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Taming the Waterways: The Europeanization of Southern Québec's Riverside Landscapes during the 16th–18th Centuries

Gary King^{1,*} and Thomas Muller²

Abstract - The arrival of Europeans in the New World effected the interaction of 2 temperate biogeographical eco-zones: the Palaearctic and Nearctic. Alfred Crosby has hypothesized that the success of the Europeans as imperialists was due, in part, to the ability of their introduced biota to bring about the collapse of the indigenous populations and local ecosystems, leading to the formation of Neo-European eco-spaces. Through a comparison of paleontological and environmental archaeological data from southern Québec, Canada, we examined Crosby's ecological imperialism model and assessed the biological impact of colonialism on the physical landscape during the 16th to early 18th centuries. The Intendant's Palace site in Québec City is employed as a case study and diachronically contextualized with data from contemporaneous sites in the region. The Europeanization of the landscape as a result of settlement construction, subsistence, and commodification was evidenced through signs of deforestation as well as the arrival of socioeconomic taxa. The biological transfer of European species did not appear to herald the collapse of local ecosystems but rather the establishment of an ecological melting pot along the early colonial waterways of southern Québec.

Introduction

Jan. 29, 1856 ... It is observable that not only the moose and the wolf disappear before the civilised man, but even many species of insects, such as the black fly and the almost microscopic "no-see-em". How imperfect a notion have we commonly of what was the actual condition of the place where we dwell, three centuries ago! Henry David Thoreau (Blake 1887:286–287).

Millions of years ago, continental drift drove the Old World and New World apart, separating Eurasia and Africa from the Americas. Over time, this geographic isolation fostered divergent evolution and biodiversification, which has led biogeographers to recognize the areas as distinctly separate biological sub-regions that are characterized by unique, indigenous flora and fauna. When the European explorers arrived in the New World, the geographic isolation between the eco-zones was disrupted. Prior to the European arrival, Old World crops, e.g., *Triticum* sp. (wheat), *Hordeum vulgare* (Barley), *Oryza* (rice), and *Brassica rapa* ssp. *rapa* (Turnip), were unknown in the Americas. Similarly, the Europeans were unfamiliar with New World crops such as *Solanum tuberosum* (White Potato), *Ipomoea batatas* (Sweet potato), and *Zea mays* (Maize) (see Appendix 1). Thoreau's remarks portray the perceived, dramatic environmental impact that the arrival of the European settlers had upon the North American flora and fauna after only a few centuries.

Organisms may spread naturally between areas through dispersal pathways that are biologically classified into corridor, filter, and sweepstakes

routes (Cox and Moore 2000). In the corridor route, the pathway presents a variety of suitable habitats throughout, with the areas at the 2 ends possessing an almost identical biota. The majority of organisms are able to disperse between the 2 end areas with little difficulty. The filter pathway comprises a more limited range of habitats, so that only organisms that can exist in those habitats can disperse between the interconnecting regions. In the third type of dispersal pathway, the end regions are islands surrounded by a sea (sometimes literally) of unsuitable habitat. Elton (1958) introduced the concept of man as an impetus for the passive, artificial distribution of animals and plants beyond the prescribed boundaries of their original geographic range. Alfred Crosby (1972) coined the term "Columbian Exchange" to describe the widespread ecological transfer of organisms between the Old World and New World that was initiated by European contact with the Americas in the 15th century.

In his later work, Crosby (2004) expanded his initial position and argued that Europeans were successful imperialists because wherever they went their agriculture and domesticated animals thrived and the indigenous populations and local ecosystems collapsed. He referred to the areas of successful European settlement as Neo-Europes and posited that Europe and the Neo-Europes shared ecological similarities—having similar climates and being located completely or, at least, two-thirds within the temperate zones of the northern and southern latitudes. The ecological commonality between the regions is significant because the domesticated plants

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(Appendix 1) and animals (Appendix 2) upon which the Europeans relied typically needed a warm–cool climate with an annual precipitation of 50 to 150 cm in order to flourish (Crosby 2004).

Although ecological similarities may have accommodated the arriving biota's biological needs and facilitated its success upon initial establishment, dense populations of indigenous organisms were already present in the natural environment and would have greeted the European species with competition unless they were otherwise displaced. In order to successfully colonize the New World, the European species would have needed to be suited to survival in specific environments as well as to exhibit characteristics enabling them to out-compete the native biota. Otherwise the species would have died out or, through an inability to self-disperse, had their populations restricted to specific regions.

The successful colonization of new habitats by foreign biota is believed to call for the establishment of viable, self-sustaining populations by the initial or early introductions (Sakai et al. 2001). The habitat type (e.g., complex and established natural community [cf. Elton 1927] and human-disturbed habitat [cf. Horvitz et al. 1998]) plays a vital role in determining the characteristics essential for population establishment. Sakai et al. (2001) proposed that successful invasive species will exhibit high fecundity rates as well as competitiveness.

When confronted with an established natural community where breeding sites are already utilized, food resources are already being eaten, and shelters are currently occupied by other species, the advantage of an organism being able to quickly produce large numbers of offspring and out-compete competitors is apparent. In order to survive, the non-native organism must establish itself in a niche, often through the displacement of 1 or more organisms by means of interspecific competition (King 2010a).

However, adventitious species are not always faced with resistance from a well-established endemic biota. In areas that have been modified or destroyed by human influence or natural disasters, niches may be vacant. The modification or destruction of an area may temporarily empty previously occupied niches by displacing or extirpating the organisms that formerly resided in them. Furthermore, major alterations to an environment may also result in the indigenous organisms being no longer suitably adapted to the location. Where competition for resources and space is minimal, the only conflicts with which a foreign species are confronted concern the ecological constraints inherent to that species.

Biogeographical accounts of the modern North American flora and fauna reveal a number of species

identifiable as originating from the Old World (Palearctic). In addition to the myriad of purposefully imported organisms such as domesticated plants and animals, all of which had some important socio-economic significance, a number of alien species were unwittingly introduced during colonization. Prominent among these are the majority of the at least 1683 immigrant arthropod species in the continental United States, 66% of which originated from the western Palearctic (Sailer 1983). In Newfoundland alone, Carl Lindroth (1957) estimated 23% of the flora and 14% of the ground beetles to be of European origin. According to Crosby (2004), this presence of western Palearctic flora and fauna in North America, reflects the inherent Europeanization of the landscape.

In order to formulate their hypotheses, both Crosby (2004) and Lindroth (1957) analyzed modern environments and historical documents. In this paper, we examine paleontological and archaeological data to evaluate the impact of European settlement to southern Québec, Canada, on the indigenous animal and plant biota and to assess the extent by which the settlers constructed archaeologically identifiable European eco-spaces along Québec's waterways. We propose that the observable biological changes are a result of a larger settlement package reflecting the cultural needs and identity of colonists arriving in New France.

The early colonists were primarily agriculturalists dependent on their imported flora and fauna, which were transported during colonization and reinforced later through trade or subsistence. If the forests had not already been cleared or partly cleared through natural means or artificially by the native populations, the Europeans' primarily agricultural lifestyle would have demanded a physical transformation of the landscape in order to accommodate growing crops and grazing herds. In New Zealand, the environmental impact of settlement resulted in biotic extirpation, deforestation, sedimentation, and changes to erosion rates (Martin 1984, McGlone 1983, McGlone and Wilmshurst 1999). Is the initial physical transformation of Québec's existing natural landscape by the colonists therefore succeeded by an ecological shift in the endemic biota? Did it secure the invasion of the foreign synanthropic and disturbed-land species, heralding an ecological transformation and the formation of a Neo-European landscape (*sensu* Crosby 2004)?

This paper presents a new contribution to our understanding of Québec's colonization, relating a story of landscape anthropogenesis and biological transfer in an effort to discern the role of human activities in shaping the colonial landscape and their

impact on the indigenous flora and fauna. It will bring together a range of published and unpublished sources and address issues pertaining to the mechanisms and pathways for the initial colonization of non-human biota. Furthermore, it will demonstrate that the biological transfers were influenced not only by ecological similarities between Europe and the Neo-Europes, but also by socioeconomic conditions made opportune by the colonists.

Methodology

If ecology often seems like a jigsaw puzzle in fog with all the pieces at least potentially recoverable, palaeoecology resembles a similar game with most parts irretrievably lost and bedevilled by Time's constant changing of the picture thereon (Buckland et al. 1981:381).

Preserved biological remains, such as insects, from archaeological sites have been effectively employed as bioindicators of palaeoecosystems and archaeological reconstructions due to their ecological diversity, their tendency to be often ignored or perceived as unimportant to humans, and their sensitivity and rapid reaction to environmental change (Bain and Prévost 2010; Buckland 2005; Coope 1977, 2000; Elias 1994; Kenward 1979, 1999; King et al. 2010; Prévost and Bain 2007; Robinson 1983, 2001). The study of palaeoecological materials, therefore, has huge potential to stand as evidence of past human activities (Huchet and Greenberg 2010; Kenward 1999; King 2012, 2013, 2014a, 2016; King et al. 2014; Ponel et al. 2000; Sadler 1991), living conditions (Bain 1997, 1998, 2004; Buckland et al. 1996; Kenward and Hall 1996; King and Hall 2008; King and Henderson 2014; McGovern 1991), diet (Bain 1998, 2001; Buckland 1982; Kenward and Hall 1996; King 2010a, 2014b), and climate and ecology (Ashworth et al. 1997; Bain and Prévost 2010; Coope 1973, 1977; Elias 1994; Hall et al. 2007; King 2010a). Thus, environmental remains may play a crucial yet neglected role in archaeology—in our investigations of the human, and wider ecological and climatic, past.

In the present study, multiple biological mediums were analyzed in an effort to construct a time-depth perspective of human-induced environmental change within the southern region of Québec. The investigation comprised a survey of both published and unpublished regional datasets from selected pre-Columbian and colonial era sites of both paleontological and archaeological nature. We compared new data from the Intendant's Palace in Québec City to concurrent sites in Montréal and Québec City, QC,

and employed palaeoecological and biogeographical methodologies to reconstruct past environmental conditions and to assess changes in species' distributions over time.

Setting the stage: A brief overview

Late glacial and post-glacial ecology, Québec. Circa 18,000 years ago, the present-day region of Québec was coated in a glacier believed to be over 1 km thick. The last glaciation, the Wisconsin, ended ~10,000 years ago. During this era, ice sheets extended across most of Canada, New England, the Upper Midwest, and parts of Montana and Washington, with a resulting tabula rasa for most of the biota. Most of the species which lived in the region during the previous interglacial and subsequent interstadials migrated southward as the glaciers advanced. As the ice sheets retreated during the Late Glacial, the biota started re-colonizing the re-exposed land. Approximately 12,000 years ago, the shores of the Gaspé Peninsula, the Lower St. Lawrence, and sections of the Lower North Shore were free of ice (Fulton and Andrews 1987). Freed from ice, the lowlands of the St. Lawrence River Valley became flooded with marine waters, forming the Champlain Sea (Miller 2010) and the Goldthwait Sea. Between 11,000 and 10,000 years ago, sites in Saint-Eugène and Saint-Hilaire, QC, were located near large bodies of glacial meltwater (Elias et al. 1996), which would have influenced the maximum temperatures within the region (Ashworth 1977, Morgan 1987, Mott et al. 1981). However, Elias et al. (1996) demonstrated a warming trend at these sites from 11,000 to 10,000 years ago. In the Québec City area, the glacier subsisted longer and formed an ice barrier which prevented the marine water of the Goldthwait Sea from mixing with the fresh water of Lake Vermont, a substantial-sized body of water that linked Lake Champlain with Lake Ontario (Denton and Pital 2002). Circa 11,000 BP, the ice sheets began to retreat from the northern shore of the St. Lawrence.

Dyke and Prest (1987) indicated that by 10,000 years ago, the ice sheets had retreated well to the north of this region of Québec, and, that the last glacial episode appears to have ended in the province by ca. 6500 years ago. Between 9000 and 5000 years ago, the postglacial Great Lakes and other lakes in the St. Lawrence River Valley began to drain through the region and into the Goldthwait Sea (Miller 2010), and ca. 6000 years ago the Goldthwait Sea was beginning to recede. During this period of deglaciation, arctic and alpine plant species were rapidly replaced by boreal and temperate flora (cf. Colpron-Tremblay and Lavoie 2010) and fauna (Elias 1994). In the Boniface River watershed,

deglaciation and marine regression occurred slightly later, which resulted in the establishment of vegetation cover by ca. 6000 BP (Gajewski et al. 1993, Lauriol 1982). It has been generally accepted that by the late Holocene, the stability of the climate encouraged a consistency in faunal presence, at least for beetles (cf. Elias 1996, Elias et al. 1996). However, the composition of the biota locally in southern Québec was more fluid because the region was subject to periodic outbreaks of fire (cf. Colpron-Tremblay and Lavoie 2010, Lavoie 2001) and epidemics of *Choristoneura fumiferana* Clem. (Spruce Budworm) (Simard et al. 2006).

Pre-Columbian occupant. Humans were already occupying a large part of the North American continent while thick ice sheets still covered Québec in its entirety. Archaeologists who study northeastern North America typically categorize the Amerindian occupation into 4 periods: Paleoindian, Archaic, Woodland, and Historic. These periods are primarily delineated on the basis of material culture characteristics and socioeconomic activities relating to mobility patterns, settlement, and subsistence.

While Québec was still partly covered in glaciers (ca. 12,000–10,000 BP), evidence indicates an Early Paleoindian presence. Although Clovis sites had been discovered in Ontario and New England, it was not until 2003 that the first Québec Early Paleoindian site was found near Lake Mégantic (Chapdelaine 2004a). A handful of Late Paleoindian (ca. 10,000–8000 BP) sites have also been identified. The Gaspé and Lower St. Lawrence regions have proven particularly rich in Late Paleoindian sites, including Saint-Anne-Des-Monts, La Martre, Mitis, Bic, Squatec, Saint-Romuald, and Rimouski (Benmouyal 1987, Chalifoux 1999, Chalifoux and Burke 1995, Chapdelaine and Bourget 1992, Dumais 2000, Dumais et al. 1993, Laliberté 1992).

During the Archaic period (8000–3000 BP), Amerindians were seemingly able to explore and occupy increasingly larger portions of Québec following the glacial melts and afforestation. The regions surrounding Lake Mistassini, e.g., the Abitibi and the Saguenay, were occupied. In Québec City, evidence for Archaic period human activity has been recovered from beneath Place-Royale (Chapdelaine 2012). Archaic era discoveries were also unearthed on the sites of the Hazeur House and Rue Sous-le-Fort (Chrétien 1995).

The emergence of the Woodland period (3000 BP to European contact) is distinguishable from the Archaic primarily through the appearance of pottery; however, the bow and arrow were also adopted. Habitation sites containing corded pottery

and chipped-stone tool kits have been discovered at Batiscan and Lambert sites along the St. Lawrence near Trois-Rivières (Levesque et al. 1964) as well as Québec City (Chrétien 1992). Circa 800 AD, Iroquoians began practicing sophisticated agricultural methods, which had become quite advanced by the 14th century. The adoption of small-scale farming appears to have spread gradually eastward. In Québec City, the earliest evidence for the domestication of crops, i.e., corn, dates to the 13th century at Place-Royale and Cap Tourmente, and even then, a marine hunting economy seemingly prevailed (cf. Chapdelaine 2004b). In 2006, a hearth and stone-flakes were uncovered at the site of the Intendant's Palace in Québec City, which may support the presence of indigenous populations around 1300 AD (Bain et al. 2009).

European contact. European explorers, whalers, and fishermen were visiting the northeast region of North America as early as the 11th century. Both the *Saga of Erik the Red* (Sephton 1880) and the *Saga of the Greenlanders* (Thordarson nd.) make reference to Norse exploration and settlement to the south and west of Greenland. Archaeological evidence from a Norse site in Newfoundland, L'Anse aux Meadows, indicates occupation of the region around 1000 AD (Brown 2007). Moreover, as early as the 15th century, Basques fished Newfoundland's Grand Banks. The Basques ventured up the St. Lawrence River and used the Île aux Basques as a whaling station from the late 16th to the early 17th century (Turgeon 1998).

Jacques Cartier sailed up the St. Lawrence River in 1535 and documented encounters with the Iroquois villages Stadacona, near present-day Québec City, and Hochelaga, near present-day Montréal (Cartier 1906a, Stephens 1890). In 1541, Cartier attempted to establish a colony at Charlesbourg-Royal, near present-day Cap-Rouge. By late May 1542, Cartier's colonists were replaced by new crew members under the command of Sieur de Roberval. However, Roberval abandoned the site in late 1543 (Cartier 1906b, Stephens 1890). François Gravé Du Pont and Pierre de Chauvin de Tonnetuit founded a settlement/trading post, Tadoussac, at the mouth of the St. Lawrence River in Québec. In 1608, Samuel de Champlain established a settlement at modern-day Québec City (Champlain 1878). The present paper focuses on a case-study review of archaeological samples collected at the Intendant's Palace site in Québec City (CeEt-30). Comparisons are made with other sites in southern Québec, particularly Îlot Hunt in Lower Town Québec City (CeEt-100) (the plot was originally granted to Charles Aubert de las Chesnaye in 1687; L'Anglais 1998) and Pointe-à-

Callière in Montréal (BjFj-10) (from contexts dating to the year of settlement, 1642; King 2010b).

Case study: Intendant's Palace site, Québec City

The Intendant's Palace site or the îlot des Palais is located in the Lower Town area, on a section of land between the Cap-aux-Diamants cliff and the original channel of the St. Charles River (Fig. 1). It is bordered by the streets Saint-Vallier and Saint-Nicolas as well as the Rue des Prairies. Originally, the widow of Guillaume Couillard was the first colonist to claim the piece of land. Following that, the site was bought and utilized by Intendant Jean Talon for his economic ventures: ship-building (1665–1671), beer brewing (1668–1675), and potash production (1670) (cf. Auger et al. 2009, Fortin 1989). Initially located near the brewery, the potash works expanded into a larger building between 1685 and 1688 (Bain et al. 2009). The potash, used in the manufacturing of glass and soap, was exported to Europe and helped the settlers earn revenue through the sale of tree stumps (as the potash process called for the leaching of wood ash; Vachon 1979).

The brewery was closed in 1675, leaving the large building vacant. In 1684, the Intendant Des-

meules took up residence in the building, henceforth known as the Intendant's Palace. The former brewery served as the official residence for New France's Intendant and accommodated the storehouse for the King's Stores as well as a 4-celled prison (Auger et al. 2009). The Palace Complex included formal gardens and potentially an enclosed boat basin. Providing access to the river, this basin would have facilitated the transfer of goods to the King's Store from ships coming up the Saint-Charles River (Auger et al. 2009). The First Intendant's Palace caught fire on 5 January 1713, and construction on the Second Intendant's Palace began to the northeast 3 years later (Bain et al. 2009). Following the construction of the new palace, the original palace continued to house the King's Stores and a bakery. Stables and other buildings were incorporated into the Palace Complex, and a formal garden was established (Bain et al. 2009). In 1723, two 3-storey latrines were constructed at both ends of the palace (Auger et al. 2009). The King's Stores were destroyed during the British Conquest in 1759, and the palace was destroyed during the American invasion in 1775 (Auger et al. 2009). The use of the former King's Stores site is uncertain between 1760 and 1852. However,

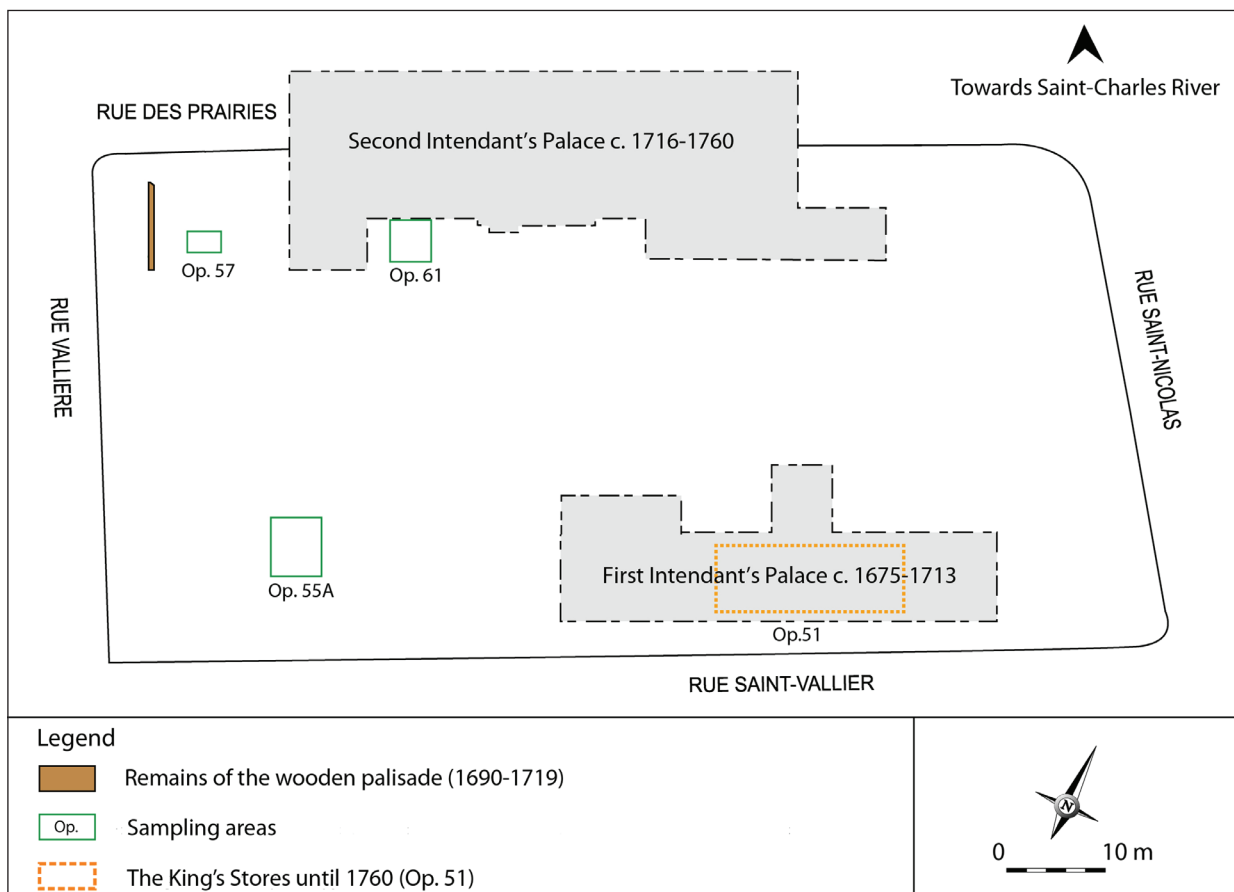


Figure 1. The Intendant's Palace site (CeEt-30).

from 1852 to 1971, it housed the Boswell Brewery (Auger et al. 2009).

Sample processing

Our assessment focused on the processing of sediment samples which were in storage at the Université Laval, Québec City. The samples were collected in bulk, as part of the Université Laval's field school, using trowels, and were not screened or processed in the field, ensuring that the soil remained intact in small blocks for laboratory-based assessment. The samples selected for the present analysis represent material collected since the year 2000 (see below for details pertaining to particular samples). The procedures for laboratory analysis followed those prescribed for the retrieval of insect remains (Kenward et al. 1980, 1986). Although the investigation was designed to retrieve several kinds of environmental material, the procedures for each proxy primarily differed on the basis of sieve mesh aperture. The recovery of insect remains required the smallest sieve mesh as well as the inclusion of an additional step, kerosene flotation.

The procedure for the recovery of insect remains has undergone several amendments over the past 60 years, which has resulted in the establishment of a fairly standardized technique. While the method is not without problems (cf. Kenward 1974; Rousseau 2009, 2011), it has proven cost-effective and time-efficient.

In accordance with the standardized methodology, we weighed the sediment samples and measured their volume prior to processing. The samples were then placed in large, clean buckets or wash tubs. We added warm water to the buckets to promote and facilitate sample dilution. Depending on the compactness of the samples, some were covered and left to soak for up to a week. When soaking was required, sodium carbonate (50–100 g) was added to assist with disaggregation. Once the samples had separated, we washed them repeatedly over a 250- μ geological sieve until all visible soil had been removed. The retained residue from each sample was allowed to drip-dry for 30 minutes then transferred from the sieve to a clean bucket. The samples were not allowed to dry completely and remained slightly damp. An equal volume of kerosene was added to the buckets and massaged into the samples for ~1 minute. Afterward, we decanted any excess kerosene and filled the buckets with cold water to within 5 cm of the top. The water was used to moderately agitate the samples in order to ensure that particles did not remain trapped under or between others. The samples were then left to settle for 10 to 30 minutes.

During this stage, insect remains and some other organics floated and remained on the surface at the water-kerosene interface. We carefully poured the water-kerosene solution over a 250- μ geological sieve. This retained material is referred to as the light fraction. Water was then re-added to the buckets containing the remainder of the samples, and the process was repeated twice to ensure maximum recovery of insect fragments. After retrieving 3 flots, we washed the light fractions in dish detergent to remove any remaining kerosene. Once the water had drained, the light fractions were transferred into jars and stored in methyl-alcohol. The samples remaining in the buckets, the heavy fraction, were washed with dish detergent and allowed to air dry (cf. Bain 2001; Rousseau 2009). We evaluated the light fractions using a low-power binocular microscope and stored the remains in vials containing methyl alcohol. To assist in the recovery of other environmental mediums such as plant macrofossils and vertebrate microfossils, we poured the dried heavy fractions through a tiered stack containing 1-mm, 0.5-mm, and 250- μ geological sieves. We then sorted through the individual sieves for environmental remains using a magnifying glass and stored the recovered remains in vials.

We identified the insect remains through comparative analysis with modern-day species in collections at the René Martineau Insectarium at the Canadian Forestry Services Centre in Québec City, Canada, as well as the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Gainesville, FL, USA. Taxonomy and nomenclature for the coleopteran (beetle) remains follows Arnett and Thomas (2000) and Arnett et al. (2002). The identification of plant macrofossils, molluscs, and vertebrate microfossils relied on comparative analysis with modern specimens located in the reference collections of the Environmental Archaeology and Zooarchaeology laboratories, respectively, at the Université Laval. Additional assessments were carried out using modern reference collections housed at the Environmental Archaeology facilities at the University of Florida, Gainesville, FL, USA. Taxonomy and nomenclature for the plant macrofossils corresponds with Marie-Victorin (2002).

Palaeoecological approach

In studying the past, palaeoecologists have typically relied on the analysis of modern species to produce analogous ecological data on particular species and species groups, and to be used as controls to be contrasted with the fossil species associations.

Through comparison with modern analogs, researchers are able to ascertain information about ecological components, species associations, and behavioral characteristics of various species and apply that knowledge to the fossil remains. In the present study, we drew upon the ecological data of modern species in order to reconstruct a portrait of environmental conditions in the past.

We assigned the identified paleontological and archaeological taxa to broad ecological categories (*sensu* Robinson 1981, 1983, 1991; King 2010a) in order to recognize and group clusters of species that were representative of particular habitats. Each of the taxa was assigned one of the categories according to ecological data. Robinson (1981, 1983) designated 10 species ecological groupings: aquatic, pasture/dung, probable meadowland, wood and trees, marsh/aquatic plants, bare ground/arable, dung/foul organic material, Lathridiidae, synanthropes, and species especially associated with structural timbers. Later, an 11th group was added, i.e., species on roots in grassland (*cf.* Robinson 1991). The present investigation drew upon Robinson's ecological categorization method as modified by King (2010a)

(Table 1).

Although the ecological grouping system employed here was designed for the interpretation of beetle assemblages, its application to a wider range of biota served to help clarify the environmental conditions in the region and provided insight into the flora, fauna, and geography in the vicinity of the archaeological sites. The palaeoecological approach addressed issues pertaining to species composition and environmental conditions in the area.

Biogeographical approach

Biogeography, as the study of living things in time and space, may be utilized to address issues such as the distribution of species throughout time, the mechanisms behind the distribution, and the human influence upon these patterns of species distribution (Cox and Moore 2000). Here, we consulted documentary, paleontological, and archaeological accounts in order to note diachronic changes in species' distribution as well as geographical ranges (*cf.* King et al. 2014). Both regional and local case studies were evaluated from pre-Columbian and early settlement sites. As the existing species' re-

Table 1. Description of ecological categories.

Group #	Ecological group name	Description
Group 1	Aquatic	Species that can spend most of their adult life under water, e.g., <i>Helophorus</i> spp.
Group 2	Pasture/dung	Species, such as dung beetles, that are more commonly associated with dung in the field than manure heaps. It included species from the genus <i>Aphodius</i> .
Group 3	Probable meadowland and grassland	Species that are typically found in meadowlands and grasslands or which mostly feed on leaves and stems of vetches, clovers, and other grassland flora, e.g., <i>Sitona</i> spp.
Group 4	Wood and trees	Species of trees as well as organisms that are found in the wood, leaves, bark, and fruits of live trees and shrubs; species which feed on wood that is undergoing various stages of decay, e.g., scolytids; and species generally found in a forested environment but not necessarily on the trees.
Group 5	Marshland and Water-edge species	Marshland and aquatic plants as well as species of beetles that feed exclusively on marsh or aquatic plants, e.g., <i>Notaris acridulus</i> , or live in damp or wet terrestrial environments.
Group 6	Disturbed ground/arable	Biota that inhabit bare ground, arable soils, and weedy disturbed ground, e.g., <i>Amara</i> spp.
Group 7	Dung/foul organic material	Species that live in different types of foul organic matter such as decaying vegetation, dung, compost, carrion, and manure heaps. The associated Coleoptera are primarily decomposers, e.g., <i>Cer-cyon</i> spp.
Group 8	Mould (Lathridiidae, <i>sensu</i> Robinson 1981)	Families of beetles that primarily feed on fungi and mould on decaying plant material, e.g., <i>Lathridius minutus</i> group.
Group 9	Synanthropes	Species that are associated with human-made environments. Consists of species that usually inhabit or are associated with human-made structures, e.g., <i>Ptinus fur</i> and <i>Typhaea stercorea</i> , and landscapes, e.g., cereals and cultivated legumes.
Group 10	Species especially associated with structural timbers	Coleopteran species that live in dry, dead wood and are able to reproduce in structural timbers, e.g., <i>Anobium punctatum</i> .
Group 11	On roots in grassland	Primarily members of the families Scarabaeidae and Elateridae that as larvae feed on the roots of grassland herbs, e.g., <i>Phyllopertha horticola</i> .

cords presumably represent only a fraction of the original ecological community in the past, it must be understood that the biogeographical mapping of remains is able to provide only a provisional reflection of the past. With that in mind, we used the biogeographical interpretation to denote the geographic presence of each species at archaeologically dated points in time. By observing the temporal changes in the biota, it was possible to obtain a more accurate portrait of the presence of the introduced species. By assessing changes in the presence and absence of native species in comparison to foreign species over time, we were able to formulate inferences regarding the Europeanization of the local environment during different settlement periods.

Results of the Case Study

Science is simply common sense at its best, that is, rigidly accurate in observation and merciless to fallacy in logic. (Huxley 1880)

The results of the study are presented in the appendices as presence–absence data (Appendices 3, 4). Beetle remains comprised the majority of new data. A few plant macrofossils were also recovered. The current study did not contribute any new floral species to the existing datasets of Bain et al. (2009) and Fortin (1989); however, it further substantiated the presence of the previously identified taxa. Although the remains of fish, fowl, and vertebrate macrofauna were present in several contexts (J. Bernard, Uni-

versité Laval, Québec City, QC, Canada, 2011 pers. comm.), the assessment only recovered a single vertebrate microfaunal ecofact (*Rattus* sp.) from the latrines; CeEt-30 44B4. Similarly, molluscs were scarce in the samples and were only identified from CeEt-30 51C50 southeast.

CeEt-30 61A41 and 61A30: the shipyard or Talon’s brewery

The samples 61A41 and 61A30 pertain to contexts that were taken to the north of the First Intendant’s Palace site. Wood litter, branches, and bark as well as sand and clay were prevalent in the context in a manner that is reminiscent of natural deposits. Although his initial field notes place the deposit between 1608 and 1716, Pelletier (2010) revised the timeframe to between 1665 and 1675.

The assemblages for samples 61A41 and 61A30 were composed primarily of indigenous biota. Of the taxa that we could assign to one of the 11 ecological groups, wetland and waterside coleopteran species, Group 5, dominated (Fig. 2). *Bembidion scopulinum* is associated with river margins, particularly those without vegetation (Lindroth 1963), and *B. affine* is a common wetland species. The hydrophilid *Crenitis morata* prefers shallow standing water or edges of stagnant bodies of water (Smetana 1988). Both the staphylinids are indicative of a waterside environment. *Anotylus insecatus* is common in riverside meadows and flood debris, especially those containing decaying vegetation (Koch 1989), and

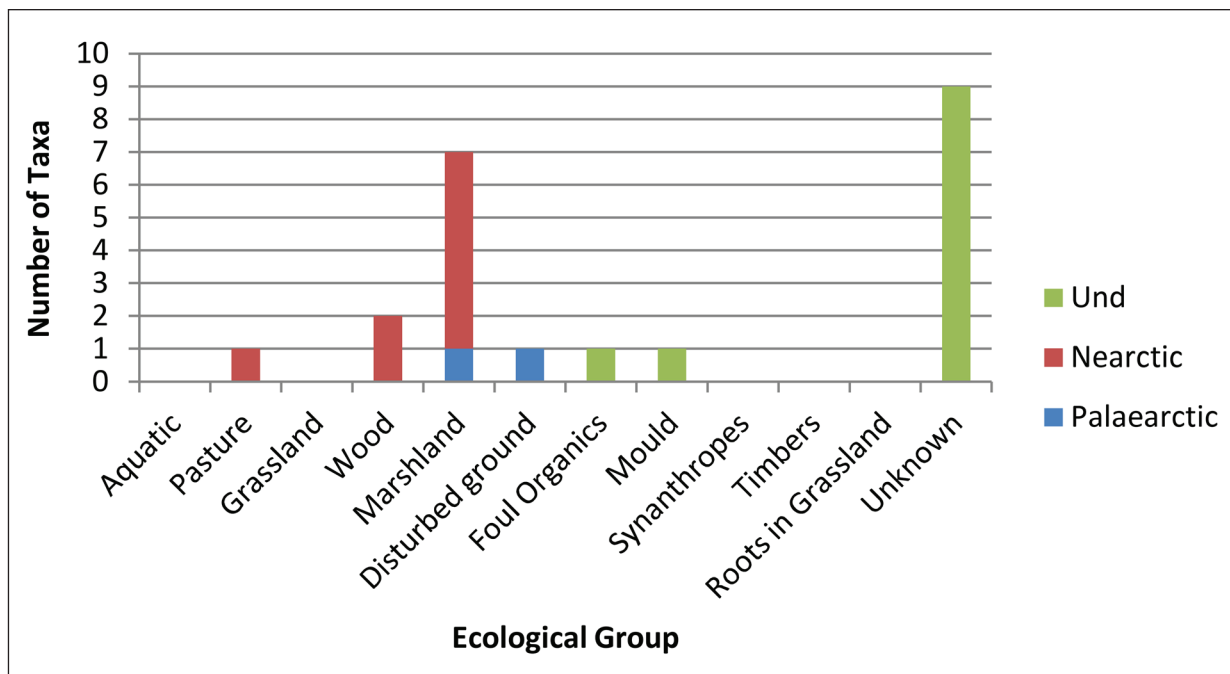


Figure 2. CeEt-30 61A41 and 61A30: Species diversity of insect remains by ecological group (1665 and 1675).

Olophrum rotundicolle prefers to frequent water-sides with rich vegetation, moss, alders, and willows (Böcher 1995). The scarab *Dialytes ulkei* is also a common beetle in riparian habitats, where it is strongly associated with the presence of deer dung and has been recorded in sheep manure (Gordon and Skelley 2007).

Two Palaearctic carabids were recovered. The carabid *Loricera pilicornis* is a hygrophilous beetle common in floodplains and on river banks (Lindroth 1961). Koch (1989) associated the species with moist woodland environments as well as in flood debris and under loose bark. *Amara aenea* (Common Sun Beetle) prefers sparsely vegetated, sandy or stony soils in open areas (Duff 1993).

Species included in Group 4 were also present in the assemblage. The staphylinid *Sepedophilus testaceus* and the scolytid *Polygraphus rufipennis* support the presence of wood. *S. testaceus* is associated with rotting wood and bark and wood mould, especially with hardwoods (Koch 1989). *Polygraphus rufipennis* will infest a wide range of conifers, although usually prefers dead or dying spruce (Bright 1976). The samples also yielded an individual of the Cryptophagidae family, which generally feed on moulds and fungal spores on vegetation and wood (Campbell et al. 1989).

During this study, diagnostic plant macrofossils and non-insect fauna were not recovered from the samples. However in his report, Pelletier (2010) made reference to the presence of a single *Juglans cinerea* (Butternut or White Walnut) seed.

CeEt-30 55A69: the shipyard

Of the archaeological deposits sampled on the Palace site, one of the oldest is associated with context 55A69, ca. 1665–1671. The context comprised a layer of clay, which contained tar, horsehair, and worked wood, believed to be associated with the shipbuilding industry. The sample yielded a moderately rich diversity of coleopteran remains, containing 24 taxa.

Context 55A69 produced a wealth of endemic and European biota. As in 61A41 and 61A30, Group 5 waterside species were present in the sample (Figs. 3, 4). Several of the recovered native plant taxa are associated with riverside environments: *Lycopus americanus* (American Water Horehound), *Carex* spp. (sedges), and *Verbena* sp. (verbain) (Bain et al. 2009). Additionally, the carabid *Bembidion affine* implies the presence of a wetland environment, and the semi-aquatic hydrophilid *Phaenonotum exstriatum* prefers shoreline habitats where it lays its eggs on dead leaves or small pieces of wood (Archangel-sky and Durand 1992).

The sample contained several species of European weed, disturbed-land specialists, flora, including *Galeopsis* sp. (Hemp Nettle), *Hyoscyamus niger* (Henbane), *Capsella bursa-pastoris* (Shepherd's Purse), *Euphorbia helioscopia* (Sun Spurge), and *Sonchus asper* (Thorny Sowthistle) (cf. Bain et al. 2009). These Group 6 species prefer an open environment with disturbed soils. Of the coleopteran taxa, only the Nearctic staphylinid *Philonthus sericans* is loosely associated with a disturbed-land environment

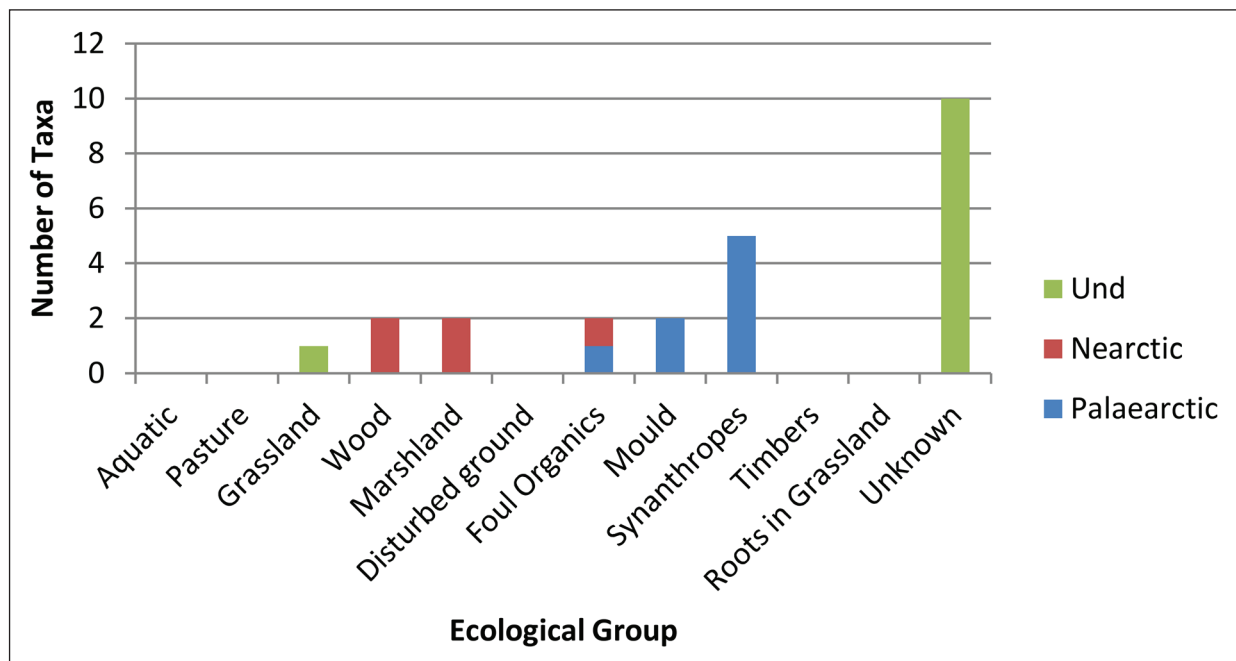


Figure 3. CeEt-30 55A69: Species diversity of insect remains by ecological group (ca. 1665–1671).

(Smetana 1995). However, several members of *Sitona* sp. are associated with meadows and grasslands (Group 3), especially those containing clovers.

In addition to the weed species, the assemblage consisted of several European synanthropic taxa, Group 9 (Figs. 3, 4). The remains of wheat and cultivated *Vitis* sp. (grape) were recovered. *Sitophilus granarius* (Granary Weevil) and, to a much lesser extent, *Tenebrio obscurus* (Dark Mealworm Beetle) are indicative of the presence of stored cereal grains (cf. King 2010a). *Carpophilus hemipterus* is a common pest of stored fruits (Hinton 1945) and has been known to attack cereals. *Dermestes lardarius* (Larder Beetle) is representative of the presence of dead animal or food of animal origin (Duff 1993); indeed, fish remains and the bones of large mammals were noted in the assemblage. Group 8 beetles of the families Endomychidae, Lathridiidae, and Mycetophagidae are commonly associated with mouldy vegetation, particularly sweet compost such as straw and cereal. They may be associated with the cereal remains or perhaps straw used to edulcorate the deposit. The European hydrophilid *Megasternum obscurum* is prevalent in fetid environments containing rotting organic matter (Backlund 1945). Smetana (1995) has recorded *Philonthus sericans* in organic matter such as leaf litter, compost, and carcasses.

The presence of wood was suggested by 2 indigenous Group 4 beetles: the tenebrionid *Neatus tenebriodes* and the weevil *Dryophthorus americanus*. *Neatus tenebriodes* is associated with the bark pabulum in general and is not known to have a particular host species. However, *D. americanus* infests *Pinus*

spp. (pine) and would have exploited its presence in the vicinity of the site (Blatchley and Leng 1916) or its use on the site. Moreover, the remains of *Alnus rugosa* (Speckled Alder), *Aralia nudicaulis* (Wild Sarsaparilla), and *Thuja* sp. (cedar) were found on the sample (Bain et al. 2009).

CeEt-30 55A61: possible shipyard (ca. 1665-1671)

The assemblage from 55A61 was dominated by taxa associated with waterside environments, floodplains, and wet, decaying organic matter (Fig. 5). The endomychid *Myceteae subterranea* (formerly *M. hirta*) was the only synanthropic species recovered from the assemblage. Although the species is commonly associated with human environments, it is not an obligatory synanthrope and has been known to attack mould on damp wood and vegetation in natural settings (cf. Koch 1989). Thus, we classified it with group 8 or mould-affiliated species. However, *M. subterranea* is believed to be an introduced species and, as it is flightless, is indicative of human activity in the area.

The assemblage was primarily composed of European decomposer fauna, Group 7. *Cercyon analis*, *Gyrophynus fracticornis*, *Aphodius prodromus*, and *Calamosternus* (formerly *Aphodius*) *granarius* are general indicators of foul environments containing decaying vegetation and dung. However, the taxa have also been associated with the decaying vegetation in flood debris (Duff 1993, Jessop 1986, Koch 1989). Although categorized as a foul decomposer, *Cercyon littoralis* is not associated with dung; rather, it provides evidence towards the presence

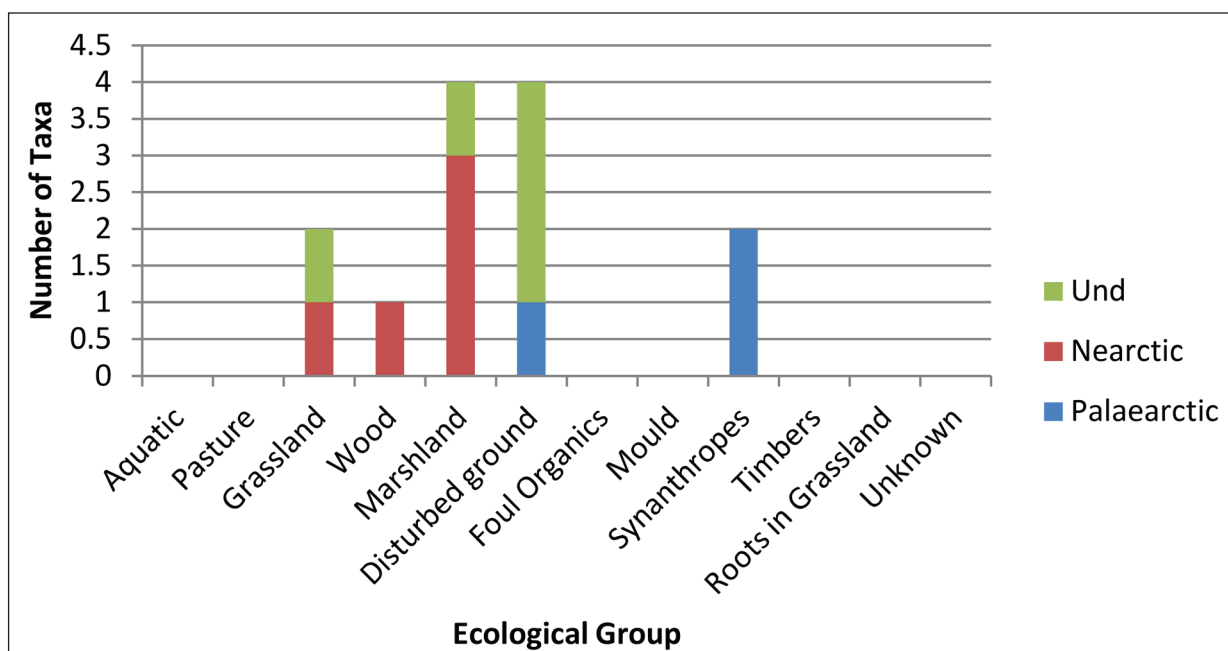


Figure 4. CeEt-30 55A69: Species diversity of botanical remains by ecological group (ca. 1665–1671).

of foul decaying vegetation usually in the form of wrack or detritus in wash-zones along shorelines (Backlund 1945, Duff 1993). Similarly, the recovery of *Bembidion affine* and the *Cicindela duodecimguttata* (Twelve-spotted Tiger Beetle) suggests a river-side, wetland environment (Johnsgard 2001).

CeEt-30 51C60: Talon’s brewery

The archaeological remains of the brewery (1668–1675) were identified and documented by

Moussette (1994) and Simoneau (2009). The samples from lot 51C60 were taken from outside of the brewery during the 2007 excavation. The samples yielded 13 coleopteran taxa as well as 12 plant taxa (Figs. 6, 7). Both indigenous and foreign taxa were present.

Group 5 water-side plant species *Carex* spp. and *Eleocharis* sp. were abundant in the samples. However, the environment was only represented by a single individual of *Atomaria ochracea* among the

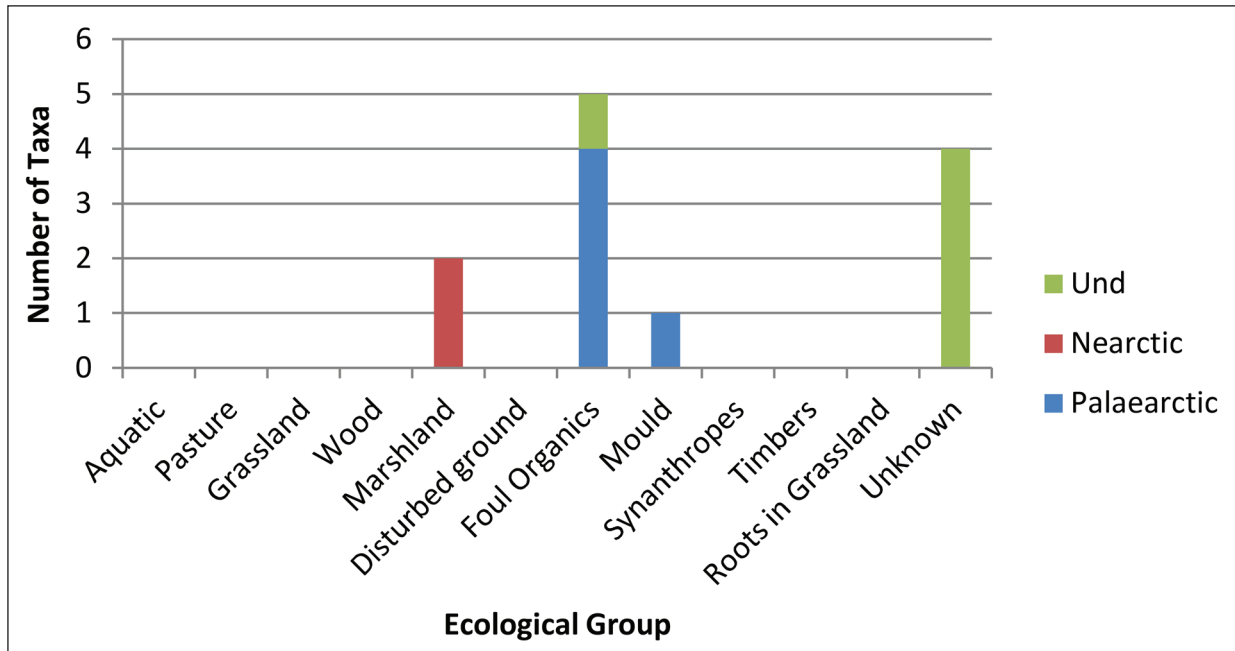


Figure 5. CeEt-30 55A61: Species diversity of insect remains by ecological group (1665–1671).

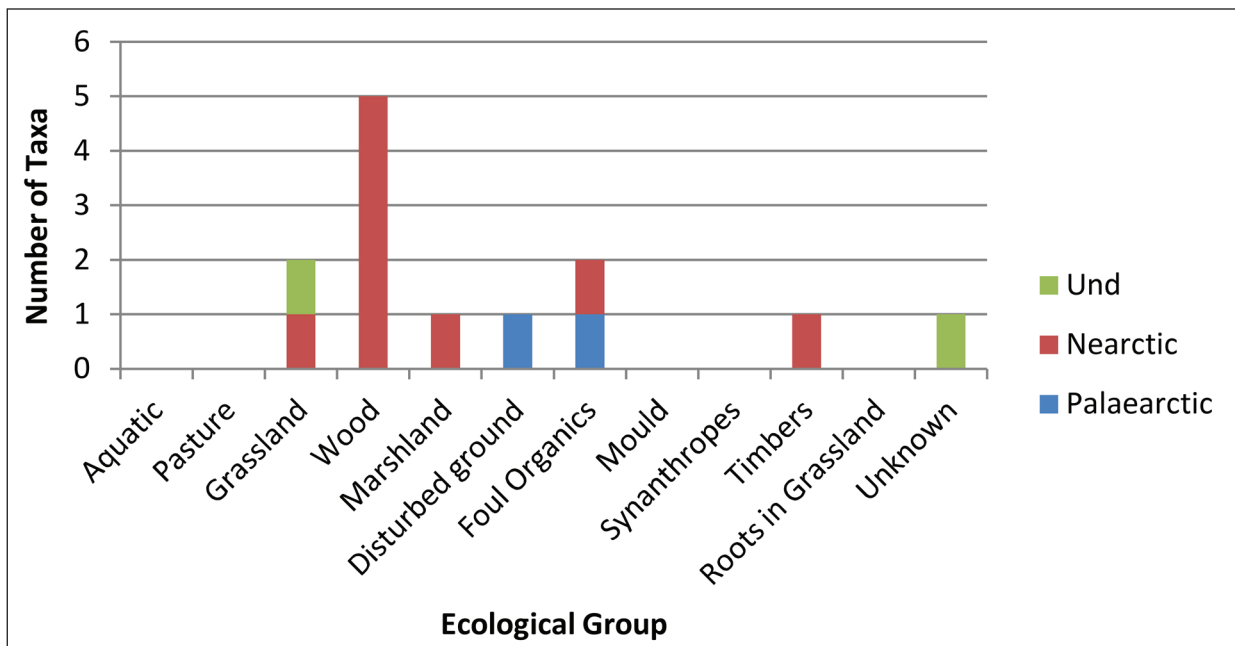


Figure 6. CeEt-30 51C60: Species diversity of insect remains by ecological group (1668–1675).

coleopteran specimens. *Atomaria ochracea* (syn. *Atomaria fuscata* Schönherr) has been collected in wetland environments and flood debris as well as grasslands and woodlands (Johnson 1993). The presence of *Philonthus sericans* and *Cercyon analis* may also indicate flood debris. *Amara aenea* can be found in sandy shore habitats with flood debris but also evidences grassy meadows (Koch 1989).

An open grassland environment was suggested by the presence of the Group 3 carabids *Bembidion grappii* and *Pterostichus adstrictus*. *Bembidion grappii* prefers open alpine habitats (Lavoie 2001), whereas *P. adstrictus* is weakly associated with coniferous meadowlands and occasionally woodlands. The remains of grasses (Poaceae) and *Oxalis stricta* (Yellow Woodsorrel) were also identified and are indicative of open environments such as grasslands and meadowlands.

Several coleopteran species were associated with wood and woodland environments, Group 4. While Koch (1989) has collected *Sepedophilus testaceus* from river floodplain deposits, he associates the staphylinid with wood mould, bark, twigs, and wood chips, as well as leaves and moss. Similarly the tetratomid *Pisenus humeralis* is typically found on wood-rotting fungi (Lawrence and Leschen 2010). *Rhyncholus brunneus* (Cedar Bark Weevil) is associated with cedar and the scolytid *Phloeotribus piceae* is known to attack *Picea* spp. (spruce; Bright 1976). Moreover, several species of the genus *Laemophloeus* are part of the bark fauna. The Group 10 anobiid *Priobium*

sericeus was also found in the assemblage. The anobiid attacks structural timbers and has been found in floor boards, sills, and buildings along the east coast (Campbell et al. 1989). The remains of several tree species were found in the assemblage, including Speckled Alder, Wild Sarsaparilla, and birch.

CeEt-30 51C50 S.E.: the King’s Stores (1725–1750)

Bioarchaeological data for the samples from the King’s Stores have been presented in several previous studies (Bain et al. 2009, Fortin 1989, Muller 2010). The environmental samples from lot 51C50 were not overly rich. In his analysis of coleopteran remains from the southeastern and southwestern quadrants, Muller (2010) recognized 24 taxa. The present study examined a sample from the southeast quadrant. The sample suffered poor preservation and yielded few remains.

No identifiable botanical remains were recovered. The coleopteran assemblage was composed of both endemic and foreign species (Fig. 8). The Nearctic biota was represented by what may be *Entomophthalmus rufiolus* (False-click Beetle). The Group 4 species is strongly associated with *Carya* (hickory; Muona 2001). A second False-click Beetle was also present but was not identifiable to species.

The Palaearctic species were associated with cereals or potentially cereal-straw, Group 9. *Sitophilus granarius* is regarded as a primary pest of stored

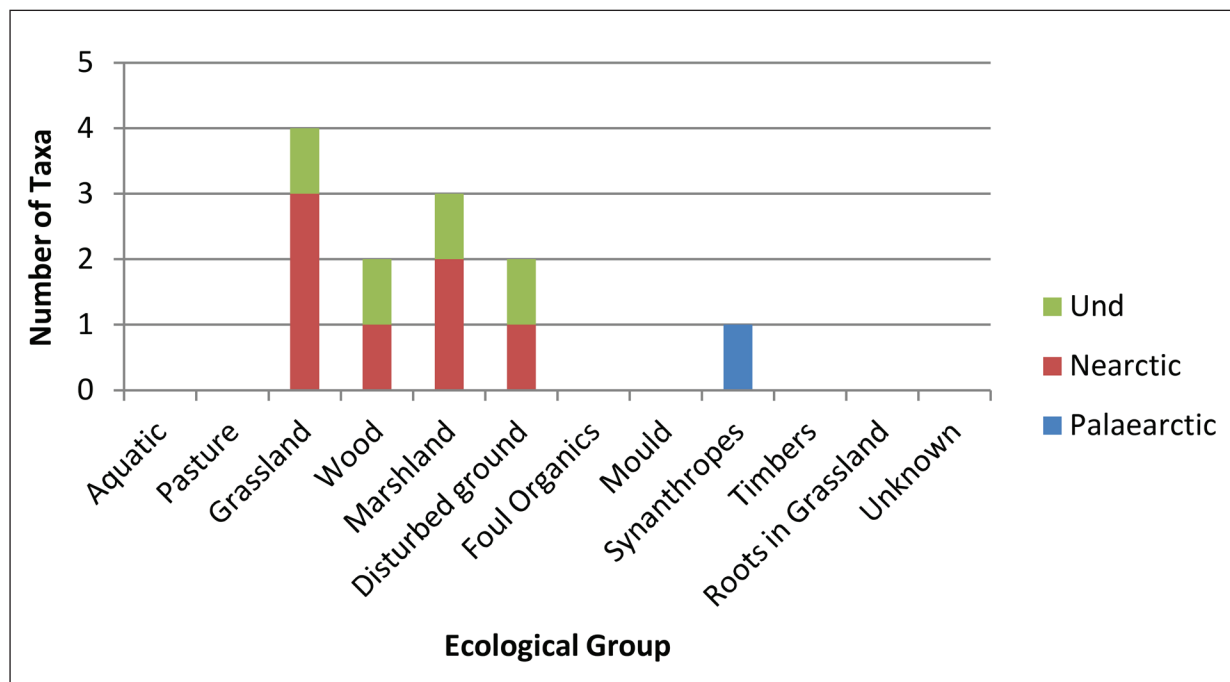


Figure 7. CeEt-30 51C60: Species diversity of botanical remains by ecological group (1668–1675).

grains. However, while the granary beetle requires the presence of cereal grains for reproduction, it has been found in both modern and archaeological contexts in association with wheat-based thatch (King 2010a, 2012). The polyphagous spider beetle *Ptinus fur* has been recovered from a range of synanthropic and natural habitats but demonstrates an affiliation with cereals and hay (cf. King 2010a) and is part of Carrott and Kenward’s (2001) house fauna group. Both the *Latridius minutus* group (Square-nosed Fungus Beetle) and the handsome fungus beetle *Mycetaea subterranea* (Hairy Cellar Beetle) are associated with sweet compost such as hay and cereals (Koch 1989) but have been noted on mould under bark in natural settings (Böcher 1988).

Two species of freshwater gastropods were present in the sample, representing Group 1. The marsh snail *Lymnaea palustris* group includes both Nearctic and Palaearctic subspecies, which are common in ditches and pools of freshwater. *Bithynia tentaculata* (Faucet Snail) is a Palaearctic species and has been found in slow-moving and standing bodies of water as well as relatively unpolluted nearshore areas (Vaillancourt and Lafarriere 1983). The Faucet Snail was previously believed to have been introduced to the New World in 1870 (Mills et al. 1993). The gastropods aestivate on dry vegetation such as wood near shores (Byrne et al. 1989, cf. Jokinen 1978, Korotneva et al. 1992).

CeEt-30 57B4-B6: latrines of the Second Intendant’s Palace (1723–1775)

Unsurprisingly, the latrine samples were dominated by socioeconomic, primarily Group 9, taxa (Figs. 9, 10). Both autochthonous and foreign species were recovered. According to Bain et al. (2009), at least 70 plant species were identified from the privies. They recovered the remains of imported plants such as *Prunus dulcis* (Almond), *Olea europaea* (Olive), and *Coffea arabica* (Arabian Coffee) alongside a myriad of native taxa including Butternut, *Vaccinium* spp. (blueberries), *Crataegus* spp. (hawthorn fruits), and *Viburnum* spp. (viburnum fruits; the fruit of *V. lentago* [Nannyberry] is edible). However, in the present study, we recovered 17 unique plant taxa, including *Malus* spp. (apples), *Menthis arvensis* (Field Mint), and *Ficus* sp. (fig).

The coleopteran remains yielded a similar ecological assemblage. The privy samples predominantly yielded socioeconomic species. *Sitophilus granarius* and *S. oryzae/zeamais* are primary infesters of stored cereal products and capable of attacking undamaged grains (cf. King 2010a). The remains of what may be *Bruchus pisorum* (Pea Weevil) were present. The species is oligophagous of *Pisum sativum* (Garden Pea), although it has been known to attack beans and seeds (Koch 1992). *Ptinus fur* (White-marked Spider Beetle) was recovered and has been known to infest sweet compost, such as grains and straw, in houses and granaries (Carrott

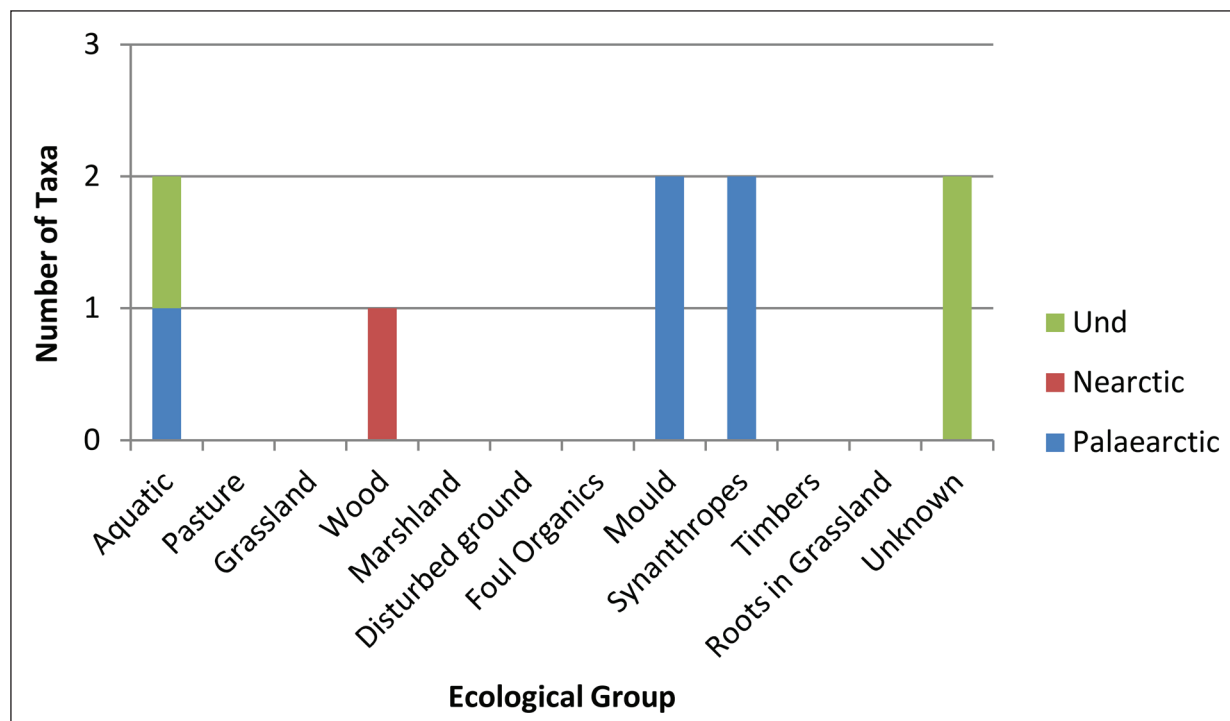


Figure 8. CeEt-30 51C50 S.E.: Species diversity of invertebrate remains by ecological group (1725–1750).

and Kenward 2001), in addition to dried and decaying animal and vegetable matter (Campbell et al. 1989). It has been suggested that the presence of hay in privy samples may indicate attempts at sweetening (Bain and King 2011).

Creophilus maxillosus and *Trox scaber* (Hide Beetle) are occasional carrion-feeders (Hinton 1945, Osborne 1983, Vaurie 1955). *Creophilus maxillosus* (Hairy Rove Beetle) is known to feed on fresh or partly decomposed meat and old bones as well

as fly and beetle larvae (Campbell et al. 1989). In addition to attacking dried carrion, *T. scaber* also infests hides, fleece, and skins (Koch 1989). The decomposer (Group 7) entomofauna included both Nearctic (e.g., *Philonthus sericans*) and Palaearctic (e.g., *Gnathocerus rotundatus*, *Cercyon analis*, and *Gryohypnus fracticornis*) taxa that are generally associated with environments containing foul, decaying organic matter.

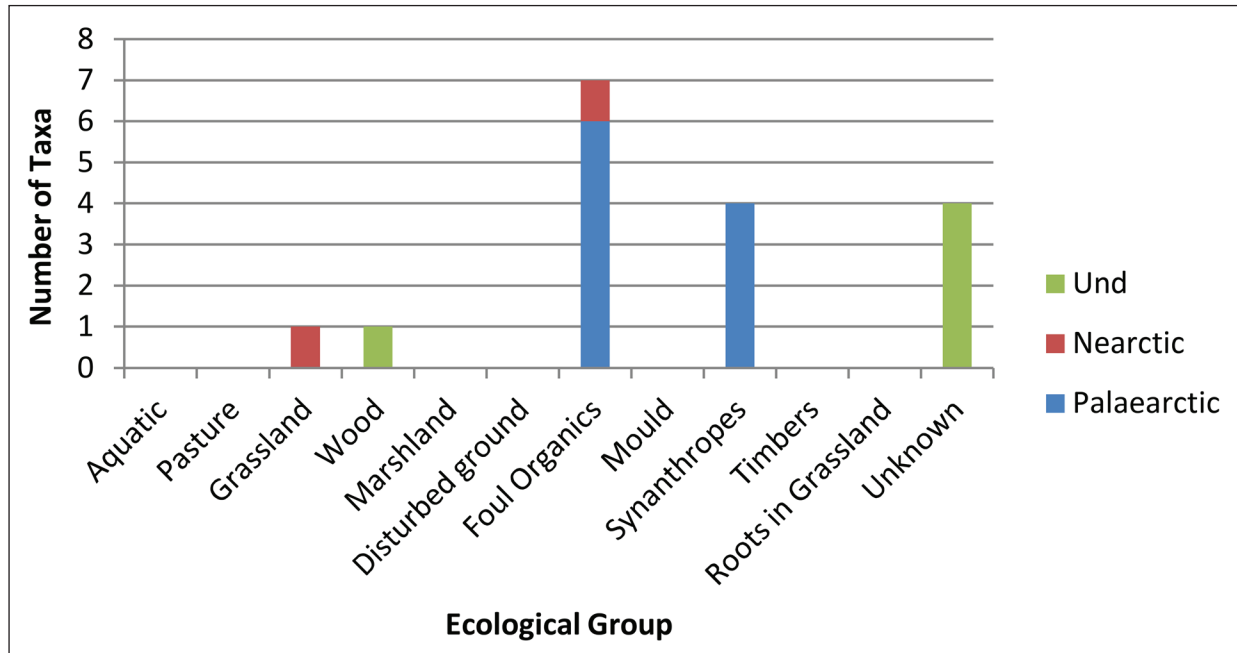


Figure 9. CeEt-30 57B4-B6: Species diversity of insect remains by ecological group (1723–1775).

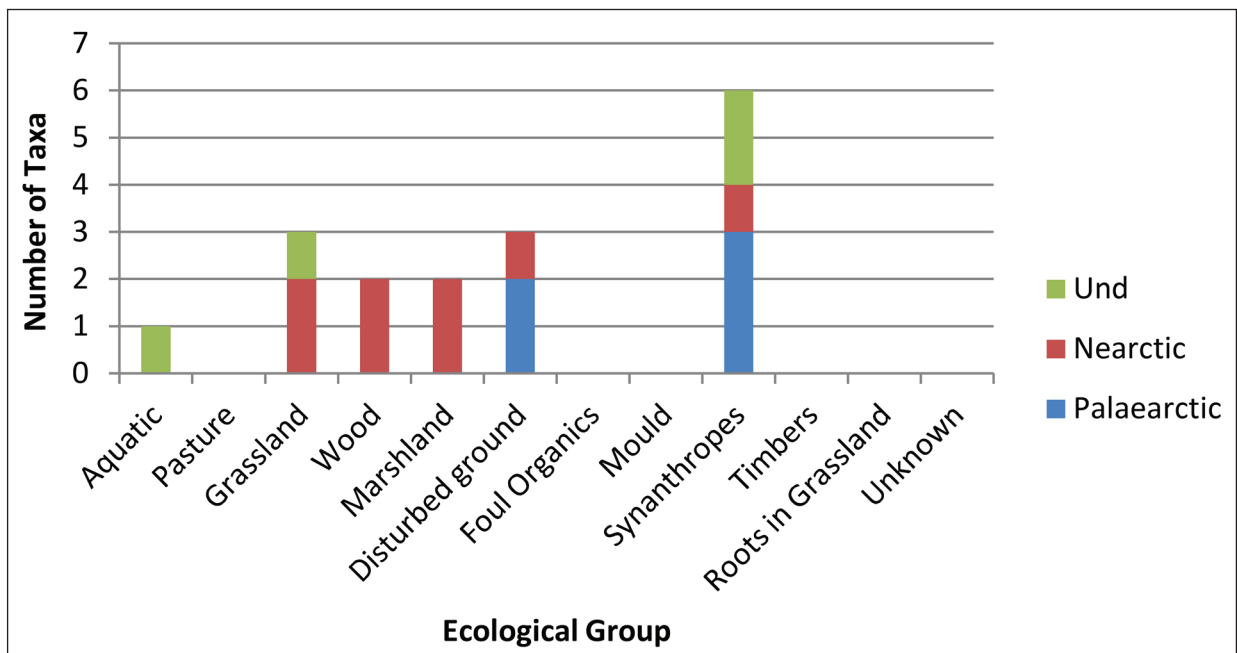


Figure 10. CeEt-30 57B6: Species diversity of botanical remains by ecological group (1723–1775).

Discussion

Follow humbly wherever and to whatever abysses
Nature leads, or you shall learn nothing. (Huxley
1860)

A chronological assessment of ecological change

Pre-Columbian Holocene conditions. The vast majority of palaeoentomological studies in North America concentrate on the Late Pleistocene to Early Holocene epochs during which major climatic changes occurred. Over that time period, recently deglaciated areas experienced a rapid replacement of arctic and alpine faunas by more thermophilous, boreal, and temperate faunas (cf. Elias 1994). Regarding the flora, Colpron-Tremblay and Lavoie (2010) indicate an afforestation period occurred in the Montmorency Forest, north of Québec City, before 9500 BP, which is marked by an increase in the pollen percentages of *Pinus banksiana* (Jack Pine). Prior to the increase in *P. banksiana*, the region was characterized by low pollen concentrations of *Picea* spp. (spruce) and Cyperaceae (sedges). Circa 9500 BP, a densification of the forest cover began, which is denoted by the emergence of *Abies balsamea* (Balsam Fir) and *Betula papyrifera* (White Birch) and a corresponding decrease in *P. banksiana* (Colpron-Tremblay and Lavoie 2010). *Acer spicatum* (Mountain Maple) and *Coptis trifolia* (Three-leaf Goldthread) also appeared. However, the pollen concentration of *Alnus viridis* ssp. *crispa* (Green Mountain Alder), Cyperaceae, and Poaceae (grasses) remained high until 7000 BP, which suggests that the forest cover remained less dense than today; after 7000 BP, the pollen concentrations of these species significantly decreased, which is considered to be representative of a closing of the forest canopy and the establishment of the fir/White Birch forest that persists in the region today (Colpron-Tremblay and Lavoie 2010).

At the high altitude site of Lac à l'Empêche Mountain in the Charlevoix region, a spruce forest with dense cover was present 4500 years ago (Brais et al. 1996, Bussi eres et al. 1996, Payette and Morneau 1993). In the last 3000 years, the region has been subjected to deforestation, leading to the gradual decrease in the presence of spruce as a result of sporadic outbreaks of forest fire (Bussi eres et al. 1996). Lavoie (2001) inferred that the post-fire areas were a mosaic of forest and open areas with a forest cover varying from 30% to 50%, based on the interpretation of subalpine insect remains. Bussi eres et al. (1996) put forth the idea that the post-fire environment would have favored the establishment of *Sphagnum* (moss) colonies. The moss carpets in this newly opened environment would have created mi-

crohabitats for hygrophilous beetles (Lavoie 2001). The opening of the tree cover would have also exposed the declining spruce trees to attack by bark beetles, contributing to an increase in the beetles' populations (Lavoie 2001). In the mountains of the Charlevoix region, the beetle remains suggest that a subalpine environment may have been present at the onset of the colonial period.

Garneau (1997) describes in detail the evolution of the natural environment at the site of the Grande Place in Québec over a 2000-year period leading up to the historic era. Around the time that Cartier was exploring the region, the site was dominated by a mature cedar forest in a wetland environment that was prominent in the terrestrial area between the riverside and the cliff face. While cedars were dominant, spruce, fir, *Fraxinus* (ash), Red Maple, *Populus* (poplar), and *Ulmus* (elm) were also present (Garneau 1997). Similar ecological conditions were inferred for what would become the Lower Town area of Québec City (Baillargeon 1981). Garneau (1997) also posited that stands of *Quercus* (oak) and *Tsuga* (hemlock) may have existed on the sandbars near the Grande Place site.

Although there is a paucity of studies recounting the palaeoecological conditions of the Late Woodland Period in Québec, the journals of Cartier offer some insight into the pre-European environment. During his second voyage to the New World in 1535, Cartier depicted the natural environment around the village of Stadacona (present-day Québec City) and Bacchus Island (l'île d'Orléans). In his writings, the French explorer makes reference to coastal forests composed of oaks, elms, ash, *Juglans* (walnuts), cedars, and maples interlaced with *Taxus* (yews), cydrons (*Verbena* [vervain]), wild grapes, *Cannabis sativa* (Hemp), and white thorns with plum-sized fruits (*Craetagus* [hawthorns]) (Cartier 1906a:47, Stephens 1890:50). Cartier's mention of the presence of Hemp in the coastal forests is noteworthy as the plant is not considered to be indigenous. However, as plant macrofossils have been documented from 10th-century Anglo-Scandinavian sites (e.g., Kenward et al. 2003) and *Cannabis* pollen has been recorded from Viking period and earlier sites in Scandinavia (e.g., Fries 1962, Hafsten 1956, Larsson and Lagerås 2015, Tolonen 1978), the Norse exploration and brief settlement in the region may have provided a pathway for the introduction of the species to North America.

At a location a few days journey from Stadacona towards Hochelaga (present-day Montréal), Cartier added *Salix* (willow), birch, fir, and spruce to his account of the natural flora and reemphasized the abundance of wild grapes along the riverside

(Stephens 1890:58). It is evident that the indigenous peoples were engaged in agriculture as they brought cereals and gourds aboard Cartier's ship (Cartier 1906a:46). Unfortunately, Cartier did not describe the village of Stadacona; thus, his accounts cannot be drawn upon to infer the extent of environmental impact inflicted by the native populations.

The pre-Columbian environment in Québec was, unsurprisingly, not static. Following the emergence of thermophilous and forest biota in the early Holocene, a gradual densification of the forest cover occurred in both the mountain regions, with fir and White Birch emerging as the dominant tree species, and the riverside environs, with major cedar forests prevailing. The areas were subject to natural, auto-genic disturbances such as forest fires and flooding. While archaeological investigations reveal the presence of indigenous populations in the province dating to the Paleoindian Period, the lack of associated environmental archaeological assessments makes it difficult to clearly establish the level of human disturbance in the region prior to the arrival of Europeans. However, Cartier's portrayal of the riverside environment around Stadacona during his 1535 voyage does paint a picture of a rather undisturbed landscape.

Culture-steppe: the Europeanization of the landscape. The arrival of the French colonists in Québec had an observable impact upon the natural environment. In 1541, Cartier depicted the landscape surrounding the Charlesbourg-Royal colony near the Cap-Rouge River. In his journal, Cartier mentioned the presence of oaks, cedars, *Fagus* (beeches), and *Acer saccharum* (Sugar Maple), among other trees (Cartier 1906b:97; Stephens 1890:104). He also referred to a tree he called hanneda (annedda), whose bark the natives believed to be a cure for all sickness and which Cartier claimed cured scurvy and syphilis (Erichsen-Brown 1979). Based on the description offered by Cartier and the high vitamin-C concentrations in the bark, the tree was likely *Picea rubens* (Red Spruce) or perhaps *Tsuga canadensis* (Eastern Hemlock). South of the forest, Cartier described a thick grove of wild grapes and hawthorns (Cartier 1906b:97). According to Cartier (1906b:97), the fertility of the land appealed to the colonists and they ploughed the spot and planted cabbage, turnips, and lettuce.

The colonists constructed a fort on the cliff. Cartier (1906b:98) described a forest of oaks and other trees, "no thicker [than] the Forrests of France" located near the fort, which was easily brought to tillage. The land surrounding the fort was not completely forested. Cartier mentioned a grassy meadow to the west of the river bordered by wild grapes and Hemp (Stephens 1890:106).

Archaeobotanical assessments of samples from the Cartier-Roberval Upper Fort site (probably taken from both inside and outside of buildings) have revealed a range of endemic and imported plant species (Bouchard-Perron and Bain 2009). Over 85% of the identified plant remains were European in origin and of a domestic nature, such as: peas, *Lens culinaris* (Lentil), olives, Barley, and wheat. In addition to the European economic plants, the site yielded some evidence for the presence of Palaeartic weed species. Bouchard-Perron and Bain (2009) made particular mention of the weed species *Agrostemma githago* (Corncockle) and *Euphorbia* sp. (spurge) and proposed that the taxa were imported accidentally alongside the harvested wheat. While that is the most likely pathway for the introduction of the weeds, certain species of *Euphorbia* have been used medicinally in remedies for pinworms and cramps (cf. Erichsen-Brown 1979). Brinkkemper and van Haaster (2012) similarly note that Corncockles were recommended in some historical sources as effective antihelminths.

As the site was occupied only from 1541–1543, the sparse representation of indigenous flora in the examined samples is noteworthy. The majority of the evidence for the endemic taxa came from tree and shrub species, which may likely demonstrate the continued presence of a natural woodland environment surrounding the fort rather than ecological conditions within the immediate vicinity of the site. The paucity of open environment or disturbed-land species, European or indigenous, may imply the creation, for the most part, of a sterilized anthropogenic environment within the fort. The absence of grass and other open environment species may suggest that the fort was not constructed in a meadowland but rather in an area of recently cleared woodland. The clearance of an established forest would have displaced the woodland biota and created an open niche susceptible to the colonization of the environment by species specialized for open-land habitats, whereas it might be argued that the construction of the fort upon an open environment would not have completely displaced the local flora, allowing for the possible recovery of some grassland taxa. However, a more detailed analysis of the site would need to be pursued in order to address these questions.

After Cartier and Roberval's failed attempt at colonization, Champlain resettled the area in 1608. Although Champlain's sketch of the basin area lacks specifics, it does hint at a predominantly forested environment with an open terrain (sandy or rocky) bordering the edge of the basin (Fig. 11). The next environmental archaeological evidence for Québec City is derived from the early contexts (61A41 and

61A30) at the Intendant's Palace site in the Lower City. Tentatively dated to ca. 1665, the contexts provided little environmental signal of a European presence and were mostly of an endemic natural biota. However, the recovery of 2 Palaeartic carabid beetles confirms a European presence in the region. The coleopteran assemblage paints a portrait of a terrestrial floodplain or wetland environment with hardwoods and spruce. The recovery of *Dialytes ulkei* may suggest that deer and/or sheep may have frequented the area. The coleopteran remains may provide insight into the natural entomofauna of the forested riverside environment of the St. Lawrence, as described by Garneau (1997).

If the dates are correct, the paucity of European biota in the assemblage is surprising, as other colonial sites reveal an assortment of Palaeartic taxa very early in their respective settlement history. Non-obligatory synanthropes, especially mycetophagous taxa, have been recovered from contexts at Pointe-à-Callière, Montréal, dating to 1642, the year of its settlement (King 2010b), and the 1611 contexts from James Fort in Jamestown, VA, USA, evidence an established Europeanized urban environment only 4 years after its founding (King et al. 2010). However, the ecofacts recovered from both of those sites were collected from artificial, man-made environments, whereas the early Québec City contexts

(61A41 and 61A30) may be associated with a more natural (or at least a seemingly less externally influenced) setting.

Contemporaneous contexts (55A69 and 55A61) from the shipyard in Québec City have yielded a combination of endemic and European biota. As in 61A41 and 61A30, the indigenous species primarily reflected the presence of a waterside/floodplain environment as well as the exploitation of wood remains. Moreover, the samples yielded European fauna (primarily decomposer species) capable of occupying similar waterlogged, organic habitats. While environmental remains from 55A61 were primarily indicative of the floodplain habitat, those from 55A69 revealed the additional presence of an open-ground/disturbed-land environment. Although this ecological signal was reflected by both European and North American weed species, only 2 coleopteran species (both Nearctic) represented it. Context 55A69 was also composed of several synanthropic taxa representing the presence of food remains. Additionally, *Sonchus oleraceus* (Common Sowthistle) was recovered. This European disturbed-land species may have been accidentally imported as a weed; however, it is an edible as well as medicinal plant that is also a favored food of hogs and rabbits. The economic aspect of the assemblage was primarily European in origin.



Figure 11. Champlain's sketch of the basin ca. 1613. "Illustrations de Les Voyages de Champlain. Planche en regard de la Québec". P. 176. Bibliothèque Nationale de France, dépôt des cartes et plans C85849. Paris, France.

Unlike 61A41 and 61A30, the shipyard contexts evidenced the presence of European taxa within an anthropogenic environment. The assemblage from 55A61 was suggestive of human activity in the vicinity primarily through the recovery of imported floodplain/waterside taxa alongside endemic species. Context 55A69 demonstrated more discernible evidence of human settlement, yielding both disturbed-land and synanthropic taxa. The presence of a clear disturbed-land/open-ground biota rather than a woodland assemblage likely reflects the ecological result of the deforestation of the area during the settlement process. By 1665, the Lower City supported both indigenous and allochthonous biota. The flora, in particular, seem to reflect the coexistence of species from both biogeographical regions. Although a few Nearctic species were present, the food-related and decomposer coleopteran taxa were dominated by European species. The Nearctic staphylinids and scarabs from 61A41 and 61A30 were absent in the shipyard assemblages, and instead the niche was represented by common Palaearctic species such as *Gyrophynus fracticornis*, *Aphodius prodromus*, and *Calamosternus granarius*.

The representation of Nearctic and Palaearctic species in the environmental remains from the samples procured outside Talon's Brewery suggest an ecological context similar to the shipyard samples. Water-side taxa were present in small numbers, likely reflecting the proximity of the St. Charles River. Unlike the shipyard contexts, however, very

few foul decomposers were recovered, suggesting that the ground may not have been as damp.

Wood-related and open grassland species dominated the samples. The presence of the carabids *Bembidion grapii* and *Pterostichus adstricus* suggest the existence of a coniferous or alpine-like meadowland. A depiction of Québec City ca. 1670 portrays an open environment surrounding the brewery with the St. Lawrence River in the background and a pocket of forest in the foreground (Fig. 12). The plant macrofossils show a blend of Nearctic and European species with native grasses, *Oxalis stricta*, and *Polygonum pensylvanicum* (Pennsylvania Smartweed), coexisting with allochthonous weeds such as *Stellaria media* (Common Chickweed), *Lapsana communis* (Common Nipplewort), *Taraxacum officinale* (Common Dandelion), and *Nepeta cataria* (Catnip) (Fortin 1989). It also appears that wood, likely with bark, was stored on the site. The identified wood-related coleopteran taxa were endemic and comprised species mostly associated with dead or dying wood. The wood may have been intended for construction or firewood.

Alternatively, given the proximity to the brewery, the bark from the wood may have played a role in the brewing process. The recovery of *Rhyncolus brunneus* and *Phloeotribus piceae* suggest the presence of cedar and spruce on the site, and Fortin (1989) identified both plant species in her analysis of the botanical remains. Additionally, the European imports *Humulus lupulus* (Hops) and *Hyoscyamus niger* (Henbane;



Figure 12. Québec from the west, ca. 1670, depicting small boats in front of the brewery, marked 5 (Anon., "L'entrée de la Rivière St Laurent et la ville de Québec dans le Canada", Bibliothèque Nationale de France, dépôt des cartes et plans, Paris, France. S.H. portf. 128, div. 6, piece 1).

often considered a weed, but noteworthy as Rabin and Forget [1998] list it as a pre-hops ingredient in the brewing process) were recovered (Fortin 1989). Although Boucher (1664) mentioned only wine and bouillon (a brew made from fermented yeast and grain), Josselyn (1672) upon visiting New England referred to a beer made with boiled spruce bark, and Kalm (1772:324, 414) noted spruce-beer during his tour of Québec in 1749. Among the beetles, the only other potential evidence of anthropogenic activity in the vicinity was the presence of *Priobium sericeus*. Today, this Nearctic anobiid attacks structural timbers and worked wood (Campbell et al. 1989); however, in nature, it likely preferred to attack exposed and debarked sections of dead trees.

The paucity of synanthropic taxa in the context in addition to the myriad of open land species indicates an untended environment in which opportunistic natural species, both indigenous and foreign, had recolonized. Some human activity, such as the storage of wood, may have been indicated. Although both biogeographical zones were represented, the flora and entomofauna from Talon's Brewery (51C60) were predominantly Nearctic. However, similar contexts evaluated by Bain et al. (2009) yielded a

wider range of Palaearctic flora. In comparison, the samples from within the brewery were almost entirely European, both economic and weed flora (Bain et al. 2009).

The shoreline or beach samples from the nearby Îlot Hunt site (ca. 1675–1699) provided a coleopteran assemblage that was similar to the shipyard biota (Bain and King 2011). The ground beetles and weevils were indigenous taxa while the decomposers and mycetophagous individuals were European in origin. The beetle remains evidence a typical riverside floodplain environment littered with organic debris. The recovery of *Dryophthorus americanus* and *Laemophloeus* indicate that wood or wood debris may have been present on site.

Fonville's 1699 image of Québec City suggests that there may have been a ditch in the northwest corner of the palisade near the First Intendant's Palace (Fig. 13). The coleopteran assemblage from the ditch indicates the continued presence of a biogeographically mixed environment: predominantly Palaearctic decomposer and economic species that coexisted with Nearctic ground beetles (Bain et al. 2009). The former indicated a fetid habitat potentially containing disposed domestic waste, and the latter, i.e.,

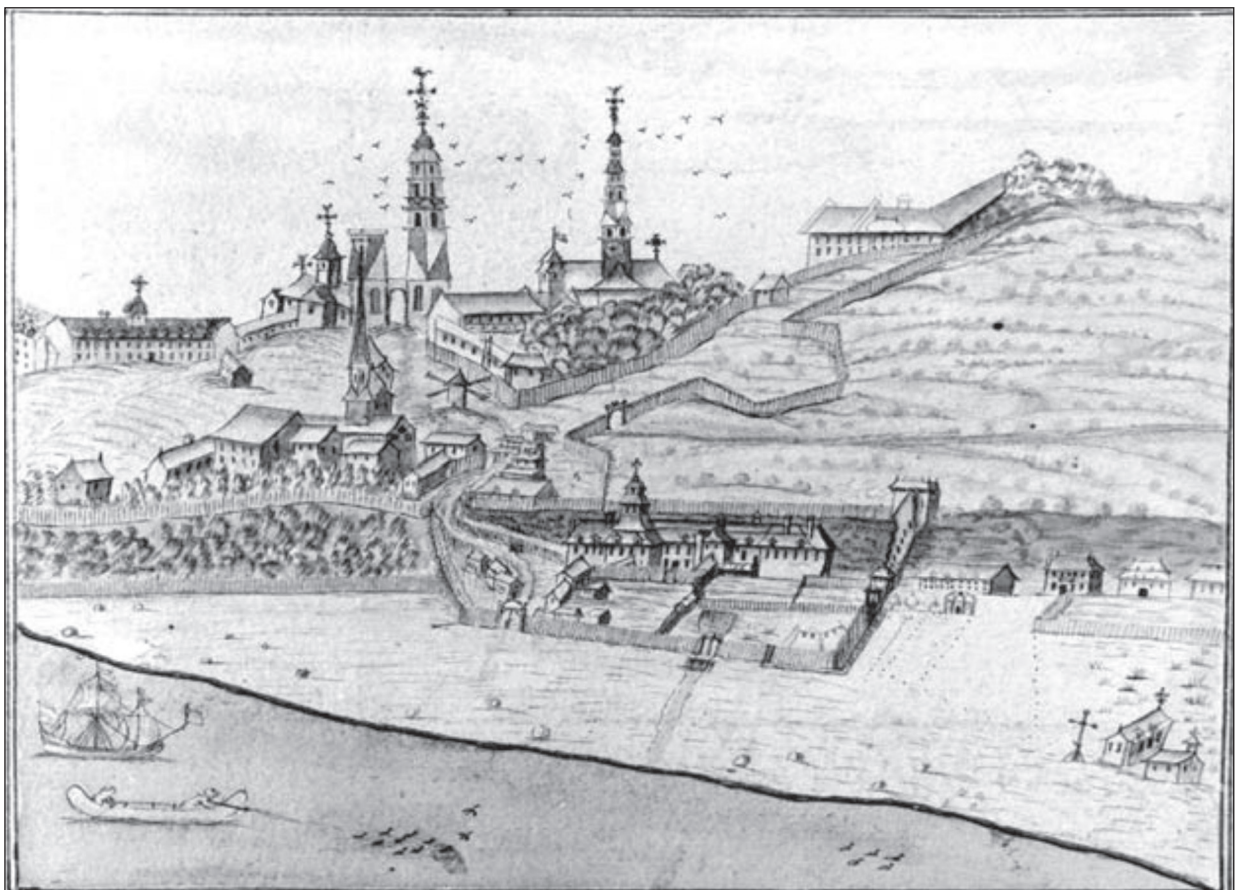


Figure 13. “Québec veu dv Nord Ouest”, 1699 (attributed to Fonville, National Archives of Canada, C-46450).

Stenelophus comma, provided an ecological signal for the presence of an open, sandy space near water (cf. Bain et al. 2009). The plant macrofossils demonstrated that the European flora, particularly dry-land weeds, also dominated the context. Meanwhile, the cedar wood remains from the palisade posts showed

that the colonists continued (as suggested by the Neartic wood-related taxa from the earlier contexts) to exploit the endemic natural resources of surrounding forests (Bain et al. 2009). Villeneuve's 1685 map shows that forested areas were still plentiful in Québec City's hinterlands (Fig. 14).



Figure 14. Lower Town, Québec ca. 1685; denoted as 2. “Carte des Environs de Quebec en La Nouvelle France Mesuré sur le lieu très exactement en 1685 et 86 par le Sr Devilleneuve Ingénieur du Roy”. Bibliothèque Nationale de France, dépôt des cartes et plans. Paris, France. S.H. portf. 127, div 7, piece 4.

The Nearctic biota remained strongly represented within the Lower Town of Québec City at the beginning of the 18th century. The entomofauna, particularly the carabids, recovered from the beach level in front of the Dauphine Battery at îlot Hunt (ca. 1700–1725) suggest a sparsely vegetated riverside setting with a sandy substrate (Bain and King 2011), an inference which is supported by Fonville's depiction of Québec City in 1699 (Fig. 13). However, it should be noted that Fonville focuses on the Intendant's Palace and is believed to portray the St. Charles at low tide. Species reflecting a waterside environment dominated the beach-level assemblage. The hydrophilids *Hydrochus* sp. and *Helophorus frosti* represent aquatic habitats (Smetana 1988), and *Crenitis morata* implies the presence of standing pools of water (Smetana 1988). Both of the riffle beetles *Optioservus ovalis* and *Stenelmis* are often found in or around cool, rapid-moving streams (Arnett et al. 2002). The presence of moss is evidenced by both *Cytilus alternatus* and *O. ovalis* (Arnett et al. 2002) at îlot Hunt (CeEt-110). The endemic beetles *Hylesinus aculeatus* and *Monarthrum mali* indicate the presence of felled or weakened trees, especially ash (Campbell et al. 1989) although maples, elm, birch, beech, oak, and *Tilia* (linden) may have also been present (Bright 1976, Wood 1982). The recovery of the bark beetle *Dryocoetes* also suggests the possibility of fir, spruce, pine, or hemlock wood having been present in the vicinity (Bright 1976), and the weevil *Pityophthorus* further evidences spruce or pine (Wood 1982). Botanical remains of fir and spruce were recovered from the nearby site of the First Intendant's Palace (Fortin 1989).

The Palaearctic taxa were only weakly represented in the early 18th-century beach-level contexts at îlot Hunt. The staphylinids and the scarab *Calamosternus granarius* would have been able to occupy microhabitats within decaying vegetation, riverside wrack, or perhaps even damp moss (see Koch 1989). Although primarily considered synanthropic, the *Latridius minutus* group is also capable of infesting natural environments containing plant debris and bark (Böcher 1988). *Sitophilus granarius* (Granary Weevil) was also present in the assemblage. The Granary Weevil is a primary pest of stored cereals and typically taken as an indicator for the presence of grains. While the species has been occasionally found in wheat thatch and straw (King 2010a, 2012), it and the Nearctic *Anthonomus rubi* (Strawberry Blossom Weevil) most likely indicate the dumping of human waste. A 1710 ordinance shows that garbage was to be transported to the site (Roy 1919), most likely for the intentional formation of renewed

land through waste deposition (Bain and King 2011). Although the early 18th-century shoreline samples exhibited subtle signs of human activity in the vicinity, the indigenous taxa dominated the assemblage, implying the existence of a predominantly natural riverside setting.

After the fire destroyed the First Intendant's Palace in 1713, the construction of the new palace complex heralded an ecological transformation in the physical landscape of the Lower Town. To the north of the palace, the riverside setting was altered and a large breakwater constructed (Bain et al. 2009). Ecologically, the area exhibited a rapid decline in the number of Nearctic plant species that hitherto had frequented the vicinity (Bain et al. 2009). The documented growth of the Lower Town during this time records an urbanization of the landscape as the urban expansion away from Place Royale encroached upon the former isolation of the original palace (Bain et al. 2009).

The environmental samples dating to this period are associated with anthropogenic contexts such as the latrines and the King's Stores. As one would expect, both contexts yielded numerous socioeconomic taxa reflecting the presence of various commodities of both local and foreign origin, such as cereals, fruits, nuts, meat, *Linum usitatissimum* (Flax), and Hemp (Bain et al. 2009, Fortin 1989, Muller 2010). In addition to these economic species, the contexts, especially the King's Stores, yielded a range of natural biota. Several dry-land species were recovered in addition to waterside/wetland taxa. Whereas the weed taxa associated with dry landscapes may have been transported to the buildings together with the produce, the majority of the native weed flora derived from a very moist environment (cf. Bain et al. 2009, Fortin 1989).

Similarly, the freshwater gastropods *Lymnaea palustris* group and *Bithynia tentaculata* from the King's Stores (51C50 Southeast) as well as the aquatic Coleoptera (Dytiscidae and *Cercyon* spp.; 51C50 Southwest) (Muller 2010) emphasize the enduring presence of the riverside biota. Moreover, the cocoons of thousands of *Tubifex* sp. were recovered from the King's Store (Fortin 1989). These freshwater worms inhabit the organic sediments, often muddy, of lakes, rivers, and sewers, where they feed on detritus and decaying organic, vegetable, and animal matter (see Fortin 1989). The majority of the coleopteran remains, particularly the mycetophages, economic pests, and staphylinids, were European in origin. (For a detailed analysis of each room, see Bain et al. [2009].) However, as in the earlier Québec City contexts, the ground beetle species (*Bembidion wingatei*, *B. versicolor*, *Elaphrus* sp.) as well as the wood-related entomofauna (*Ostoma*

ferruginea and *Sepedophilus* sp.) were primarily endemic (cf. Muller 2010). Bain et al. (2009) have suggested the waterside and aquatic taxa from King's Stores represent the conditions of the cellar (the bottom of the cellar likely dipped into the high water table of the former marshland), whereas the economic species, with the possible exception of certain vegetables, were likely stored in the drier conditions of the upper floors. Moreover, they posited that the cellar may have served to temporarily store spoiled or overly infested commodities.

Despite the growth of the Lower Town and its urbanization, the pre-Columbian marshland environment depicted by Garneau (1997) appears to have endured the attempts at anthropogenesis into the 18th century. Indeed, Charlevoix (1763) commented about the marshy terrain in a 1720 observation of the nearby hospital. After the destruction of the King's Stores in 1760, the prevalence of marshland flora decreases; however, the proximity of the river is sparsely represented by taxa such as *Carex* spp. Bouchard-Perron (2010) reported that contexts associated with the destruction of the King's Stores yielded the charred remains of a couple of economic species (wheat and peas); however, the majority of the floral remains indicate the return to an open environment with disturbed-land taxa, such as grasses and wildflowers. Although endemic species were recovered, the majority of the disturbed-land taxa were European. In addition to the disturbed-land taxa, plant macrofossils from indigenous tree and shrub species, such as spruce, hawthorn, and elderberry, appear in the contexts (cf. Bain et al. 2009).

Pathways and mechanisms for biotic transfer

The post-glacial geographic regions of Québec and Europe are separated by the Atlantic Ocean. As such, species dispersal required human agency to facilitate movement through the sweepstakes route. Ballasting has been proposed by several authors as a mechanism of transport (Buckland 1981; Buckland and Sadler 1990; Buckland et al. 1995; Klimaszewski et al. 2010; Lindroth 1957, 1963; Sadler 1991). Lindroth (1957) noted that ship's ballast commonly included sand, turf, rubbish, lead, stones, and a myriad of building materials, resulting in the accidental transportation of disturbed-land species and waterside taxa.

Unlike samples from colonial Newfoundland and Boston (Bain and King 2011, Bain and Prévost 2010), the 17th- and early 18th-century contexts from Montréal (King 2010b) and Québec City did not yield convincing evidence to support ballast dumping as a primary means of biotic transfer. The introduced disturbed-land species were closely related

to agricultural practices, and several of the weed species exhibit an association with crop fields or grazing land.

The evidence for biotic transfer via ballast is associated with the collection and use of turf and water-side material. Although the majority of the identified water-side taxa were indigenous, *Cercyon littoralis* was recovered from the shipyard assemblage and the beachfront Îlot Hunt site. This hydrophilid is typically confined to sandy, clay-mixed seashores, where it lives in decaying organic matter, mainly under seaweed and wrack (Hansen 1987). Whereas the species is currently categorized as amphi-Atlantic (living on both sides of the Atlantic ocean), it has a well-established fossil record for Europe (Roper 1999, Smith et al. 2000) but lacks pre-Columbian records for North America. While the beetle is likely introduced, was it imported directly to Québec? It was found in 17th-century contexts in Newfoundland (Bain and Prévost 2010), and may have been brought to Québec City by natural mechanisms. Whitehouse (2006) has proposed birds and water as possible agents for the short-distance transportation of taxa from Norway to Scotland, and Makja et al. (2006) found that over 50% of the beetle species from owl nests in Nova Scotia were adventives. The amphi-Atlantic freshwater gastropod *Lymnaea palustris* group and Palaearctic *Bithynia tentaculata* may have been similarly introduced, as these snails are known to use passive transport by birds as a means of natural dispersal (von Proschwitz 1997). It seems likely that ships crossing the Atlantic were relieved of some of their ballast load prior to embarking into the shallower waters of the St. Lawrence River, thus accounting for the paucity of associated taxa from early colonial sites along Québec's rivers. The presence of the European ground beetles *Amara aenea* and *Loricera pilicornis* may provide more definitive evidence of ballast dumping as they prefer the sandy terrain of waterside environments; however, both species are also associated with agricultural crops in cultivated land (Bengtson 1981, den Boer 1977) and have been recovered archaeologically from inside buildings and wells that yielded other evidence of agricultural practices (Greig et al. 2004, Kenward 1979).

The majority of the introduced taxa are associated with socioeconomic activities. A number of the plant species provide primary evidence for the importation of crop species such as wheat, barley, and peas, which are further supported by the recovery of the flora's invertebrate pest species, e.g., *Sitophilus granarius* and *Bruchus* sp. The samples also yielded a number of taxa making up what Kenward and Hall (1997) referred to as a stable-manure indicator

group: grain pests, species often found in hay, house biota, and foul decomposers. This biotic assemblage may have been introduced to the New World accidentally alongside the imported domesticated animals. Similarly, the large domesticated grazers may have provided a pathway for the introduction of meadowland and grassland taxa. Seeds and insects are capable of passing through dietary tracts intact (cf. Osborne 1983) and may have been deposited onto the ships and subsequently in the New World via the animal cargo. These socioeconomic species, purposefully or unwittingly introduced, reflect the cultural heritage of the settlers as agriculturalists, and may provide environmental archaeological evidence towards cultural transference as the colonists arrived in Québec with a settlement package consisting of domesticates, hence importing their familiar Old World culture with the intention of plying it in the unfamiliar environs of New France.

Ecological impact: deforestation, soil erosion, and biotic extirpation

Both historical descriptions from explorers and Garneau's (1997) palaeoecological reconstruction portray the existence of a forested, wetland environment along the St. Charles River at the onset of colonization. Cartier's (1906b:98) comment regarding forest thickness informs forest density, suggesting forest openness. Moreover, if lots 61A41 and 61A30 are viewed as natural, early Columbian contexts or indications of enduring post-settlement pockets of forest, the coleopteran (albeit limited) evidence of large grazing herbivores implies an open-environment forest (cf. Whitehouse and Smith 2004), and the scarcity of recovered saproxylic taxa suggests that the extant forest was not an old-growth wild-wood reminiscent of the European *Urwald* (Whitehouse 2006), but rather a dynamic environment with declining woodland similar to the flood-susceptible environment discussed by Garneau (1997).

By the mid-17th century, deforestation during settlement construction had resulted in the formation of a biogeographical melting pot in Québec City's gradually urbanizing Lower Town. While indigenous wood-related taxa were represented in the majority of the contexts, other woodland species (i.e., species associated with the wider forest ecology and not specifically wood) were lacking, suggesting that the taxa represent the human exploitation of the hinterland woodland environments and the importation of wood to the site as opposed to the continued presence of natural, forested ecosystems on the site. The earlier occurrence of deforestation is evidenced by the emergence of disturbed-land and open-land taxa. These ecological groups included both indig-

enous and foreign taxa, implying that the deforestation process had permitted the allochthonous biota to gain a foothold in the New World, but not secure ecological dominance. The quick re-occupation of the Lower Town environment by Nearctic species may have been facilitated by the presence of nearby meadowlands (for the open-land taxa), as mentioned by Cartier (Stephens 1890), and the previous, and seemingly enduring, occupation of the immediate vicinity by disturbed-land species capable of exploiting the dynamic floodplain habitats and flood debris along the riverside. The waterside habitat continued to be dominated by indigenous taxa into the early 18th century, and likely reflects the survival of established natural habitats and microhabitats in the vicinity that were competitively challenging for allochthonous organisms to penetrate.

Deforestation is a known agent of soil erosion in modern times. The roots of the trees anchor the sediments, which upon the removal of the trees can be washed away by flowing water (Lal 1996, Southgate and Whitaker 1992). In a floodplain environment as inferred for the Lower Town of colonial Québec, fast-moving water would have been capable of washing away the nutrient-rich topsoil. However, slow-moving or stagnant washover from the river may have continued to deposit organic detritus, which, while capable of slowly washing away the top soil, would have also provided a nutrient supplement. The presence of a floodplain, marshy environment is evidenced in several of the archaeological contexts, as is the deposition of flood debris. While the samples do not provide clear evidence for soil erosion, the 18th-century contexts do indicate an increase in the number of sand-related species, possibly evidencing its occurrence. Alternatively, the rise in sand-related taxa may be associated with another known ecological side-effect of landscape anthropogenesis—sedimentation. However, that is difficult to discern solely from the available ecofacts of the present investigation.

The studies reviewed in this evaluation were insufficient to address questions of biotic extirpation. Considering the available coleopteran data, several endemic species present at the pre-Columbian L'Empêche site were absent in the settlement samples. Does this evidence biotic extirpation or simply differences in original faunal composition? Further studies of the natural environmental conditions immediately preceding the arrival of the Europeans need to be undertaken in order to better establish the original, natural biota of the riverside region. Whereas certain endemic species may have been displaced from the immediate vicinity during the deforestation and subsequent urbanization

processes, that tenuous possibility alone cannot be taken as evidence for extirpation, as the species may have survived in the surrounding landscape.

Conclusions and Future Directions

The last word in ignorance is the man who says of an animal or plant, "What good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering. (Aldo Leopold 1953)

The establishment of permanent settlements along Québec's waterways in the early 17th century achieved a physical transformation of the landscape in response to a gradual urbanization of the environment. The human-induced ecological change is primarily supported by evidence of deforestation and the arrival of European species. However, the native biota was not completely displaced by the arrival of the colonists or their subsequent activities, and the environmental archaeological evidence suggests that it endured in waterside habitats and competed with the foreign species in open-land and disturbed-land environments.

Although both an urbanization of the local environment and the arrival of a European ecological package were observed in the present study, there was no clear indication that the arrival of the colonists resulted in the collapse of the local ecosystem or the establishment of a definitively Neo-European environment in the Lower Town of Québec City during the first century and a half of permanent settlement (*sensu* Crosby 2004). Rather, the environmental archaeological evidence from the artificial, urban environments tells a story of a community that was shared by species from both biogeographical eco-zones—depicting an area that was not completely transformed but, perhaps, was influenced by the Exchange. Unsurprisingly, European taxa were prevalent in contexts associated with interior environments such as the Brewery, the King's Stores, and the Latrines. As archaeological records from Old World contexts demonstrate centuries, if not millennia, of cohabitation, or at least association, between the European synanthropes and humans, the biota would likely have had a competitive advantage over the indigenous taxa in exploiting the available microhabitats. However, even in the interior of the buildings, the Palaeartic species were not uncontested, and endemics, such as waterside taxa, were recovered in those contexts.

As the environmental archaeological samples were collected from within the confines of settlements, they are unable to speak directly of the ecological impact of colonialism upon the hinterlands during the creation of agricultural land and grazing pastures. The recovery of autochthonous dry-land flora alongside Palaeartic crop species in the King's Stores may indicate that the agricultural lands, like the open spaces in the urban environment, were subject to attempted re-colonization by endemics. The sampling bias towards urban contexts similarly makes it difficult to ascertain the impact of the colonization process upon the surviving pockets or regions of natural land. The wood-related species recovered from Québec City evidence the exploitation of forest environments and the continued association of endemic taxa with wood, but were the introduced species capable of expanding their range beyond the confines of the Europeanized zones to invade and exploit niches within forested environments?

Crosby (2004) painted a picture of a European biota that, upon arriving in the New World, would have initially dominated the newly created urban settings before advancing into the surrounding natural environments. The samples procured from the outside of buildings did not provide evidence of a dominant Palaeartic presence during the first century and a half of permanent settlement. A truly Neo-European ecological environment did not seem to exist early on in Québec. Moreover, archaeological evidence for the expansion of the species beyond the confines of the settlement was not discernible from the analyzed contexts. Certain taxa, e.g., *Brassica* sp., are both aggressive and prolific (Oduor et al. 2011), which may have enabled them to successfully compete with endemic species and expand into natural settings by exploiting corridor, filter, and sweepstake pathways. Species such as *Hyoscyamus niger*, while opportunistic, do not compete well against established communities (LaFantasie 2008), and their expansion would have been dependent upon the availability of disturbed areas. Other species, like the flightless *Sitophilus granarius*, would have been restricted to the islands of human habitat, particularly grain stores, and have only been capable of dispersing to similar habitats in other New World settlements through human agency (King 2010a). Although this study did not support the formation of a true Neo-Europe (in the sense of being an ecological mirror of Europe in the fashion that Crosby proposed for areas such as the Canary Islands), it does indicate that biological transfer to southern Québec arose primarily from taxa associated with socioeconomic activities.

Future directions

Future research needs to explore several different directions. It is imperative to develop our understanding of the wider context. Are the trends observed in the settlements unique, or are they also exhibited in natural settings? As such, further integration of environmental archaeological and paleontological studies needs to be pursued. Through marriage of these disciplines in examining historical date contexts, it may be possible to glean a better understanding of the ecological impact of the European arrival. Moreover, in order to better understand anthropogenic impact, a foundation for comparison needs to be established. How does the biotic history of pre- and post-Columbian indigenous sites compare to that seen in the colonial settlements? What was the pre-Columbian biota of the riverside ecosystems?

As the discipline of environmental archaeology, particularly the sub-field of archaeoentomology, is still developing in North America, there is presently a paucity of evidence upon which to draw comparisons. Further integration of all aspects of the discipline into archaeological investigations should continue to be encouraged as the additional comparative information would enhance our understanding of landscape transformation and the human-environmental impact. It would be of interest to compare the biota from urban, riverside contexts to urban, non-riverside settings and rural environments. While finding suitable deposits may make these exercises challenging, the assessments will likely foster a clearer understanding of dispersal, biotic transfer, and ecological impact serving to further illuminate and advance the story of Québec's Europeanization.

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Appendix 1. Examples of domesticated plants involved in the Columbian Exchange (cf. Crosby 1972).

New World to Old World	Old World to New World
Almond	Agave
Apple	Amaranth
Apricot	Arrowroot
Artichoke	Avocado
Asparagus	Beans (e.g., pinto, lima, etc.)
Aubergine	Black Raspberry
Banana	Bell Pepper
Barley	Blueberry
Beet	Canistel
Black pepper	Cashew
Broccoli	Chia
Brussels sprouts	Chicle
Cabbage	Chirimova
Cantaloupe	Chili peppers
Carrot	Cranberries
Cauliflower	Coca
Cinnamon	Cocoa
Citrus (orange, lemon, etc)	Cotton
Clove	Courgette
Coffee	Custard Apple
Collard greens	Guava
Cucumber	Huckleberry
Fig	Jerusalem Artichoke
Flax	Jicama
Garlic	Maize
Hazelnut	Manioc
Hemp	Papaya
Lettuce	Passionfruit
Millet	Peanut
Nutmeg	Pecan
Oats	Pineapple
Olive	Potato
Onion	Pumpkin
Peach	Quinoa
Pea	Rubber
Pear	Sapodilla
Pistachio	Squash
Radish	Strawberry
Rice	Sugar-apple
Rye	Sunflower
Soybean	Sweet potato
Sugarcane	Tobacco
Tea	Tomato
Turnip	Vanilla
Wheat	Wild rice
Walnut	Yerba maté
Watermelon	Yucca
Wine grape	
Yam	

Appendix 2. Domesticated animals involved in the Columbian Exchange (cf. Crosby 1972).

Old World to New World	New World to Old World
Cat	Alpaca
Camel	American Mink
Chicken	Chinchilla
Cow	Guinea pig
Donkey	Llama
Ferret	Muscovy Duck
Goat	Turkey
Goose	
Guinea Fowl	
Honeybee	
Horse	
Pig	
Rabbit	
Rock Pigeon	
Silkworm	
Water Buffalo	

Appendix 3. Preserved insect and gastropod remains from sites in southern Québec. + signifies introduced to North America, * signifies Holarctic, ** signifies may or may not be introduced. Sources: Lac à l'Empêche (Lavoie 2001), Îlot Hunt sites modified from Bain and King (2011) to incorporate new data, and Pointe-à-Callière (King 2010b); all others from this study.

		Lac à l'Empêche	Beach Îlot Hunt CeEt110	Beach Dauphine Battery Îlot Hunt CeEt110	Shipyard Îlot Palais CeEt30 55A69	Possible Shipyard Îlot Palais CeEt30 55A61	Talon Brewery Îlot Palais CeEt30 51C60	Îlot Palais CeEt30 61A41	Îlot Palais CeEt30 61A 30	Latrine Îlot Palais CeEt30 57B4	Latrine Îlot Palais CeEt30 57B5	Latrine Îlot Palais CeEt30 57B6	King's Store Îlot Palais CeEt30 51C50	Pointe-à-Callière BjFj101 11G40	Pointe-à-Callière BjFj1001 11E 72
INSECTA															
COLEOPTERA															
Carabidae															
<i>Agonum</i> spp. **				p											
<i>Amara aenea</i> Degeer+	Group 6						p	p							
<i>A. hyperborea</i>	Group 3	p													
<i>Bembidion affine</i> Say	Group 5				p	p			p						
<i>B. grapii</i>	Group 3	p					p			p					
<i>B. musicola</i> Hayward	Group 5			p											
<i>B. scopulinum</i> Kirby	Group 5		p	p				p							
<i>B. versicolor</i> LeConte or <i>mimus</i> Hayward	Group 5		p												
<i>Bembidion</i> spp. **					p	p									
<i>Calathus ingratus</i>	Group 4	p													
<i>Cicindela duodecimguttata</i> Dejean	Group 5					p									
<i>Loricera pilicornis</i> Fabricius+	Group 5							p							
<i>Notiophilus aquaticus</i> Linnaeus	Group 3	p													
<i>Patrobis septentrionis</i> Dejean	Group 5	p													
<i>P. stygicus</i> Chaudoir	Group 5	p													
<i>Pterostichus adstrictus</i> Eschscholtz*	Group 3						p								
<i>P. brevicornis</i> Kirby	Group 3	p													
<i>P. leconteianus</i> Lutshnik	Group 5	p													
<i>P. punctatissimus</i> Randall	Group 4	p													
<i>P. adstrictus</i> Eschscholtz/ <i>pensylvanicus</i> LeConte								p							
<i>Scaphinotus bilobus</i> Say	Group 4	p													
<i>Sphaeroderus nitidicollis</i> LeConte	Group 4	p													
<i>Syntomus americanus</i> Dejean	Group 3	p													
<i>Trechus crassiscapus</i> Lindroth	Group 5	p													
Hydrophilidae															
<i>Cercyon analis</i> Paykull+	Group 7		p			p	p			p	p				p
<i>C. littoralis</i> Gyllenhal**	Group 7			p		p									
<i>Cercyon</i> spp.**			p			p									
<i>Crenitis morata</i> Horn	Group 5			p				p							
<i>Helophorus frosti</i> Smetana	Group 5			p											
<i>Megasternum obscurum</i> Marsham+	Group 7				p										
<i>cf. Phaenonotum exstriatum</i> Say	Group 5				p										

		Lac à l'Empêche	Beach Îlot Hunt	Beach Dauphine Battery Îlot Hunt	Shipyard Îlot Palais CeE130 55A69	Possible Shipyard Îlot Palais CeE130 55A61	Talon Brewery Îlot Palais CeE130 51C60	Îlot Palais CeE130 61A41	Îlot Palais CeE130 61A 30	L. atrine Îlot Palais CeE130 57B4	L. atrine Îlot Palais CeE130 57B5	L. atrine Îlot Palais CeE130 57B6	King's Store Îlot Palais CeE130 51C50	Pointe-à-Callière BjF101 11G40	Pointe-à-Callière BjF1001 11E 72
Histeridae															
<i>Gnathoncus rotundatus</i> Kugelmann+	Group 7									p					
<i>Margarinotus</i> sp.**						p									
Histeridae sp.**					p										
Clambidae															
<i>Clambus</i> sp.**					p			p							
Staphylinidae															
<i>Acidota crenata</i> Fabricius	Group 4	p													
<i>A. quadrata</i> Zettersted	Group 3	p													
Aleocharinae spp.**											p			p	p
<i>Anotylus insecatus</i> Gravenhorst	Group 5							p							
<i>A. rugosus</i> Fabricius+	Group 7														p
<i>Carpelimus bilineatus</i> Keisenwetter+	Group 5		p												p
<i>C. obesus</i> Keisenwetter+	Group 5														p
<i>Carpelimus</i> sp.**			p	p											
<i>Creophilus maxillosus</i> Linnaeus+	Group 7										p	p			
<i>Gyrophypnus fracticornis</i> O.F. Müller+	Group 7					p					p				p
<i>Lathrobium</i> sp.	Group 5	p													
<i>Neohypnus</i> sp.**	Group 7		p	p				p							
<i>Olophrum rotundicolle</i> Sahl.	Group 5							p							
<i>Olophrum</i> spp.**									p						
<i>Oxytelus sculptus</i> Gravenhorst+	Group 7														p
<i>Philonthus sericans</i> Gravenhorst	Group 7				p		p			p	p				
<i>Philonthus</i> spp.**						p					p	p			
<i>Quedius mesomelinus</i> Marsham+	Group 7			p						p	p				
<i>Quedius</i> spp.**					p		p					p			
<i>Sepedophilus testaceus</i> Fabricius	Group 4						p	p							
<i>Stenus</i> spp.**	Group 5	p													
Staphylinidae indet.**					p										p
Trogidae															
<i>Trox scaber</i> Linnaeus+	Group 7									p	p				
Scarabaeidae															
<i>Aegialia</i> sp.	Group 5			p											
<i>Aphodius prodromus</i> Brahm+	Group 7					p									
<i>Calamosternus</i> (syn <i>Aphodius</i>) <i>granarius</i> Linnaeus+	Group 7			p		p									p
<i>Dialytes ulkei</i> Horn	Group 2							p							

		Lac à l'Empêche	Beach Îlot Hunt	Beach Dauphine Battery Îlot Hunt	Shipyard Îlot Palais CeE130 55A69	Possible Shipyard Îlot Palais CeE130 55A61	Talon Brewery Îlot Palais CeE130 51C60	Îlot Palais CeE130 61A41	Îlot Palais CeE130 61A 30	Latrine Îlot Palais CeE130 57B4	Latrine Îlot Palais CeE130 57B5	Latrine Îlot Palais CeE130 57B6	King's Store Îlot Palais CeE130 51C50	Pointe-à-Callière BjFJ101 11G40	Pointe-à-Callière BjFJ1001 11E 72
Byrrhidae															
<i>Cytilus alternatus</i> Say	Group 5			p											
Elmidae															
<i>Optioservus ovalis</i> LeConte	Group 5			p											
<i>Stenelmis</i> sp.	Group 5			p											
Eucnemidae															
cf. <i>Entomophthalmus rufiolus</i> LeConte	Group 4												p		
Eucnemidae indet.													p		
Dermestidae															
<i>Dermestes lardarius</i> Linnaeus+	Group 9				p										
Bostrichidae															
<i>Stephanopachys rugosus</i> Olivier	Group 4	p													
Anobiidae															
<i>Priobium sericeus</i> Say	Group 10						p								
<i>Ptinus fur</i> Linnaeus+	Group 9								p	p			p		
<i>Ptinus</i> spp. **					p				p	p	p		p		p
Anobiidae spp. **								p							
Nitidulidae															
<i>Carpophilus hemipterus</i> Linnaeus+	Group 9				p										
<i>Omosita</i> sp.**					p										
Silvanidae															
cf. <i>Pediacus fuscus</i> Erichson*	Group 4									p					
Silvanidae indet. **					p										
Laemophloeidae															
<i>Laemophloeus</i> sp.	Group 4		p	p			p								
Cryptophagidae															
<i>Atomaria ephippiata</i> Zimmermann	Group 5							p							
<i>A. ochracea</i> Zimmermann	Group 5						p								
<i>Atomaria</i> sp.**								p							
<i>Cryptophagus</i> sp.**	Group 8							p							p
Endomychidae															
<i>Mycetaea subterranea</i> Marsham+	Group 8		p		p	p							p	p	
Coccinellidae															
<i>Chilocorus stigma</i> Say	Group 4			p											
Lathridiidae															
<i>Latridius minutus</i> group Linnaeus+	Group 8		p	p	p								p	p	
Corticaria/Corticarina sp. **														p	
Lathridiidae indet. **					p										
Mycetophagidae															
<i>Typhaea stercorea</i> Linnaeus+	Group 9				p										
Tetratomidae															
<i>Pisenus humeralis</i> Kirby	Group 4							p							

		Lac à l'Empêche	Beach Îlot Hunt	Beach Dauphine Battery Îlot Hunt	Shipyards Îlot Palais CeE130 55A69	Possible Shipyards Îlot Palais CeE130 55A61	Talon Brewery Îlot Palais CeE130 51C60	Îlot Palais CeE130 61A41	Îlot Palais CeE130 61A 30	Latrine Îlot Palais CeE130 57B4	Latrine Îlot Palais CeE130 57B5	Latrine Îlot Palais CeE130 57B6	King's Store Îlot Palais CeE130 51C50	Pointe-à-Callière B[F]101 11G40	Pointe-à-Callière B[F]1001 11E 72
Tenebrionidae															
<i>Neatus tenebroides</i> Beauvois	Group 4			p											
<i>Tenebrio obscurus</i> Fabricius+	Group 9			p											
Tenebrionidae indet. **				p											
Bruchidae															
<i>Bruchus cf. pisorum</i> Linnaeus+	Group 9									p					
Bruchidae indet. **							p								
Chrysomelidae															
<i>Cryptocephalus</i> sp. **							p								
Curculionidae															
<i>Anthonomus signatus</i> Say	Group 3		p	p											
<i>Dorytomus</i> sp.	Group 4														
<i>Dryophthorus americanus</i> Bedel	Group 4		p		p										
<i>Hyllobius warreni</i> Wood	Group 4	p													
<i>Rhyncolus brunneus</i> Mannerheim	Group 4	p				p									
<i>Sitona</i> spp.**	Group 3				p										
<i>Sitophilus granarius</i> Linnaeus+	Group 9			p	p				p				p		
<i>S. oryzae</i> Linnaeus/ <i>zeamais</i> Mots.+	Group 9											p			
Scolytidae															
<i>Dryocoetes</i> sp.	Group 4			p											
<i>Hylesinus aculeatus</i> Say	Group 4			p											
<i>Ips latidens</i> LeConte	Group 4	p													
<i>Monarthrum mali</i> Fitch	Group 4			p											
<i>Phloeotribus piceae</i> Swaine	Group 4	p				p									
<i>Pityophthorus</i> sp.	Group 4			p											
<i>Polygraphus rufipennis</i> Kirby	Group 4	p					p								
<i>Scolytus piceae</i> Swaine	Group 4	p													
Coleoptera spp. indet. **							p							p	
HYMENOPTERA															
Formicidae															
<i>Formica neorufibarbis</i> Emery	Group 4	p													
<i>Myrmica alaskensis</i> Wheeler	Group 4	p													
Hymenoptera spp. indet. **							p								
GASTROPODA															
BASOMMATOPHORA															
Lymnaeidae															
<i>Lymnaea palustris</i> group Muller**	Group 1												p		
MESOGASTROPODA															
Bithyniidae															
<i>cf. Bithynia tentaculata</i> Linnaeus+	Group 1												p		

Appendix 4. Plant macrofossils from archaeological sites in southern Québec. + signifies introduced to North America, * signifies Holarctic, ** signifies may or may not be introduced. Source for Cartier-Roberval Upper Fort, CeEu4: Bouchard-Perron and Bain (2009); all other data from this study.

			Cartier-Roberval Upper Fort CeEu4 52A2	Cartier-Roberval Upper Fort CeEu4 65B2	Cartier-Roberval Upper Fort CeEu4 70A6	Shipyard Îlot Palais CeE130 55A69	Talon Brewery Îlot Palais CeE130 51C60	Latrine Îlot Palais CeE130 57B6
<i>Abies balsamea</i> Linnaeus	Balsam fir	Group 4	p		p			
<i>Alnus incana</i> cf. <i>rugosa</i> Clausen	Alder cf. Speckled Alder	Group 5				p	p	
<i>Aralia</i> cf. <i>nudicaulis</i> Linnaeus	Wild Sarsaparilla	Group 4				p	p	p
Asteraceae **	Asteraceae		p	p				
cf. <i>Beta</i> sp.+	Beets	Group 9					p	
cf. <i>Betula</i> sp. **	Birch	Group 4					p	
<i>Brassica</i> sp.**	Mustard	Group 6			p			
<i>Capsella bursa-pastoris</i> Moench+	Shepherd's purse	Group 6				p		
<i>Carex</i> sp. **	Carex	Group 5				p	p	
<i>Chenopodium</i> sp. **	Goosefoots	Group 6	p		p	p		
<i>Crataegus</i> sp.	Hawthorn	Group 3	p	p				p
<i>Eleocharis</i> sp.	Spikerushes	Group 5					p	
<i>Euphorbia helioscopia</i> Linnaeus+	Sun Spurge	Group 6				p		
<i>Euphorbia</i> sp. **	Spurge		p	p				
<i>Fagus grandifolia</i> Ehrh.	American Beech	Group 4	p					
cf. <i>Ficus</i> sp.+	Fig	Group 9						p
<i>Fragaria</i> sp.	Strawberries	Group 3	p			p	p	p
<i>Galeopsis</i> sp.+	Hemp nettle	Group 6				p		
<i>Geranium</i> sp.	Cranebills	Group 3					p	
<i>Hordeum vulgare</i> Linnaeus+	Common Hulled Barley	Group 9	p	p	p			
<i>Hordeum vulgare</i> Linnaeus+	Common Barley	Group 9	p	p	p			
cf. <i>Hordeum</i> sp.+	Barley	Group 9	p	p				
<i>Hyoscyamus niger</i> Linnaeus+	Henbane	Group 6				p		
<i>Lycopus americanus</i> Linnaeus	American Water-horehound	Group 5	p			p		
cf. <i>Malus</i> sp. +	Apple	Group 9						p
<i>Mentha arvensis</i> Linnaeus*	Field Mint	Group 9						p
<i>Olea europaea</i> Linnaeus+	Cultivated olive	Group 9	p		p			
<i>Oxalis stricta</i> Linnaeus	Yellow woodsorrel	Group 3	p	p			p	
<i>Pisum</i> sp.+	Peas	Group 9	p					
Poaceae **	True Grasses	Group 3				p	p	p
<i>Portulaca oleracea</i> Linnaeus+	Common Purslane	Group 9						p
<i>Potamogeton</i> sp. **	Pondweed	Group 1						p
<i>Prunus pennsylvanica</i> Linnaeus	Pin Cherry	Group 9	p	p				
<i>Prunus</i> cf. <i>virginiana</i> Linnaeus	Choke Chery	Group 9	p		p			
<i>Prunus</i> sp. **	Cherry	Group 9	p	p				p
<i>Quercus ruba</i> Linnaeus	Red Oak	Group 4	p	p				
<i>Quercus</i> sp.	Oak	Group 4	p	p				

			Cartier-Roberval Upper Fort CeEu4 52A2	Cartier-Roberval Upper Fort CeEu4 65B2	Cartier-Roberval Upper Fort CeEu4 70A6	Shipyard Îlot Palais CeE130 55A69	Talon Brewery Îlot Palais CeE130 51C60	Latrine Îlot Palais CeE130 57B6
<i>Rubus</i> sp.	Raspberries; blackberries	Group 6	p	p	p			p
<i>Rumex</i> spp. **	Docks	Group 6				p		
<i>Sambucus</i> sp.	Elder	Group 5	p		p			
<i>Sonchus asper</i> Linnaeus+	Thorny Sowthistle	Group 6				p	p	
<i>Sonchus oleraceus</i> Linnaeus+	Common Sowthistle	Group 6				p		p
<i>cf. Sorbus</i> sp.	Mountain Ash or Rowan	Group 4	p					p
<i>Taraxacum officinale</i> Weber+	Common Dandelion	Group 6						p
<i>Thuja</i> sp.	Cedar	Group 5				p		p
<i>Triticum aestivum</i> Linnaeus/ <i>compactum</i> Host+	Bread wheat/Clubbed wheat	Group 9	p		p			
<i>Triticum</i> sp. +	Wheat	Group 9	p	p	p	p		
<i>cf. Utricularia</i> sp.	Bladderworts	Group 5						p
<i>Vaccinium</i> sp.	Cranberry/ Blueberry	Group 9						p
<i>Verbena</i> sp. **	Vervains	Group 6				p	p	
<i>Vitis vinifera</i> Linnaeus+	European grape	Group 9				p		
<i>Vitis</i> sp. **	Grape	Group 9	p	p	p			
<i>Zea mays</i> Linnaeus	Maize	Group 9	p	p	p			
<i>cf. Zea</i> sp.	Maize	Group 9	p	p				