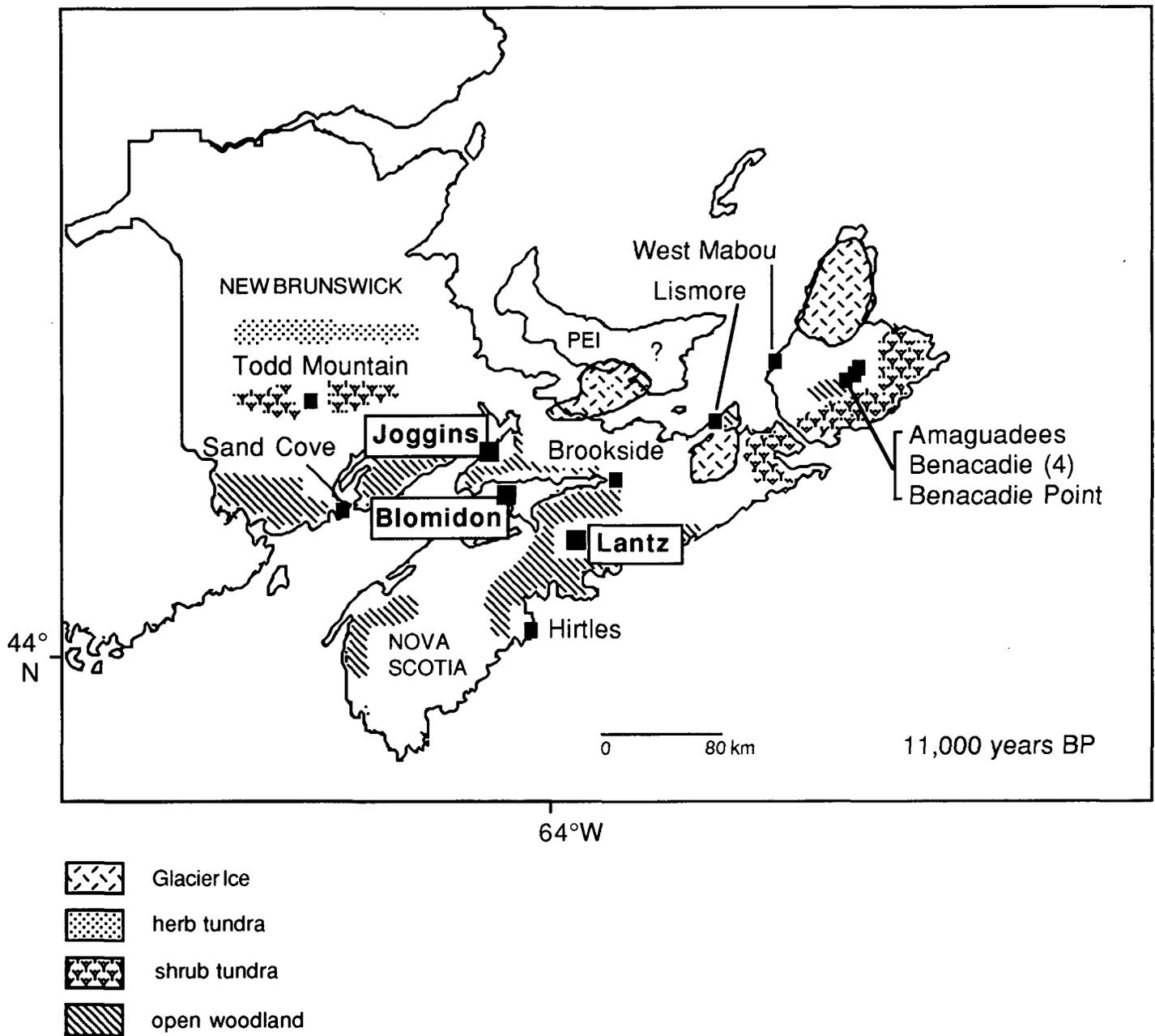


Fig. 1. Approximate ice positions and nature of vegetation in relation to late-glacial buried organic sites at Joggins, Lantz and Blomidon, Nova Scotia, and other late-glacial sites in Nova Scotia and New Brunswick, Canada at about 11,000 years B.P.

(McNeely, 1989). The site was originally described as a 10 to 15 cm thick, compact fibrous peat, overlying 50 cm of reddish brown diamicton, and more than 2 m of yellow sand with red silt lenses (Fig. 2). The peat was overlain by 30 to 40 cm of sand of undetermined origin (Mott *et al.*, 1986a; Stea and Mott, 1989). A bulk sample of compressed fibrous peat produced a radiocarbon date of $11,400 \pm 100$ years B.P. (GSC-3550). Two additional samples from upper and lower, 2 cm increments yielded ages of $11,100 \pm 120$ years B.P. (GSC-3924) and $11,800 \pm 110$ years B.P. (GSC-3915) respectively. Since the original description, the cliff has eroded back, leaving a very thin silty peat bed exposed at the top of the bluff under overhanging grass. Up to 16 cm of silty peat overlies 10 cm of reddish green sand, which in turn rests on top of a reddish diamicton.

Pollen analysis (R. Mott *in* McNeely, 1989) suggested a wet, sedge covered area, surrounded by shrub and herb tundra-like vegetation, dominated by willow (*Salix*) and buffaloberry (*Shepherdia canadensis*). Mott interpreted the older date of 11,800 years B.P. to mark the beginning of organic accumulation as the climate warmed following deglaciation and the younger date of 11,100 years B.P. to represent the time of cessation of organic deposition caused by severe climatic deterioration that decimated the vegetation. The younger date of 11,100 years B.P. is 300 years before the onset of the Younger Dryas in the Maritimes (Mayle *et al.*, 1993a) and may likely date an erosional surface in the peat.

A small beetle assemblage was isolated from a bulk peat sample weighing 10.3 kg and equivalent to the period 11,800

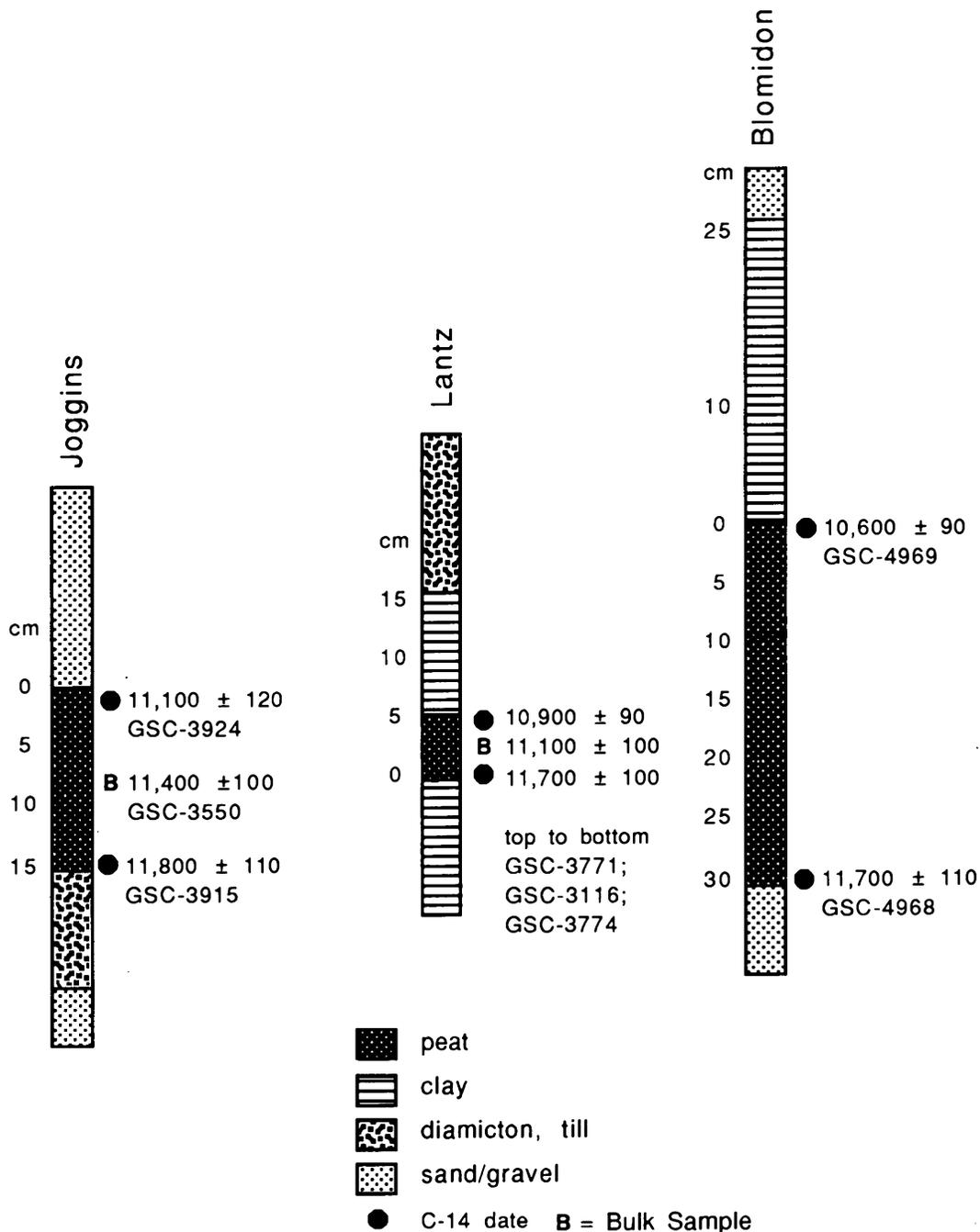


Fig. 2. Stratigraphy and radiocarbon chronology of late-glacial buried organic sites of Allerød age containing fossil Coleoptera at Joggins, Lantz and Blomidon, Nova Scotia, Canada.

to 11,100 years B.P. Clay above the peat contained no beetles and silts below the peat yielded few specimens. In all about 22 kg of material was examined. Although reworking of fossils is a possibility no obvious evidence was observed. The site contained the ground beetles *Bembidion* and cf. *Agonum*, an aquatic beetle, *Helophorus* cf. *lacustris/auricollis*, a chrysomelid, *Donacia/Plateumaris*, staphylinids including *Olophrum* cf. *rotundicolle* and numerous *Stenus* spp., a byrrhid, *Cytilus* cf. *alternatus*, a weevil, and two scolytid (bark) beetles. The scolytids are notable in that their numbers, compared to the relatively sparse fauna, are higher than what has been encountered in other Nova Scotia sites.

At least five specimens of *Phloeotribus piceae* and eight *Polygraphus rufipennis* were recovered from this site. *Phloeotribus piceae* inhabits conifer trees of the genus *Picea* spp., rarely *Abies* spp. and *Larix* spp. It is a widely distributed, transcontinental beetle whose distribution follows the boreal forest region from Manitoba to Quebec and the north-eastern United States (Bright, 1976). *Polygraphus rufipennis* inhabits all conifers in its range. Its distribution is transcontinental in Canada and includes the eastern United States, south to North Carolina and Tennessee, western United States south to Oregon and New Mexico (Bright, 1976).

The few species that can be identified are common inhabitants of the modern boreal forest in Canada and have been found in sites of similar age in Nova Scotia (Miller and Morgan, 1991; Miller, 1995, 1996, 1997a).

Lantz

The Lantz site is located in central Nova Scotia in the clay quarry of L.E. Shaw Ltd. (44°58'40"N, 43°29'10"W; Fig. 1). The peat bed, up to 40 cm thick, overlies a sand unit and a lower massive to laminated clay unit. Up to 15 cm of grey silty sand overlies the peat (Fig. 2). A reddish, blocky, clay-rich diamicton covers the organic unit (Mott *et al.*, 1986a; Stea and Mott, 1989; McNeely and McCuaig, 1991; Mott and Stea, 1993). A bulk sample of the peat was dated at 11,100 ± 100 years B.P. (GSC-3116). One centimetre increments from the top and bottom of the peat horizon have been dated at 10,900 ± 90 years B.P. (GSC-3771) and 11,700 ± 100 years B.P. (GSC-3774) respectively. Wood from sandy clay in the upper sand unit produced a date of 9690 ± 110 years B.P. (GSC-4042). A calcareous concentration in lower clay unit yielded a date of 11,310 ± 125 years B.P. (Q.C.-1411).

Pollen analysis (Stea and Mott, 1989; Mott and Stea, 1993) suggested an abundance of shrubs and herbs dominated the site at 11,700 years B.P., but that spruce trees invaded the surrounding area soon after, to form open woodlands with interspersed low shrubs and herbs. An abrupt change occurred at about 10,900 years B.P., causing a decline in spruce and an increase in shrub birch, other shrubs and herbs.

An assessment of the Lantz site indicates a Coleoptera fauna (Table 1) dominated by aquatic or semi-aquatic beetles such as the chrysomelid *Donacia/Plateumaris* and *Helophorus*, *Colymbetes* and *Hydraena*. Staphylinids, such as *Olophrum consimile*, *Olophrum rotundicolle* and *Stenus* are riparian species. *Olophrum consimile* can be found in deciduous leaf litter (especially *Alnus* and *Salix*) along the margins of streams, ponds or lakes. They may also be taken from clumps of *Carex*. *O. consimile* has a transcontinental distribution that generally follows the boreal forest, with southern extensions along the western mountains (Campbell, 1983). Bark beetles, *Phloeotribus piceae* and *Polygraphus rufipennis*, indicate the presence of trees, consistent with palynological interpretations from Lantz. Although reworking of fossils is a possibility no obvious evidence was observed.

Blomidon

The site is located on the Blomidon Peninsula, north-east of Wolfville, at an elevation of about 30 m (45°13'20"N, 64°20'30"W; Fig. 1). At the base of the section a reddish silty till is overlain by a grey to red silty clay (Fig. 2). Peat overlies clay and is, in turn, overlain by a thin clay layer, then 1 to 2 m of sand (Stea *et al.*, 1992; Mott and Stea, 1993). Two radiocarbon dates were obtained from the 35 cm thick layer of compressed peat. The basal 3 cm of peat

Table 1. Coleoptera from the late-glacial Lantz Site, Nova Scotia, Canada.

| TAXA | level | 1 | 2 | bulk* |
|---|-------|----|---|-------|
| CARABIDAE** | | 1 | 2 | 4 |
| cf. <i>Bembidion</i> sp. | | | | 1 |
| <i>Blethisa</i> cf. <i>B. quadricollis</i> Haldeman | 1 | | | 1 |
| cf. <i>Blethisa</i> sp. | | | 1 | |
| cf. <i>Stereocerus haematopus</i> (Dejean) | | | | 1 |
| gen. indet. | | | 1 | 1 |
| DYTISCIDAE | | 4 | 3 | 6 |
| <i>Colymbetes</i> sp. | | | 1 | 1 |
| <i>Deronectes</i> sp. | | | | 1 |
| <i>Rhantus</i> sp. | 1 | | | |
| <i>Hydroporus</i> sp. | 1 | | | |
| gen. indet. | 2 | 2 | | 4 |
| HYDROPHILIDAE | | 2 | 0 | 6 |
| <i>Enochrus/Cymbiodyta</i> | 1 | | | 1 |
| <i>Helophorus</i> sp. | 1 | | | |
| <i>Helophorus</i> sp A | | | | 1 |
| <i>Helophorus</i> sp B | | | | 2 |
| gen. indet. | | | | 2 |
| HYDRAENIDAE | | 12 | 0 | 14 |
| <i>Hydraena</i> sp. | 12 | | | 14 |
| STAPHYLINIDAE | | 25 | 9 | 48 |
| <i>Gymnusa</i> sp. | | | | 1 |
| <i>Olophrum consimile</i> (Gyllenhal) | 1 | 1 | | 2 |
| <i>Olophrum rotundicolle</i> (C.R. Sahlberg) | | 1 | | 2 |
| <i>Olophrum</i> spp. | | | 1 | 7 |
| Omaliniinae | | | 1 | |
| <i>Stenus</i> spp. | 24 | 4 | | 36 |
| Aleocharinae | | | 1 | |
| SCARABAEIDAE | | 1 | 0 | 1 |
| gen. indet. | | 1 | | 1 |
| CHRYSOMELIDAE | | 7 | 1 | 37 |
| <i>Donacia/Plateumaris</i> | 7 | 1 | | 37 |
| ELATERIDAE | | 0 | 2 | 0 |
| gen. indet. | | | 2 | |
| SCOLYTIDAE | | 1 | 0 | 3 |
| <i>Phloeotribus piceae</i> Swaine | 1 | | | |
| <i>Polygraphus rufipennis</i> (Kirby) | | | | 1 |
| gen. indet. | | | | 2 |

*cm levels 1 = 0-5; 2 = 5-10; 3 = bulk

**total number of individuals for each Family

produced a date of 11,700 ± 110 years B.P. (GSC-4968) and the top 2 cm dated at 10,600 ± 90 years B.P. (GSC-4969). The origin of a sand body overlying the peat is somewhat problematic, although it has been interpreted as ponded sediment.

Pollen analysis (Stea *et al.*, 1992; Mott and Stea, 1993) indicates a sequence of herb and shrub tundra-like conditions to open spruce woodlands, followed by a reversion to shrub tundra conditions, presumably during the Younger Dryas.

A total of 77 kg was obtained from peat and clay units at Blomidon. Organic material occurs on both sides of the road. Although reworking of fossils is a possibility no obvious evidence was observed. Most Coleoptera samples were taken from the southwest side of the road opposite the location sampled for pollen and radiocarbon dating (Tables 2, 3). The beetle fauna throughout the sampled levels consisted largely of Staphylinidae from the genera *Stenus* and *Olophrum*. *Micropeplus laticollis* has been collected from soil, in spruce duff, also from red squirrel midden and nests of Canada Jay. Its distribution is transcontinental boreal from Alaska south to Colorado and east to Quebec and New Hampshire (Campbell, 1963).

A small carabid assemblage includes *Chlaenius niger*, a very hygrophilous species found in swamps and at the edge of pools where the vegetation is rich but incoherent. Its distribution is almost transamerican, west to Washington State but not reaching the Pacific coast and in the east south to Texas, Florida and Cuba (Lindroth, 1969). *Elaphrus lapponicus* is less strictly riparian than other *Elaphrus*. It is very hygrophilous and depends on cold water, but often occurs around wells and trickles with low vegetation and moss. It rarely ascends above the timber limit and is not a true inhabitant of the tundra. In Canada it is found from Labrador, west to Yukon, and in Alaska (Goulet, 1983).

Aquatic beetles are from both the Dytiscidae and Hydrophilidae, including *Helophorus*, *Rhantus* and *Hydrobius*. Bark beetles, of the family Scolytidae are represented by *Phloeotribus piceae* and *Polygraphus rufipennis*.

SUMMARY OF THE PALAEOENVIRONMENT

Between 12,000 and 11,000 years B.P. ice in Nova Scotia (Fig. 1) retreated to local ice caps in the highland regions (Stea and Mott, 1989). Pollen profiles at Lantz and Blomidon indicate an amelioration of climate that resulted in tundra vegetation giving way to an open spruce woodland. The beetle assemblages described from these sites are similar to each other and contain species whose modern distribution are transcontinental and boreal in nature. Perhaps most interesting is that during this time interval bark beetles have been recovered from Blomidon, Joggins, and Lantz discussed here as well as Lismore (Miller and Morgan, 1991), Hirtles (Miller, 1995) and Benacadie Point (Miller, 1997a). At some sites the distribution of bark beetles corresponds well with the distribution of open woodland/boreal forest suggested by pollen analysis (Stea and Mott, 1989; Mayle and Cwynar, 1995). However, Coleoptera evidence at Joggins and Lismore (Miller and Morgan, 1991) and Benacadie Point on Cape Breton

Table 2. Coleoptera from the late-glacial Blomidon Site, Nova Scotia, Canada, south section.

| TAXA | level | 1 | 2 | 3 | 4 | 5 | 6* |
|---|-------|----|----|----|----|----|----|
| CARABIDAE** | | 3 | 1 | 2 | 4 | 3 | 5 |
| cf. <i>Agonum</i> sp. 1 | | | | | | 1 | |
| cf. <i>Agonum</i> sp. 2 | | | | 1 | 2 | | |
| <i>Bembidion</i> cf. <i>B. petrosom</i> Gebler | | | | | | | 1 |
| <i>Bembidion</i> sp. | | 1 | | | | | |
| <i>Dyschirius integer</i> sp. | | | | | 1 | 1 | 1 |
| <i>Elaphrus</i> cf. <i>E. clairvillei</i> Kirby | | | 1 | | | | |
| cf. <i>Patrobus</i> | | 2 | | | | | |
| gen. indet. | | | | 1 | 1 | 1 | 3 |
| HALIPLIDAE | | 0 | 0 | 1 | 0 | 0 | 0 |
| <i>Halipus</i> sp. | | | | 1 | | | |
| DYTISCIDAE | | 2 | 1 | 1 | 0 | 1 | 1 |
| <i>Colymbetes</i> sp. | | | | | | | 1 |
| gen. indet. | | 2 | 1 | 1 | | 1 | |
| HYDROPHILIDAE | | 2 | 8 | 5 | 7 | 4 | 3 |
| <i>Helophorus</i> sp. A | | 1 | | | | | |
| <i>Helophorus</i> sp. B | | | | | | | 1 |
| <i>Hydrobius melaenus</i> (Germar) | | | | | | 1 | 1 |
| cf. <i>Enochrus</i> / <i>Cymbiodyta</i> | | 1 | 6 | | | | |
| gen. indet. | | | 2 | 5 | 7 | 3 | 1 |
| HYDRAENIDAE | | 3 | 10 | 0 | 1 | 6 | 1 |
| <i>Hydraena</i> sp. | | 2 | 9 | | 1 | 6 | 1 |
| <i>Ochthebius</i> sp. | | 1 | 1 | | | | |
| MICROPEPLIDAE | | 0 | 0 | 1 | 0 | 0 | 0 |
| <i>Micropeplus laticollis</i> Mäklin | | | | 1 | | | |
| STAPHYLINIDAE | | 7 | 9 | 41 | 14 | 53 | 39 |
| <i>Acidota quadrata</i> (Zetterstedt) | | | | | | | 1 |
| <i>Eucnecosum tenue</i> / <i>brunnescens</i> | | | | | | | 2 |
| cf. <i>Eucnecosum</i> | | 1 | 1 | | | | |
| <i>Gymnusa</i> sp. | | 1 | | | | 1 | |
| <i>Lathrobium</i> cf. <i>L. nigrum</i> LeConte | | | | 1 | 1 | | |
| cf. <i>Lathrobium</i> sp. | | | | 2 | | | 2 |
| <i>Olophrum consimile</i> (Gyllenhal) | | | | 1 | | 3 | 5 |
| <i>Olophrum</i> cf. <i>O. consimile</i> (Gyllenhal) | | 1 | 1 | | 1 | | |
| <i>Olophrum rotundicollis</i> (C.R. Sahlberg) | | 3 | 4 | 5 | 5 | 5 | 1 |
| <i>Olophrum</i> spp. | | | | 7 | 5 | 11 | 6 |
| Omalinae | | | | | 1 | 1 | 7 |
| cf. <i>Philonthus</i> / <i>Quedius</i> | | | 1 | | 1 | 8 | |
| <i>Stenus</i> nr. <i>S. dolosus</i> Casey | | 1 | | | | | |
| <i>Stenus</i> spp. | | | 2 | 25 | | 24 | 13 |
| Aleocharinae | | | | | | | 2 |
| SCARABAEIDAE | | 0 | 0 | 1 | 0 | 0 | 0 |
| genera indet. | | | | 1 | | | |
| BYRRHIDAE | | 0 | 1 | 1 | 0 | 0 | 0 |
| cf. <i>Cytilus alternatus</i> (Say) | | | 1 | 1 | | | |
| CHRYSOMELIDAE | | 12 | 10 | 30 | 20 | 19 | 6 |
| <i>Donacia</i> / <i>Plateumaris</i> sp. | | 12 | 10 | 30 | 20 | 19 | 6 |
| CURCULIONIDAE | | 1 | 0 | 1 | 0 | 1 | 2 |
| gen. indet. A | | | | | | | 1 |
| gen. indet. B | | | | | | | 1 |
| gen. indet. | | 1 | | 1 | | 1 | |
| SCOLYTIDAE | | 0 | 0 | 1 | 1 | 3 | 4 |
| <i>Carphoborus</i> sp. | | | | 1 | | | |
| <i>Phloeotribus piceae</i> Swaine | | | | | | | 2 |
| cf. <i>Phloeotribus piceae</i> Swaine | | | | | 1 | 1 | |
| cf. <i>Polygraphus rufipennis</i> (Kirby) | | | | | | 1 | 1 |
| gen. indet. | | | | | | 1 | 1 |

*cm levels 1 = 25-30; 2 = 20-25; 3 = 15-20; 4 = 10-15; 5 = 5-10; 6 = 0-5 section sampled from top down, 0-5cm = top of peat

**total number of individuals for each Family

Table 3. Coleoptera from the late-glacial Blomidon Site, Nova Scotia, Canada, north section.

| Taxa | level | 1 | 2 | 3 | 4* |
|--|-------|----------|----------|-----------|-----------|
| CARABIDAE** | | 4 | 1 | 0 | 1 |
| <i>Chlaenius niger</i> Randall | | 1 | | | |
| <i>Dyschirius</i> sp. | | 2 | | | |
| <i>Elaphrus</i> cf. <i>E. lapponicus</i> Gyllenhal | | 1 | | | |
| <i>Elaphrus</i> sp. | | | 1 | | |
| gen. indet. | | | | | 1 |
| STAPHYLINIDAE | | 3 | 2 | 26 | 16 |
| <i>Acidota quadrata</i> (Zetterstedt) | | | | 1 | |
| <i>Eucnecosum tenue / brunnescens</i> | | | | 5 | 2 |
| <i>Olophrum consimile</i> (Gyllenhal) | | 1 | | | |
| <i>Olophrum rotundicolle</i> (C.R. Sahlberg) | | 1 | | 8 | 8 |
| <i>Olophrum</i> sp. | | | 1 | | |
| <i>Gymnusa</i> sp. | | 1 | | 1 | |
| cf. <i>Lathrobium</i> | | | | | 1 |
| <i>Stenus</i> sp. | | | 1 | 5 | 4 |
| Aleocharinae | | | | 6 | 1 |

*cm level 1 = 5-15; 2 = 0-5; 3 = 0-10 above peat; 4 = 10-25 above peat section sampled from top down, 0-5 cm = top of peat

**total number of individuals for each Family

Island (Miller, 1997a) indicates trees may have been more widespread than palynological evidence suggests. Bark beetles such as *Phloeotribus piceae* and *Polygraphus rufipennis* are found under the bark of spruce or spruce and fir respectively. Compared with southern Ontario, where open ground to boreal conditions, including the presence of bark beetles, seems to have been established by 13,000 to 12,500 years B.P. (Morgan *et al.*, 1984; Schwert *et al.*, 1985), colder conditions persisted in parts of Nova Scotia and New Brunswick to about 11,800 years B.P.

DISCUSSION

The Coleoptera recovered from late-glacial sites in Nova Scotia and New Brunswick, illustrate three recognizable phases based upon the presence of one or more species (Miller, 1996, 1997a, 1997b). The periods can be divided into (1) a tundra to tree-line assemblage older than about 11,800 years B.P., (2) a boreal assemblage from 11,800 to 10,800 years B.P., and (3) a northern boreo-montane assemblage younger than 10,800 years B.P. Mean July temperatures for these assemblages are probably in the range of (1) <9 to 12°C, (2) 14 to 18°C, and (3) 12 to 15°C respectively.

Coleoptera at Joggins, Lantz and Blomidon are discussed in relation to the overall context of late glacial beetles in the Maritimes. Although small, the composition of the assemblages at Joggins, Lantz and Blomidon is similar to contemporary Nova Scotia sites in the upper part of Hirtles (Miller, 1995), at Lismore (Miller and Morgan, 1991), Campbell

(Miller, 1996), Brookside (Mott *et al.*, 1986b), Benacadie Point, and the middle of Benacadie (4) and Amaguadees (Miller, 1997a). All these assemblages belong to phase 2, typical of a wide range of the modern boreal forest. The exception to the sites from this time interval is Todd Mountain (11,500 years B.P.) in central New Brunswick where the beetle assemblage contains tundra to tree-line species (Miller, 1992). The species list at Todd Mountain includes some of the more widely ranging boreal beetles, such as *Acidota quadrata* and *Olophrum rotundicolle* found at other sites. However, there are also species more indicative of northern boreal, tree-line and tundra environments including, *Dyschirius nigricornis*, *Elaphrus lapponicus*, *Helophorus arcticus* and *Olophrum boreale*. Coleoptera suggest a considerable temperature gradient that allowed *H. arcticus* to survive in central New Brunswick several hundred years after its last record in Nova Scotia (Miller, 1995, 1997a). By 11,500 years ago all sites in Nova Scotia, including the three new sites described here, suggest mean July temperatures of 14 to 18°C while at Todd Mountain, Coleoptera suggest 9 to 12°C. Using palynological and chironomid evidence, Levesque *et al.* (1997) have described, and accurately quantified, a steep climatic gradient of at least 9°C during the late-glacial from central New Brunswick south to Maine.

Coleoptera assemblages from Benacadie (4), Amaguadees (Miller, 1997a), West Mabou (Miller, 1996) and Sand Cove, New Brunswick (Miller, 1997b) that are younger than 10,800 years B.P., include the staphylinid *Olophrum boreale*. This has been interpreted as an indication of the expansion of a more northern boreo-montane assemblage becoming evident during the Younger Dryas. Even though the appearance of the "*O. boreale* assemblage" may not provide clear evidence of a drop in temperature, its appearance signals some change in the environment that includes temperature and a response to a change in vegetation cover. At both Amaguadees and Benacadie (4), (Miller, 1997a) and perhaps at West Mabou (Miller 1996), appearance of the "*O. boreale* assemblage" may lag the onset of the Younger Dryas. Dates at Amaguadees and Benacadie (4) suggest the greatest numbers of *O. boreale* are found sometime between 10,800 and 10,400 years B.P., suggesting beetles did not respond immediately to deteriorating climate, but gradually changed during the Younger Dryas event. The eurythermic species living in the Maritimes may have been able to adapt, at least for a time, to the deteriorating climate. The possibility exists that the date of 10,400 years B.P. at Amaguadees may be too young, and is a result of modern root contamination (Miller, 1997a).

At Blomidon, samples possibly as young as 10,600 years B.P. contain bark beetles, indicating the presence of trees following the onset of Younger Dryas cooling. For some reason the "*O. boreale* assemblage" identified at other sites has not been found at Blomidon. Perhaps these "colder" beetle species are not seen in sites farther from glaciers on Cape Breton Island (Stea and Mott, 1989) or in southern New Brunswick. Lismore also shows no indication of an "*O. boreale* assemblage" (Miller and Morgan, 1991). During the 12,000 to 10,800 years B.P. interval, *Olophrum boreale* and species sometimes occurring on modern coastal tundra may have

been more numerous in the highlands of Cape Breton or in central New Brunswick near Todd Mountain. During the Younger Dryas they may have expanded locally to be recorded in fossil deposits on Cape Breton and in southern New Brunswick, but not at Blomidon or Lismore.

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