The Little Ice Age and Neutral Faunal Assemblages

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The Neutrals and their immediate ancestors lived in southwestern Ontario from ca. AD 1100 to 1650, a period which saw a global climatic cooling episode known as the Little Ice Age (LIA), beginning ca. AD 1450. Neutral faunal assemblages at this time show a decrease in the relative frequencies of field-dwelling species (mainly woodchuck), while forest-dwellers (mainly deer) and dog increase. We suggest two explanations for this shift. One is that the LIA increased the frequency of poor crop years, thus making horticulture a less reliable subsistence strategy and compelling the Neutrals to rely more on meat. The other is that population increases resulted in the creation of more field-edge environments, thus in-creasing the habitat available for deer. The decline in woodchuck may have been caused by the increase in dog, bred both for food and crop-protection. These two hypotheses are not mutually exclusive.

Introduction

The Little Ice Age (LIA) (Lamb 1977; Bernabo 1981; Gajewski 1987; McAndrews 1988), a period of cooler climate extending from ca. AD 1450 to 1850, has received little archaeological attention in southern Ontario. Our aim is to document and explain changes in prehistoric subsistence patterns in southwestern Ontario which **may have been related** to climatic change. The Neutrals were chosen for this study for three reasons: (1) they and their direct ancestors lived both before and during the LIA, allowing a before and after comparison, (2) they lived near the northern border of the temperate deciduous forest province in southwestern Ontario, an ecotone in which we would expect to see the ecological consequences of small climatic fluctuations (Noble 1984; McAndrews and Manville 1987) (Fig. 1) and (3). Twenty-seven faunal analyses of Neutral and pre-Neutral sites were available to provide data for our study.

If there are statistically significant changes through time in Neutral faunal assemblages, this would require explanation. We offer two: (1) that subsistence strategies changed due to climatic change, or (2) that they changed due to increasing human impact on the environment. A shift in cultural preferences could have resulted in a change in **faunal** use; however, this possibility is difficult to analyze due to the paucity of ethnohistoric data on the Neutrals. This paper will focus only on the possible ecological explanations, on the assumption that "people were not entirely selective in their animal food choices" (Crawford 1984).

Neutral Subsistence

Daillon (1866) records that the Neutral diet consisted primarily of maize, beans, and squash, abundantly supplemented by fish, deer, beaver, and wapiti. According to Sagard (1939) deer were more abundant in Neutralia than in Huronia. The Neutral diet is said to have been similar to that of the Hurons, differing mainly in the species of fish which were available to them and the greater consumption of fruits and nuts in Neutralia (Daillon 1866). The ethnohistoric dietary record corresponds well with the archaeological evidence of historic Neutral faunal assemblages (Prevec and Noble, 1986).

A cross-cultural comparison of faunal assemblages should reflect cultural differences. Prevec and Noble (1986) note the abundance of deer, racoons and squirrels on historic Neutral sites, whereas the contemporary Petun faunal assemblages are notable for a paucity of deer and an abundance of beaver, woodchuck and black bear. The differences in assemblages are believed to reflect mainly the Petun role in the Georgian Bay fur trade (Prevec and Noble 1986).

The Climatic History of Ontario After AD 1000

Oguntoyinbo (1986) notes that climatologists are increasingly finding "teleconnections", that is, strong correlations of climatic phenomena in widely separated geographical areas. The practice of inferring paleoclimates in areas which lack good records by correlation with nearby regions is gaining credence with paleoecologists and paleoclimatologists.

Southwestern Ontario is one of the most fertile areas in Canada, with the mildest climate in the eastern part of the country. Most of this area receives between 760 and 1,014 mm of precipitation annually, and mean annual temperatures range between 6.4° - 9.3°; the frost-free period runs from 129 to 198 days (Environment Canada 1982 a,b,c). The area lies in the transition zone between the cool temperate Great Lakes-St. Lawrence forest province and the temperate deciduous forest province (McAndrews and Manville 1987).

Griffin (1961) noted the probable impact of the deteriorating climate of the LIA on the Oneota and other groups in eastern North America, yet suggested that the Iroquois did not suffer from the LIA due to the ameliorating effects of the Great Lakes. This suggestion was based on the lack of any observable cultural deterioration in Iroquois prehistory during the LIA and may have led to an assumption on the part of many investigators that the LIA had no influence on cultures in southern Ontario. Baerreis and Bryson (1965) and Baerreis *et al.* (1976) amplify Griffin's work in the Upper Mississippian regime. Dincauze and Hasenstab (1989) suggest that Iroquoian development was in part encouraged by the LIA, which, they suggest, caused the decline of Cahokia, and allowed more peripheral regions to develop independently.

Borehole temperature logs taken in the region of Hearst and Kapuskasing in northern Ontario indicate a short period of warm climate from AD 900 to 1250, followed by a gradual cooling of about 2°C lasting until about AD 1800, after which the climate rapidly warms to modern values, which are similar to those of the period from AD 900 to 1250. Although these climatic fluctuations are of small magnitude, their effect on the vegetation in some locations is quite significant. Most estimates agree that the LIA in the northern hemisphere represented a cooling of between 1 ° and 2° C. Although this sounds like a small difference, temperatures at the end of the Wisconsin glaciation are estimated to have been only 5° - 6° colder than at present (West, 1979).

Pollen diagrams from Crawford Lake, Ontario (McAndrews, 1988), Marion Lake, Michigan (Ber-

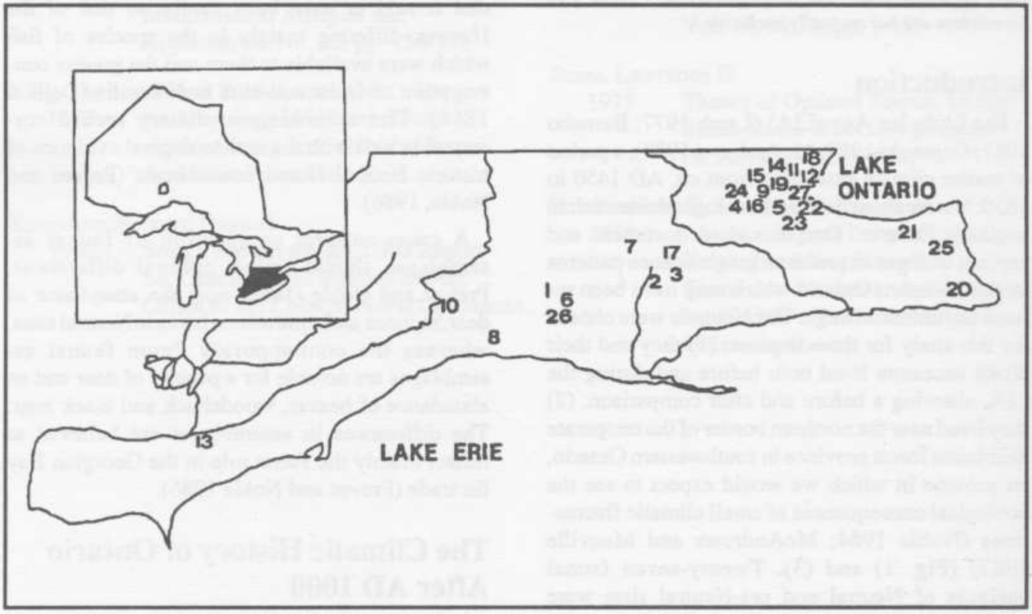


FIGURE 1

Locations of sites used in this paper. 1: Dewaele, a Glen-Meyer site. 2: Cooper (Glen-Meyer). 3: Force (Glen-Meyer). 4: Gunby (Late Pickering). 5: Collins (Glen-Meyer and/or Uren). 6: Perry (Middleport). 7: Moyer (Middleport/Early Neutral). 8: Pound (Middleport/Early Neutral). 9. Winking Bull (Middleport/Early Neutral). 10: Harrietsville. 11: Morriston (formerly Ivan-Elliott). 12: Chypchar (formerly Billie Goat's Gruff). 13: Wolfe Creek. 14: Raymond Reid. 15: Macpherson. 16: Knight-Tucker. 17: Cleveland. 18: Brown. 19: Christianson. 20: Sherk-Sahs. 21: Thorold. 22: Bogle 1.23: Bogle 2.24: Hood. 25: McIntosh. 26: Walker. 27: Hamilton.

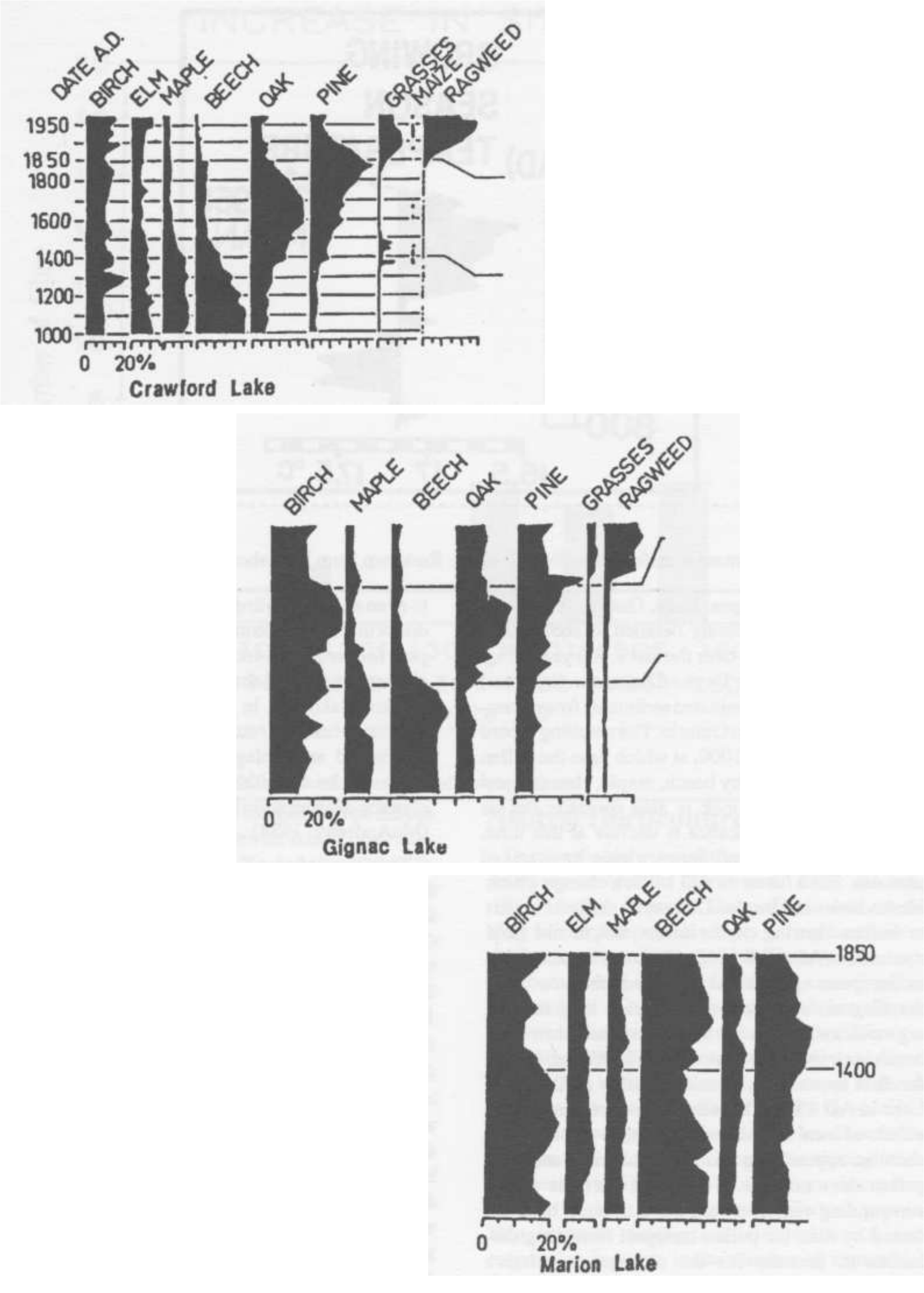


FIGURE 2

Pollen diagrams of selected taxa from Crawford Lake, Marion Lake, and Gignac Lake. Redrawn from McAndrews (1988), Bernabo (1981), and Burden et al. (1985)

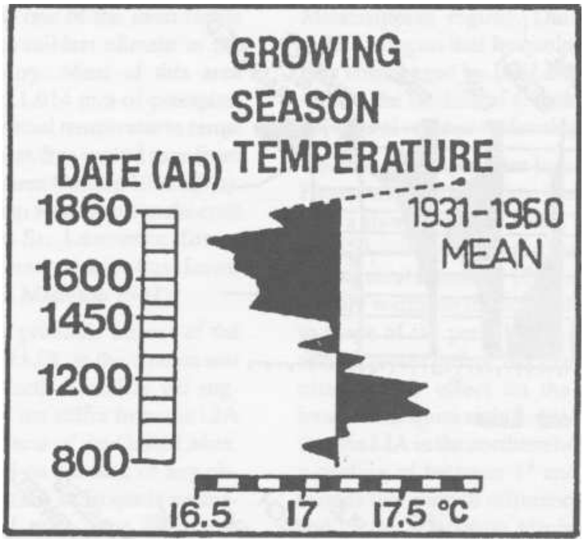


FIGURE 3
Calibrated pollen climate transfer curve for Michigan. Redrawn from Bernabo (1981).

nabo, 1981), and Gignac Lake, Ontario (Burden *et* al., 1986) are sufficiently detailed to show small climatic fluctuations over the last 1,000 years (Fig. 2). McAndrews and Boyko-Diakonow (in press) analyzed annually laminated sediments from Crawford Lake, in southern Ontario. The resulting record extends back to AD 1000, at which time the pollen record is dominated by beech, maple, elm, oak and birch (Fig. 2). Hemlock is also common but its paleoclimatic significance is unclear at this time. This mixed hardwood forest yields to a mixed pine-oak-birch forest ca AD 1400, a change which McAndrews and Boyko-Diakonow attribute in part to Indian clearing of the forest and to old field succession. After AD 1850, this forest in turn yields to European agricultural fields, which show up in the diagram as a dramatic increase in grass and ragweed, and a decrease in oak and pine. However, beech is already in decline by AD 1200, well before the first appearance of maize pollen at Crawford Lake in AD 1360. This cannot be explained by the effects of local Indian horticulture, as no other taxa show an appreciable decline at this time and herb pollen does not rise. Very large portions of the surrounding region would have to have been affected by man for pollen transport from long distances to account for the changes in relative importance of the tree taxa. Of the five dominant tree types in the pre-1400 portion of the diagram, beech has the most southerly northern distribution limit. It would therefore be expected to react first to even a slight cooling of the climate. There is little doubt that the suddenness of the increase in oak and pine following the arrival of maize is due to forest clearance and field abandonment (McAndrews and Boyko-Diakonow, in press). However, the failure of the forest to return to its previous beech-dominated assemblage following field abandonment may be due either to ecological inertia or to a climatic deterioration which occurred in the interim (McAndrews, 1988).

The Gignac Lake diagram (Fig. 2) from Awenda Provincial Park, on the south shore of Georgian Bay, also shows the effect of Indian horticulture (Burden *et al.,* 1986). Maize pollen appears in small quantities in subzone 3d (the same zonation is used in McAndrews and Boyko-Diakonow, in press). However, as with Crawford Lake, beech begins its decline prior to the subzone 3c/3d transition, which represents the onset of local Indian horticulture.

Bernabo (1981) does not discuss the possible effects of Indian horticulture in Michigan, but does note that "beech pollen undergoes a protracted decline at each site from AD 1200 to 1600, generally hitting its lowest levels about AD 1450" (Bernabo, 1981). He further develops a calibrated pollen-climate transfer function, and applies it to the fossil pollen data from the Marion, Heart, Jones and Twenty-seven Lakes sites (Fig. 3). The resulting palaeotemperature curves are partially validated by instrumental records from the early 1800s, and also by correlation with worldwide

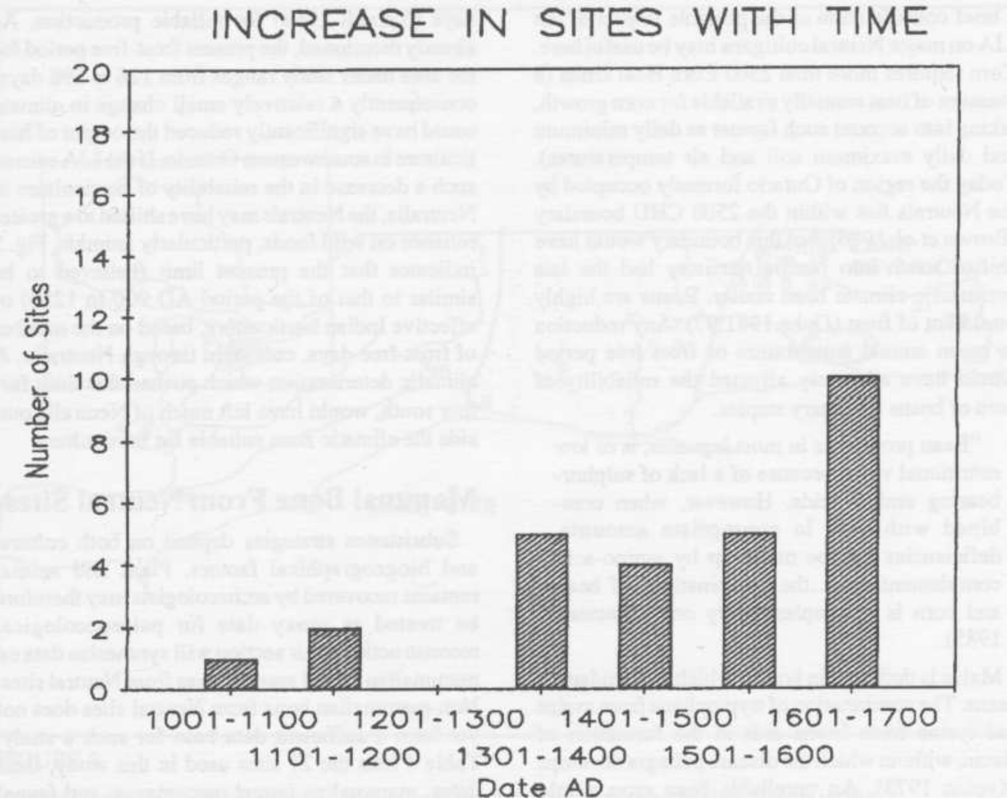


FIGURE 4
Number of Neutral sites with faunal analyses plotted through time.

records of proxy data such as oxygen Isotope curves from glacier ice-cores on Devon Island, and tree-ring data from California. He concludes that "a protracted Little Ice Age cooling took place after ca AD 1200 and growing season temperatures reached 1°C below the 1931-1960 mean in the 1700s." The correlation with other sites around the world suggests that the LIA was an essentially synchronous global phenomenon.

Gajewski (1987) uses statistical methods to interpret the palynology of seven lakes across the northeastern United States. He finds that a warm period occurred between AD 1000 and 1200, and a cooler period from AD 1450 to 1850, corresponding with Lamb's (1977) dates for the LIA. For purposes of our paper, the dates ca. AD 1450-1850 have been adopted for the LIA; however, time lags in response to changing conditions may have varied depending on individual circumstances of site locations. Several authors use different dates for the LIA; this is to be expected since the change was gradual rather than abrupt.

Neutral Horticulture

Despite the growing number of plant macrofossil analyses in Ontario (Crawford, 1987; Fecteau, 1985; Ounjan, in prep.), the available data are not easy to interpret beyond simply noting the presence or absence of particular species. There is little doubt that corn, beans, and other cultigens were abundant after at least AD 1350; the question is how important were they to the Neutral diet. It is difficult to determine this from plant macrofossil data alone, as a change in the relative importance of horticultural produce need not affect the ratios in which the various crops were produced. The increase in the number of horticultural village sites through time (Fecteau 1985) suggests either an increased reliance on horticulture or, more likely, a population increase among horticulturalists. A corresponding increase in the number of sites which have been analyzed for faunal material can be seen in the data presented in this paper (Fig. 4).

In the absence of any direct palaeoethnobotanical indication of change in Neutral plant use over time, a brief consideration of the possible impact of the LIA on major Neutral cultigens may be useful here. Corn requires more than 2500 Corn Heat Units (a measure of heat annually available for corn growth, taking into account such factors as daily minimum and daily maximum soil and air temperatures). Today the region of Ontario formerly occupied by the Neutrals lies within the 2500 CHU boundary (Brown *et* al. 1980), but this boundary would have shifted south into Neutral territory had the late prehistoric climate been cooler. Beans are highly intolerant of frost (Duke 1981:97). Any reduction in mean annual temperature or frost free period would have adversely affected the reliability of corn or beans as dietary staples.

> "Bean protein, as in most legumes, is of low nutritional value because of a lack of sulphur-bearing amino acids. However, when combined with corn in appropriate amounts, deficiencies can be made up by amino-acid complementation... the combination of bean and corn is a complementary one" (Fecteau 1985).

Maize is deficient in lysine, which is abundant in beans. The combination of tryptophane from maize and lysine from beans aids in the formation of niacin, without which the disease pellagra develops (Kaplan 1973). An unreliable bean crop would have reduced the economic and nutritional value of horticulture because of the loss of the benefits of complementation. Conversely, a reduction in the corn crop would have reduced the value of bean. Both crops would have been necessary for a stable horticultural food-base; therefore, the less resistant crop would limit horticulture as a subsistence strategy. The exact requirements of the varieties of beans and corn used by the Neutrals are not known, nor are they ever likely to be knowable. Beans were not used extensively in Ontario until the 1300s (Fecteau 1985). This bean-maize complementation allowed greater reliance on horticulture, and it has been suggested that this supported an increase in population (Wright 1972; Fecteau 1985).

Changes in the climate and the vegetation landscape may cause changes in animal distributions. While it has not yet been shown that the LIA caused any species to be extirpated in southern Ontario, population densities of some species may have changed. However, a reduction in the reliability of corn, beans, and squash horticulture may have resulted in a modification of Neutral subsistence strategies. The more important Indian crops require 120 and preferably 140 frost-free days (Yarnell 1964) for reliable production. As already mentioned, the present frost-free period for the area under study ranges from 126 to 198 days; consequently a relatively small change in climate could have significantly reduced the output of horticulture in southwestern Ontario. If the LIA caused such a decrease in the reliability of horticulture in Neutralia, the Neutrals may have shifted to **a** greater reliance on wild foods, particularly animals. Fig. 5 indicates that the present limit (believed to be similar to that of the period AD 900 to 1250) of effective Indian horticulture, based on the number of frost-free days, cuts right through Neutralia. A climatic deterioration which pushed this limit further south, would have left much of Neutralia outside the climatic zone suitable for horticulture.

Mammal Bone From Neutral Sites

Subsistence strategies depend on both cultural and biogeographical factors. Plant and animal remains recovered by archaeologists may therefore be treated as proxy data for palaeoecological reconstruction. This section will synthesize data on mammalian faunal assemblages from Neutral sites. Non-mammalian bone from Neutral sites does not *yet* form a sufficient data base for such a study. Table 4 lists the 27 sites used in this study, their dates, mammalian faunal percentages, and faunal analysts. According to Howard Savage (personal communication), "a faunal analysis of 500 randomly identified bones from a given site in southern Ontario provides a reliable base for ascertaining the mammalian species living in the vicinity of the site". Several sites have been included that contain less than 500 identified bones in our attempt to synthesize all available Neutral mammalian faunal material. Table 1 classifies selected mammalian species of southern Ontario into two groups: forest and field species. Those not included in the table are rare, or could not be conveniently assigned to either habitat, such as wetland taxa like beaver. Fig. 6 shows the variation in the forest and field groups through time, an estimate of the proportion of variation in the faunal material which can be accounted for by the change in time. The forest group increases in importance after AD 1450, while the field group decreases. The r for the forest group is 0.261, and that of field taxa is 0.255. This indicates that slightly more than *25%* of the variation in the percentages of these groups is accounted for by a simple change through time. It would have been nice to see values closer to 1.0 (that is, changes in time account for all changes in percentages of mammalian species). However, climate does not

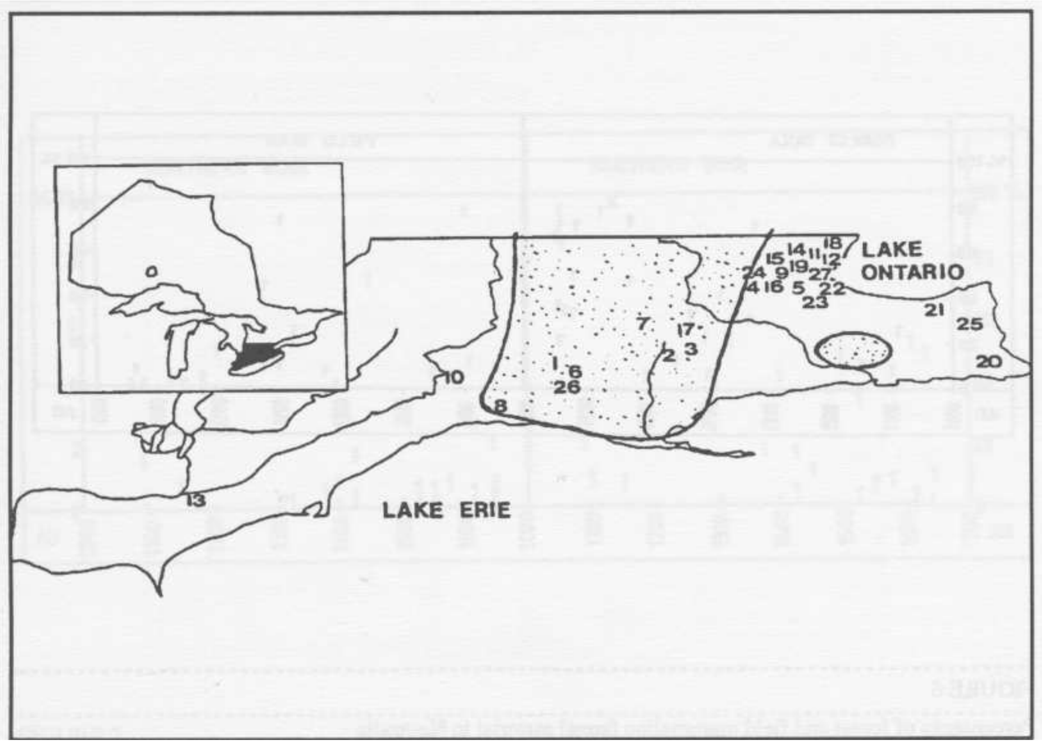


FIGURE 5
Present Northern limits of effective Indian horticulture. Numbers refer to sites shown in Fig. 1.

FOREST
Moose, snowshoe hare, wolf, marten, fox, felids, black bear, skunk, chipmunk, cervids, porcupine

FIELD
Eastern Cottontail, woodchuck, grey squirrel, mouse, short-tailed weasel

TABLE 1
Habitats of selected mammalian species. Based on Burt (1972) and Whitaker (1980). Grey squirrel has been included in the field group due to its habit of feeding in corn fields.

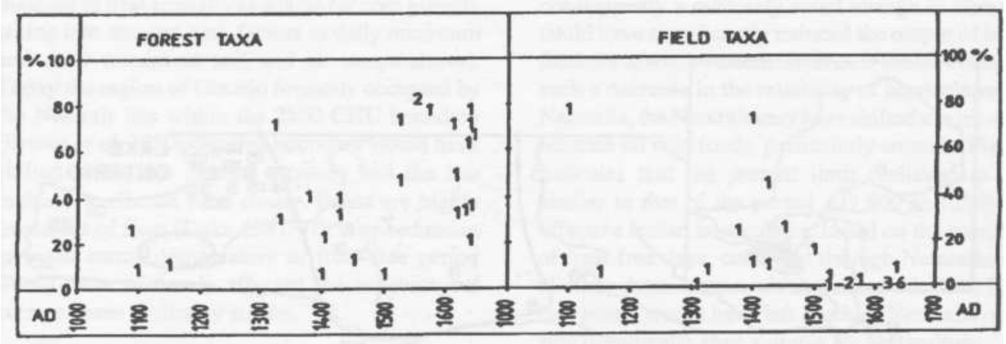


FIGURE 6
Percentages of forest and field mammalian **faunal** material in **Neutralia**

SPECIES OR GROUP	r	r^2	SIGNIFICANT AT .05 LEVEL
Forest taxa	0.51	0.26	yes
Field taxa	-0.50	0.26	yes
Northern taxa	-0.005	<0.001	no
Southern taxa	-0.004	<0.001	no
Fur bearers	-0.10	0.01	no
Beaver	-0.003	<0.001	no
Large mammals	0.56	0.31	yes
White-tailed deer	0.51	0.26	yes
Canis spp.	0.48	0.23	yes
Woodchuck	-0.49	0.24	yes

TABLE 2
Values of r and r^2 for selected taxa and groups of taxa

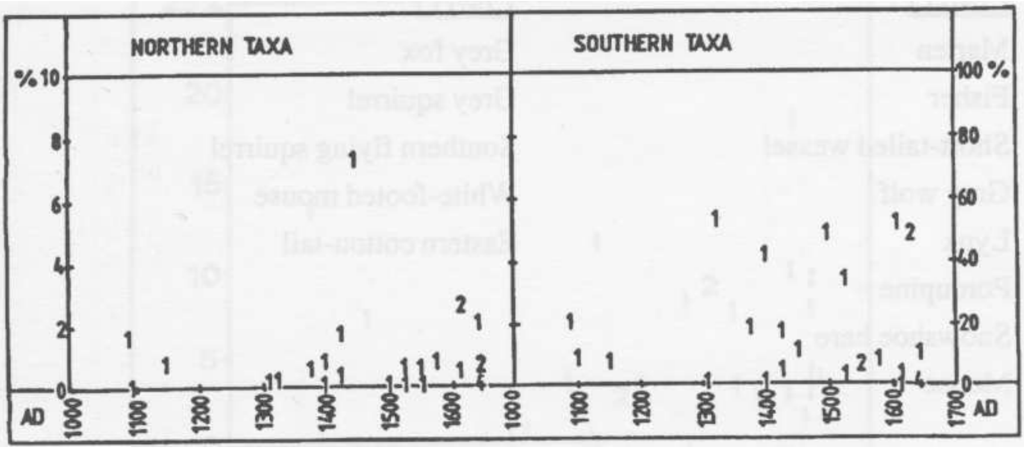


FIGURE 7
Variation in the percentages of Northern and Southern taxa

follow a strictly linear relationship with time, and other factors affect faunal percentages including site location, site use, warfare, recovery bias, etc. These factors have not been modelled in this paper. We are not attempting to show that faunal use varies only with time, but that time changes have significant explanatory value for faunal assemblages. When factors other than time which affect the assemblages are taken into consideration, the 25% of the variation accounted for by time becomes significant and requires explanation. The values of r and r^2 for various species and groups of species are presented in Table 2.

If these changes were due to a shift in animal populations as a result of climatic deterioration, we might expect to see a change in the frequency of taxa which are currently distributed mostly to the north of the area under consideration and those distributed mainly to the south. Table 3 lists those mammalian taxa which are near the limit of their range in southern Ontario. Fig. 7 and Table 2 show that there are no such significant changes.

If it was not the availability of the different mammalian taxa that changed, then it may have been hunting practices that changed. In order to determine what may have prompted such a change, we must examine in more detail, from a cultural perspective, what animals were being taken before and after AD 1450. Animals will be hunted for food, ritual, raw materials, or pest control. While the Huron traded beaver pelts with Europeans (Wright 1963), Fig. 8 and Table 2 show that there was no change with time in the percentage of animals hunted for their fur (beaver, muskrat, mink, racoon, otter, marten, chipmunk, fisher, weasel, and grey squirrel, which the Neutral nation is known ethnographically to have traded to other Indians [Wright 1963]). The amount of grey squirrel was stable through time. Had the hunting practices been influenced by European trade, perhaps through the Hurons, we would expect to find an increase in beaver remains through to the mid-1600s. Fig. 9 and Table 2 show that this is not the case.

Large animals will usually be hunted for food; Fig. 10 and Table 2 show an increase after AD 1450 in the frequency of mammals having an average weight greater than 4 kg (beaver, dog, bear, racoon, otter, felids, cervids, and moose). This suggests that large animals became more important in the Neutral

NORTHERN TAXA (SPECIES NEAR SOUTHERN LIMIT)

Marten

Fisher

Short-tailed weasel

Grey wolf

Lynx

Porcupine

Snowshoe hare

Moose

SOUTHERN TAXA (SPECIES NEAR NORTHERN LIMIT)

Grey fox

Grey squirrel

Southern flying squirrel

White-footed mouse

Eastern cotton-tail

TABLE 3

Species now near the limit of their range in Ontario south of the French River/Mattawa River axis. Based on Burt (1972) and Whitaker (1980).

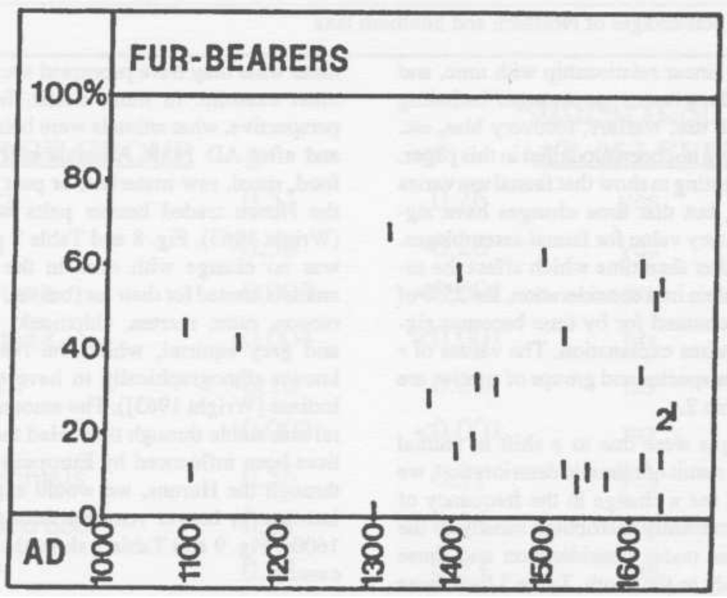


FIGURE 8

Variation in the percentages of fur-bearers

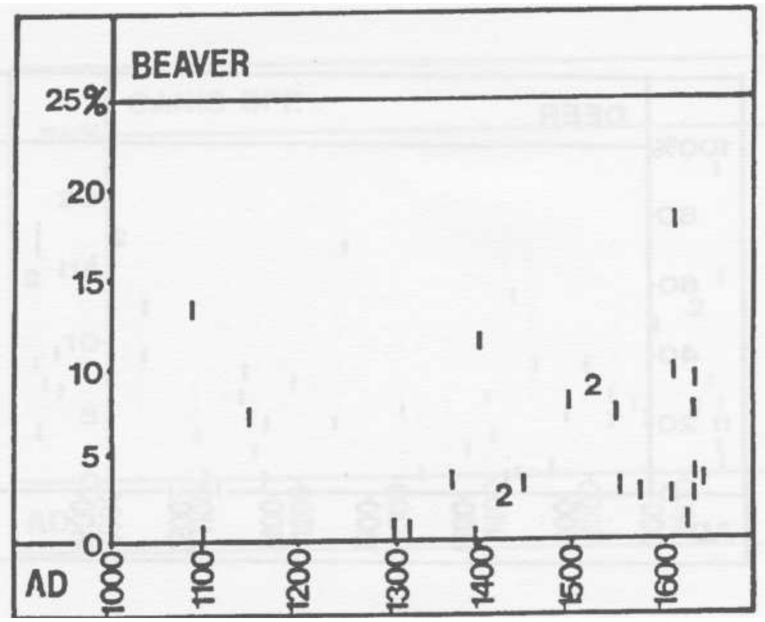


FIGURE 9
Variation in the percentages of beaver

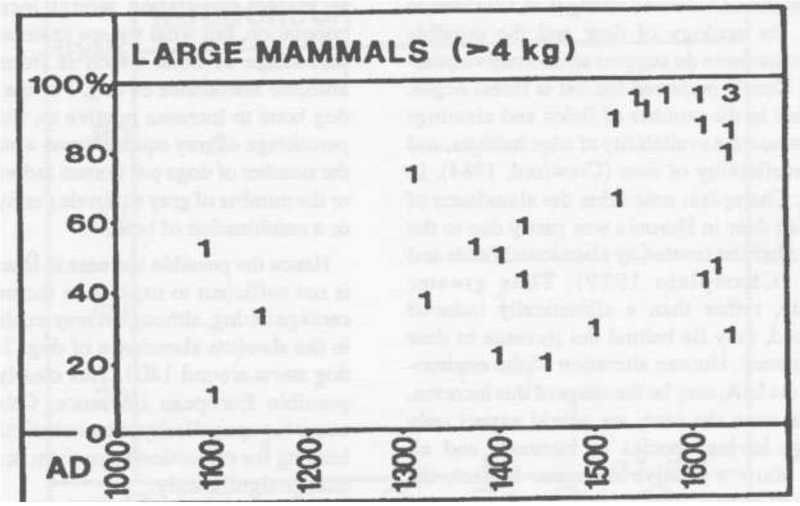


FIGURE 10
Variation in the percentages of large mammals

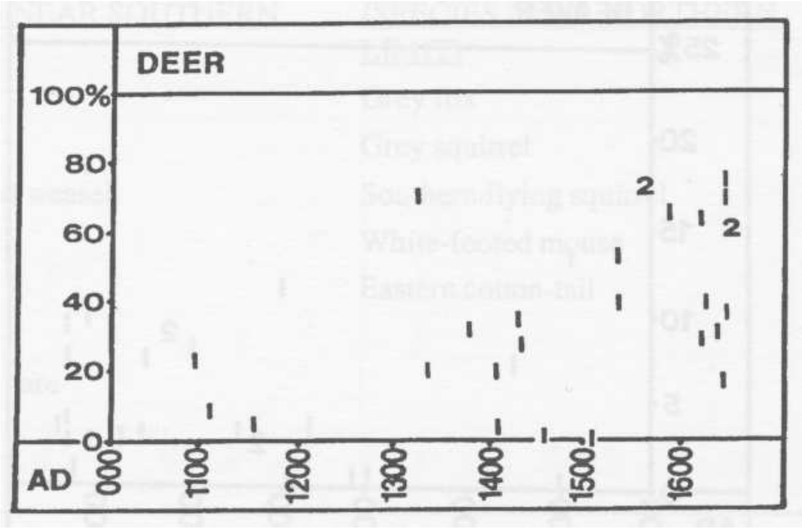


FIGURE 11
Variation in the percentages of white-tailed deer

diet after this date. Figure 11 and Table 2 show that this is mostly due to an increase in white-tailed deer. Although the increase in deer appears to support the notion that the LIA caused changes in subsistence practices, the ecology of deer and the possible population increase do suggest an alternative interpretation. Deer's preferred habitat is forest edges. An increase in the number of fields and clearings would increase the availability of edge habitats, and thus the availability of deer (Crawford, 1984). In AD 1615, Champlain noted that the abundance of white-tailed deer in Huronia was partly due to the favourable habitat created by abandoned fields and villages (Champlain 1929). Thus greater availability, rather than a climatically induced greater need, may lie behind the increase in deer bone frequency. Human alteration of the environment, not the LIA, may be the cause of this increase. But if this were the case, we would expect only forest-edge-loving species to increase, and all others to show a relative decrease. In fact, the frequency of beaver, grey squirrel, black bear, and racoon show no significant change over time.

Dog also increased; Fig. 12 and Table 2 show a marked increase in *Canis spp.* excluding wolf. Sagard (1939) noted that the Hurons raised dogs for food; the Neutrals probably did the same. Theincrease in Neutral dog bone may indicate that as the climate deteriorated dog became more important, either as food or for use in hunting. An increase in human population would increase the dog population, but what we are examining here is the percentage of bone which is from dog, not the absolute abundance of dog. For the percentage of dog bone to increase relative to, for example, the percentage of grey squirrel bone would require that the number of dogs per human individual increase, or the number of grey squirrels per Indian decrease, or a combination of both.

Hence the possible increase in human population is not sufficient to explain an increase in the percentage of dog, although it may explain an increase in the absolute abundance of dog. The increase in dog starts around 1400. This clearly predates any possible European influence. Other carnivores occur too sporadically to be statistically significant; hunting for protection from them probably did not change significantly.

Hunting for crop protection, however, does show a significant change. The sciuridae, which includes squirrels, chipmunks, and woodchucks, show a slight decrease with time. However, since grey squirrel was also an important fur-bearer for the Neutrals, it may have been hunted more for the pelt,

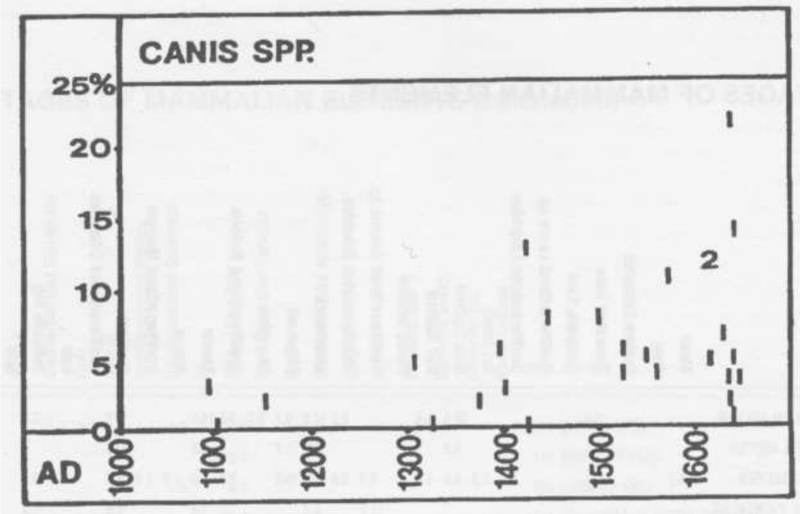


FIGURE 12
Variation in the percentages of *Canis spp.*

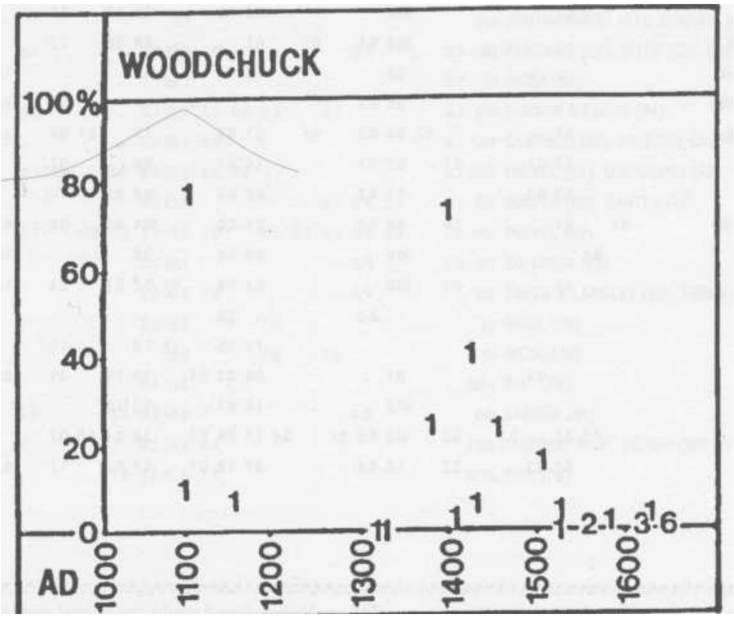
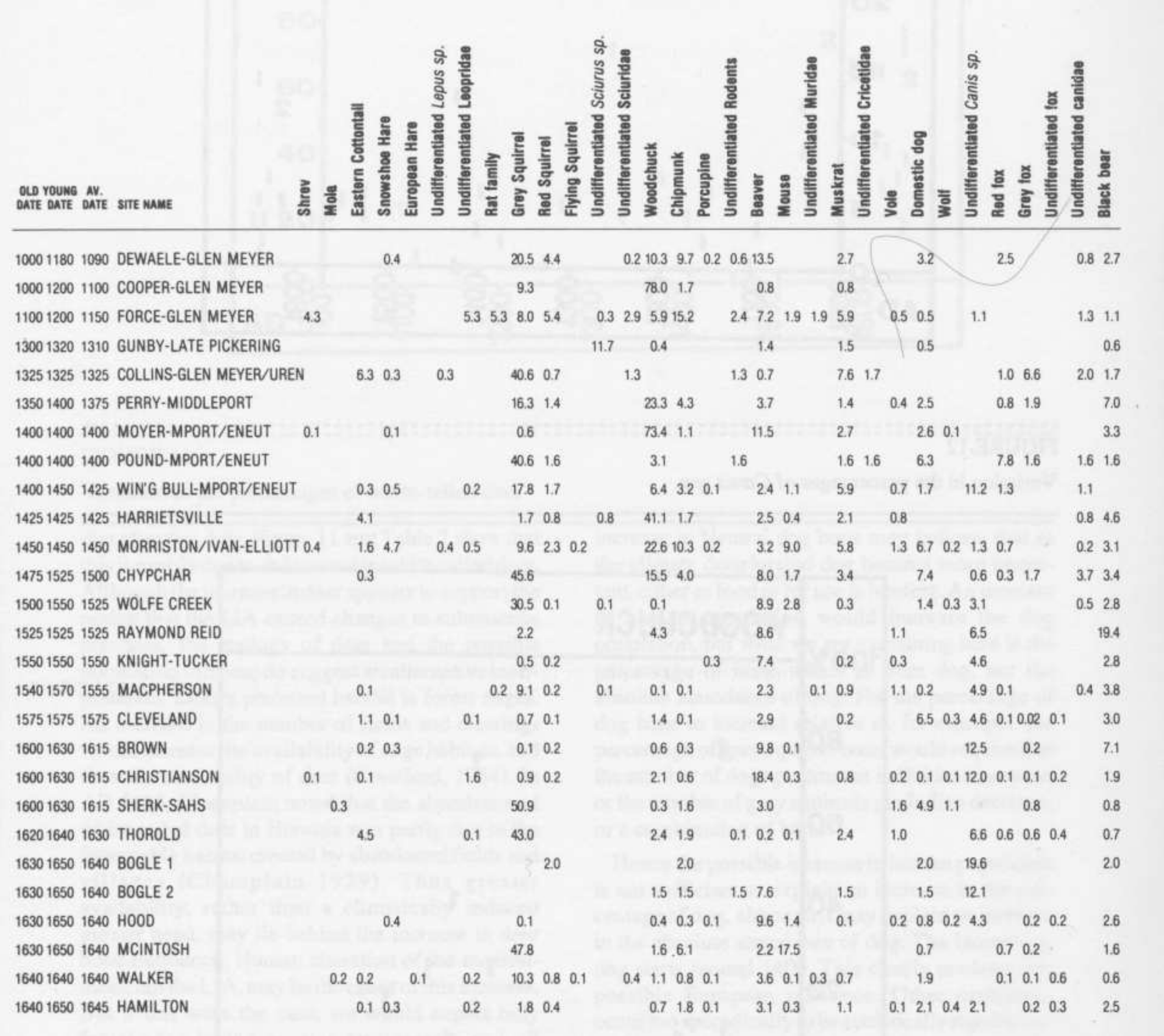


FIGURE 13
Variation in the percentages of woodchuck

PERCENTAGES OF MAMMALIAN ELEMENTS

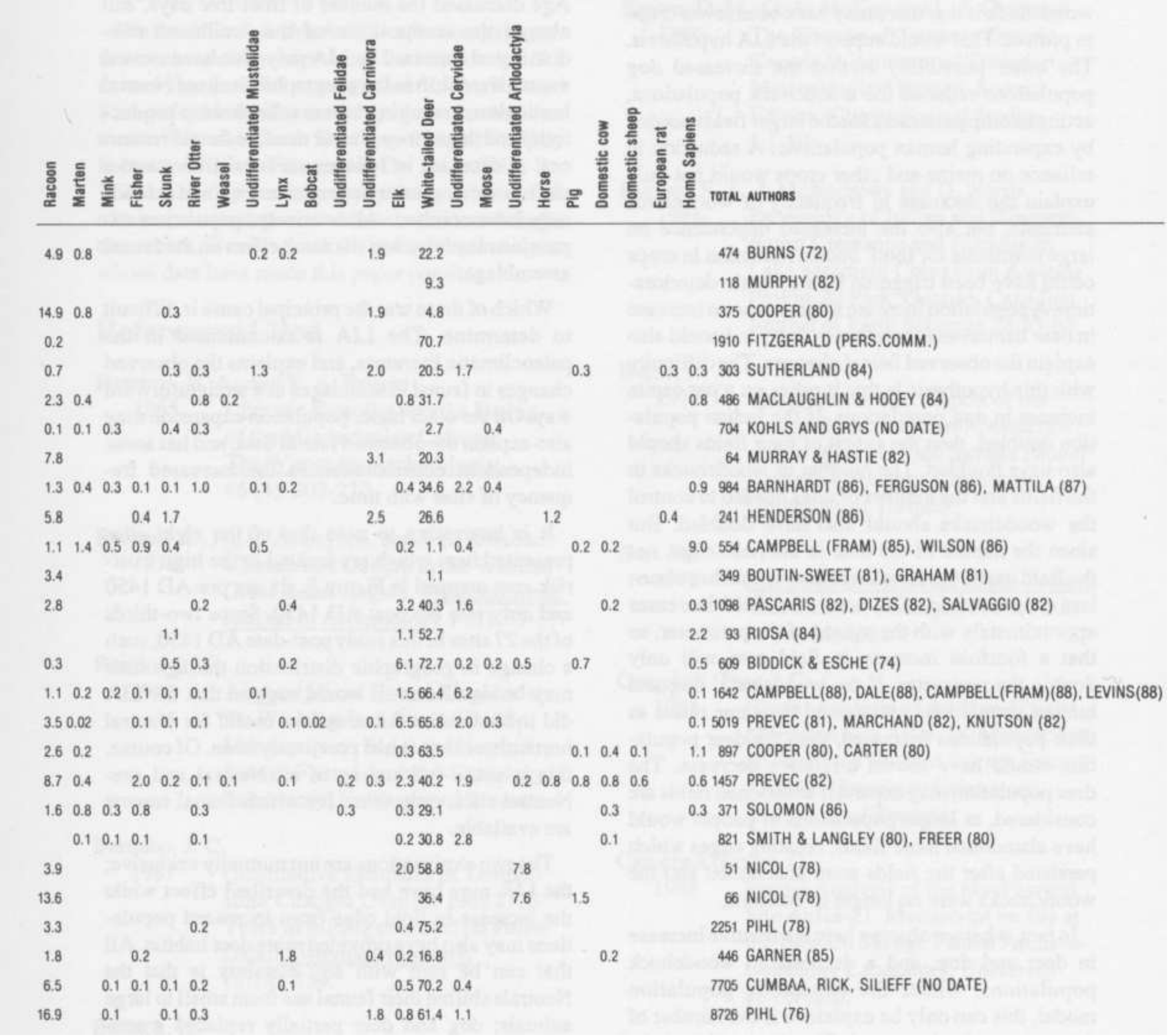


OLD DATE	YOUNG DATE	AV. DATE	SITE NAME	Shrev	Mola	Eastern Cottontail	Snowshoe Hare	European Hare	Undifferentiated *Lepus sp.*	Undifferentiated Leopridae	Rat family	Grey Squirrel	Red Squirrel	Flying Squirrel	Undifferentiated *Sciurus sp.*	Undifferentiated Sciuridae	Woodchuck	Chipmunk	Porcupine	Undifferentiated Rodents	Beaver	Mouse	Undifferentiated Muridae	Muskrat	Undifferentiated Cricetidae	Vole	Domestic dog	Wolf	Undifferentiated *Canis sp.*	Red fox	Grey fox	Undifferentiated fox	Undifferentiated canidae	Black bear
1000	1180	1090	DEWAELE-GLEN MEYER				0.4					20.5	4.4			0.2	10.3	9.7	0.2	0.6	13.5			2.7			3.2			2.5			0.8	2.7
1000	1200	1100	COOPER-GLEN MEYER									9.3					78.0	1.7			0.8			0.8										
1100	1200	1150	FORCE-GLEN MEYER	4.3						5.3	5.3	8.0	5.4		0.3	2.9	5.9	15.2		2.4	7.2	1.9	1.9	5.9		0.5	0.5		1.1				1.3	1.1
1300	1320	1310	GUNBY-LATE PICKERING												11.7		0.4				1.4			1.5			0.5							0.6
1325	1325	1325	COLLINS-GLEN MEYER/UREN			6.3	0.3		0.3			40.6	0.7			1.3				1.3	0.7			7.6	1.7					1.0	6.6		2.0	1.7
1350	1400	1375	PERRY-MIDDLEPORT									16.3	1.4				23.3	4.3			3.7			1.4		0.4	2.5			0.8	1.9			7.0
1400	1400	1400	MOYER-MPORT/ENEUT	0.1			0.1					0.6					73.4	1.1			11.5			2.7			2.6	0.1						3.3
1400	1400	1400	POUND-MPORT/ENEUT									40.6	1.6				3.1			1.6				1.6	1.6		6.3			7.8	1.6		1.6	1.6
1400	1450	1425	WIN'G BULL-MPORT/ENEUT			0.3	0.5			0.2		17.8	1.7				6.4	3.2	0.1		2.4	1.1		5.9		0.7	1.7		11.2	1.3			1.1	
1425	1425	1425	HARRIETSVILLE			4.1						1.7	0.8		0.8		41.1	1.7			2.5	0.4		2.1		0.8							0.8	4.6
1450	1450	1450	MORRISTON/IVAN-ELLIOTT	0.4		1.6	4.7		0.4	0.5		9.6	2.3	0.2			22.6	10.3	0.2		3.2	9.0		5.8		1.3	6.7	0.2	1.3	0.7			0.2	3.1
1475	1525	1500	CHYPCHAR			0.3						45.6					15.5	4.0			8.0	1.7		3.4			7.4		0.6	0.3	1.7		3.7	3.4
1500	1550	1525	WOLFE CREEK									30.5	0.1		0.1		0.1				8.9	2.8		0.3			1.4	0.3	3.1				0.5	2.8
1525	1525	1525	RAYMOND REID									2.2					4.3				8.6					1.1			6.5					19.4
1550	1550	1550	KNIGHT-TUCKER									0.5	0.2						0.3		7.4			0.2		0.3			4.6					2.8
1540	1570	1555	MACPHERSON			0.1					0.2	9.1	0.2		0.1		0.1	0.1			2.3		0.1	0.9		1.1	0.2		4.9	0.1			0.4	3.8
1575	1575	1575	CLEVELAND			1.1	0.1			0.1		0.7	0.1				1.4	0.1			2.9			0.2			6.5	0.3	4.6	0.1	0.02	0.1		3.0
1600	1630	1615	BROWN			0.2	0.3					0.1	0.2				0.6	0.3			9.8	0.1							12.5		0.2			7.1
1600	1630	1615	CHRISTIANSON	0.1		0.1				1.6		0.9	0.2				2.1	0.6			18.4	0.3		0.8		0.2	0.1	0.1	12.0	0.1	0.1	0.2		1.9
1600	1630	1615	SHERK-SAHS		0.3							50.9					0.3	1.6			3.0					1.6	4.9	1.1			0.8			0.8
1620	1640	1630	THOROLD			4.5				0.1		43.0					2.4	1.9		0.1	0.2	0.1		2.4		1.0			6.6	0.6	0.6	0.4		0.7
1630	1650	1640	BOGLE 1										2.0					2.0									2.0		19.6					2.0
1630	1650	1640	BOGLE 2														1.5	1.5		1.5	7.6			1.5			1.5		12.1					
1630	1650	1640	HOOD				0.4					0.1					0.4	0.3	0.1		9.6	1.4		0.1		0.2	0.8	0.2	4.3		0.2	0.2		2.6
1630	1650	1640	MCINTOSH									47.8					1.6	6.1			2.2	17.5					0.7			0.7	0.2			1.6
1640	1640	1640	WALKER		0.2	0.2		0.1		0.2		10.3	0.8	0.1		0.4	1.1	0.8	0.1		3.6	0.1	0.3	0.7			1.9			0.1	0.1	0.6		0.6
1640	1650	1645	HAMILTON			0.1	0.3			0.2		1.8	0.4				0.7	1.8	0.1		3.1	0.3		1.1		0.1	2.1	0.4	2.1		0.2	0.3		2.5

TABLE 4

Faunal data for Neutral sites in Southern Ontario. In the site name column Glen Meyer, Late Pickering, Middleport (and abbreviations) and E. Neutral (and abbreviations) refer to cultural ancestors of the Neutrals. The site dates used are from the original publications, in some cases modified by Fitzgerald (per-

PERCENTAGES OF MAMMALIAN ELEMENTS (concluded)



Racoon	Marten	Mink	Fisher	Skunk	River Otter	Weasel	Undifferentiated Mustelidae	Lynx	Bobcat	Undifferentiated Felidae	Undifferentiated Carnivora	Elk	White-tailed Deer	Undifferentiated Cervidae	Moose	Undifferentiated Artiodactyla	Horse	Pig	Domestic cow	Domestic sheep	European rat	Homo Sapiens	TOTAL	AUTHORS
4.9	0.8						0.2	0.2			1.9		22.2										474	BURNS (72)
													9.3										118	MURPHY (82)
14.9	0.8			0.3							1.9		4.8										375	COOPER (80)
0.2													70.7										1910	FITZGERALD (PERS.COMM.)
0.7				0.3	0.3		1.3				2.0		20.5	1.7				0.3			0.3	0.3	303	SUTHERLAND (84)
2.3	0.4				0.8	0.2						0.8	31.7									0.8	486	MACLAUGHLIN & HOOEY (84)
0.1	0.1	0.3		0.4	0.3								2.7		0.4								704	KOHLS AND GRYS (NO DATE)
7.8											3.1		20.3										64	MURRAY & HASTIE (82)
1.3	0.4	0.3	0.1	0.1	1.0		0.1	0.2				0.4	34.6	2.2	0.4							0.9	984	BARNHARDT (86), FERGUSON (86), MATTILA (87)
5.8			0.4	1.7							2.5		26.6				1.2				0.4		241	HENDERSON (86)
1.1	1.4	0.5	0.9	0.4			0.5					0.2	1.1	0.4				0.2	0.2			9.0	554	CAMPBELL (FRAM) (85), WILSON (86)
3.4													1.1										349	BOUTIN-SWEET (81), GRAHAM (81)
2.8					0.2			0.4				3.2	40.3	1.6					0.2			0.3	1098	PASCARIS (82), DIZES (82), SALVAGGIO (82)
				1.1								1.1	52.7									2.2	93	RIOSA (84)
0.3				0.5	0.3			0.2				6.1	72.7	0.2	0.2	0.5		0.7				0.5	609	BIDDICK & ESCHE (74)
1.1	0.2	0.2	0.1	0.1	0.1		0.1					1.5	66.4	6.2								0.1	1642	CAMPBELL(88), DALE(88), CAMPBELL(FRAM)(88), LEVINS(88)
3.5	0.02		0.1	0.1	0.1			0.1	0.02		0.1	6.5	65.8	2.0	0.3							0.1	5019	PREVEC (81), MARCHAND (82), KNUTSON (82)
2.6	0.2											0.3	63.5					0.1	0.4	0.1		1.1	897	COOPER (80), CARTER (80)
8.7	0.4		2.0	0.2	0.1	0.1		0.1		0.2	0.3	2.3	40.2	1.9		0.2	0.8	0.8	0.8	0.6		0.6	1457	PREVEC (82)
1.6	0.8	0.3	0.8		0.3					0.3		0.3	29.1						0.3			0.3	371	SOLOMON (86)
	0.1	0.1	0.1		0.1							0.2	30.8	2.8					0.1				821	SMITH & LANGLEY (80), FREER (80)
3.9												2.0	58.8			7.8							51	NICOL (78)
13.6													36.4			7.6		1.5					66	NICOL (78)
3.3					0.2							0.4	75.2										2251	PIHL (78)
1.8			0.2					1.8			0.4	0.2	16.8						0.2				446	GARNER (85)
6.5		0.1	0.1	0.1	0.2			0.1				0.5	70.2	0.4									7705	CUMBAA, RICK, SILIEFF (NO DATE)
16.9		0.1		0.1	0.3						1.8	0.8	61.4	1.1									8726	PIHL (76)

sonal communication) based on glass bead seriation. Where a range of dates is offered, the average of the two extremes is used. European introductions (horse, pig, cow, sheep and rat) are included as an indication of the intrusive content of the faunal assemblage.

or even for food despite its small size, than for crop protection. One animal which is hunted even today for crop protection is the woodchuck. Fig. 13 and Table 2 show a decrease in the frequency of woodchuck in Neutral sites. Since woodchuck is near the middle of its range in southern Ontario, a climatic change is not likely to have affected its frequency. One explanation for the reduction in the hunting of woodchuck is that there may have been fewer crops to protect. This would support the LIA hypothesis. The other possibility is that the increased dog populations reduced the woodchuck populations, acting as crop protectors for the larger fields needed by expanding human populations. A reduction in reliance on maize and other crops would not only explain the decrease in frequency of woodchuck elements, but also the increased dependence on large mammals for food. Such a reduction in crops could have been triggered by a climatic deterioration. A population increase might cause an increase in deer habitat and therefore in deer, and could also explain the observed faunal changes. The difficulty with this hypothesis is that it relies on a per capita increase in dog populations. If the Indian population doubled, then the extent of their fields should also have doubled. The number of woodchucks in the fields and the number of dogs needed to control the woodchucks should also have doubled. But since the habitat of the deer is the field-edge, not the field itself, the increase in deer would have been less than twofold. The area of a field increases approximately with the square of the perimeter, so that a fourfold increase in field area will only double the perimeter. If the woodchuck, dog and human populations maintained the same ratios as their populations increased, then the deer population would have shown a relative decrease. The deer population may expand if abandoned fields are considered, as larger populations of people would have abandoned more fields, creating edges which persisted after the fields were abandoned and the woodchucks were no longer of concern.

In fact, what we observe here is a relative increase in deer and dog, and a decrease in woodchuck populations. Under the expanding population model, this can only be explained if the number of dogs per capita increased. The dogs reduced the woodchuck populations, and the increase in deer populations led to an increase in deer hunting. If we assume that the dog population was controlled by the Indians, then we must explain why the dog population was allowed to increase. Dogs may have had several functions. They may have been used for hunting or for woodchuck control, they may have been bred for food, and they may have been pets. They probably filled all of these functions. It is then not difficult to explain the increase in dog under the expanding population model.

Conclusion

The advent of colder weather during the Little Ice Age decreased the number of frost-free days, and altered the composition of the deciduous tree-dominated forests. The LIA may also have caused a southward shift in the geographic limits of Neutral horticulture, resulting in less reliable crop productivity and therefore a greater need for faunal resources. A decrease in reliance on horticulture and a shift towards greater dependence on animal foods may have resulted. Alternatively, population expansion may have had the same effect on the faunal assemblage.

Which of these was the principal cause is difficult to determine. The LIA is documented in the paleoclimatic literature, and explains the observed changes in faunal assemblages in a straightforward way. On the other hand, population expansion may also explain the observed faunal data, and has some independent corroboration in the increased frequency of sites with time.

It is interesting to note that of the eight sites presented here which are located in the high frost-risk area mapped in Figure 5, six are pre-AD 1450 and only two are post-AD 1450. Since two-thirds of the 27 sites in this study post-date AD 1450, such a change in geographic distribution through time may be significant. It would suggest that the LIA did indeed make this area less useful for Neutral horticulture than it had previously been. Of course, this is not a full survey of all Neutral and pre-Neutral sites, only those for which faunal reports are available.

The two explanations are not mutually exclusive; the LIA may have had the described effect while the increase in field edge from increased populations may also have provided more deer habitat. All that can be said with any certainty is that the Neutrals shifted their faunal use from small to large animals; dog and deer partially replaced wood-chuck in the faunal assemblages.

The most parsimonious solution is usually that which best explains the available data with the fewest suppositions. In this case, both scenarios are based on known events, and both explain the faunal data. Neither can be eliminated as significantly less parsimonious than the other. Both hypotheses deserve further exploration, and may perhaps be testable with much larger faunal data bases. Independent evidence may also provide insight into the demography of the Neutrals, corroborating one hypothesis without necessarily invalidating the other.

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