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Smoking Pipes as Indicators of Sociopolitical Changes in Huron-Wendat Social Networks

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Abstract

Ceramic smoking pipes are among the most distinctive artifacts recovered from Iroquoian sites dating from AD 1350 to 1650 in what is today New York, Ontario, and Quebec. In this study, we conduct network analyses of pipe forms to examine assemblages of relations among the ancestral and colonial-era Huron-Wendat during a period of coalescence, conflict, and confederacy formation. We bring these networks based on pipe form together with previous network analysis of collar decoration on ceramic vessels to develop insights about the social networks that each artifact type comprises. Our findings indicate that, unlike pottery collar decorations (which are primarily associated with women and reflect highly cohesive social networks), Huron-Wendat smoking pipes (which are more closely associated with men) were less cohesive and reflect the formation of coalitional networks. We interpret these patterns in the context of defensive alliances that formed to provide mutual aid among communities and nations. These differences highlight the distinct social and material domains in which these artifacts operated, offering complementary perspectives on the complex social dynamics that shaped the social and political landscapes of precolonial and early colonial northeastern North America.

Résumé

Les pipes à fumer en céramique comptent parmi les artefacts les plus distinctifs retrouvés sur les sites iroquoiens datant de 1350 à 1650 apr. J.-C., dans ce qui est aujourd'hui l'État de New York, l'Ontario et le Québec. Dans cette étude, nous produisons des analyses de réseaux des formes des fourneaux pipes pour examiner les ensembles de relations parmi les Hurons-Wendat ancestraux et ceux de l'époque coloniale, durant une période de fusions, de conflits et de formation de confédérations. Ces réseaux basés sur les formes de pipes sont combinés aux analyses de réseaux antérieures portant sur les décors des parements de vases en céramique, afin de mieux comprendre les réseaux sociaux engendrés par chacun de ces deux types d'artefacts. Nos résultats indiquent que, contrairement aux décors sur les parements de vases—principalement associés aux femmes et reflétant des réseaux sociaux très cohésifs—les pipes à fumer des Hurons-Wendat, plus étroitement associées aux hommes, formaient des réseaux de coalition moins cohésifs. Nous interprétons ces patterns dans un contexte d'alliances défensives établies pour offrir une aide mutuelle entre communautés et nations. Ces différences soulignent les domaines sociaux et matériels distincts dans lesquels ces artefacts évoluaient, offrant des perspectives complémentaires sur les dynamiques sociales complexes qui ont façonné les paysages sociaux et politiques de l'Amérique du Nord-Est précoloniale et du début de l'époque coloniale.

Keywords: Huron-Wendat; network analysis; Ontario; smoking pipes; sociopolitical dynamics

Mots-clés: Hurons-Wendat; analyse de réseau; Ontario; pipes à fumer; dynamiques sociopolitiques
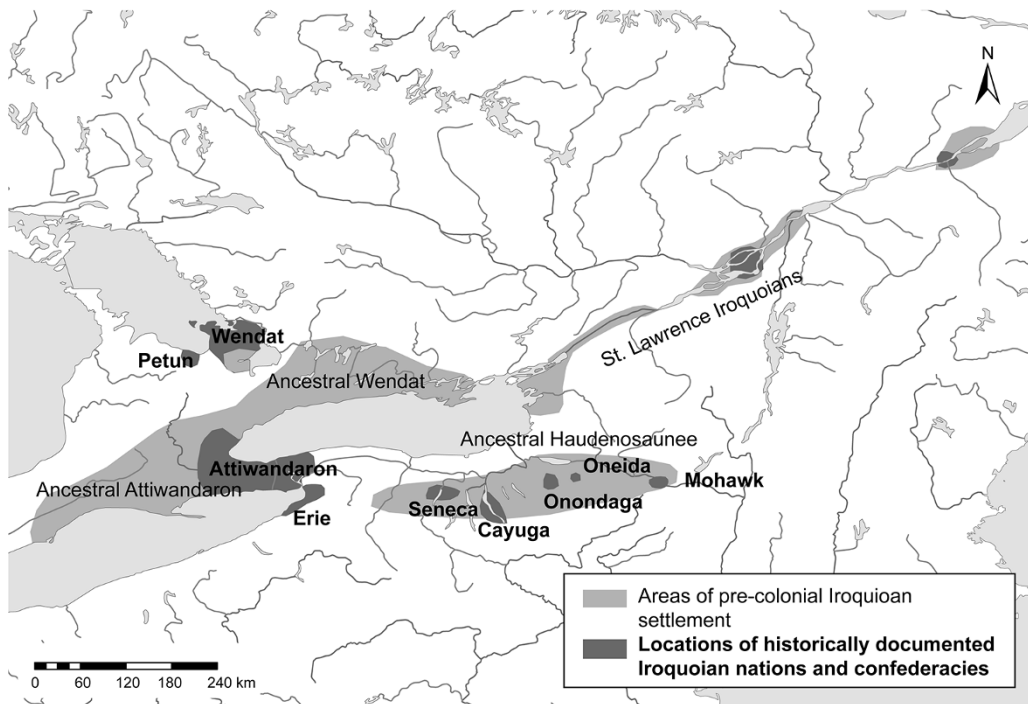
Figure 1. Territories associated with ancestral and historic Northern Iroquoian populations in northeastern North America. Map by Jennifer Birch.

Ceramic smoking pipes are among the most commonly preserved items of material culture on Iroquoian archaeological sites dating from AD 1350 to 1650 in present-day New York, Ontario, and Québec. The consumption of tobacco (primarily *Nicotiana rustica* [Winter 2000]) was a widespread practice among Indigenous peoples in the late precolonial and colonial Northeast. Ethnohistoric and archaeological records locate pipe smoking in a wide range of social and political contexts (Ferland 2007; Hall 1997; Hayes 1992; Rafferty and Mann 2004). Here, we approach smoking pipes as both assemblages of artifacts that reflect the local behavioral contexts in which they were enmeshed and as relational assemblages at the regional scale that speak to the emergent and declining interconnections between and among those people who made, carried, traded, and smoked them.

Analysis of patterns in the manufacture and formal qualities of pipes can provide information about patterns of social behavior. We are particularly interested in what formal network analysis of pipe attributes reveals in the context of politogenesis and population movement during the AD 1350–1650 period in southern Ontario. This region was home to the historical Huron-Wendat Confederacy and populations that were ancestral and connected to it (Figure 1). The latter part of this period, circa AD 1500–1650, is of particular interest on account of (1) the coalescence and relocation of communities and nations, (2) increases in violent conflict, and (3) the crystallization of the Huron-Wendat Confederacy as a formalized political institution.

Previous work by the authors has focused on network analyses of Northern Iroquoian pottery collar decoration (Birch and Hart 2018, 2021; Hart 2012, 2020; Hart and Engelbrecht 2012, 2017; Hart et al. 2016, 2017, 2023). The primary contributions of this work rely on a theoretical framework whereby collar decoration is understood to have been a means by which women signaled their social and political affiliations, with decorative motif choices being shared among members of both tightly knit and widespread social and political networks. In the Northeast and Mid-Atlantic regions, the manufacture and circulation of ceramic pipes have been shown to be more heterogeneous than that of ceramic vessels (Bollwerk 2016; Braun 2015; Creese 2016; Smith 1992). For this reason, it makes good sense to compare

network topologies and other measures of network cohesion for assemblages of both artifact categories to capture and compare the sets of relations that each represents.

The primary objective of this study is to reconstruct the social networks in which ceramic pipes were used within the region the Huron-Wendat occupied and to trace changes in those networks over time. The second objective is to compare the structure and modifications of the pipe networks with those of the ceramic vessels produced by the Huron-Wendat and their ancestors. These two categories of objects were used in different contexts, for different tasks, and by people with different social and political identities. Did the signals conveyed by these two forms of material culture—representing different social and material domains in which they were manufactured, used, and deposited—result in similar network topologies? How do changes in the form and structure of those networks map onto (or not) processes such as community coalescence, intergroup conflicts, and the emergence of alliances and political confederations? To address these questions, we use network analyses of similarity matrixes generated from site-level counts of pottery collar decoration and pipe-bowl-form categories. We initiate our analyses by examining the Huron-Wendat region within the context of pan-Iroquoian networks. We then perform formal network analyses exclusively on the Huron-Wendat region, which has the largest smoking pipe dataset. We find that network topologies reflect differing social and material domains within the context of sociopolitical change over the course of three centuries.

Interpretive Models for the Study of Iroquoian Smoking Pipes

Interpretive models applied to smoking pipes have taken a variety of forms in attempts to explain pipe functions or roles in Iroquoian societies. One dominant model has focused on the role of pipes in political and diplomatic activities (e.g., Kuhn 2003; Kuhn and Sempowski 2001; Wonderley and Sempowski 2019). While it is acknowledged that pipe smoking was both a widespread practice and an inherently individual activity, it was synonymous with political and diplomatic protocols as well as the promotion of the psychological qualities that rendered a person an effective participant in those settings (Hough 1861:53, 102, 106; Thwaites 1896–1901:58:187–189; Wonderley and Sempowski 2019:98). According to ethnohistoric observers such as the Jesuit priest Paul Le Jeune (Thwaites 1896–1901:10:219, 15:27), pipe smoking was a mandatory element of council meetings. Among the nineteenth-century Haudenosaunee, to meet and discuss political matters was "to bring our pipes together" (Hough 1861:102, 106).

Other frameworks emphasize ritual and shamanistic contexts (e.g., Hall 1997; Mathews 1976; von Gernet 1992; von Gernet and Timmins 1987), including the potency of tobacco as an aid in achieving altered and affective states. Of course, the symbolic and cosmological significance of pipe smoking (e.g., Mann 2004; Rafferty 2016; Wonderley 2005) means that it could also be regarded as an aid to commensal politics. According to seventeenth-century AD Jesuit missionaries: "The Indians never spoke of business nor came to any conclusion without having a pipe in their mouths; they said the smoke went to their brains and gave them enlightenment on their difficulties" (Tooker 1964:50, citing Thwaites 1896–1901: 10:219, 15:27). Although archaeologists interested in political and ritual functions in Iroquoian societies have utilized analyses of elements and assemblages of smoking pipes to those ends, it has also been recognized that according to ethnohistoric texts, pipe smoking was virtually ubiquitous in both individual and more formal group settings, as well as politicized and mundane contexts (Chapdelaine 1992:39; Tremblay 2006:67–72; von Gernet 1995:69, 71).

Recent approaches combine political, ritual, and personal meanings attached to these artifacts with relational and ontological approaches, emphasizing that pipes were both vehicles for affective presence and relational identification (Cipolla 2023; Creese 2016; Watts 2020). Creese (2016:32) argues that smoking pipes are "relational-affective objects that become extensions of the self through persistent intimacies of skilled production, habitual use, and memory work"—they are identified with their users during life and afterward. In exchanges and gifting, it is the identification of a pipe with the giver that affects the pipe's meaning (Creese 2016:44).

In much archaeological research in the Eastern Woodlands, pipe smoking is interpreted, implicitly or otherwise, as a male activity (Agbe-Davies 2016:22; Bollwerk 2016:52; Hall 1997; Linton 1924; von Gernet 1995). Regarding the Wendat specifically, Heidenreich (1978:381) writes that "tobacco growing,

the manufacture of pipes, and smoking were apparently male activities (Boucher 1881:55)." With the exception of one source on the Delaware, there is no evidence that women smoked pipes in the pre–AD 1650 Eastern Woodlands (von Gernet 1995:69). The French explorer Jacques Cartier described pipe smoking as a male activity among the Iroquoians he met in the St. Lawrence River valley (Biggar 1924:184). Council meetings are also understood as men's spaces vis-à-vis the dominant interpretive model of pipes being essential to political and diplomatic relations. It is also tempting to contrast the association of smoking with mental clarity and a state of relative peace with the socialization of Iroquoian men for fierceness and prowess on the warpath. However, we must reserve a healthy measure of doubt for the assertion that men were exclusively responsible for either pipe smoking or pipe manufacture in the interpretation of archaeological assemblages. We acknowledge that ethnohistoric observers were men and that they inhabited predominantly male social spaces, which could therefore reflect a gender bias. Jordan (2014) demonstrated a close association between women's work groups and evidence for pipe smoking at the early eighteenth-century Seneca Townley-Read site, for example. However, the evidence for pipe smoking as a gendered activity in the precolumbian world is less clear in the archaeological record of earlier centuries. Although pipe smoking is commonly associated with male political activity, ethnohistoric accounts also describe pipe smoking as something that took place in a wide range of settings: during travel by canoe (Thwaites 1896–1901), in houses (Wrong 1939:88), and during the torture of prisoners (Thwaites 1896–1901:13:53–55). Smoking pipes are also frequently recovered from a wide range of archaeological contexts, including post molds (Curtis and Birch 2020), semisubterranean sweat lodges (Braun 2015), pit features (Timmins 1997), and midden contexts. For this reason, our preference here is to not associate pipes equivocally with any one domain of social or gendered practice but rather to look at their stylistic similarities as potential sources of information on past relational networks.

Although pipes are present in the Iroquoian archaeological record from the onset of settled village life, increases in the proportion of smoking pipes relative to ceramic vessels began in the fourteenth century AD. Archaeologists have noted increasing diversification of pipe forms and decorative elements in fifteenth- and sixteenth-century AD assemblages, coincident with coalescence of populations into large villages and towns (Creese 2016; Smith 1992). The formal and stylistic qualities of smoking pipes have been shown in some regions to be distinct from patterns associated with ceramic vessels (e.g., Smith 1992; Woolfrey et al. 1976).

Ceramic pipe manufacture appears to have been a more heterogeneous activity than ceramic vessel manufacture. This may be an indication that communities of practice for pipe makers were differently structured, perhaps less conformist or more individualistic than communities of practice found among potters. LA-ICP-MS analysis of smoking pipes and pipe fragments from the sixteenth-century AD Keffer site in southern Ontario showed them to be more chemically diverse than pottery vessels (Creese 2016). Petrographic analysis of smoking pipes from the fourteenth-century AD Holly village in southern Ontario indicated that they were made by larger numbers of individuals of differing skill levels using a wider range of materials, including minerals and materials imbued with cosmological significance (Braun 2015).

Pipes were also exchanged over long distances (Drooker 2004; Kuhn 1985; Kuhn and Sempowski 2001), a practice that also undoubtedly contributed to the diversification of pipe assemblages. More portable than pots, pipes may have been traded or exchanged as part of the gift economy or as part of interactions between individuals and representatives of groups engaged in political activities. Given the nature of the dataset being considered in this study, multiple interrelated and socially embedded variables of production, circulation/distribution, and consumption may have been at work in creating the pipe assemblages subject to analysis.

Relations and Assemblages in the Interpretation of Network Models

Our previous Iroquoian network analyses have focused on pottery collar decoration (e.g., Birch and Hart 2018, 2021; Hart 2012; Hart and Engelbrecht 2012; Hart et al. 2016, 2017, 2023). Collars are several-millimeter-thick bands of clay that encircle the rims of pots extending up to several centimeters below the lips. They provide highly visible platforms onto which were added decorative motifs consisting primarily of incised or stamped lines during the post–AD 1350 period in the Northeast. These designs were

Table 1. Mean Percentages of Plain Pipe-Bowl and Pottery Collars in Huron-Wendat Territory Assemblages by Time Span.

Time Span	Mean % Plain Pipe Bowls			Mean % Plain Collars			*t*-test	
	Sites (*n*)	Mean	σ	Sites (*n*)	Mean	σ	*t*	*p*[a]
1350–1450	22	20.30	16.72	33	3.41	2.80	5.7115	0.0001
1400–1500	22	11.39	10.56	33	2.57	2.19	4.6708	0.0001
1450–1550	24	10.18	7.70	31	4.45	4.00	3.5675	0.0007
1500–1600	17	8.92	6.52	30	5.50	4.92	2.0342	0.0442
1550–1650	11	6.40	5.66	33	5.53	5.28	0.8694	0.6471

[a]Monte Carlo permutation *p*-value.

drawn from a corpus of socially mediated decorative elements and motifs. Decorated collars had high absolute and contextual visibility (Carr 1995). Following Bowser (2000; Bowser and Patton 2004), we have suggested that decorative motifs on collars were a mechanism through which women—the primary manufacturers and users of pots—signaled memberships in social and political networks (Hart and Engelbrecht 2012).

Although pots were highly visible in longhouse and other domestic contexts, they also were viewed in larger public spaces in the context of food preparation and consumption (e.g., feasts and ceremonials). Conversely, smoking pipes were smaller, more portable, and visible in a wider range of social and political contexts. The forms of Iroquoian pots were fairly standardized, with globular bodies, restricted necks, and generally vertical rims, with or without collars (see, e.g., MacNeish 1952). It was the decorations on collars that differentiated each pot and constituted signals of the maker's/user's sociopolitical networks (Hart and Engelbrecht 2012; Hart et al. 2016). Although the pipe bowls—like pot collars— were frequently decorated with incised, stamped, and/or punctated designs, given the size of the pipe bowl, these designs were less visible at a distance than those on pottery collars. The shape of a bowl itself was more visible than its decoration. A 2.5–5.0 cm tall pipe bowl's shape was distinguishable in public near contexts at distances of 4–8 m, based on analyses of physical space and human perception (Bowser and Patton 2004:177 after Hall 1966, 1972). Details of incised, stamped, and/or punctated decorations were visible at shorter distances, with specific attributes in only intimate (1 m) settings, such as during pipe sharing. Consequently, although bowl decorations may have conveyed information about the pipe owner, their effectiveness at conveying that information was more spatially restricted than the bowl's form, which could be seen and interpreted at greater distances by more people. Others have noted the significance of Iroquoian bowl form in analyses (e.g., Noble 1992:42): "for non-effigy pipes, the bowl form is often more significant than the applied designs."

As with pottery collars and their decorations, varied bowl forms were not necessary for pipes to serve their immediate function—containing smoldering tobacco leaves or other plant material to deliver smoke to the smoker's respiratory tract. The fact that there are varied, but limited, pipe-bowl shapes suggests they were drawn from a socially mediated corpus, and that they conveyed information about the smoker, identifying the individual as a participant in a particular social and/or political network. Knowledge and skills related to pipe manufacture and the shared cultural and practical repertoire surrounding "how to make a pipe" were transmitted among communities of practice (Wenger 2008). That a significantly larger mean percentage of pipe bowls is undecorated relative to pottery collars (Table 1), except in the 1550–1650 time span, further suggests that a bowl's shape was important. In the 1550–1650 time span, effigy pipe percentages increase, whereas plain pipe-bowl percentages decrease relative to earlier times (Figure 2). Given that an effigy may carry more information than geometric or impressionistic designs, a rise in the frequency of effigy pipes may have corresponded to a rise of encoded social signals associated with change(s) in the sociopolitical relations the Huron-Wendats nurtured with their neighbors.

Following from these considerations, our approach emphasizes pipes as assemblages of artifacts *and* assemblages of relations. We understand pipe form as representing both individual behaviors and
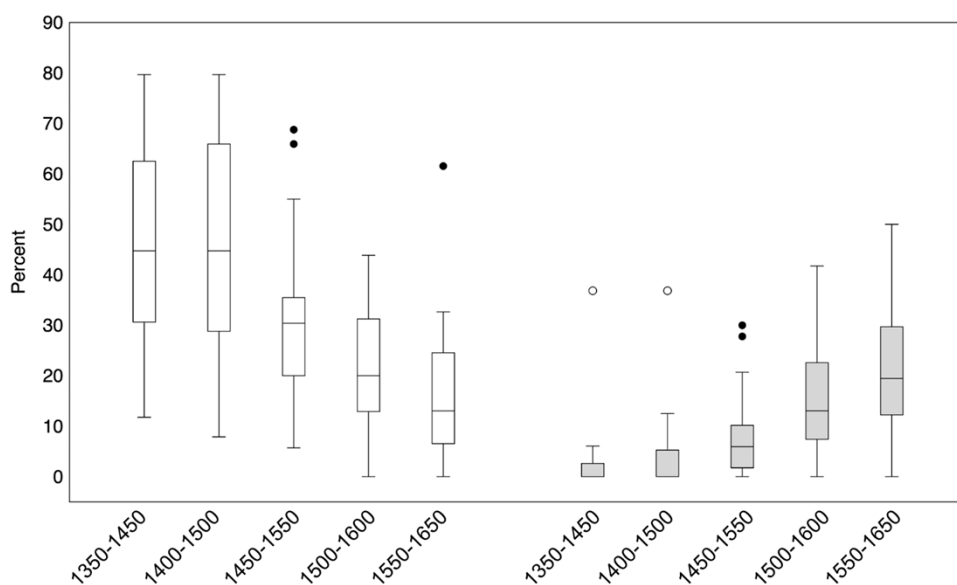
Figure 2. Box plots of plain (white) and effigy (gray) pipe percentages from Huron-Wendat territory.

networks of interaction. Pipes were utilized as a media of "self-definition" (Creese 2016:27) by people (consciously or otherwise) as a means of relating to or identifying with larger social groups (Jones 1997; Peeples 2018). Our analytical units in this analysis are pipe assemblages at the site level that might include pipes that were used in or carried to myriad contexts over their use life. Because of this, the concept of an assemblage in terms of a physical aggregation of materials deposited in the archaeological record defines the analytical units being considered (Schiffer 1976).

Given that they are embedded in ordered sets of person–thing relations, networks based on the attributes of smoking pipes can be understood as forming their own relational assemblages (Knutson 2021; Van Oyen 2016). This framework recognizes variability in the entities or practices that might be expressed in network connections (individuals, groups, things, places, etc.) and what those connections represent (the movement of objects, persons, ideas, practices or styles, access, etc.). Archaeologists are familiar with the notion that cultures are always coming into being as the result of the interplay between structure and agency (Giddens 1984). An approach based on networks as assemblages of relations likewise recognizes that networks are also emergent and encode social, spatial, and temporal trajectories in ways that allow us to consider the interconnected agency and relationality of network entities as a historical process (Van Oyen 2016:360–361). However, we acknowledge that although network models and visualizations allow us to observe and describe relational phenomena, they do not necessarily *explain* them (Knutson 2021:798). Consequently, network models must be considered in dialogue with information from the archaeological and historical records, or Indigenous traditional knowledge.

Huron-Wendat Networks

Here, we focus on that portion of present-day southern Ontario that is associated with the Huron-Wendat confederacy in historical seventeenth-century Wendake and the region to the south, on the north shore of Lake Ontario, where ancestors of the historical Huron-Wendat lived (Figure 1). This region provides the largest sample of sites with pipe-form data and site-level chronologies that have been updated though Bayesian analyses of new radiocarbon dates on annual plant products (Birch et al. 2021; Manning et al. 2018, 2019). The AD 1350–1650 archaeological record pertaining to village development, coalescence into defensive village aggregates, population movement, and the eventual formation of the Wendat Confederacy is robust and provides a strong backdrop for interpreting changes
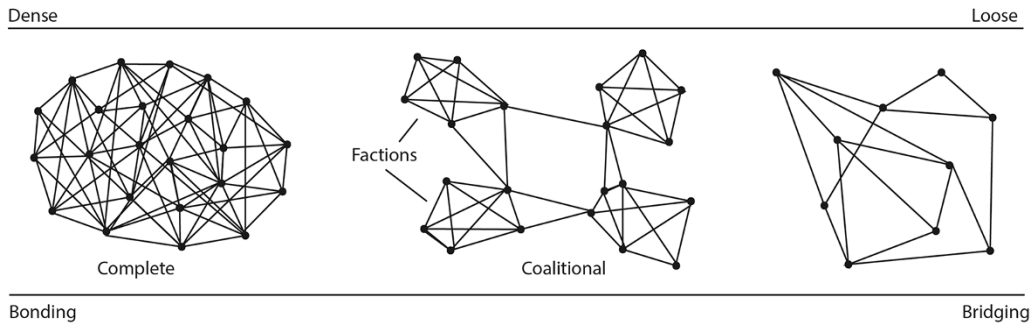
Figure 3. Typology of network structures (from Birch and Hart 2018:Figure 2, after Crowe 2007:Figure 1; Ramirez-Sanchez and Pinkerton 2009:Figure 2).

in pipe networks over time (Birch and Williamson 2013; Williamson 2014). Although we include the Haudenosaunee and St. Lawrence regions in pan-Iroquoian pipe-bowl network visualizations, the number of sites with pipe-bowl data in these regions is too small at present to warrant the separate analyses that we provide of the Huron-Wendat region. Such analyses will be conducted and presented on later occasions.

Previous analyses have shown that networks based on pottery collar decoration track Huron-Wendat history and reveal patterns not otherwise apparent in standard analyses of settlement and artifactual data (e.g., Birch and Hart 2021; Hart et al. 2016). There is a consistent trend in our previous pottery collar network analyses for increased cohesion (connectedness) of the networks of the Huron-Wendat region culminating in a highly cohesive AD 1550–1650 network, when communities coalesced in Wendake and the historically documented Huron-Wendat Confederacy formed (Birch and Hart 2018; Hart et al. 2016). This trend resulted from Huron-Wendat women adopting meta-identifier collar designs that signaled the mutual interests of new social configurations in the form of simple diagonal or vertical lines, which helped to integrate families and communities within the Confederacy (Birch and Hart 2018, 2021; Hart et al. 2016).

As represented in Figure 3, network topologies occur on a spectrum ranging from looser bridging networks with sparse ties between nodes to denser bonding networks in which there are many ties connecting nodes into a more complete whole. These topologies reflect differing kinds of social capital and relationships between actors—in this case village communities—that confer different kinds of economic and social benefits to network members (Crowe 2007; Pretty and Ward 2001; Putnam 2000; Ramirez-Sanchez and Pinkerton 2009). Dense networks are characterized by bonding ties—strong ties that accrue benefits to inwardly focused organizations reflecting reciprocity and solidarity. Loose networks are characterized by bridging ties—weaker ties that accrue benefits to externally focused individual actors reflecting information and access to external resources. Coalitional networks are hybrids, in which there are densely connected network partitions and factions characterized by bonding ties, with factions connected to other factions through bridging ties.

Our previous analyses of pottery collar networks indicate that Huron-Wendat networks were complete, characterized by strong bonding ties (Birch and Hart 2018). These reflected the power of women within the Huron-Wendat Confederacy—their active roles in forming and maintaining relationships, as well as their social and political importance in their respective communities and nations. They used pottery collar decorations to signal their memberships and facilitate cohesion within their social and political networks. The inward focus of these networks accrued social capital and associated benefits to individual women, their matrifamilies, clans, and communities.

If pipe-bowl forms performed the same symbolic meta-identifying, integrating function, then we would expect networks based on bowl forms to also become more cohesive through time and to be characterized by bonding ties. However, we also acknowledge that the topologies of pipe-bowl forms and collar decorations may differ, reflecting their varied patterns of use, identity, and visibility as reviewed above.

Methods and Materials

Pipe-bowl-form data were compiled from the literature using the standard suite of 15 categories employed in Iroquoian archaeology (e.g., Emerson 1954; Smith 1995) plus a sixteenth category for effigy pipes. Counts of pipe forms according to the 16 categories were recorded for each site (Supplemental Table 1). With respect to our previous analyses, we include Petun sites (Garrad 2014) with the Huron-Wendat territory sites. We include sites in Prince Edward County, at the headwaters of the St. Lawrence River in Ontario, with sites located in the St. Lawrence River valley. Pottery collar data (Supplemental Table 2) were extracted from our previously published dataset (e.g., Birch and Hart 2018; Hart et al. 2023), consisting of counts for each of 29 decorative motif analytical categories (categories 2–30) as adjusted from Engelbrecht (1971, 1996; Hart et al. 2023). According to our earlier analyses, undecorated collars—Engelbrecht's analytical category 1—were not included in the analyses. Each site was assigned to a 50-year time span, with the series beginning at AD 1350 and ending at AD 1650, based on recent Bayesian analysis of radiocarbon dates (e.g., Birch et al. 2021; Manning et al. 2018, 2019) or estimates based on artifact-based chronologies.

Because whole pipe bowls that analysts can readily assign to form categories are often scant or absent on any given site, and the number of bowl fragments that can be confidently assigned to form categories is often small, we initially included all sites with at least 10 categorized pipe bowls/bowl fragments. We recognized it is likely the number of forms represented at any given site will increase with larger sample sizes, potentially skewing analytical results. To assess this possibility, the number of forms (richness) on the sites was sorted by number of categorized bowls from smallest to largest. The sorted form counts were then used with the runs test, as implemented in PAST 4.1.1 (Hammer et al. 2001) to determine if there are patterns (runs) greater or less than the sample mean in the sequence of values that depart from random (e.g., McKenzie et al. 1999). If the number of forms increased with larger sample sizes, we expected the sequence of values to depart significantly ($p \leq 0.05$) from random. If so, the test was repeated by eliminating the lowest number of bowls in the sequence. This procedure was repeated until the *p*-value was >0.05. Only those sites with pipe-bowl-form counts in the final iteration of the test were included in the subsequent analyses. Because the samples differed for the various analyses, the count threshold varied. Count thresholds are indicated in table captions and/or text as appropriate.

Site-level frequency counts of pipe-bowl-form and pottery-collar-decoration categories were used in PAST to calculate Morisita overlap index matrixes (Morisita 1959). Morisita overlap index values range from 0 (representing no similarity) to 1 (indicating complete similarity). This index is recommended in situations where there is variation in sample size and diversity between cases (e.g., Brughmans and Peeples 2023), having been shown to be largely independent of each (Morisita 1959; Wolda 1981). Following previous analyses, subsamples from the resulting matrixes were extracted for analysis based on 100-year time spans with 50-year overlaps (1350–1450, 1400–1500, 1450–1550, 1500–1600, 1550–1650). This accounted for chronological uncertainty, date estimate ranges for site occupations falling across time-span boundaries, the periodic movements of village populations from old to newly constructed villages, and population circulation among extant villages.

Network visualizations were performed in Visone 2.27.1 (Brandes and Wagner 2004), with weighted graphs and ties with Morisita index values <0.500 deleted, eliminating the weakest ties in the networks. We used the backbone layout option (Nocaj et al. 2015), an algorithm that untangles networks and identifies with heavier lines those ties with greatest influence on network structure. We performed Louvain community detection analyses in pan-Iroquoian networks as implemented in Visone, with initial clusters set to uniform and edge weight to Morisita overlap index values. This algorithm maximizes network modularity—the division of networks into clusters of nodes (Blondel et al. 2008; Grujić and Radivojević 2024).

Although visualizations provide qualitative means to compare networks, there are also network statistics, such as those that measure cohesion, which allow quantitative comparisons. Cohesion is a measure of network connectedness: the more connected a network (ties between nodes), the greater its cohesion (Borgatti et al. 2018). There is no single measure of cohesion. Instead, there is a suite of

measures, which taken together, provide a relative assessment of network cohesion between graphs. These include the following:

(1) *k*-cores index: the subgraph (k) with the greatest number of nodes with a maximum degree $\geq k$
(2) density: the total number of ties divided by the total number of possible network ties
(3) average degree: the average number of ties between nodes and other nodes in the network
(4) average path length: the average number of edges that are needed to reach a node from another node
(5) compactness: the mean of all reciprocal distances (path lengths) in the graph
(6) diameter: the longest number of edges from one node to another
(7) clustering coefficient: the average number of closed triplets divided by the total number of triplets in each node's ego network

Greater cohesion is reflected by larger *k*-core indices, density, average degree, compactness, and clustering coefficient values and lower average path length and diameter values. Cohesion measures were performed in UCINET 6.764 (Borgatti et al. 2002) on Morisita index matrixes binarized at ≥ 0.500 (binarization is required for many cohesion measures).

Results

Pan-Iroquoian Networks

Pan-Iroquoian pipe-bowl-form networks are presented in Figure 4 for three-time spans: AD 1350–1450, 1450–1550, and 1550–1650, including sites with at least 15 categorized pipe bowls (runs test $p = 0.060$). Gray-scale shading is based on Louvain community detection analyses. The initial two visualizations (1350–1450 and 1450–1550) indicate that pipe-bowl forms do not partition along geographical or ethnic lines. Rather, the Louvain-detected communities contain sites from multiple regions within Northern Iroquoia, although St. Lawrence Iroquoian sites seem to be more connected with Haudenosaunee than Huron-Wendat sites. Two communities were detected in the 1350–1450 network, both of which contain sites from multiple regions. Three communities were detected in the 1450–1550 network, two of which contain sites from multiple regions, whereas the third contains all but two of the sites are from the Huron-Wendat region—which are primarily those located on the north shore of Lake Ontario. The 1550–1650 network more fully discriminates along ethnic and geographical lines, with most Huron-Wendat region sites falling within two detected communities, and most Haudenosaunee region sites falling in a third. The discrimination between Huron-Wendat and Haudenosaunee sites is not perfect, but it does suggest that the consolidation of the Huron-Wendat Confederacy in historical Wendake is at least partially reflected in pipe-bowl forms. This is consistent with pan-Iroquoian networks based on pottery collar decorations (Birch and Hart 2018; Hart et al. 2023).

Huron-Wendat Territory Networks

We initially compared networks based on our complete samples of Huron-Wendat territory sites with pottery collar decoration or pipe-bowl-form (accounting for runs test results) data. Each sample included sites that had only data for that artifact category and sites that had data for both. Visualizations of each 100-year time span are presented in Figure 5. Clearly, the collar-decoration networks are more cohesive than are the pipe-bowl-form networks. This is confirmed by the cohesion measures (Table 2). All measures indicate that the collar-decoration networks have greater cohesion than do the pipe-bowl-form networks.

To further compare network cohesion, we reran the analyses using only those sites that have both pipe-bowl-form and collar-decoration data (Figure 6; Table 3). Network visualizations clearly demonstrate greater cohesion in the collar decoration than in the pipe-bowl-form networks. Because pairs of networks have the same sample sizes and represent the same sites, all of the measurements are directly comparable. The cohesion measurements are consistent with those from the full samples of sites; collar-decoration networks consistently have greater cohesion than do the pipe-bowl-form networks.

Because the networks for each time span contain the same sites, it would be possible to perform permutation *t*-tests for those measures that are based on node-level values to determine if the means of the
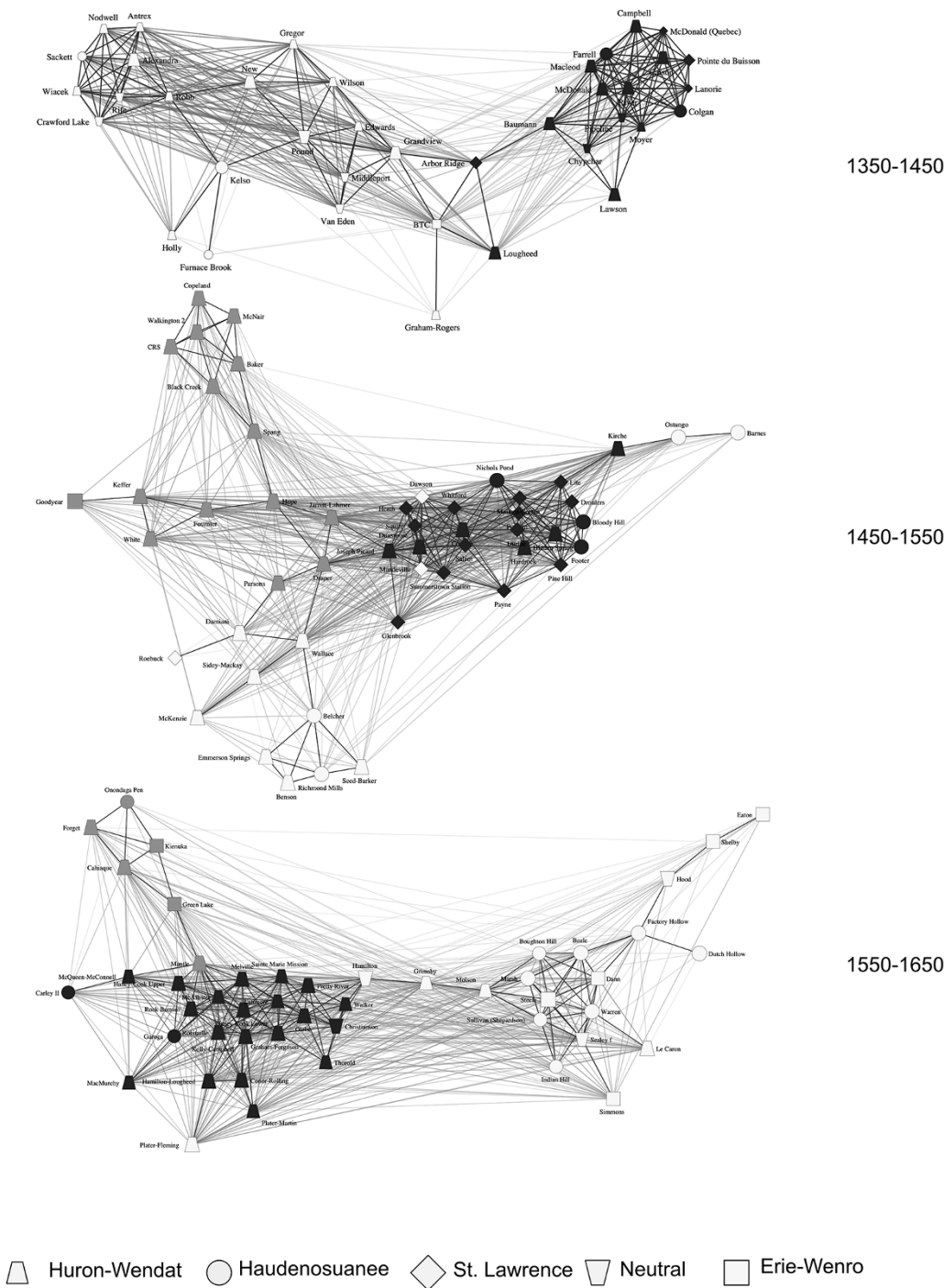
Figure 4. Pan-Iroquoian pipe-bowl-form networks with ties having Morisita index values ≥0.50. Node shadings identify the Louvain community detection results.

measures are significantly different. However, the measures for most of the collar-decoration networks have no variance; they are complete networks, so *t*-tests are inappropriate. Therefore, to further assess the differences between the pipe-form and collar-decoration networks, we performed statistical tests for
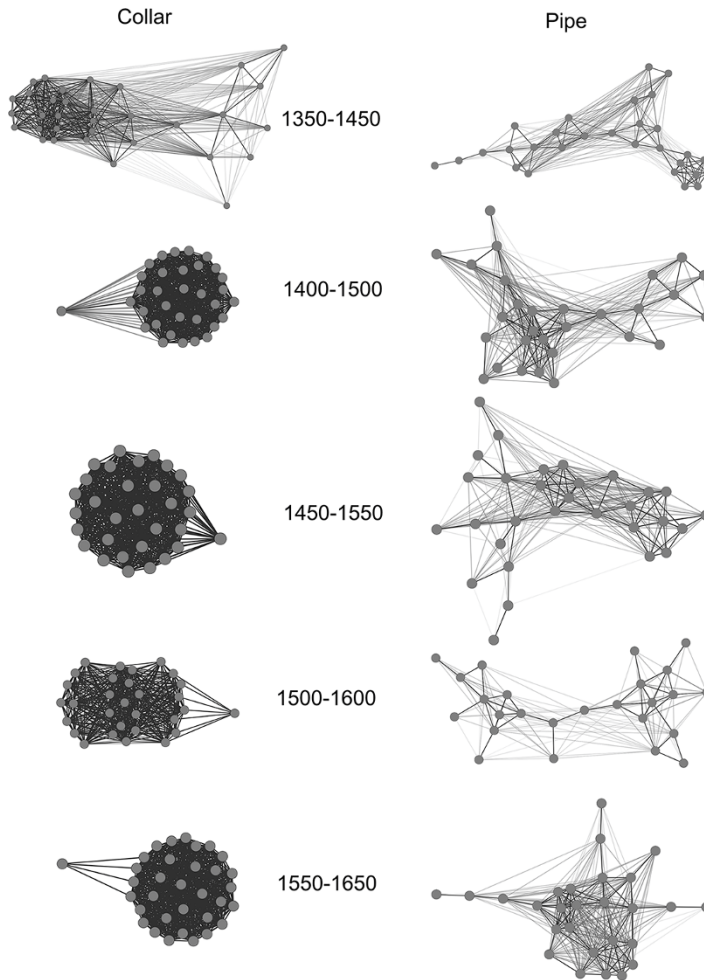
Figure 5. Pottery collar decoration and pipe-form network backbone visualizations by 100-year time span with Morisita index values ≥0.500, including all Huron-Wendat territory sites. See Table 2 for cohesion measures.

two measures on valued networks (Table 4). The first test compares densities of paired networks with both pipe-form and collar-decoration data in UCINET. This test uses a bootstrap method to compare the densities of two networks with the same nodes, analogous to a traditional paired *t*-test (Snijders and Borgatti 1999); *p*-values in this test represent the proportion of absolute differences in the bootstrap routine that are as large as the observed value. In all cases, there is a significant difference between the networks, with collar-decoration networks having greater densities than the pipe-form networks. We also did permutation *t*-tests in UCINET on node-level degree values for valued networks. The permutation *p*-values indicate significant differences between the pipe-form and collar-decoration networks, with the collar-decoration networks having larger average (mean) degrees.

To further explore network configurations, we examined *k*-cores, cutpoints, and blocks for networks binarized at a Morisita overlap index threshold of 0.80 for that subset of Huron-Wendat territory sites having both pottery and pipe data (Table 5). This enabled us to understand how the network structures affect configurations and social capital. As noted earlier, *k*-cores represent the number of nodes with a degree ≥*k*. The *k*-core index used here is the maximum-sized *k*-core in a network. Cut points, on the other hand, are nodes that bridge structural holes. Their removal disconnects a network at that point, resulting in two or more blocks (non-separable subgraph). Bonding ties are reflected by high *k*-core index values, whereas bridging ties are represented by larger numbers of cut points and blocks

Table 2. Network Cohesion Measures for Huron-Wendat Territory Collar-Decoration and Pipe-Form Graphs Binarized at ≥0.50 for Sites with Pipe Counts ≥10 (Runs *t*-test Monte Carlo *p* = 0.1440).

Time Span (AD)	Category	Nodes (*n*)	*K*-cores *k* (k/n)	Density	Average Degree	Average Path Length	Compactness	Diameter	Clustering Coefficient
1350–1450	Collar	33	24 (0.7272)	0.879	28.121	1.121	0.939	2	0.925
1350–1450	Pipe Form	29	14 (0.4828)	0.549	15.379	1.505	0.766	3	0.828
1400–1500	Collar	33	34 (0.8947)	0.980	36.263	1.020	0.990	2	0.990
1400–1500	Pipe Form	29	14 (0.4828)	0.648	18.138	1.355	0.823	3	0.809
1450–1550	Collar	31	31 (0.9118)	0.971	32.059	1.029	0.986	2	0.986
1450–1550	Pipe Form	30	13 (0.4343)	0.568	16.467	1.464	0.779	3	0.757
1500–1600	Collar	30	27 (0.9310)	0.948	25.552	1.052	0.974	2	0.974
1500–1600	Pipe Form	25	7 (0.2800)	0.427	10.240	1.643	0.702	3	0.679
1550–1650	Collar	33	31 (0.9394)	0.947	30.303	1.053	0.973	2	0.993
1550–1650	Pipe Form	27	17 (0.6269)	0.732	19.037	1.274	0.865	3	0.881

(Crowe 2007:478). It is already evident from the analysis at a Morisita overlap index threshold of 0.50 that the pottery collar networks have larger *k*-core indices than do the pipe-bowl-form networks. This is emphasized in the 0.80 threshold networks. In all time spans, the pipe-bowl-form networks had lower *k*-core indices. These are substantially lower in the last three time spans, with the pipebowl maximum *k*-cores representing only 12.5% to 20.0% of the nodes in the pottery-collar *k*-core index. Cutpoints were present in all 0.80 threshold pipe-bowl networks, the removals of which resulted in three to five blocks. No cutpoints were present in the pottery collar networks. These results indicate that unlike the complete pottery-collar networks, the Huron-Wendat pipe-bowl-form networks are coalitional, with bridging ties between factions (subgraphs).

Discussion

The pipe-form networks reveal changes in intercommunity relations before, during, and after processes of coalescence and confederacy formation. In the 1350–1450 period, Louvain community detection analysis revealed three groups, each with members drawn from across the pan-Iroquoian network. One community included predominantly Huron-Wendat and St. Lawrence Iroquoian members—as well as two Haudenosaunee-territory sites in a relatively tightly bonded configuration. These sets of relations may relate to our previous suggestion that St. Lawrence Iroquoian groups (and groups of women, at that) served as "brokers" in the pan-Iroquoian networks (Hart et al. 2017). Another large Louvain-detected community includes Huron-Wendat and Haudenosaunee-territory communities in a slightly looser network, although also with a tightly bonded cluster of sites consisting of members of both groups. The third—and smallest—Louvain-detected community includes sites belonging to three different ethnic groups, although all are located in western New York and the Niagara Peninsula. This suggests that in the 1350–1450 period, communities of practice and sets of relations among the makers and users of ceramic pipes transcended geographic and ethnic boundaries. At this time, the primary unit of social and political organization would have been the coresidential community (Williamson and Robertson 1994), with the crystallization of nations-cum-ethnic groups likely only emerging in the later 1400s–1500s (Birch 2015; Hart and Engelbrecht 2017). Consequently, these networks likely reflect sets
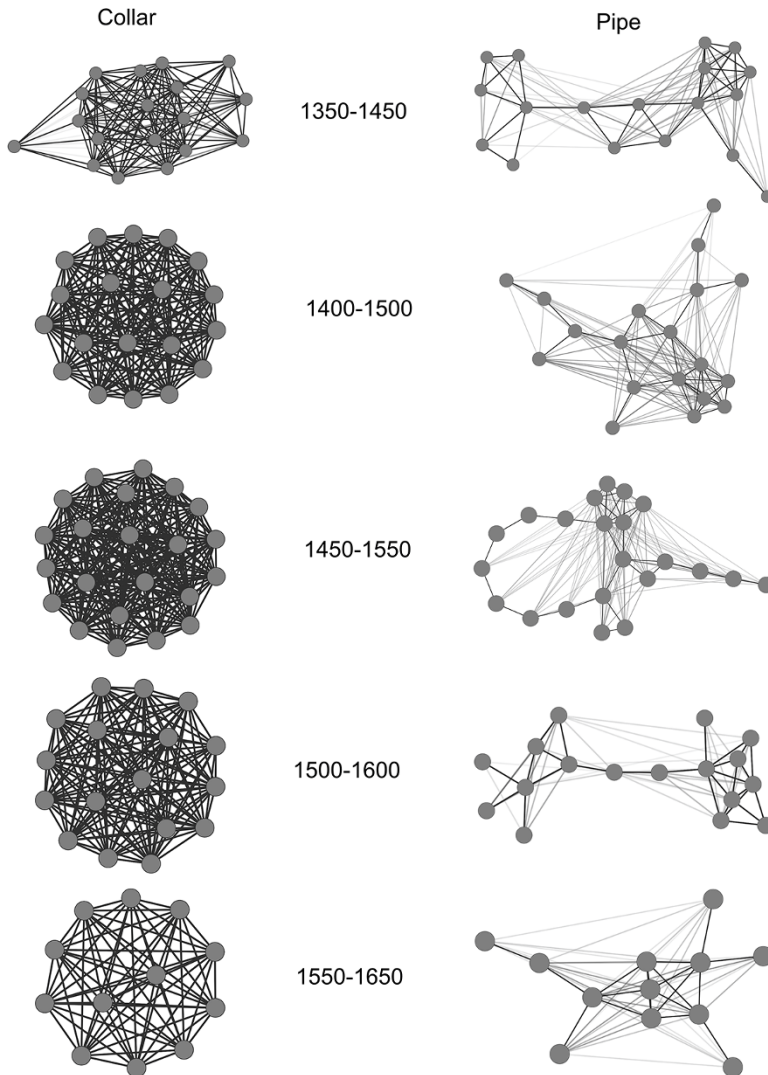
Figure 6. Pottery collar decoration and pipe-form network backbone visualizations by 100-year time span with Morisita index values ≥0.500, including only Huron-Wendat territory sites with pottery and pipe data. See Table 3 for cohesion measures.

of relations at the intracommunity (site) level as opposed to the influence of any larger social-structural units.

In the 1450–1550 period, we expect that the following societal trends influenced pipe-form networks: (1) the onset of heightened hostilities among nascent nations and confederacies and (2) the coalescence of multiple, previously distinct communities into larger defensive aggregates. The Louvain community detection analysis for this interval detects three groups. Two of these communities are composed primarily of ancestral Huron-Wendat sites. One of these includes sites north and south of the west end of Lake Ontario and Niagara Peninsula, suggesting a potential set of network interactions in that subregion. The other group is largely composed of communities on the north shore of Lake Ontario. It is during this period (ca. 1475–1550) that a great amount of evidence for violent conflict in the region is found in the north-shore region—including population aggregation in heavily palisaded villages containing human remains bearing perimortem trauma (Williamson 2007, 2023). The two Wendat-dominated subsets of the network graph exhibit a coalitional network structure. It may well be that the networks of relations defined in this graph reflect defensive-cum-political communities during this period of heightened tensions.

Table 3. Network Cohesion Measures Binarized at ≥0.50 for Huron-Wendat Territory Sites with Both Collar-Decoration and Pipe-Form Data with Pipe Counts ≥16 (Runs Test $p = 0.15938$).

Time Span (AD)	Category	Nodes (n)	K-Cores k (k/n)	Density	Average Degree	Average Path Length	Compactness	Diameter	Clustering Coefficient
1350–1450	Collar	18	15 (0.8333)	0.941	16.000	1.059	0.971	2	0.956
1350–1450	Pipe Form	18	9 (0.5000)	0.562	9.556	1.490	0.772	3	0.759
1400–1500	Collar	19	18 (0.9474)	1.000	18.001	1.000	1.000	1	1.000
1400–1500	Pipe Form	19	10 (0.5263)	0.708	12.737	1.292	0.854	2	0.791
1450–1550	Collar	22	21 (0.9545)	1.000	21.000	1.000	1.000	1	1.000
1450–1550	Pipe Form	22	10 (0.4545)	0.524	11.000	1.593	0.742	3	0.738
1500–1600	Collar	17	16 (0.9412)	1.000	16.000	1.000	1.000	1	1.000
1500–1600	Pipe Form	17	5 (0.4118)	0.426	6.824	1.699	0.692	3	0.598
1550–1650	Collar	12	11 (0.9167)	1.000	11.000	1.000	1.000	1	1.000
1550–1650	Pipe Form	12	7 (0.5833)	0.833	9.167	1.167	0.917	2	0.849

Table 4. Permutation *t*-tests of Network Density and Node-Level Degree by 100-Year Time Span for Valued Graphs of Huron-Wendat Territory Sites with Collar-Decoration and Pipe-Form Data.

Time Span (AD)	Category	Nodes (n)	Density	p[a]	Average Degree	p
1350–1450	Collar	18	0.7864	0.0002	13.368	0.0001
1350–1450	Pipe Form	18	0.5894		10.019	
1400–1500	Collar	19	0.8577	0.0002	15.439	0.0001
1400–1500	Pipe Form	19	0.6452		11.613	
1450–1550	Collar	22	0.9280	0.0002	19.489	0.0001
1450–1550	Pipe Form	22	0.5415		11.371	
1500–1600	Collar	17	0.9549	0.0002	15.278	0.0001
1500–1600	Pipe Form	17	0.4794		7.670	
1550–1650	Collar	12	0.9564	0.0002	10.520	0.0001
1550–1650	Pipe Form	12	0.6442		7.086	

[a]Proportion of absolute differences as large as the observed.

In the 1550–1650 networks, a relatively hard break is reflected in the Wendat-dominated and Haudenosaunee-dominated networks. A century of tensions between members of the Wendat and Haudenosaunee confederacies appears to have resulted in two distinct networks, connected by a small number of Attawandaron (Neutral) communities/nodes. It seems clear that processes of coalescence, conflict, and confederacy building significantly influenced network structure. The communities of practice that determined the formal qualities of pipe forms as well as the social signals encoded and transmitted in their use diverged sharply along Wendat and Haudenosaunee lines.

Table 5. *K*-Core indices, Cutpoints, and Blocks for Pipe-Bowl-Form and Collar-Decoration Networks Binarized at a Morisita Overlap Index Threshold of 0.80 for Sites Having Both Pipe and Pottery Data from Huron-Wendat Territory Sites.

Time Span	Pipe Bowl Form			Pottery Collar Decoration		
	K-core	Cutpoints	Blocks	K-core	Cutpoints	Blocks
1350–1450	6	2	3	9	0	1
1400–1500	7	3	4	11	0	1
1450–1550	4	2	3	20	0	1
1500–1600	2	2	5	16	0	1
1550–1650	2	2	5	11	0	1

We now consider whether the signals conveyed by ceramic collars and pipe bowls—each representing different social and material domains in terms of how they were manufactured, used, and deposited—resulted in similar or different network topologies, including how the social networks in which they were entangled organized and evolved in similar or different ways. As noted above, only the data from the Huron-Wendat territory networks are sufficiently robust to consider this question.

When we compare the connectivity and topology of ancestral and historic Huron-Wendat territory network structures based on ceramic collar design and pipe form, notable patterns emerge that are representative of the social and spatial worlds in which the makers and users of pots and pipes operated. Networks based on ceramic design sequences are highly connected and bonded, whereas networks based on pipe form are coalitional throughout the 1350–1600 sequence. In the 1550–1650 sequence, the pipe network becomes denser and more bonded than in any of the other graphs, concurrent with the consolidation of the Huron-Wendat confederacy in historic Wendake on the peninsula between Lake Simcoe and Georgian Bay in the first decades of the 1600s.

We then have to ask how these relational differences in the form and structure of pot and pipe networks might be interpreted in relation to the archaeological and historical records in terms of patterns related to manufacture, use, and deposition. This includes how changes in the form and structure of those networks do or do not map onto processes such as community coalescence, population movement, intergroup contacts and conflicts, and the emergence of political confederation. In Huron-Wendat society, the manufacture of pots was likely a more communal endeavor than the manufacture of pipes. We have previously suggested (e.g., Hart and Engelbrecht 2012; Hart et al. 2016) that pottery vessels were produced by women in family groups, as was characteristic of Iroquoian female activities (see Engelbrecht 2003; Martelle 2002; Perrelli 2009). Conversely, pipe manufacture may have been something men engaged in on a more individual basis, and in more loosely structured communities of practice.

In his analysis of a sample from a large pipe assemblage of the sixteenth-century ancestral Huron-Wendat Keffer village site, Creese (2016) found that there was greater variation in the physical and chemical attributes of pipes than in pottery. He suggests that "pipe production at Keffer was an open field of practice in which individuals from a cross-section of society made pipes as and when desired . . . . The many pipes at Keffer were most certainly made by many, rather than by the few" (Creese 2016:40). Although Creese's analysis was confined to a single village, he suggested the following:

> A diverse array of clay smoking pipes were implicated in the development of personal routines, bodily habits, dress and adornment, as well as informal and formal modes of affirming friendship, hospitality, and life-giving interdependence. These relationships were probably central to successful village life, and, in turn, help to explain the temporal coincidence of the "adaptive radiation" of Ontario Iroquoian smoking pipes with a period of widespread village nucleation and longhouse growth [Creese 2016:46].

The proliferation of pipe smoking among individuals originating from diverse clans and Nations and the associated cultural protocols around engagement in diplomatic and ceremonial relations requiring a state of "good mind" may have been an aid in commensal politics at both the household and community

levels. Although it is tempting to associate pipe assemblages with the community-cum-village-cum-site at which they were deposited, pipes may have also been carried into a wide range of social and geographic contexts. Although Iroquoian men's social worlds were always more distributed than women's (Birch and Williamson 2018:93–97), this would have especially been the case in the post-1550 world, where trade and warfare became a more frequent part of men's taskscapes. The social networks that men operated in were distributed in multiple ways: (1) as ex-officio members of matrilineal, matrilocal households; and (2) as individuals and groups who operated beyond the "wood's edge," where male social power was exercised—as opposed to "the clearing," the domestic realm where women's power resided (Hamell 1992). Although men's social networks may have been formed across a wide range of social, political, and geographic contexts, the pipes in our analysis were ultimately deposited in the archaeological record by residents of (and possibly visitors to) the sites from which assemblages derive.

Although networks based on ceramic collar decoration are remarkably bonded and stable throughout the 1400–1650 sequence, it seems notable that the most visible transformation in pipe-form networks occurs concurrently with the historically documented period in which the four nations of the Wendat Confederacy coalesced physically and politically. Although the origins of the confederacy purportedly lay with an alliance between the original two nations to settle in what became Simcoe County, Ontario, escalating conflict with the Haudenosaunee led ancestral Wendat populations formerly inhabiting the north shore of Lake Ontario and the Trent Valley to form a defensive alliance in the first decades of the 1600s (Birch et al. 2021; Trigger 1976:156–157). Military alliances have enduring impacts on social, political, and economic relations (Kohut 2022; Roscoe 2009). Joint participation in feasts, ceremonials, council meetings, and war parties would have brought men's activities and signaling communities into closer relational alignment—though this was an alignment that nevertheless remained more coalitional than that produced by Huron-Wendat women's signaling networks. As in other cases where power is decentralized, widely shared, and embedded in daily social life (Bowser and Patton 2004), the political dimension of both women's and men's activities can be understood as complementary rather than contradictory (see also Alfred [2009] regarding the importance of opposites and complementarity in Indigenous governance).

Conclusion

We have seen that similarity networks based on pipe-bowl forms in Huron-Wendat territory over a period of 300 years (AD 1350–1650) became more segregated from other regions in Northern Iroquoia. However, when examined separately, the networks were less cohesive than similarity networks based on pottery collar decorations. That Northern Iroquoia was a dynamic region during these three centuries would be an understatement. This is particularly true of the Huron-Wendat territory. These 300 years witnessed a consolidation of population into large, defended villages and towns; increased interregional conflicts; and the movement of Huron-Wendat villagers from the north shore of Lake Ontario and Trent Valley into the historical Wendake area south of Georgian Bay. This created a buffer zone between the Huron-Wendat and Haudenosaunee, and the formation of the Huron-Wendat Confederacy, after which they experienced the regular presence of European explorers and clergy, epidemics, famines, the fur trade, Haudenosaunee aggression, and ultimately, the dispersal of Huron-Wendat peoples to the west, east, and south.

The Huron-Wendat Confederacy was in large part a defensive mechanism, bringing populations and nations together socially, politically, and physically into a federation for mutual aid and defense concentrated in historic Wendake. As the Confederacy formed, Huron-Wendat women increasingly adopted meta-identifier decorative motifs in the form of simple diagonal or vertical lines for their pottery collars (Birch and Hart 2018, 2021). These motifs reflected the bonding ties characteristic of complete networks that connected together families, villages, and nations in new sociopolitical and geographical settings, and reflected women's power in the new politics of the confederation. Women accumulated and used bonding social capital to maintain the fabric of the new confederation as an inwardly focused network of interactions.

The smoking-pipe-bowl-form similarity networks were quite different. Rather than complete, bonding networks, they consisted of factions, each with internally strong ties, with weaker bridging ties

between the factions. But there is strength in weak ties (Granovetter 1973). These weaker, bridging ties facilitated the spread of information and links to mutual defensive aid across disparate factions, allowing them to draw on defensive assistance (information, military aid, trading partners turned allies) from villages across Wendake and beyond. The bridging social capital maintained an integrated defensive force composed of men from different Huron-Wendat clans, communities, and nations.

We see this, then, as a reflection of the differing nature of social relationships of men and women within the structure of the Confederacy. The first was used by women to fully integrate diverse peoples into a single sociopolitical entity. The second was used primarily by men as a mechanism to affect a dispersed but connected defensive and political strategy in response to external threats that precipitated the movement and consolidation of populations and the formation of the Confederacy. It now remains to be seen if pipe-form and pottery networks differed in the same manner within and between Haudenosaunee and St. Lawrence Iroquoian communities. Detailed data on pipe-bowl decoration is limited at present. However, future efforts expanding these data may allow analyses that complement those presented in this article.

Competing Interests. The authors declare none.

References Cited

Agbe-Davies, Anna S. 2016. *Tobacco, Pipes, and Race in Colonial Virginia: Little Tubes of Mighty Power.* Routledge, Abingdon, Oxon, England.

Alfred, Taiaiake. 2009. *Peace, Power, Righteousness: An Indigenous Manifesto.* 2nd ed. Oxford University Press, New York.

Biggar, Henry P. 1924. *The Voyages of Jacques Cartier.* Publications of the Public Archives of Canada No. 11. F. A. Acland, Ottawa, Ontario.

Birch, Jennifer. 2015. Current Research on the Historical Development of Northern Iroquoian Societies. *Journal of Archaeological Research* 23(3):263–323.

Birch, Jennifer, and John P. Hart. 2018. Social Networks and Northern Iroquoian Confederacy Dynamics. *American Antiquity* 83(1):13–33.

Birch, Jennifer, and John P. Hart. 2021. Conflict, Population Movement, and Microscale Social Networks in Northern Iroquoian Archaeology. *American Antiquity* 86(2):350–367.

Birch, Jennifer, Sturt W. Manning, Samantha Sanft, and Megan Anne Conger. 2021. Refined Radiocarbon Chronologies for Northern Iroquoian Site Sequences: Implications for Coalescence, Conflict, and the Reception of European Goods. *American Antiquity* 86(1):61–89.

Birch, Jennifer, and Ronald F. Williamson. 2013. *The Mantle Site: An Archaeological History of an Ancestral Wendat Community.* AltaMira Press, Lanham, Maryland.

Birch, Jennifer, and Ronald F. Williamson. 2018. Initial Northern Iroquoian Coalescence. In *The Archaeology of Villages in Eastern North America*, edited by Jennifer Birch and Victor D. Thompson, pp. 89–105. University of Florida Press, Gainesville.

Blondel, Vincent D., Jean-Loup Guillaume, Renaud Lambiotte, and Étienne Lefebvre. 2008. Fast Unfolding of Communities in Large Networks. *Journal of Statistical Mechanics* 2008(10): P10008. https://dx.doi.org/10.1088/1742-5468/2008/10/P10008.

Bollwerk, Elizabeth A. 2016. An Examination of the Social Dynamics behind Native Smoking Pipe Variation in the Late Woodland and Early Contact Period Middle Atlantic Region. In *Perspectives on the Archaeology of Pipes, Tobacco and Other Smoke Plants in the Ancient Americas*, edited by Elizabeth A. Bollwerk and Shannon Tushingham, pp. 51–76. Springer International, Cham, Switzerland.

Borgatti, Stephen P., Martin G. Everett, and Lin C. Freeman. 2002. *UCINET for Windows: Software for Social Network Analysis.* Harvard Analytic Technologies, Harvard, MA.

Borgatti, Stephen P., Martin G. Everett, and Jeffrey C. Johnson. 2018. *Analyzing Social Networks.* 2nd ed. SAGE, Los Angeles.

Boucher, Pierre. 1881. *Canada in the Seventeenth Century.* Translated by Edward Louis Montizambert. George E. Desbarts, Montreal.

Bowser, Brenda J. 2000. From Pottery to Politics: An Ethnoarchaeological Study of Political Factionalism, Ethnicity, and Domestic Pottery Style in the Ecuadorian Amazon. *Journal of Archaeological Method and Theory* 7(3):219–248.

Bowser, Brenda J., and John Q. Patton. 2004. Domestic Spaces as Public Places: An Ethnoarchaeological Case Study of Houses, Gender, and Politics in the Ecuadorian Amazon. *Journal of Archaeological Method and Theory* 11(2):157–181.

Brandes, Ulrik, and Dorothea Wagner. 2004. Visone- Analysis and Visualization of Social Networks. In *Graph Drawing Software*, edited by Michael Jünger and Petra Mutzel, pp. 321–340. Springer, Berlin, Heidelberg.

Braun, Gregory V. 2015. Ritual, Materiality, and Memory in an Iroquoian Village. PhD dissertation, Department of Anthropology, University of Toronto, Toronto.

Brughmans, Tom, and Matthew A. Peeples. 2023. *Network Science in Archaeology*. Cambridge University Press, Cambridge.

Carr, Christopher. 1995. A Unified Middle-Range Theory of Artifact Design. In *Style, Society, and Person: Archaeological and Ethnological Perspectives*, edited by Christopher Carr and Jill E. Neitzel, pp. 171–258. Plenum Press, New York.

Chapdelaine, Claude. 1992. The Mandeville Site: A Small Iroquoian Village and a Large Smoking-Pipe Collection – An Interpretation. In *Proceedings of the 1989 Smoking Pipe Conference: Selected Papers*, edited by Charles F. Hayes, III, pp. 31–40. Research Records No. 22. Rochester Museum and Science Center, Rochester, New York.

Cipolla, Craig N. 2023. When Smoking Pipes Grow Fins: Revisiting the Matter-Meaning Dualism in Archaeology. *Current Anthropology* 64(5):550–580.

Creese, John L. 2016. Making Pipes and Social Persons at the Keffer Site: A Life History Approach. In *Perspectives on the Archaeology of Pipes, Tobacco and Other Smoke Plants in the Ancient Americas*, edited by Elizabeth A. Bollwerk and Shannon Tushingham, pp. 27–49. Springer International, Cham, Switzerland.

Crowe, Jessica A. 2007. In Search of a Happy Medium: How the Structure of Interorganizational Networks Influence Community Economic Development Strategies. *Social Networks* 29(4):469–488.

Curtis, Jenneth E., and Jennifer Birch. 2020. *Spang Archaeological Project (194H/AlGt-66) Permit Report Permit #2018-29138*. Report on file, Archaeology and History Branch, Parks Canada, Gatineau, Quebec, Canada.

Drooker, Penelope B. 2004. Pipes, Leadership, and Interregional Interaction in Protohistoric Midwestern and Northeastern North America. In *Smoking and Culture: The Archaeology of Tobacco Pipes in Eastern North America*, edited by Sean Rafferty and Rob Mann, pp. 73–124. University of Tennessee Press, Knoxville.

Emerson, John N. 1954. The Archaeology of the Ontario Iroquois. PhD dissertation, Department of Anthropology, University of Chicago, Chicago.

Engelbrecht, William E. 1971. A Stylistic Analysis of New York Iroquois Pottery. PhD dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

Engelbrecht, William E. 1996. Appendix A: Ceramic Code and Data. In *Reanalyzing the Ripley Site: Earthworks and Late Prehistory on the Lake Erie Plain*, edited by Lynne P. Sullivan, pp. 129–153. New York State Museum Bulletin 489. University of the State of New York, Albany.

Engelbrecht, William E. 2003. *Iroquoia: The Development of a Native World*. Syracuse University Press, Syracuse, New York.

Ferland, Catherine (editor). 2007. *Tabac et fumées: Regards multidisciplinaires et indisciplinés sur la tabagisme, XVe–XXe siècles*. Presses de l'Université Laval, Quebec.

Garrad, Charles. 2014. *Petun to Wyandot: The Ontario Petun from the Sixteenth Century*. Mercury Series Archaeology Paper 174. Canadian Museum of History, Gatineau, Quebec; University of Ottawa Press, Ottawa, Ontario, Canada.

Giddens, Anthony. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press, Cambridge.

Granovetter, Mark S. 1973. The Strength of Weak Ties. *American Journal of Sociology* 78(6):1360–1380.

Grujić, Jelena, and Miljana Radivojević. 2024. Community Detection. In *The Oxford Handbook of Archaeological Network Research*, edited by Tom Brughmans, Barbara J. Mills, Jessica Munson and Matthew A. Peeples, pp. 573–593. Oxford University Press, Oxford.

Hall, Edward T. 1966. *The Hidden Dimension*. Doubleday, Garden City, New York.

Hall, Edward T. 1972. *The Silent Language*. Anchor Press, Garden City, New York.

Hall, Robert L. 1997. *An Archaeology of the Soul: North American Indian Belief and Ritual*. University of Illinois Press, Urbana.

Hamell, George R. 1992. The Iroquois and the World's Rim: Speculations on Color, Culture, and Contact. *American Indian Quarterly* 16(4):451–469.

Hammer, Øyvind, David A. T. Harper, and Paul D. Ryan. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1):4.

Hart, John P. 2012. The Effects of Geographical Distances on Pottery Assemblage Similarities: A Case Study from Northern Iroquoia. *Journal of Archaeological Science* 39(1):128–134.

Hart, John P. 2020. Reassessing an Inferred Iroquoian Village Removal Sequence in the Mohawk River Basin, New York, USA. *Journal of Anthropological Archaeology* 60:101236.

Hart, John P., Jennifer Birch, and Christian Gates St-Pierre. 2017. Effects of Population Dispersal on Regional Signaling Networks: An Example from Northern Iroquoia. *Science Advances* 3(8):e1700497. https://doi.org/10.1126/sciadv.1700497.

Hart, John P., Jennifer Birch, and Christian Gates St-Pierre. 2023. Social Network Analysis of Iroquoian Sites in the St. Lawrence River Valley: AD 1400–1600. *Journal of Historical Network Research* 8(1):98–144.

Hart, John P., and William Engelbrecht. 2012. Northern Iroquoian Ethnic Evolution: A Social Network Analysis. *Journal of Archaeological Method and Theory* 19(2):322–349.

Hart, John P., and William E. Engelbrecht. 2017. Revisiting Onondaga Iroquois Prehistory through Social Network Analysis. In *Process and Meaning in Spatial Archaeology: Investigations into Pre-Columbian Iroquoian Space and Place*, edited by Eric E. Jones and John L. Creese, pp. 189–214. University Press of Colorado, Boulder.

Hart, John P., Termeh Shafie, Jennifer Birch, Susan Dermarkar, and Ronald F. Williamson. 2016. Nation Building and Social Signaling in Southern Ontario: AD 1350–1650. *PLoS ONE* 11(5):e0156178. https://doi.org/10.1371/journal.pone.0156178.

Hayes, Charles F., III. (editor). 1992. *Proceedings of the 1989 Smoking Pipe Conference: Selected Papers*. Research Records No 22. Rochester Museum and Science Center, Rochester, New York.

Heidenreich, Conrad E. 1978. Huron. In *Northeast*, edited by Bruce G. Trigger, pp. 368–388. Handbook of North American Indians: Vol. 15. William C. Sturtevant, general editor. Smithsonian Institution, Washington, DC.

Hough, Franklin B. 1861. *Proceedings of the Commissioners of Indian Affairs: Appointed by Law for the Extinguishment of Indian Titles in the State of New York*. Joel Munsell, Albany, New York.

Jones, Siân. 1997. *The Archaeology of Ethnicity: Constructing Identities in the Past and Present*. Routledge, London.

Jordan, Kurt A. 2014. Enacting Gender and Kinship around a Large Outdoor Fire Pit at the Seneca Iroquois Townley-Read Site, 1715–1754. *Historical Archaeology* 48(2):61–90.

Knutson, Sara Ann. 2021. Itinerant Assemblages and Material Networks: The Application of Assemblage Theory to Networks in Archaeology. *Journal of Archaeological Method and Theory* 28(3):793–822.

Kohut, Lauren. 2022. Warfare and Alliance: A Human-Scale GIS Analysis of Defensive Alliances in the Colca Valley, Peru. In *Global Perspectives on Landscapes of Warfare*, edited by Hugo C. Ikehara-Tsukayama and Juan Carlos Vargas Ruiz, pp. 247–272. University Press of Colorado, Louisville.

Kuhn, Robert D. 1985. Trade and Exchange among the Mohawk-Iroquois: A Trace Element Analysis of Ceramic Smoking Pipes. PhD dissertation, Department of Anthropology, State University of New York, Albany.

Kuhn, Robert D. 2003. Reconstructing Patterns of Interaction and Warfare between the Mohawk and Northern Iroquoians during the AD 1400–1700 Period. In *A Passion for the Past: Papers in Honour of James F. Pendergast*, edited by James V. Wright and Jean-Luc Pilon, pp. 145–167. University of Ottawa Press, Ottawa, Ontario, Canada.

Kuhn, Robert D., and Martha L. Sempowski. 2001. A New Approach to Dating the League of the Iroquois. *American Antiquity* 66(2):301–314.

Linton, Ralph. 1924. *Use of Tobacco among North American Indians*. Anthropology Leaflet No. 15. Field Museum of Natural History, Chicago.

MacNeish, Richard S. 1952. *Iroquois Pottery Types: A Technique for the Study of Iroquois Prehistory*. Bulletin No. 124, Anthropological Series No. 31. National Museum of Canada, Ottawa, Ontario.

Mann, Rob. 2004. Smokescreens: Tobacco, Pipes, and the Transformational Power of Fur Trade Rituals. In *Smoking and Culture: The Archaeology of Tobacco Pipes in Eastern North America*, edited by Sean M. Rafferty and Rob Mann, pp. 165–183. University of Tennessee Press, Knoxville.

Manning, Sturt W., Jennifer Birch, Megan Anne Conger, Michael W. Dee, Carol Griggs, and Carla S. Hadden. 2019. Contact-Era Chronology Building in Iroquoia: Age Estimates for Arendarhonon Sites and Implications for Identifying Champlain's Cahiagué. *American Antiquity* 84(4):684–707.

Manning, Sturt W., Jennifer Birch, Megan A. Conger, Michael W. Dee, Carol Griggs, Carla S. Hadden, Alan G. Hogg, et al. 2018. Radiocarbon Re-Dating of Contact-Era Iroquoian History in Northeastern North America. *Science Advances* 4(12):eaav0280. https://doi.org/10.1126/sciadv.aav0280.

Martelle, Holly A. 2002. Huron Potters and Archaeological Constructs: Researching Ceramic Micro-Stylistics. PhD dissertation, Department of Anthropology, University of Toronto, Toronto.

Mathews, Zena P. 1976. Huron Pipes and Iroquoian Shamanism. *Man in the Northeast* 12:15–31.

McKenzie, Dean P., Patrick Onghena, Robert Hogenraad, Colin Martindale, and Andrew J. Mackinnon. 1999. Detecting Patterns by One-Sample Runs Test: Paradox, Explanation, and a New Omnibus Procedure. *Journal of Experimental Education* 67(2):167–179.

Morisita, Masaaki. 1959. Measuring of Interspecific Association and Similarity between Assemblages. *Memoirs of the Faculty of Science, Kyushu University, Series E (Biology)* 3(1):65–80.

Noble, William C. 1992. Neutral Iroquois Smoking Pipes. In *Proceedings of the 1989 Smoking Pipe Conference: Selected Papers*, edited by Charles F. Hayes III, pp. 41–50. Research Records No. 22. Rochester Museum and Science Center, Rochester, New York.

Nocaj, Arlind, Mark Ortmann, and Ulrik Brandes. 2015. Untangling the Hairballs of Multi-Centered, Small-World Online Social Media Networks. *Journal of Graph Algorithms and Applications* 19(2):595–618.

Peeples, Matthew A. 2018. *Connected Communities: Networks, Identity, and Social Change in the Ancient Cibola World*. University of Arizona Press, Tucson.

Perrelli, Douglas J. 2009. Iroquoian Social Organization in Practice: A Small-Scale Study of Gender Roles and Site Formation in Western New York. In *Iroquoian Archaeology and Analytic Scale*, edited by Laurie E. Miroff and Timothy D. Knapp, pp. 19–50. University of Tennessee Press, Knoxville.

Pretty, Jules, and Hugh Ward. 2001. Social Capital and the Environment. *World Development* 29(2):209–227.

Putnam, Robert D. 2000. *Bowling Alone: The Collapse and Revival of American Community*. Simon & Schuster, New York.

Rafferty, Sean M. 2016. Smoking Pipes of Eastern North America. In *Perspectives on the Archaeology of Pipes, Tobacco and Other Smoke Plants in the Ancient Americas*, edited by Elizabeth A. Bollwerk and Shannon Tushingham, pp. 13–26. Springer International, Cham, Switzerland.

Rafferty, Sean M. and Rob Mann (editors). 2004. *Smoking and Culture: The Archaeology of Tobacco Pipes in Eastern North America*. University of Tennessee Press, Knoxville.

Ramirez-Sanchez, Saudiel, and Evelyn Pinkerton. 2009. The Impact of Resource Scarcity on Bonding and Bridging Social Capital: The Case of Fishers' Information-Sharing Networks in Loreto, BCS, Mexico. *Ecology and Society* 14(1):22. http://www.ecologyandsociety.org/vol14/iss1/art22/, accessed August 8, 2024.

Roscoe, Paul. 2009. Social Signaling and the Organization of Small-Scale Society: The Case of Contact-Era New Guinea. *Journal of Archaeological Method and Theory* 16(2):69–116.

Schiffer, Michael B. 1976. *Behavioral Archeology*. Academic Press, New York.

Smith, David G. 1992. Stylistic Variation in Middleport Smoking Pipes. In *Proceedings of the 1989 Smoking Pipe Conference: Selected Papers*, edited by Charles F. Hayes, III, pp. 15–30. Research Records No. 22. Rochester Museum and Science Center, Rochester, New York.

Smith, David G. 1995. An Analysis of the Pottery and Pipes from Sainte-Marie among the Hurons and the Heron Site. In *Before & Beyond Sainte-Marie: 1987–1990 Excavations at the Sainte-Marie among the Hurons Site Complex (circa 1200–1990)*, edited by Jeanie Tummon and W. Barry Gray, pp. 61–103. Friends of Sainte-Marie, Midland, Ontario; Copetown Press, Dundas, Ontario, Canada.

Snijders, Tom A. B., and Stephen P. Borgatti. 1999. Non-Parametric Standard Errors and Tests for Network Statistics. *Connections* 22(2):161–170.

Thwaites, Reuben G. 1896–1901. *The Jesuit Relations and Allied Documents*. 73 vols. Burrows Brothers, Cleveland, Ohio.

Timmins, Peter A. 1997. *The Calvert Site: An Interpretive Framework for the Early Iroquoian Village*. Mercury Series Archaeological Survey of Canada Paper 156. Canadian Museum of Civilization, Hull, Quebec.

Tooker, Elisabeth. 1964. *An Ethnography of the Huron Indians, 1615–1649*. Bureau of American Ethnology Bulletin 190. Smithsonian Institution, Washington, DC.

Tremblay, Roland. 2006. *The St. Lawrence Iroquoians: Corn People*. Éditions de l'Homme, Pointe-à-Callière, Montreal, Canada.

Trigger, Bruce G. 1976. *The Children of Aataentsic: A History of the Huron People to 1660*. McGill–Queen's University Press, Montreal.

Van Oyen, Astrid. 2016. Historicising Material Agency: From Relations to Relational Constellations. *Journal of Archaeological Method and Theory* 23(1):354–378.

von Gernet, Alexander D. 1992. Hallucinogens and the Origins of the Iroquoian Pipe/Tobacco/Smoking Complex. In *Proceedings of the 1989 Smoking Pipe Conference: Selected Papers*, edited by Charles F. Hayes III, pp. 171–185. Research Records No. 22. Rochester Museum and Science Center, Rochester, New York.

von Gernet, Alexander D. 1995. Nicotian Dreams: The Prehistory and Early History of Tobacco in Eastern North America. In *Consuming Habits: Global and Historical Perspectives on How Cultures Define Drugs*, edited by Jordan Goodman, Paul E. Lovejoy and Andrew Sherratt, pp. 65–85. Routledge, London.

von Gernet, Alexander D., and Peter A. Timmins. 1987. Pipes and Parakeets: Constructing Meaning in an Early Iroquoian Context. In *Archaeology as Long-Term History*, edited by Ian Hodder, pp. 31–41. Cambridge University Press, Cambridge.

Watts, Christopher. 2020. The Embodied Performance and Affective Presence of Iroquoian Animal Effigy Pipes. *World Archaeology* 52(3):429–448.

Wenger, Étienne. 2008. *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press, Cambridge.

Williamson, Ronald F. 2007. "Otinontsiskiaj ondaon" ("The House of Cut-Off Heads"): The History and Archaeology of Northern Iroquoian Trophy Taking. In *The Taking and Displaying of Human Body Parts as Trophies by Amerindians*, edited by Richard J. Chacon and David H. Dye, pp. 190–221. Springer, New York.

Williamson, Ronald F. 2014. The Archaeological History of the Wendat to AD 1651: An Overview. *Ontario Archaeology* 94:3–63.

Williamson, Ronald F. 2023. Introduction. In *The History and Archaeology of the Iroquois Du Nord*, edited by Robert von Bitter and Ronald F. Williamson, pp. 1–29. Canadian Museum of History, Gatineau, Quebec; University of Ottawa Press, Ottawa, Ontario.

Williamson, Ronald F., and David A. Robertson. 1994. Peer Polities beyond the Periphery: Early and Middle Iroquoian Regional Interaction. *Ontario Archaeology* 58:27–48.

Winter, Joseph C. 2000. Introduction to the North American Tobacco Species. In *Tobacco Use by Native North Americans: Sacred Smoke and Silent Killer*, edited by Joseph C. Winter, pp. 3–8. University of Oklahoma Press, Norman.

Wolda, Henk. 1981. Similarity Indices, Sample Size and Diversity. *Oecologia* 50(3):296–302.

Wonderley, Anthony. 2005. Effigy Pipes, Diplomacy, and Myth: Exploring Interaction between St. Lawrence Iroquoians and Eastern Iroquois in New York State. *American Antiquity* 70(2):211–240.

Wonderley, Anthony, and Martha L. Sempowski. 2019. *Origins of the Iroquois League: Narratives, Symbols, and Archaeology*. Syracuse University Press, Syracuse, New York.

Woolfrey, Sandra, Prince Chitwood, and Norman E. Wagner. 1976. Who Made the Pipes? A Study of Decorative Motifs on Middleport Pipe and Pottery Collections. *Ontario Archaeology* 27:3–12.

Wrong, George M. (editor). 1939. *The Long Journey to the Country of the Hurons by Father Gabriel Sagard*. Translated by H. H. Langton. Champlain Society, Toronto.