Paleoenvironment and the Archaeological Record at the L’Anse aux Meadows Site, Newfoundland

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Archaeological evidence from the marine terrace and fen at the site indicates brief episodic occupation for over 5000 years. Five cultural episodes have been identified, although the site is renowned for its Norse settlement.

A fen on the site has provided both artifacts and fossil pollen. Although the pollen spectra are dominated by disturbance taxa, they indicate little or no human impact. Both the archaeological data and the pollen spectra are consistent with brief episodes of occupancy. Relationships between regional environmental changes and the human response are indistinct, although a cool interval after 2500 B.P. coincides with a 1000 year hiatus in occupation.

For the Norse period, the pollen record is compatible with the view that L’Anse aux Meadows was a small, short-lived way station.

INTRODUCTION

In North America, pollen analysis is often applied to paleoenvironmental reconstruction at archaeological sites (see Hevly, 1981), and, despite commonly poor pollen preservation (King et al., 1975), it has been used to infer site function, diet, and anthropogenic disturbance. The long term influence of climate on cultural change is better developed by pollen analysis of more continuously deposited lake sediment and peat. Even then, direct climatic impacts may be difficult to isolate from autogenic changes related to pedogenesis, and from changes resulting from human impact (Simmons and Tooley, 1981).

Pollen records can seldom be tightly resolved temporally, in part because of uncertain dating and because standard sampling procedures generally homogenize pollen data on a scale of decades to centuries. In effect, the spectra have limited use for the identification and interpretation of the short-term events which commonly trigger cultural changes (Fitzhugh and Lamb, 1985).

The problems are least where archaeological sites include deposits with good pollen preservation, which allows reconstruction of both local and regional environments, and where, by close interval sampling, the sensitivity of the pollen spectra can be maximized. The L’Anse aux Meadows site in northern Newfoundland offers such an opportunity. It has been discontinuously occupied for over 5000 years (Wallace, 1986) although it is best known as the only Norse settlement yet found in North America (Ingstad, 1977). The site in L’Anse aux Meadows National Park consists of an occupied marine terrace 4 to 6 m above sea level (a.s.l.), and a small fen (Figure 1). The fen, immediately seaward of the terrace, has accumulated peat over the last 3000 years. Its proximity to settlement should have made it, and the pollen record preserved in it, a sensitive site for paleoenvironmental reconstruction.

This paper summarizes our attempt to integrate palynology and archaeology at L’Anse aux Meadows. We analysed six peat monoliths from an east–west transect across the fen, although only Monolith 17, the most detailed and the closest to the terrace, is presented here. The pollen spectra are used to reconstruct the vegetational history of the site and the surrounding area in response to climatic and to autogenic changes, and to hu-
man impact. The study complements previous paleoecological work by Kuc (1975), Mott (1975), Henningsmoen (1977), Robertson (1978), Davis (1984), and the archaeological investigations of the site (Ingstad, 1977; Wallace, 1977, 1986).

THE SITE AND ITS REGIONAL SETTING

Geology and Topography

The Park has a low-lying, ridged and rolling topography that is controlled by glacially modified bedrock lithology and structure. Local relief seldom exceeds 50 m. The bedrock is composed of early Paleozoic (Cambrian and Ordovician) volcanics, sediments, and 'mélange' set in a black shale matrix (Cumming, 1975). Basaltic volcanics and resistant sedimentary rocks, particularly greywackes, stand out as low islands and ridges. The site lies in the lee of one of these ridges.

There are few clearly recognizable glacial deposits. Some beach and terrace deposits are composed of reworked till. However, most of
the regolith is fine-grained marine sediment that was deposited between 13,000 and 8000 B.P., when sea level declined from ca. 130 m to 30 m above present sea level (Wightman and Cooke, 1978).

Although generally thin and discontinuous, this fine-grained sediment provides an impervious veneer over much of the area, which encourages the widespread development of wetland (Grant, 1975). Close to the coast, sand and cobbles, often in the form of well-defined beach ridges and broad terraces, make up the bulk of the surficial sediment. Two prominent terraces occur at the L’Anse aux Meadows site. One stands at 12–14 m, with an intermediate berm at 10.5 m. The latter was formed at least 6500 years ago (Davis, 1984). Seaward of it is another terrace at 4–6 m from which much of the archaeological material is derived. Basal peat on it dates to ca. 5300 B.P. (Henningsmoen, 1977). Below this terrace is a series of berms that Grant (1975) has correlated with late Holocene eustatic and isostatic sea-level changes.

Vegetation

Five major ecological categories have been recognized in the Park (Meades et al., 1974; Gimbarzevsky, 1977), which lies in the forest-tundra transition (Rowe, 1972). These have been subdivided into 13 natural and 10 anthropogenic communities. The natural ones usually have well-defined landscape positions that reflect the topography.

Dry exposed ridges and exposed well-drained slopes are characterized by low statured rock and soil barren heaths. Their moss and lichen components are similar (Dicranum ssp., Cladonia ssp.) but in the rock barren the cover is discontinuous; in the soil barren it is complete. Empetrum nigrum dominates in both. Arctostaphylos alpina is co-dominant in rock barrens but in soil barrens the codominant is Rubus idaeus.

Localized snow bed communities up to 2 m high occur in the lee of ridges and in seepage channels. Alnus crispa and Dryopteris spinulosa are dominants, but Betula papyrifera, Sorbus decora, S. americana and Amelanchier bartramiana are common.

The boreal forest, 10 km south of the site, occupies well-drained coarse marine deposits. Abies balsamea, Picea mariana, and Larix laricina form a canopy 4–6 m high with Betula papyrifera and Alnus crispa common in the understorey.

High or tall tuckamore (shrub-form tree species up to 3 m tall) dominated by windpruned Abies balsamea, is widespread, particularly in sheltered locations. It often forms dense stands, with only mosaics in the understorey. Picea mariana forma semiprostata dominates in low tuckamore but Abies balsamea is common. Ericaceous species, particularly Ledum groenlandicum, Vaccinium angustifolium, and V. vitis-idaea are frequent.

Over half of the Park is classified into six wetland communities (Meades et al., 1974). Ombrotrophic bogs are dominated by Rubus chamaemorus and Sphagnum fuscum, although Empetrum nigrum and Ericaceae are numerous. Individual bogs have merged across the landscape through the development of blanket peats on low interfluves.

The other wetland communities are associated with shallow, minerotrophic peats. The widely distributed mesotrophic slope fen is dominated by Sphagnum papillosum, by the
dwarf shrubs *Betula mitchauxii*, *Larix laricina*, *Myrica gale*, *Kalmia polifolia*, and by Cyperaceae. *Rubus chamaemorus* and *Sphagnum fuscum* are common on hummocks.

The slope fen investigated here is subject to both occasional flooding by Black Duck Brook and salt spray from the ocean; it has a community composition of fen, fluvial, and beach—berm species that distinguish it from slope fens further inland. This distinctiveness is reflected in the fossil pollen.

Fluvial marsh occurs along the margins of streams where periodic flooding maintains minerotrophic conditions. It is dominated by the shrubs *Betula pumila* and *Myrica gale* and the herbs *Sanguisorba canadensis* and *Thalictrum polygamum*. Tidal marshes are present but not common; this minerotrophic environment supports salt tolerant plants, particularly *Carex salina*, *C. paleacea*, and *Plantago juncoidea*.

The dry beach—berm community is confined to a narrow zone above high tide and reflects the influence of wind and salt spray. *Lathyrus japonicus*, *Potentilla anserina*, *Iris versicolor*, and *Elymus arenarius* are dominant, together with *Heracleum maximum*, *Mertensia maritima*, *Atriplex glabriuscula*, *A. patula*, and *Angelica sylvestris*.

The site, then, is located in a severe physical environment, both marine and terrestrial, in a landscape that is mostly wetland and heath. Tree species occur as tuckamore rather than forest. Cut stumps in the heathlands suggest some anthropogenic origin for these communities. The present lack of forest cover is determined by a combination of climatic constraints on regeneration, of unfavorable sites for tree growth caused by paludification, and of widespread cutting. Until permanent settlement after the mid-nineteenth century, the area had more tree cover, although it is impossible to determine whether that cover was of forest trees or tuckamore.

**Archaeological Investigations**

The Norse settlement on the terrace was first excavated between 1961 and 1968 (Ingstad, 1977). Parks Canada continued excavation from 1974 to 1976, focusing on the landward side of the fen, and showed that L’Anse aux Meadows is a multi-component site with over 5000 years of occupation (Wallace, 1977, 1986, unpublished data). Artifacts and over a hundred C¹⁴ dates allow identification of at least five episodes of occupation by different cultural groups (Figure 2), although the cultural affinities of the late prehistoric groups are not clear. Occupation by pre-Dorset Archaic peoples from ca. 5200 B.P. is determined on the presence of highly disturbed stone features and a single C¹⁴ date. There appears to have been a cultural hiatus between 5200 and 2900 B.P. Between 2900 and 2300 B.P. was an early Dorset (Groswater) phase. Fifteen of the eighteen C¹⁴ dates for this culture come from cut wood in the basal peat of the fen. The rest are on charcoal from hearths on the terrace.

The site was apparently not occupied between 2300 and 1400 B.P., and McGhee (1979) notes a similar gap in the archaeological record for the high Arctic. Middle Dorset peoples returned at ca. 1500 B.P. and persisted until 1200 B.P. There are numerous hearths on the south shore of the bay, away from the Norse site.

Between the middle Dorset occupation and that of the Norse there was an Indian occupation, with artifacts that resemble those of the Northwest River phase of Labrador. Presumably these would have been the 'skraelings' encountered by the Norse.

The most obvious signs of Norse settlement are the remains of eight sod buildings. All except a smithy are on the terrace bordering the fen (Figure 1). Three buildings (A, D, and F) were large houses. Other structures were probably workshops. Artifacts include a bronze pin, a stone spinning whorl, and iron rivets. Pieces of worked wood were recovered from the fen. Over fifty C¹⁴ dates document the Norse episode. Half are derived from the terrace; the rest from cut wood and the peat of the fen. They range from ca. 1300 B.P. to ca. 900 B.P. Although the dates imply a long occupation, other data discussed later indicate that this was a brief settlement at a small waystation.

Dates on charcoal from hearths on the terrace and cut wood from the fen indicate settlement from ca. 700 to 300 B.P. by Indians, perhaps Beothuk.

**METHODS**

Six peat monoliths from an east—west transect across the fen were sampled for pollen...
Figure 2. Stratigraphy, pollen density, and loss on ignition for Monolith 17. Pollen density is for taxa in the pollen sum.
analysis (Figure 1). Three monoliths (17, 15, and 14) were collected in 1976 during excavations by Parks Canada. Their identification numbers are used here. Monoliths 1, 2, and 3 were collected in 1978 in order to extend the transect across the fen. The thickest monolith, 17, was sampled at contiguous 1 cm intervals.

Pollen was concentrated from 0.9 ml samples using standard methods (Faegri and Iversen, 1975). Prior to concentration, tablets containing a known number of Lycopodium clavatum spores were added to each sample (Stockmarr, 1971); this allows calculation of pollen density and, when sedimentation is known, influx.

Tree and shrub taxa comprise the pollen sum, which ranges from 205 to 492. These taxa probably represent the regional pollen rain. The exclusion of the more local herbs from the sum separates the percentages of regional taxa from the fluctuations which characterize the local component. The percentage of the local taxa are calculated on the same pollen sum. This approach facilitates interpretation of both local and regional vegetation changes.

**RESULTS AND DISCUSSION**

**The Pollen Spectra**

The pollen spectra have a regional component (trees and shrubs) which, despite their apparent uniformity, indicate substantial regional vegetation changes, and a local component (herbs and Sphagnum), which shows frequent and substantial fluctuations, probably in response to disturbance (Figure 3).

A progressive reduction in conifers is indicated by the decline in *Picea* from base to surface. In the top 10 cm, *Picea* percentages have dropped to half of their values at the base. The decline for *Abies* is less pronounced. The trends in percentage representation are not supported by the pollen influx data (Figure 3), but the latter may be influenced by variable peat accumulation rates, which are not adequately documented by the C\(^{14}\) dates.

The herb fluctuations may reflect a combination of anthropogenic and natural disturbances. The slope fen, because of its small size and location, is susceptible to various physical disturbances from the ocean and from Black Duck Brook.

Because of the difficulties of establishing zones based on the pollen spectra, and because of the physical association of artifacts and peat, the monolith is zoned by chronology and archaeology (Figures 2 and 3). Zone A contains cut tree stumps and wood debitage. Zone B is based on C\(^{14}\) dates, as is Zone C, although the latter contains a layer of Norse wood artifacts at ca. 20 cm.

**Zone A. Dorset (Groswater) Phase, ca. 3000 to 2400 B.P.**

This zone is represented only closest to the terraces, in Monoliths 17, 15, and 14. Wood is plentiful throughout. The sands and gravels, interspersed with peat, are probably caused by flooding from the sea or Black Duck Brook (Figure 2).

The herb pollen and spores that characterize this zone are *Sanguisorba*, *Thalictrum*, Rosaceae, and Tubuliflorae, but not *Sphagnum*. *Picea*, *Abies*, and *Pinus* have their highest values here (Figure 3). The aquatics *Nuphar* and *Isoetes* occur in some of the basal peat, but not in Monolith 17.

*Sanguisorba*, the most prominent taxon, has its optimum development in minerotrophic fen. It, along with *Thalictrum* and some Umbelliferae, are common in disturbed habitats and roadsides in Newfoundland. Although the presence of *Nuphar* pollen and *Isoetes* spores in basal peat adjacent to Monolith 17 suggests a pond, it is more likely that they were carried 1 km from Black Duck Pond, and deposited by overflow from Black Duck Brook. Both species grow in the pond. A wash-in origin is also supported by the presence of *Isoetes* spores in moss polsters from fluvial communities along the brook (Davis, 1980), and by the tree stumps in the mineral soil at the base of the fen.

The high values, percentage and influx, for *Abies* and *Picea* imply that peat accumulation began while the site and the region was more wooded than today. Perem (1974) found *Picea* stems up to 10 cm in diameter at the base of the deposit, probably in situ. Based on rates of growth derived from European bogs, he suggested that paludification on the site began with deforestation by the Norse ca. 1000 B.P. However, our radiocarbon dates (Table I) indicate that peat growth had begun by 2500 B.P.

Trees were probably eliminated by peat ac-
Figure 3. Percentage and pollen influx diagrams for Monolith 17. Details of C\textsuperscript{14} dates are given in Table I.
cumulation, but dates on basal peat and on Abies and Picea wood overlap. If trees persisted during initial peat accumulation, they must have been scattered because the pollen spectra are dominated by light-demanding open ground herbs.

Some of the wood from the base of the peat had been cut, so felling is a possible cause of tree elimination. (Gleeson, 1979). However, paludification here is synchronous with that occurring elsewhere in Newfoundland (Davis, 1984), indicating climatic change rather than anthropogenic disturbance. Clearly, the presence of trees at the base implies that paludification did not immediately follow emergence.

Zone B. Unoccupied Phase, ca. 2300–1400 B.P.

This zone is present in all monoliths. It is characterized by high Cyperaceae influx and percentage, by large, but fluctuating values for Gramineae, a peak in Sphagnum, and low Sanguisorba and Thalictrum (Figure 3). The changes indicate succession to a mesotrophic fen community. The Gramineae were not identified to species, but the distinctive, robust pollen of Elymus arenarius, the 'self-sowing wheat' of the Norse sagas, was consistently present. Today, this species grows on beach berms and disturbed habitats.

There is no evidence for settlement during this phase, although herb pollen often associated with disturbance is present. At least two species of Umbelliferae are present, but only Heracleum maximum was identified. Today, this species grows along roadsides and in abandoned garden plots across Newfoundland.

Zone C. Middle Dorset, Indian, and Norse Phases, ca. 1400 B.P. to Present

Because of the difficulties of establishing tight chronologies for these groups and because of the limited resolution of the pollen record, ca. 42 years/cm in this zone, the phases are considered together. In general, the pollen record is marked by high but erratic values of

Sanguisorba and other herbs. Cyperaceae increases relatively and absolutely through the zone. Sphagnum, high at the bottom of this zone, declines towards the surface. Shrubs, notably Betula and Alnus increase, while Picea shows a drop in percentage, but not in influx (Figure 3).

A distinctive feature is the Rumex peak at the base of this zone. It is highest in Monolith 17 and declines seaward across the transect. In Monolith 17, the peak underlies a horizon of wood worked by the Norse. It is not, then, a consequence of their activity. The species is unidentified but it was not Rumex acetosella and R. domesticus, weeds associated with European settlement.

The spectra reflect continued paludification, but although nutrient status usually declines with increasing peat accumulation, this does not hold for this fen. The replacement of Sphagnum by Cyperaceae, and the persistence of nutrient-demanding herbs, suggests relatively high nutrient status, although peat accumulation rate declines. Robertson (1978) speculates that nutrient status rose in the near-surface with development of permafrost and increased runoff. The increase in shrub pollen probably reflects increasing regional and local shrub cover. Betula values increase seaward. Birch wood was identified in the upper 15 cm of the seaward monoliths.

The Pollen Record and Climatic Change

The Straits of Belle Isle region and southern Labrador had a series of expansions and contractions of Indian and Eskimo cultures, presumably in response to changing resources (Fitzhugh, 1972). Three major Indian expansions, at ca. 6000, 3500, and 1000 B.P., are attributed to climatic warming and expansion of the boreal forest. Eskimo expansions at ca. 4000, 2600, and 1500 B.P. were seen as a consequence of climatic cooling. However, as Fitzhugh and Lamb (1985) note, the relationships between cultural events and environmental changes, as reflected in the pollen record, are not clear except for a long period of cultural stability represented by the Maritime Archaic, which coincides with the hypsithermal, before climatic deterioration after 3000 B.P.

The Maritime Archaic is poorly represented at L'Anse aux Meadows. Unlike Port aux
Choix (Tuck, 1976), little can be said about size, complexity, or economy. The climatic deterioration following the hypsithermal is marked by a southern extension of Eskimo cultures into the Straits of Belle Isle. Fitzgerald and Lamb (1985) attribute this to changes in the range of Arctic mammals associated with changes in the strength and position of the Labrador current. At L’Anse aux Meadows, the occupation seems to end at ca. 2500 B.P.; the start of a thousand year cultural hiatus. This environmental change is the largest of the Holocene. The climatic cooling caused regional paludification and thus impoverishment of terrestrial resources, as relatively productive forest was replaced by nutrient-poor peatlands.

This cooling was well marked in eastern Canada. Picea retreated from the Labrador coast at ca. 2400 B.P. (Jordan, 1975). Richard (1980) suggests a gradual impoverishment of the forest in the forest—tundra along the Leaf River, Nouveau Quebec, after 2700 B.P. For the same time Lamb (1980) recognizes an expansion of coastal tundra in the Blanc Sablon area of Quebec, only 120 km west of L’Anse aux Meadows. A warming episode from ca. 2000 to 1500 B.P. in eastern Nouveau Quebec is inferred from peat stratigraphy (Bartley and Matthews, 1969) and from the archaeological record (Barry et al., 1977), but this is not evident in the pollen records from Nouveau Quebec and Labrador (Richard, 1980; McAndrews and Samson, 1977; Lamb, 1980).

The resumption of Eskimo settlement after 1500 B.P., the various Indian occupations, and that of the Norse are not readily explained by the vegetation changes reflected in the pollen record. For example, the Little Climatic Optimum, ca. 1100 to 800 B.P., which coincides with the Norse settlement of Greenland and voyages to North America, and with the spread of Thule culture across Northern Canada (Barry et al., 1977) is not marked in pollen and peat stratigraphies for eastern Canada (Macpherson, 1981), or in the spectra from L’Anse aux Meadows.

Complacent pollen spectra are typical for much of the Holocene in Newfoundland. Sometimes pollen influxes may be better indicators of environmental changes than pollen percentages. The changes beginning 2500 B.P. are marked by a substantial reduction in pollen influx in lake sediments in southeastern Newfoundland (Macpherson 1981), in southeastern Quebec and southern Labrador (Lamb, 1980, 1985). At Saddle Hill Pond, 1 km southeast of the L’Anse aux Meadows site, pollen influx declines to a quarter of its value prior to 3000 B.P., and sedimentation rates in the pond are halved (McAndrews and Davis, 1978). This is a response to declining forest cover caused by climatic cooling and consequent paludification. Lake productivity, as measured by a decrease in the rate of sedimentation, declined as energy inputs decreased and nutrients were stored in peat, rather than being flushed into water bodies.

The pollen influx to the peat shows variations which are difficult to explain by climatic shifts. Pollen accumulation should vary inversely with the rate of peat growth, if influx to the site is constant (Aaby and Tauber, 1985). Damman (1986) has suggested that peat accumulation is determined by the rate of decay rather than by productivity. If decay rate is constrained climatically, then climatic warming should increase humification and give high pollen concentration, while cooling, with lower humification, should be marked by more rapid peat accumulation and low pollen concentration.

The most prominent feature of the Monolith 17 pollen density curve (Figure 2) is the peak in zone C. This apparently postdates the Norse episode which places the high density temporarily in the Little Ice Age, the reverse of what would be expected. This peak may reflect the slow reestablishment of peat-forming plants after the stripping of the fen by the Norse for building materials.

**Anthropogenic Disturbance and the Pollen Record**

As noted earlier, the archaeological record indicates occupation of the site through much of the period of peat accumulation in the fen. The proximity of the fen to habitation should have made it sensitive to and subject to disturbance. The degree of impact would be constrained by population size, length of occupation, technology, and site function. We assume that all groups were concerned more with marine than with terrestrial resources but that they would have required wood for construction and fuel, and at least trampling of the fen could be anticipated.
The cut stumps at the base indicate trees across the site before initial paludification (Figure 2). Paludification may have been stimulated by cutting, but there was massive peat growth throughout the island at ca. 2500 B.P. There is no charcoal to indicate that fire was used for clearance here, in Henningsmoen's (1977) profiles, or in the nearby Road Cut sequence (Davis, 1984).

Although the pollen record may respond to climatic change, some of the perturbations may reflect plant responses to anthropogenic disturbances. Sanguisorba, Thalictrum, and many of the other herbs are common today along roadsides as opportunistic pioneers of disturbed ground. However, there are no obvious relationships between the pollen records and the pre- and post-Norse cultural remains.

The Norse occupation at ca. 1000 B.P. is not marked by indicators of forest clearance, cultigens, or European weeds. At Greenland Norse sites, exotic weeds (e.g., Rumex acetosella, Capsella bursa-pastoris, Achillea millefolium, Ranunculus acris) are common (Fredskild, 1978).

The fen must have been disturbed by trampling, but the largest disturbance is likely to have been the stripping of turf for sod house construction. The turf walls have a stratification that suggests construction from sods of several origins but most are physically and palynologically identical to the fen peat (Henningsmoen, 1977). Based on the sod requirements for the construction of the House A replica, it was estimated that ca. 2900 m² of sod would be needed for the houses and huts on the site; this is equivalent to the stripping of 10 cm of peat across the fen. The effects of stripping are not obvious in the peat and pollen stratigraphies.

L’Anse aux Meadows and Vinland

Despite numerous sites, artifacts, and inscriptions alleged to be Norse, the L’Anse aux Meadows site remains the only undeniably Norse site on North America. Helge Ingstad, who discovered the site in 1960, and his wife Anne Øistein, who excavated it, assumed that it was the Vinland in two Norse sagas, Erik the Red’s Saga and the Greenlander’s Saga (Ingstad, 1977). They note the physical resemblance of the site to descriptions in both texts, the identification of landmarks along the Labrador coast, and the distance calculations based on sailing times.

Based on archaeological and paleoecological data, Wallace (1986) suggested that the L’Anse aux Meadows site was a small transit station. The temporary nature of the settlement is indicated by the paucity of artifacts, the lack of extensive midden, and the absence of burials. Only one generation of buildings is evident. The settlement was devoted to boat repair. Nails and rivets, worked from local bog iron, are the most numerous artifacts. Most of the wooden artifacts are consistent with boat repair. The pollen record indicates no large scale or long-term impact on the local and regional vegetation.

Although no other Norse sites have been found along the eastern seaboard, the Norse did sail south of L’Anse aux Meadows. Reference in the sagas to wild grapes implies a landfall at least as far south as New Brunswick and Nova Scotia. This is supported by the recovery of three butternuts (Juglans cinerea) from the fen. The closest source is northeastern New Brunswick.

Wallace (1986) perceives Vinland as an area rather than a site, with L’Anse aux Meadows at its northern margin. Even if a single, more southerly Vinland site existed, it may have been only marginally more substantial than the settlement at L’Anse aux Meadows—if the sagas are reliable. Although there are differences between the two sagas, both indicate no more than four visits by small groups, with no occupancy lasting more than three years. Despite the apparent attractiveness of Vinland, these Norse visits were few and short. Perhaps the conflicts with the natives made permanent settlement impractical. The establishment of strong trading relations between Greenland and Europe may have obviated the incentive to settle Vinland.

CONCLUSIONS

The L’Anse aux Meadows archaeological site has been episodically occupied for over 5000 years, although evidence prior to 3000 B.P. is meager. From the latter date, the evidence from artifacts and structures on the marine terrace is supplemented by materials from the fen on the seaward side of that terrace. These materials, mostly worked wood,
indicate that the fen is part of the site. Thus the fen pollen record should be sensitive enough to provide palaeoecological information on the local impacts of the various occupants, but the record is difficult to interpret. The pollen spectra comprise both local and regional inputs. They reflect a variety of physical constraints, notably climate, substrate, and eustatic/isostatic and autogenic changes, as well as anthropogenic influences. Isolating the impact of each is difficult.

Settlement is likely to have been constrained by climate. The lack of settlement between ca. 2300 and 1400 B.P. may reflect the severe climate of that time. However, this and other climatic shifts are not obvious in the pollen record.

Similarly, the impact of man is not clear. There is no evidence for forest clearance other than that indicated by cut stumps at the base of the fen, although the pollen record indicates a progressive decline in forest cover. The lack of an unambiguous message in the pollen spectra implies, perhaps, that the impact of all occupying groups was small. Although the span of the occupations is generally known, the intensity and persistence is not. Conversely, the numerous perturbations in the record may indicate almost continuous natural disturbance.

Attempts to relate vegetation to anthropogenic disturbance of specific cultural affinity suffer from problems of resolution; an inability to pinpoint the timing and size of the occupations (except for the Norse), and the limitations of the pollen data, despite contiguous sampling. Mean resolution for each sample is 33 years, but with interpolation between C¹⁴ dates, this is refined to 28 years per sample in the lower part and 42 years per sample in the upper section.

Although the lack of impact may be attributed to short occupations by small groups, or to the limited resolution of the pollen spectra, it may be related to the seasonality of occupation. If occupation occurred mostly in the winter, impact on the frozen fen would be minimal. This does not apply to the Norse because their house construction is unlikely to have been a winter task.

The Norse have the strongest material representation at the site, but archaeological and palaeoecological evidence suggests that they spent at most a few years at L’Anse aux Meadows. Their settlement was a small way station for boat repair. The pollen record indicates no massive impacts on vegetation and perhaps none at all. Although disturbance may be implied by the behavior of the herbaceous taxa, these do not include the European weeds that accompanied Norse settlers to Greenland, and there are no signs of grazing or extensive forest clearance.

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