Geese fouled Crawford Lake 700 years ago

Iroquoian cornfields led to guanotrophy

John H. McAndrews

Today Crawford Lake hosts only one breeding pair of Canada Geese, but in the 1300s the lake was alive with roosting geese. While roosting, the pellets they defecated fertilized the water with nitrates and phosphates and this stimulated algal blooms, most especially of diatoms. With the changing of the seasons, these masses of algae died and their decay produced stinky sulfur compounds; the people of the nearby Iroquoian village must have been annoyed. The evidence for this reconstruction comes from the lake mud.

The lake is in a Conservation Area (Halton Region Conservation) located along the Guelph Line 3 km south of Campbellville. Its small size (2.4 ha) and great depth (22.5 m) make it unusual. Firstly, it is meromictic (partly circulating) whereby only the water above 15 m circulates, producing a change in temperature and renewing dissolved oxygen; in contrast the water below 15 m does not circulate, remaining oxygen-free at a constant 6°C and accumulating toxic chemical compounds. In this biologically hostile bottom water, there are no sediment-disturbing detritivores such as insect larvae. Secondly, every year the lake deposits a millimetre of unusual sediment: a white layer of lime in June and a black organic layer in October. Unlike most lakes that circulate to the bottom and support detritivores, the two layers persist and in a sediment core can be counted and dated like tree rings.

In 1968, we began studying fossil pollen, and in sediment of the early 1400s found among abundant tree pollen grains a few pollen of corn and purslane. We assumed that the corn and purslane pollen blew into the lake from nearby cornfields. Following this lead, we commissioned an archaeological survey, which identified a dozen Iroquoian village sites within a few kilometres of the lake; the closest village was 150 m from the lake on deep soil where corn is grown today. Excavation showed the Crawford Village not only was the approximate age of the fossil corn pollen but the village soil also contained charred seeds of cultivated corn, beans, squash, sunflower and tobacco. The village was reconstructed, staffed by a half dozen interpreters and draws busloads of schoolchildren and German tourists.

In the 1990s, there was renewed interest in the fossil tree pollen, which showed rapid forest succession linked in time with Iroquoian farming. Computer modeling showed that the succession could have been caused by a cold period called the Little Ice Age. On the other hand, fossil charcoal peaks contemporaneous with Iroquoian farming suggested succession following forest fires presumably set to clear land for cornfields. This rich and contradictory paleontological—archaeological record has been discussed in no fewer than seven textbooks.

To resolve loose ends, in 2001 we lifted a new sediment core. High resolution imaging of the upper 70 cm, the last 1,000 years, showed that varving (yearly layering) was irregular and that below 58 cm the varves were disrupted, making them impossible to count. Instead of relying on varve counts as we had in the previous 30 years, we made multiple Accelerator Mass Spectrometry carbon dates, which showed that the varves could only account for 90% of the millennium. Further, we saw for the first time nodules in the sediment, and they were in the late 13th century when the varves ceased being bioturbated and became easily counted. In these varves, there were abundant corn and sunflower pollen as well as fossil diatoms and rotifers, which grazed on the diatoms. When the Iroquoian pollen disappeared in the 14th century, so did the nodules, although the varves continued to the top of the core.

Microscopic analysis of the nodules showed them to all indicate Iroquoian cornfields because they had pollen of corn, sunflower, purslane and grass, spores of corn smut, grass epidermis and bits of herb charcoal. All of which suggests that the nodules are from Canada geese, which had been feeding in the autumn on the Iroquois field. The charcoal indicates the Iroquois farmers burned their fields, probably to remove organic debris. To test the nodules, we have submitted nodules to the Royal Ontario Museum for DNA analysis.

Our reconstruction indicates that at the beginning of the millennium, a fully circulating Crawford Lake was surrounded by virgin forest. About 1280 Iroquoians moved into the area, cleared forest, burned the clearings and planted corn, sunflower, squash and bean. Migrating Canada Geese and perhaps Mallard-Black Duck fed in the fields and roosted on the lake where they cast pellets. At first the pellets dispersed in the water to release nutrients and these nutrients caused algae, particularly diatoms to bloom. These nutrient-stimulated blooms from bird pellets are a form of eutrophy called guanotrophy. Decay of the organic matter used up the oxygen in the bottom water to exclude bioturbating bottom fauna and allowing the varves and subsequent pellets to persist undisturbed.

John H. McAndrews is Professor Emeritus in the Department of Botany at the University of Toronto, 25 Willcocks Street, Toronto, Ontario M5S 3B2. Jock has more bird stories for upcoming issues.