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Weaning among Colonists from Montreal and Environs: What Can Nitrogen Isotope Analysis on Dentine Tell Us?

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ABSTRACT This paleochemical study explores the differences and similarities in weaning practices between two colonist populations buried in Montreal and its environs: the rural village cemetery of Pointe-aux-Trembles (PT, 1709–1843) and the urban Notre-Dame cemetery (ND, 1691–1796). Forty-six teeth (or individuals) were microsampled in both crown and root parts of the dentine (one to four and four to six sampling sites for deciduous and permanent teeth, respectively), totaling 56 microsamples for PT (seven M1, seven m1, and three m2) and 102 for ND (22 M1 and seven m1). For both sites, a general decrease of 1.3‰ in $\delta^{15}N$ (ranging from 0.5‰ to 2.6‰) was observed between the first and last samples for permanent teeth (PT: five out of seven individuals; ND: 14 out of 22), and weaning seems to end around 2 years of age. As expected, in both parishes, weaning was mainly gradual (80%: PT; 86%: ND). An introduction of complementary food was also identified after 6 months of age (73%: PT; 81%: ND). The variation in $\delta^{15}N$ profiles suggested other scenarios such as introduction of complementary foods just after birth (four PT and four ND), absence of breastfeeding (three PT and nine ND), and abrupt weaning (three ND). Environmental and socioeconomic factors might explain these individual variations, as infant feeding practices might have changed over time in these two growing and closely related parishes.

Keywords: weaning; nitrogen; Montreal

Cette étude paléochimique explore les différences et les similitudes dans les pratiques de sevrage entre deux populations de colons enterrées à Montréal et ses environs: le cimetière rural du village de Pointe-aux-Trembles (PT, 1709–1843) et le cimetière urbain de Notre-Dame (ND, 1691–1796). Quarante-six dents (ou individus) ont été micro-échantillonnées dans la dentine de la couronne et des racines (1 à 4 et 4 à 6 sites d'échantillonnage pour les dents de lait et les dents permanentes respectivement), totalisant 56 micro-échantillons pour PT (7 M1, 7 m1 et 3 m2) et 102 pour ND (22 M1 et 7 m1). Pour les deux sites, une diminution du d ^{15}N d'une moyenne de 1,3‰ (allant de 0,5 à 2,6‰) a été observé entre le premier et le dernier micro-échantillon pour les dents permanentes (PT: 5 sur 7 individus; ND: 14 sur 22), et le sevrage semble se terminer vers l'âge de deux ans. Comme attendu, dans les deux paroisses, le sevrage a été principalement progressif (80%: PT; 86%: ND). Une introduction d'aliments complémentaires a également été identifiée après l'âge de six mois (73%: PT; 81%: ND). La variation des profils des valeurs de $\delta^{15}N$ permet également de suggérer d'autres scénarios tels que: l'introduction d'aliments complémentaires juste après la naissance (4 PT et 4 ND), l'absence d'allaitement (3 PT et 9 ND) et un sevrage abrupt (3 ND). Des facteurs environnementaux et socio-économiques pourraient expliquer ces

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variations individuelles, car les pratiques d'alimentation des nourrissons pourraient avoir changé au fil du temps dans ces deux paroisses en pleine croissance et étroitement liées.

Mots-clés: sevrage; azote; Montréal

Recently, weaning has become a crucial bioarchaeological theme that pertains to children's upbringing, their impact on demography, birth intervals (see Schurr 1998; Schurr and Powell 2005; Waters-Rist et al. 2011), and sociocultural factors that can affect child mortality (see Katzenberg et al. 1993; Katzenberg and Pfeiffer 1995; Lewis 2007). Here, weaning is considered a gradual and complex process. At birth, the newborn is mainly fed with breast milk as it contains all the nutrients and the immunity protection required for the infant. Then, the introduction of complementary food is necessary as breast milk is no longer sufficient for the newborn. Studies show that by 6 months of age, breast milk should no longer be the only source of proteins (Fildes 1995; Humphrey 2014). However, the introduction of potential contaminated food could be detrimental for the health of the child (Fildes 1995; Goodman and Armelagos 1989). The first introduction of complementary food characterizes the beginning of the weaning. The relative decrease in the frequency of breastfeeding, as well as the concomitant increase in complementary food consumption, corresponds to the whole weaning process, while the end of weaning is marked by the complete interruption of breast milk (Dettwyler and Fishman 1992; Katzenberg et al. 1996; Humphrey 2010).

Both stable carbon and nitrogen analysis have proven to be powerful tools in bioarchaeology when exploring breastfeeding and weaning (e.g., Beaumont et al. 2015; Dupras et al. 2001; Tsutaya and Yoneda 2015, among others). The latter directly reflect the cultural practices of a society. According to both historical and demographic data (Amorevieta-Gentil 2010; Gauvreau 1987; Gadoury 1991; Lemieux 1985; Robert 2012), weaning practices were strongly correlated with the environment (e.g., seasons). However, the decision to wean a child also depends on other biological factors such as the health of the child and its nutritional status (Fildes 1995), cultural factors such as female workload (Sellen and Smay 2001), or the recommendation at the time from doctors (Fildes 1987). Since bioarchaeological data on these practices in northeastern America are scarce for the seventeenth to the nineteenth centuries, the present study would be the first one to compare weaning in an urban setting versus a rural one. Although historical and demographic data are available on this topic, no isotope analysis in Quebec has used these data so far. Therefore, stable nitrogen isotopic data have been collected on both deciduous and permanent teeth in order to reveal infants' weaning histories through their first few years of life. Then, these paleodietary "profiles" have been examined in the light of the historical context to see whether isotopic and historic data corroborate each other.

Weaning Reconstruction Using Dentine Stable Nitrogen Isotope Analysis

Fogel and colleagues (1989) were the first to use nitrogen stable isotopes to study breastfeeding and weaning. They relied on the fact that the tissues of the breastfed child were further enriched in ^{15}N (2–3‰) in comparison to those of the mother. Different categories or scenarios can be used to describe weaning patterns in archaeological populations. In a typical one, a breastfed child should have elevated $\delta^{15}N$ values compared to the mother. When complementary foods are introduced while continuing the breastfeeding, the child's $\delta^{15}N$ values should decrease to postweaning values when breast milk is no longer part of the diet (i.e., the mother's $\delta^{15}N$ values assuming the diet is the same). This trophic shift of 2‰ to 3‰ corresponds to the classic weaning curve, but a shift of less than one trophic level can also occur, meaning that supplementary food from a higher trophic level than in the mother's diet was used in the diet of the child (King et al. 2018a). If the weaning is gradual, the $\delta^{15}N$ decrease should happen over several months. A gradual decrease in $\delta^{15}N$ before 6 months of age implies an early beginning of weaning with an introduction of complementary foods along with breast milk, although in utero stress might lead to similar changes in terms of the nitrogen isotopic ratios (King et al. 2018a). An abrupt decrease in $\delta^{15}N$ in the first months of life suggests either an absence of breastfeeding with a change in the child's diet compared to the mother's or an abrupt early weaning with an introduction of complementary foods while breast milk is no longer part of the diet (King et al. 2018a).

One of the available methods to study weaning in archaeology consists of sectioning the tooth in different parts (from root to crown) and $\delta^{15}N$ is measured for each of the microsamples. Because teeth grow from crown to root, this method allows a better understanding of the weaning process(es), as it can provide a detailed paleodietary biography and reflects more precisely the development of dentine (Eerkens et al. 2011; King et al. 2018b; Pfeiffer et al. 2017; Scharlotta et al. 2018). The first permanent molar (M1) is the best tooth for this type of study as its dentine enamel junction begins to form at birth. The crown is completed at circa 2.5 to 3 years with the appearance of a junction between the enamel and the cement (CEJ). Finally, the root apex closes at around 9 to 10 years of age (AlQahtani et al. 2010). By microsampling the M1, it is possible to study the weaning process from birth to childhood (Eerkens et al. 2011). The formation of the first deciduous molar (m1) reflects an even earlier period in the child's development. Its dentine starts to form before birth and its crown is completed at circa 7.5 months. The root is completed at circa 2 or 2.5 years of age. The second deciduous molar (m2) closely follows the development of m1, as its root formation is completed at circa 3.5 years of age (AlQahtani et al. 2010). There is very little variation in the developmental timing between right or left sides, location (superior or inferior), and sex (girl or boy) for the same tooth type (Hillson 2005). In short, dental microsampling is an ideal and versatile approach to explore weaning. In the case of fragmentary collections, as it is the case for some of the populations under study here, dental microsampling allows the analysis of multiple time points without the need to use multiple tissues or multiple teeth.

Breastfeeding and Weaning Between the Seventeenth and Nineteenth Centuries in Northeastern America

A few historical and demographic studies have provided considerable information concerning living conditions in the Province of Quebec, especially those of children—how they were breastfed, weaned, and why they died (Amorevieta-Gentil 2010; Grenier 1871; Thornton and Olson 1991). A few bioarchaeological studies have been completed on weaning within Quebec (Desrosiers et al. 2010; Morland 2010; Morland and Ribot 2009, 2010). They are from two historic cemeteries: St-Matthew and Notre-Dame. In a broad paleodietary perspective, Morland (2010) analyzed the population of the nineteenth-century Protestant cemetery of St-Matthew (Quebec City) and provided preliminary results on weaning. Stable isotopic analyses of carbon and nitrogen on rib samples revealed that δ^{15}N values were relatively high before 2 years of age but dropped significantly between 2 and 5 years of age. As peak values were identified around the age of 1, it was suggested that babies were breastfed until this time and started to be weaned progressively afterward. For Montreal's eighteenth-century Catholic Notre-Dame cemetery, Desrosiers and colleagues (2010) obtained bone δ^{15}N values that were very similar to those obtained by Morland (2010), although slightly lower. Dental wear patterns on deciduous teeth also suggested that weaning started around 1.5 years of age (Arkéos 2008). Since these two studies above, no further work has been done on this subject.

Analyzing both bone δ^{13}C and δ^{15}N among Anglicans from Ontario (cemetery used from 1824 to 1879), Katzenberg and Pfeiffer (1995) determined the beginning of weaning before 1 year of age. According to a second study (Herring et al. 1998) from a nineteenth-century Ontario rural population, an increase in child mortality through osteological analysis was observed between 5 and 6 months of age. The authors suggested that the complementary food introduced in the child's diet was probably contaminated, thus resulting in increased mortality. By using stable nitrogen isotopes analysis of bone, the authors concluded that the difference in δ^{15}N of adults and infants decreased at around 1 year of age, indicating that weaning had already begun (Herring et al. 1998). In short, despite these regional and temporal variations, the populations analyzed from both Quebec and Ontario followed the usual pattern of weaning as a gradual process and mothers provided some supplementary food before weaning was completed. However, it is important to remember that isotope analysis on bone collagen only allow explorations of variation in weaning patterns at the group level, in contrast to tooth microsampling that provides data on a finer scale about each individual.

Child Feeding Practices in Montreal, Quebec

At the end of the nineteenth century, in northeastern America and especially in Montreal, infant mortality was extremely high (26%) compared to other large Canadian cities or even Britain (16%) or France (15%) (Tétreault 1983:513; Thornton and Olson 1991). Infant mortality often peaked during summer, with the highest risk of contaminated water or diarrhea as the result of the early introduction of complementary food(s) (Thornton et al. 1988). In Montreal, between 1839 and 1855, three quarters of children died from digestive disorders or diarrhea (Grenier 1871). Grenier (1871), a doctor practicing in Montreal, described common errors made by parents during the child's first months. For example, it was quite rare that mothers exclusively breastfed. Being concerned that their breast milk was not sufficiently nutritious, they often gave the child complementary food, such as starch. However, as the newborn digestive tract was not ready to receive this food, diarrhea, fatigue, and constant crying probably occurred. According to him, parents thought that these were signs of hunger and weakness and continued to give additional complementary food, even alcohol or narcotics, which made matters even worse and often led to the child's death.

Wet nursing, a practice brought across the Atlantic by the colonists, has been observed in Quebec by both demographers and historians (Gauvreau 1987; Robert 2012). For example, according to Robert's (2012) demographic study, who mainly used the RPQA (Registre de la population du Québec ancien) created by the PRDH (Programme de recherche en démographie historique), there was a moderate presence of wet nursing in and around Montreal during the French Regime. Traces of this phenomenon were detected through various archives (e.g., parish, notarial, and judicial records) that mentioned infants who died at wet nurses' homes. Gauvreau's historic study (1987) also reported that children in Quebec were regularly sent to wet nurses living in the countryside, as the air quality was better than in the city, and that the rural parish of Pointe-aux-Trembles was often chosen for Montreal's children. In fact, although the practice of wet nursing was usually reserved for certain professionals (such as the military or merchants), Robert's (2012) study indicates that 62 foster children were sent to Pointe-aux-Trembles between 1754 and 1806 for wet nursing. Thornton and Olson (1991) also noted that a high number of upper-class mothers did not breastfeed. This reinforces the notion that certain urban mothers gave their child(ren) up to a wet nurse in the countryside, although the numbers suggested by Robert (2012) could be underestimated as the archives did not always mention the presence of a wet nurse.

Weaning age depended largely on the recommendations of physicians of the time, as well as cultural differences. For wet-nursed children, the weaning age was particularly dependent on the parents' financial resources. Doctors recommended weaning during the fall or the spring in order to avoid the winter cold or the summer heat (Fildes 1987). The emergence of baby teeth in the first few months after birth was considered a key phase as it meant the child could eat more solid food, like flour, animal milk, or bread crumbs soaked in water (Lemieux 1985). However, even if breast milk was still the main source of protein, the introduction of other foods such as meat broth was recommended by some physicians before the gradual appearance of the first deciduous incisors (Fildes 1995). In Quebec, it is reported that weaning started between 6 and 14 months in the countryside (Amorevieta-Gentil 2010) and was completed by 5 years of age (Amorevieta-Gentil 2010; Fildes 1987; Henripin 1954).

As discussed above, weaning patterns reflect numerous social and environmental aspects of a society. For example, a change in weaning habits can lead to a shortened birth interval followed by a demographic boom, as well as food shortages can encourage an extended period of breastfeeding. Between the seventeenth and nineteenth centuries, several key events shaped Montreal's colonial population, notably, a demographic boom and numerous epidemics linked to poverty and food shortages (Amorevieta-Gentil 2010). Therefore, the present study focuses on weaning, a research aspect poorly explored so far.

The research questions are twofold:

1) What is the paleodietary history for children who lived and died in colonial Montreal and its environs? To provide data on breastfeeding and weaning, nitrogen stable isotope composition was measured in dentine of both deciduous and permanent teeth. Therefore, age of weaning can be compared between two localities, reflecting a different environment (urban versus rural) and between individuals (those who survived or did not survive, represented respectively by the permanent teeth and deciduous ones).
2) How do these isotopic records compare with historical data? This study also aims to compare isotopic geochemical data with historic/demographic data, to glean a better understanding of the weaning process in seventeenth-nineteenth century Montreal. Knowing that historical records already suggested differences in infant feeding practices (breastfeeding or not) between different social classes and environments (Amorevieta-Gentil 2010; Fildes 1987; Lemieux 1985), an exploration of the possible differences in weaning age between the Pointe-aux-Trembles (rural, 1709–1843) and Notre-Dame (urban, 1691–1796) populations is of great interest.

Materials and Methods

Materials

The skeletal material under study consists of colonist population samples originating from two Catholic graveyards: the rural cemetery of Pointe-aux-Trembles and the urban cemetery of Notre-Dame (Fig. 1). Located on the eastern end of the island, on the shore of the St. Lawrence River and around 20 km from the fortified city of Ville-Marie (Montreal), Pointe-aux-Trembles was a small fortified village. Initially, for agricultural use, it diversified its activities when a main road, the "Chemin du Roy," was constructed in 1734 (Desjardins 2010). This road passed directly through the village that linked Ville-Marie to Quebec City. In 2012, Ethnoscop (2016) excavated 63 unmarked graves from the village cemetery that was used between

Figure 1. Map of Montreal showing the two archaeological sites (modified from Archives Montreal, 1744, BM5-C-26-050).

1709 and 1843. Some of the burials appeared to be rather close to each other (Ethnoscop 2016), but it was not possible to verify if they corresponded to some kind of family cluster. No isotopic analysis has been carried out on this collection so far.

The parish cemetery of Notre-Dame was in use from 1691 to 1796 and represented the first and largest cemetery linked to a Catholic church in Montreal (Arkéos 2008). Archaeological excavations in 2003 and 2004 uncovered more than 125 well-preserved human skeletons, all in unmarked graves, as well as numerous scattered bones, increasing the total number of individuals to 193. More than 40% corresponded to immature individuals (Arkéos 2008). Fewer than half of the individuals sampled (14 out of the 29) were found in the most recent and southern part of the cemetery (the most distant from church), while the others were located just next to the church. No particular spatial organization was noted during the excavation and no family clusters have been identified so far. To date, various bioarchaeological studies have been carried out on the Notre-Dame's cemetery human remains (Arkéos 2008; B-Hardy 2015; B-Hardy et al. in press; Crépin 2018; Desrosiers et al. 2010; Vigeant 2013; Vigeant et al. 2017). Concerning the paleochemical work, Vigeant (2013) and Vigeant and colleagues (2017) addressed diet and mobility of adult individuals only.

For this study, a sample of 46 molars from 46 different individuals were selected from the two sites (Pointe-aux-Trembles [PT], $n = 17$; Notre-Dame [ND], $n = 29$; Table 1). The crowns of the selected molars had to be well preserved with no excessive dental wear and caries. More specifically, the sample consisted of 29 permanent first molars (M1) from adults and adolescents, 14 deciduous first molars (m1), and three deciduous second molars (m2) from children.

For ND, the age and sex data were taken from previously collated osteological inventories (Arkéos 2008; Vigeant 2013; Vigeant et al. 2017), whereas the PT inventory was created during this study and reported in Gutierrez (2019) following standard methods (Bruzek 2002; Hartnett 2010; Murail et al. 2005; Schmitt 2005). Previous isotopic work on ND's children used samples that are different from the present study, except for two subadults from the study of Desrosiers and colleagues (2010).

Methods

The method used for this research had to be adapted due to the absence of demineralization of the tooth

Table 1. Number of Individuals (or Teeth) Selected for the Study and Number of Dentine Samples (by Site, Age Group, and Tooth Type).

	Pointe-aux-Trembles				Notre-Dame			
	Deciduous		Permanent		Deciduous		Permanent	
Age Group (in years)	Teeth	Samples	Teeth	Samples	Teeth	Samples	Teeth	Samples
0–1	2	3			1	1		
1–8	8	20			6	10		
8–12							3	13
12–18							7	31
18–40			7	33			11	43
>40							1	4
Total	**10**	**23**	**7**	**33**	**7**	**11**	**22**	**91**

from different protocols established by Fuller and colleagues (2003) and Eerkens and colleagues (2011). First, each tooth was cast in an epoxy resin brand Epofix. Then, using a low-speed diamond disc saw, it was cut longitudinally (bucco-lingually) into two halves. One half was set aside for future research. The dentine was initially harvested as close as possible to the enamel at the tip of the cusp using a low-speed rotary tool fitted with a 1-mm diamond tip. Subsequently, the samples were drilled close to each other, following the chronological development of the tooth, moving apically. The last samples were harvested, if possible, after the CEJ in the root of the tooth. Samples were preferably taken from the same side of the tooth but, when necessary, from both edges of the pulp cavity (Fig. 2).

Depending on the tooth size, the number of samples was reduced, especially for deciduous teeth where dentine was present in small quantities. A series of samples (one to four) were taken from 17 deciduous teeth totaling 34 samples. Between three and six samples were taken from 29 permanent teeth for a total of 124 samples (Table 1). To avoid contamination issues, the diamond tip of the rotary tool was cleaned between each sampling procedure with methanol.

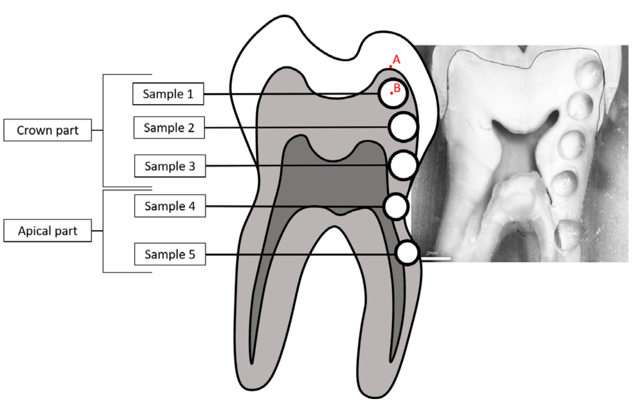

Figure 2. Internal views of molar halves showing the different samples from the dentine in relation to both crown and root. Left: schematic drawing adapted from Mays et al. (2017). Right: photograph of first permanent molar from 12Z-S1 taken with a DSX-100 microscope. The reference points used for the age determination of the sample are represented by the small lettered dots: the highest point of the dentinal cusp (A) and the midpoint of a sample as an example (B).

As there is a debate around the effect of demineralization on δ^{15}N values (Jacob et al. 2005; Schlacher and Connolly 2014), it is quite common in biological studies not to demineralize the dentine for nitrogen analyses (see Borrell et al. 2013; Fahy et al. 2014; Hobson et al. 2004; Martin et al. 2011). This is because it is not necessary to remove the inorganic part of the tooth because the vast majority of nitrogen in dentine is found in the collagen (i.e., the organic part). Borrell and colleagues (2013) and Martin and colleagues (2011) performed different tests on demineralized and non-demineralized dentine of various species. These studies observed that the δ^{15}N values were similar between the two groups (Borrell et al. 2013; Martin et al. 2011). Recently, Guiry and colleagues (2016) also tested on pig tusks the difference between demineralized and not demineralized dentine microsamples. They concluded that "treated and untreated dentine samples ($n = 18$) taken at the same location produced comparable δ^{15}N values for all samples" (Guiry et al. 2016:24), and therefore, they recommended not to use an acid pretreatment when only nitrogen analyses are performed. Although animals used in biology are slightly different from humans in archaeological studies, another research study by Vigeant and colleagues (2021) tested different percentages of hydrochloric acid (HCl) as well as the absence of demineralization on archaeological human bone. They demonstrated that unacidified samples produced similar δ^{15}N results to samples demineralized with 1% HCl and that samples demineralized with concentrations of HCl larger than 1% produced higher δ^{15}N values. Thus, on the basis of these various studies (using modern and archaeological materials), the absence of demineralization has been decided for this protocol. As carbon in non-demineralized dentine can originate from both the inorganic and organic parts, we did not analyze the carbon isotope in the dentine. This also prevented us from calculating the atomic ratio of carbon to nitrogen (C:N) and the weight percentage of carbon (%C) as quality indicators as recommended by Van Klinken (1999). Instead, we only used the weight percentage of nitrogen (%N; >0.4% for moderately well-preserved samples) to assess the preservation (Brock et al. 2012:Table 1; Guiry et al. 2016; Stafford et al. 1988).

For each sample, the powder produced by drilling was recovered and weighed between 0.6 and 1.0 mg in tin cups and analyzed using an Isoprime 100 continuous-flow mass spectrometer coupled with an Elementar Vario MicroCube elemental analyzer at the stable isotope laboratory of the Geotop Research Centre (Université du Québec à Montréal). Raw data were calibrated using three in-house reference materials (leucine, urea, and DORM-2) that are normalized to IAEA-N1, N-2, and N-3 with an analytical uncertainty of ±0.3‰. All results are expressed in the δ notation and reported in ‰ versus AIR, where $\delta^{15}N = (^{15}N/^{14}N_{sample} / ^{15}N/^{14}N_{standard} - 1)$ (Brand et al. 2014).

As dental growth is relatively stable across populations and is hardly affected by external factors, it is possible to determine an average age for each sample (Beaumont and Montgomery 2015; Greenwald et al. 2016). The age estimation of each sample assumes that dentine develops at a steady rate throughout the formation of the tooth. Moreover, tooth length shows a linear relationship with age (Beaumont et al. 2015; Liversidge and Molleson 1999). Thus, if it is possible to predict the age of an individual based on the tooth length with linear (Liversidge and Molleson 1999) or exponential (Olivares et al. 2014) equations, we are then able to attribute an age for each sample. Using an electronic caliper, a measurement of the distance between the tip of the dentinal crown (point A) and the different samples (midpoint; point B as an example) was taken for each tooth (Fig. 2). The regression formula by Liversidge and colleagues (1999) was applied for the permanent teeth, and the exponential-type equations by Olivares and colleagues (2014) were used for the deciduous teeth.

In order to maximize the sample size per age group, each sample was grouped into five different broad age groups. They were of varying duration for the first 7 years of life:

i) 0 to 6 months ($n = 43$ samples);
ii) 6 to 12 months (~1 year; $n = 22$ samples);
iii) 12 to 24 months (1–2 years; $n = 31$ samples);
iv) 24 to 60 months (2–5 years; $n = 49$ samples); and
v) 60 to 84 months (5–7 years; $n = 13$ samples).

The last life phase was added as a postweaning phase.

Results

The $\delta^{15}N$ results (158 microsamples from 46 individuals) are shown in Tables S1 and S2 for permanent and deciduous teeth, respectively. Except for one sample of a tooth (11G-S1-1), all dentine samples provided acceptable quality collagen (Brock et al. 2012; Guiry et al. 2016; Stafford et al. 1988:Table 1). To explore weaning patterns, results are presented in three major sections. The first section shows the $\delta^{15}N$ variation through different life phases by combining the deciduous and permanent teeth. The two other sections present the deciduous and the permanent teeth separately, and results are compared between the two sites.

Variation of $\delta^{15}N$ through the life phases for both parishes

Individuals analyzed in this study exhibit varied $\delta^{15}N$ profiles. In 66% of the permanent teeth sample (or 19 out of 29 individuals; PT: five out of seven; ND: 14 out of 22), the $\delta^{15}N$ profile of the individuals studied showed the expected pattern of decreasing $\delta^{15}N$ through the ages (from 0.5‰ to 2.6‰ and an average of 1.3‰). Ten individuals (PT, $n = 2$; ND, $n = 8$) had atypical permanent teeth $\delta^{15}N$ values: they had no sign of $\delta^{15}N$ decrease; instead, eight of them showed an increase and two of them showed a plateau from birth to the last sample (60- to 84-month phase) (see Table S1). Their variation suggests that there was no sign of breastfeeding. Therefore, the present results will focus on the remaining 36 individuals (PT, $n = 15$; ND, $n = 21$). Deciduous teeth, corresponding in general to an earlier age, albeit coming from children who did not survive childhood, provided higher mean values (12.3‰ ± 1.4‰) than permanent teeth (10.6‰ ± 1.3‰).

By combining the deciduous and the permanent teeth in Figure 3, a general decrease was observed between each of the phases. Zero- to 6-month phase showed the highest $\delta^{15}N$ values (12.0‰ ± 1.6‰) compared to the 60- to 84-month phase (10.1‰ ± 1.0‰). The largest gap between two consecutive phases was between 0 to 6 months and 6 to 12 months with a difference of 0.8‰. Using either the mean or the median, the oldest life phase (60–84 months) still has the lowest $\delta^{15}N$ values. Both the 6 to 12 month and 12- to 24-month phases have close means and medians with no visible change in $\delta^{15}N$ values. After the 12- to 24-month phase, the $\delta^{15}N$ values decrease.

Variation in the deciduous teeth for both parishes

Figure 4 presents for both sites (PT in A and ND in B) the deciduous $\delta^{15}N_{dentine}$ values that reflect the variation

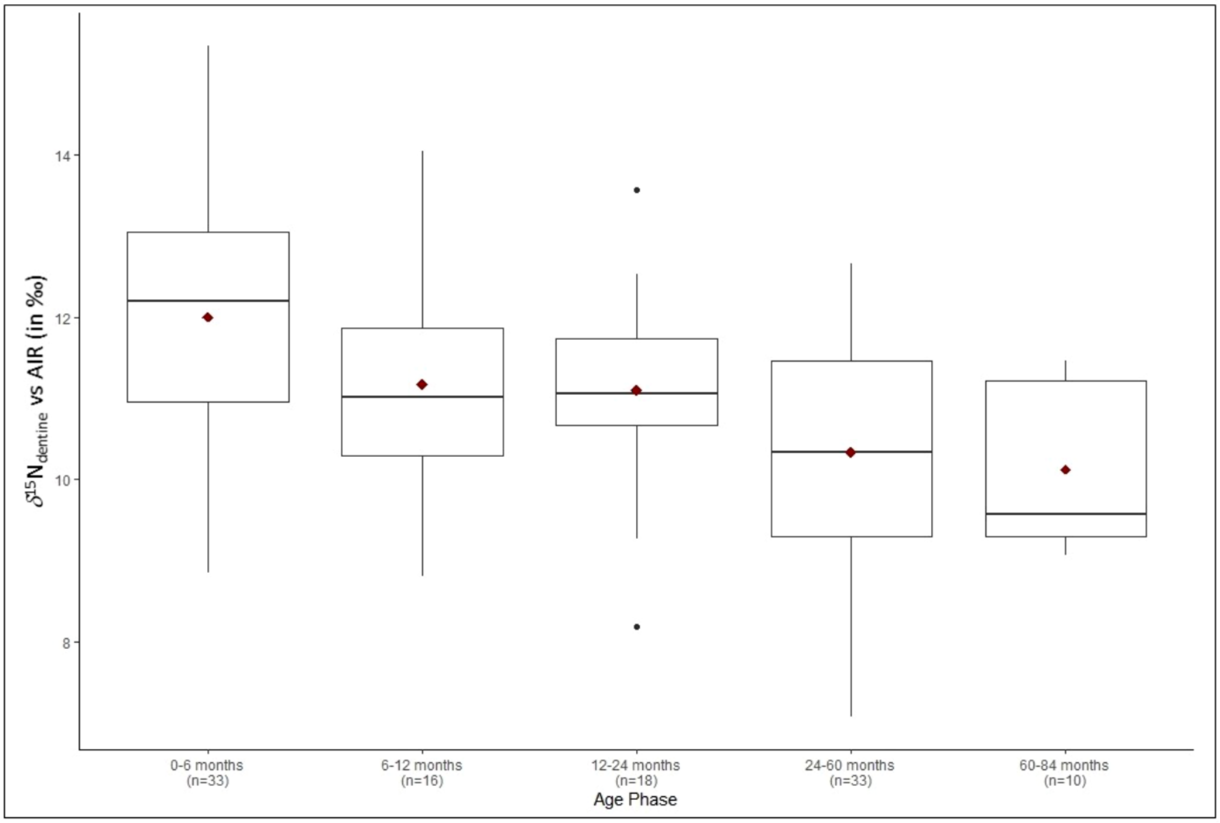

Figure 3. Boxplots showing the distribution of $\delta^{15}N_{dentine}$ values for both permanent and deciduous teeth throughout five life phases for the whole sample ($N = 36$ individuals or 110 microsamples). The diamonds show the mean values for each life phase, and the vertical lines through the boxes represent the median.

from the fetal phase to 1 year of age. It is, however, important to underline that the majority of deciduous teeth have only two data points to describe trends, thus limiting their interpretations. That said, for the deciduous teeth, 53% of the sample or nine individuals (PT, $n = 6$; ND, $n = 3$) showed a general decrease of 0.7‰ between the first and the last sampling point with a range of 0.1‰ to 2.6‰. Weaning in both parishes therefore began during the formation of m1, between birth and 3.5 years of age. Four individuals displayed a different pattern and four others had only one $\delta^{15}N$ value available, preventing their interpretation.

An increase of 1.4‰ ± 0.8‰ was observed in three individuals (7A9-S39, 7A2-S22, and 7A2-S3) from PT. For example, 7A2-S22 and 7A2-S3 presented the most abrupt increase of 0.9‰ and 2.3‰, respectively, before 6 months of age, compared to 7A9-S39 with an increase of 1.1‰ between the 0- to 6-month and 6- to 12-month phases. However, the first dentine samples for both 7A2-S22 and 7A2-S3 fall within the fetal phase. Three other individuals (12AA-S5, 7A2-S32, 12W-S13) showed respectively a 0.9‰ (12AA-S5, ND) and 0.4‰ decrease (7A2-S32, PT) between the fetal phase and the first months of life, as well as a plateau (12W-S13, ND) between the fetal phase and birth.

Variation in permanent teeth in both parishes

For both sites under study, Figure 5A,B presents the $\delta^{15}N_{dentine}$ values for the permanent teeth, showing the variation from birth to 7 years of age. In PT's permanent teeth sample, no individual showed the 2‰ depletion in $\delta^{15}N$ expected for a full trophic level shift (i.e., the classic curve), but the expected decrease in $\delta^{15}N$ through the ages is observed. Individual 7A9-C2 displayed a decrease of 1.8‰ between the first and last samples, while 7A9-S9 had a decrease of 1.0‰ between the 0- to 6-month and 6- to 12-month phases. The individual 7A9-S38 is the only one who showed a significant $\delta^{15}N$ increase in the postweaning phase (from 9.2‰ to 11.3‰ during the 60- to 84-month phase).

Concerning ND, three individuals (12BB-S13, 12DD-S5, 12EE-S1) displayed the classic curve with a 2‰ decrease. Three individuals (12D, 12DD-S2, and 11G-S1) presented a decrease of less than 1‰. Individuals 12BB-S13, 12DD-S2(2), and 12Z-S1 showed the same pattern as 7A9-S38 from PT with a late $\delta^{15}N$ increase.

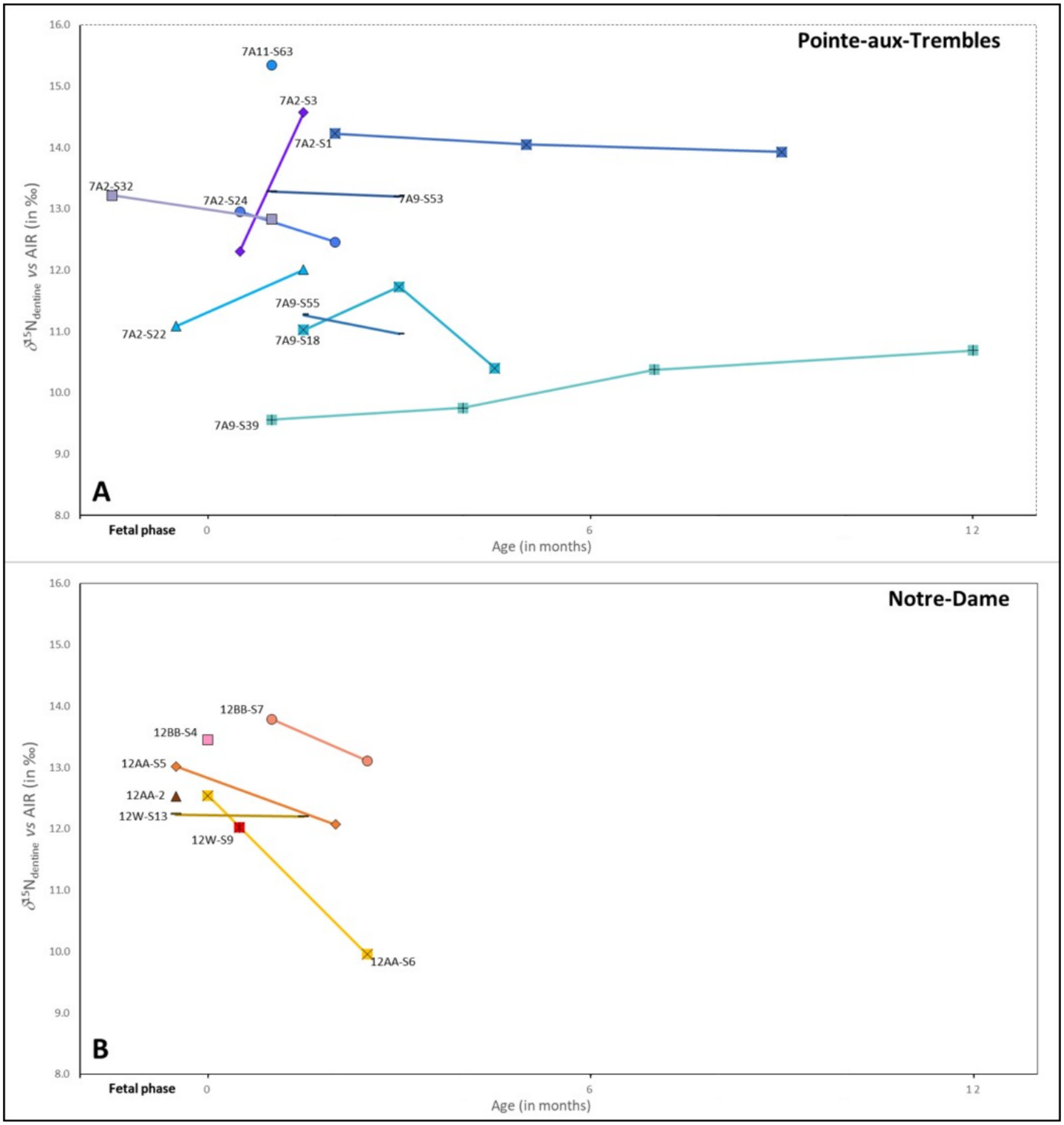

Figure 4. Deciduous $\delta^{15}N_{dentine}$ values from fetal phase to 1 year of age for Pointe-aux-Trembles in A (10 individuals, 23 samples) and Notre-Dame in B (seven individuals, 11 samples). A different line has been used for each individual.

Discussion

As stable isotopic analysis can provide a broad picture about individual diet/life histories, both trends and variations observed in our results are discussed here in the light of known historical and demographic data related to the period and region under study, between the late seventeenth century and early nineteenth century in Montreal. However, issues related to the methodology are first discussed.

A faster sampling method to determine weaning age

Although the incremental method that samples horizontal slices of dentine (e.g., Beaumont and Montgomery 2015; Eerkens et al. 2011; Fuller et al. 2003) is still widely used, it cannot be done without the demineralization of the tooth. The successive drilling proposed here requires no tooth acid treatment, thus simplifying and speeding up the analytical process,

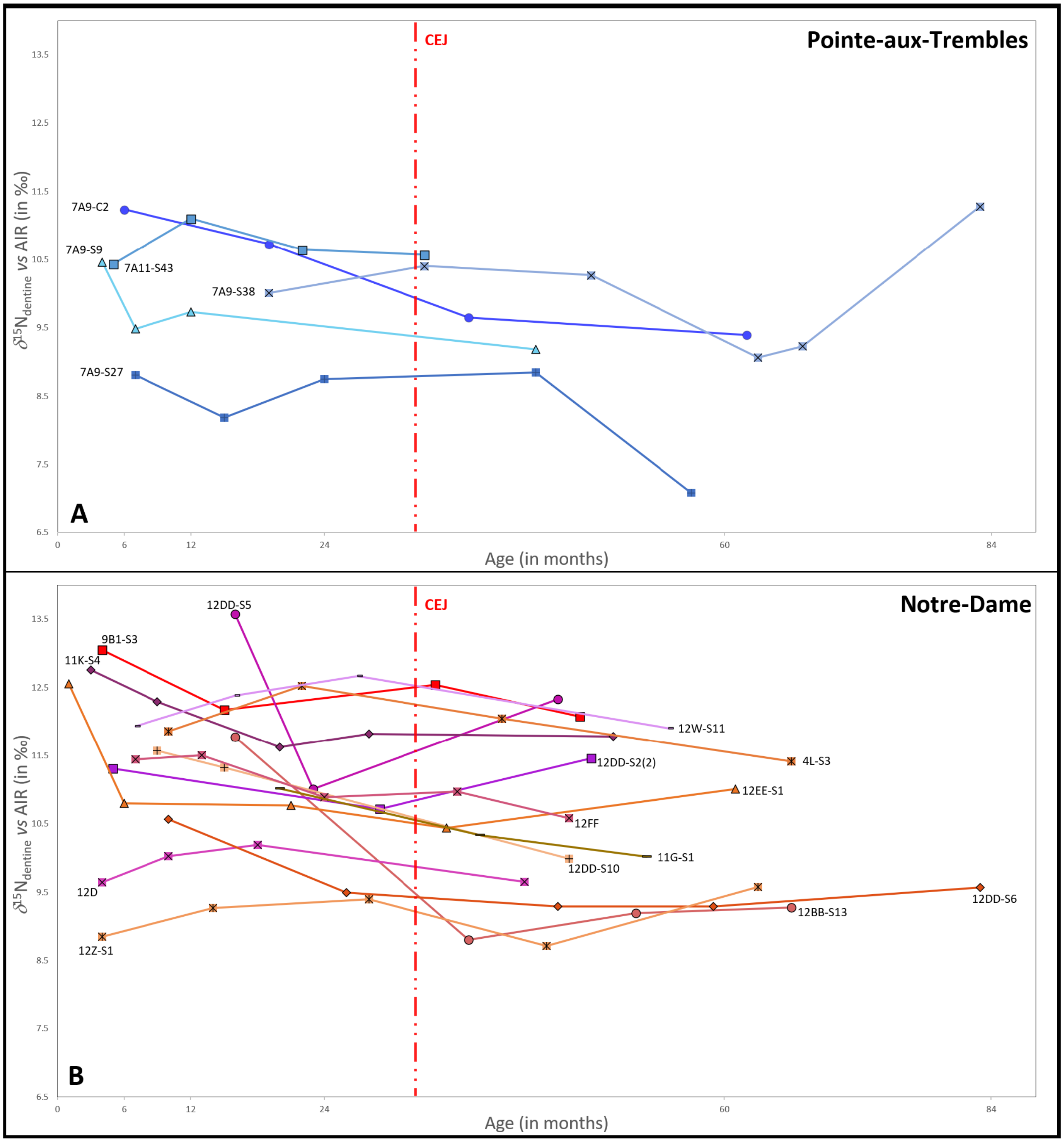

Figure 5. $\delta^{15}N_{dentine}$ values for permanent teeth from birth to 7 years of age for Pointe-aux-Trembles in A (five individuals, 23 samples) and Notre-Dame in B (14 individuals, 57 samples). A different line has been used for each individual.

but other problems occur. First, as demineralization was not done, the carbon in the dentine could not be analyzed because of the presence of inorganic carbon. Therefore, the interpretation of our results remained limited especially in relation to the unusual weaning trajectories. Second, it limits the number of samples per tooth, especially for deciduous teeth that have less dentine because of their small size (in the present study, we did up to five samples in contrast to incremental studies that usually make up to five to 10 sections, as seen in Eerkens and colleagues [2011] or Pfeiffer and others [2017], for example). The age attribution for each of our dentine samples is different from the incremental microsampling method, which is based on a standard growth rate of 4 to 5 µg per day (Scharlotta et al. 2018). Here we used mathematical equations based on dental growth, leading to biases related to intra- and interpopulation variation. However, other studies, using the incremental methodology, also question the reliability of the attribution of specific age categories for each microsample because of the variation of the dentine growth rate (Craig-Atkins et al. 2018; Eerkens et al. 2011; King et al. 2018b; Pfeiffer et al. 2017). Scharlotta and colleagues (2018) compared different methods of age estimation for incremental microsamples, and they concluded that, within the population, there was a significant dental growth variability probably related to various factors (e.g., geographic origin of individuals). Successive drilling and incremental microsampling methodologies need to be compared in future to fully appreciate their differences and similarities, especially when estimating sample age. While microsampling has revolutionized the world of isotopes in bioarchaeology, it is necessary to improve the age attribution of microsampling.

Gradual weaning over time in both parishes

In both parishes, the difference between the crown and the root samples showed that weaning started before the end of the formation of the crown of the M1 (i.e., 33 months or 2.8 years). As expected, a decrease in δ^{15}N was observed, signaling a decrease in breast milk consumption and a corresponding increase in other food sources. Three individuals from ND had a 2‰ (one trophic level) decrease as seen in the classic weaning curve. For others, the use of higher trophic level of complementary food in addition to breast milk is a possibility (King et al. 2018a). Historical data on eighteenth-century Montreal (Grenier 1871) suggested that during weaning, the introduction of meat or meat stock in a child's diet was not recommended within the first few months. However, Dr. Grenier recommended if the quantity of breast milk was insufficient and mothers had no access to a wet nurse, a mixture of cow's milk with some hot water and sugar could be given (Grenier 1871). The combination of the proteins from human breast milk and animal milk should induce a reduced ^{15}N enrichment (Fuller et al. 2006), explaining thus the absence of a classic curve for these individuals.

A general decrease in δ^{15}N in the m1 showed that complementary food was introduced during its formation (before 1 year old), albeit some individuals showed different patterns. In both parishes, breast milk was the main source of protein before 6 months of age. Then, the largest gap in δ^{15}N values is between the 0- to 6-month and the 6- to 12-month phases (Fig. 3). Complementary food was introduced after 6 months of age, which is expected as milk is no longer nutritionally sufficient for the child after this age (Humphrey 2014).

The δ^{15}N values for the 6- to 12-month and the 12- to 24-month phases are quite similar (Fig. 3). Hence, gradual weaning occurred, which is expected as it was recommended by the doctors at the time (Fildes 1987; Morel 1976). Finally, beyond the 12-to 24-month phase, a general decrease in δ^{15}N is observed, which means that breast milk was probably no longer the main source of protein (Fig. 3). The preliminary ND study that was carried out on adults and infants' bones (Desrosiers et al. 2010) agrees with our results. A statistical difference between the individuals over 2 years of age ($n = 22$; mean δ^{15}N = 10.9‰) and those under 2 years of age ($n = 17$; mean δ^{15}N = 11.9‰) was observed. Desrosiers and colleagues (2010) suggested that weaning ended at around 2 to 3 years of age.

Early weaning and/or in utero stress

In both parishes, some individuals had an early introduction of complementary food (i.e., before 6 months of age). In PT, 27% of the whole sample (four out of 15 individuals) showed a decrease in δ^{15}N values during the 0- to 6-month phase, while in ND, only 19% of the whole sample (four out of 21 individuals) showed a significant change before 6 months of age. Parish records show that PT was a key parish where children from Montreal were sent (Amorevieta-Gentil 2010; Robert 2012). When rural mothers had to look after urban children for wet nursing, they probably could not breastfeed their own children at the same time. These rural children could therefore have been weaned earlier with an early introduction of complementary food, and this was for the benefit of the urban children (Morel 1976). The introduction of complementary food before 6 months of age likely introduced stress for the child whose digestive system was not fully formed at this age (Grenier 1871). Two individuals (7A2-S24 and 7A9-S18, who died between 1.3 and 1.5 years of age) from PT displayed *cribra orbitalia* on their skeletons, which could be associated with iron deficiency (Zarifa et al. 2016). For a newborn, iron deficiency can have serious consequences for growth and cognitive development. The iron intake from breast milk is perfectly regulated so that the infant receives the ideal amount for its development, as long as the mother's iron intake is sufficient (Goldberg 2009). Stopping breastfeeding too early does not allow the child to have the necessary amount of nutrients if the postweaning food is inadequate. This explanation of a possible causal relationship between inadequate weaning and *cribra orbitalia* remains hypothetical as 7A9-S55 (age of death: 1.3 years) also showed similar orbital lesions but does not seem to have been weaned early. A δ^{15}N decrease of 0.3‰ before 6 months of age is observed for this child, but this change is within analytical uncertainty and thus cannot be considered. However, other factors than iron deficiency may explain *cribra orbitalia*. For example, Walker and colleagues (2009) have suggested that a lack of vitamin B12 can also lead to anemia and thus to *cribra orbitalia*. During famine, some mothers, with a B12 deficiency in their milk, prolonged breastfeeding due to a shortage in postweaning food, which led to a higher risk of vitamin B12 deficiency for the child (Walker et al. 2009).

Another hypothesis for these two individuals (7A2-S24 and 7A9-S18) is the possibility of in utero stress (King et al. 2018a). We could assume that after birth, in utero stress could have ceased as the infant was no longer intrinsically linked to the mother, leading to a decrease in δ^{15}N values. Given the small number of data points for those individuals, it is quite difficult to precisely identify the causal factor (either a dietary change or a chronic stress). The presence of pathological evidence of, for example, *cribra orbitalia* suggests that this decrease in δ^{15}N values might be stress related. However, the hypothesis of a dietary change cannot also be excluded because of the following facts: the decrease in δ^{15}N values did last for several months, and both 7A2-S24 and 7A9-S18 survived after this decrease (ages at death, respectively: 1–1.3 years and 1.3–1.5 years). A postbirth diet with lower trophic levels would have also resulted in a decrease in the δ^{15}N values for the mother's breast milk and therefore the infant (Beaumont et al. 2015; King et al. 2018a).

Two other individuals from PT (7A2-S32: 1.5–2 years old) and from ND (12AA-S5: 2–2.5 years old) showed a decrease in δ^{15}N that ranged between 0.4‰ and 0.9‰ and that occurred since the fetal phase and the first months of life. This could have been due to the rapid introduction of complementary food in their diet, which was a common practice in the region of Montreal (Grenier 1871); in utero stress; or an absence of breastfeeding due to various reasons (e.g., short birth interval, mother's death). As seen previously, as only two data points are available per individual, all these scenarios, however, remain hypothetical.

Absence of breastfeeding or abrupt weaning

Three individuals from ND (12AA-S6, 12DD-S5, and 12EE-S1) can be distinguished by their abrupt and/or early weaning. The individual 12AA-S6 shows a sudden 2.5‰ decrease during the 0- to 6-month phase. Unlike the majority of the population sample, breastfeeding ended before 1 year of age. It is also possible that this individual was not breastfed at all but had an introduction with lower δ^{15}N food than the mother's food or in utero stress. The individual 12AA-S6 died in Montreal at about 1.5 years of age and had no skeletal pathology. As suggested historically (Gadoury et al. 1985; Grenier 1871), many factors (e.g., epidemics, diarrheal diseases, famine, mother's death) could have provoked a premature death. Early weaning or an absence of breastfeeding is one potential stress that could have abruptly weakened the immune system. For 12EE-S1, we observed a δ^{15}N decrease of 1.8‰ during the 0- to 6-month phase. An absence of breastfeeding, an abrupt weaning, and in utero stress are three possible scenarios as described above, but because of the lack of data points, they remain hypothetical again. On the contrary, the individual 12DD-S5 was probably weaned abruptly but during the 12- to 24-month phase with a δ^{15}N decrease of 2.6‰.

Death during childhood could reflect multiple stressful events. For example, Pavard and colleagues (2005) demonstrated that the absence of breastfeeding led to an increase in infant mortality. Their historical and demographic study was based on the population of the St Lawrence Valley between the seventeenth and eighteenth centuries. Andersson and colleagues (1996) reported similar results in Sweden during the nineteenth century, where motherless infants had the worst survival rate. This hypothesis could explain the unusual individual δ^{15}N variations in the present data set for the deciduous teeth, where two (one from PT and one from ND) out of 17 individuals seem not to have been breastfed at all. Previous studies (Beaumont and Montgomery 2016; Fuller et al. 2005; Hobson et al. 1993; Katzenberg and Lovell 1999) also showed that severe and chronic disease(s) and/or nutritional stress(es) (e.g., famine, deficiencies) could result in a δ^{15}N increase. The 1.1‰ increase between the 0- to 6-month and 6- to 12-month phases for 7A9-S39 from PT (age at death: 3–3.5 years; Fig. 4A) could be an example of such stress. Furthermore, this individual presented signs of growth disruption, such as dental enamel hypoplasia (Goodman and Rose 1991; Roberts and Manchester 2007), which could support this unusual isotopic increase. Additionally, 10 individuals in the permanent teeth sample (PT, $n = 2$; ND, $n = 8$) showed no sign of breastfeeding. Eight of them displayed an increase in δ^{15}N through the ages that might be linked to the nutritional stress of not being breastfed. The two others might not display any nutritional stress in their δ^{15}N values due to adequate food after birth despite the absence of breast milk in their diet.

Late ^{15}N enrichment

Among the individuals analyzed from PT, four individuals (or 80% of the permanent teeth sample) showed a gradual weaning. However, only one female 7A9-S38 (16–22 years old) demonstrated higher δ^{15}N values from 9.2‰ to 11.3‰ during the 60- to 84-month phase. At ND, 12 individuals (or 86% of the permanent teeth sample) showed a gradual weaning. Three of them (12BB-S13, 12DD-S2 (2), and 12Z-S1; age at death:

8–12 years, 18–30 years, and 18–40 years, respectively) displayed a pattern similar to 7A9-S38 from PT and showed a late enrichment in ^{15}N (Fig. 5). For these examples, several explanations are possible. From the 1690s, shortages or threats of famine every 10 years were common (Amorevieta-Gentil 2010; Dechêne 1974). During periods of shortage, physiological stress may affect children, leading to an increase in $\delta^{15}N$ values. In their study of the Irish famine, Beaumont and Montgomery (2016) observed higher $\delta^{15}N$ values during physiological stress (followed by a return to lower $\delta^{15}N$ values after the stress ended). However, the high postweaning rise in $\delta^{15}N$ could also be due to a change in the diet for these individuals with the introduction of higher trophic level food such as fish or meat (Desloges 2009).

Dietary and temporal variations

Individuals analyzed here exhibit very diverse $\delta^{15}N$ profiles. While weaning has been discussed thoroughly, dietary variation cannot be excluded. Unfortunately, as no other $\delta^{15}N$ data are available for PT's collection, we cannot explore diet in detail. However, as $\delta^{15}N$ bone collagen in ND's population previously showed high variation for adults, and therefore potentially for mothers and their breast milk values (range from 9.7‰ to 14.4‰) (Vigeant et al. 2017), our sample might be reflecting similar causes for this high intragroup variation (e.g., family traditions, socioeconomic context). Vigeant and colleagues (2017), who analyzed carbon from collagen and carbonate, already provided some dietary information about ND's population (e.g., diet based primarily on C_3 resources and very secondarily on C_4 resources). Nevertheless, additional isotopic analysis of PT's sample would also allow us to better understand both rural and urban diet and explore variable weaning trajectories. In particular, differences in $\delta^{13}C$ and $\delta^{15}N$ values can sometimes reveal other interacting factors (e.g., supplementary food different from mother's diet, physiological stress events) (Beaumont et al. 2015).

In addition to the environmental difference between the two populations, there is also a temporal one. ND's cemetery was used between the late seventeenth century and the late eighteenth century, whereas PT's cemetery was used between the early eighteenth and nineteenth centuries. Amorevieta-Gentil (2010) noted that the interval between births had shortened over the centuries in the province of Quebec, from 25.8 months for the seventeenth century to 21.8 months for the eighteenth century. As discussed previously, this birth interval difference may be related to changes in breastfeeding practices. However, this hypothesis has not been tested here, and further research on this topic is needed.

Conclusion

This isotopic analysis of 46 individuals from the ND and PT cemeteries allowed us to explore weaning practices between the seventeenth and nineteenth centuries on the island of Montreal. As expected, breast milk is the main source of protein in general for both parishes until 6 months of age. However, certain individuals (27% and 19% of the whole sample for PT and ND, respectively) seemed to have received complementary food before this age and/or had in utero stress. The infants of PT could have received complementary food earlier than the infant in ND due to the employment of PT's mothers as wet nurses, leading to an early weaning of their own children. For the majority of the individuals (80% and 86% of the permanent teeth samples of PT and ND, respectively), weaning was gradual, which was the recommendation at the time and ended around the age of 2. Finally, four individuals (PT = 1, ND = 3) displayed a late ^{15}N enrichment. Shortage of food inducing a physiological stress or a change in their diet could explain this variation. The great diversity of weaning patterns in both parishes could reflect multiple factors as environmental differences between PT and ND. Future research should, however, focus on building a more complete database for the $\delta^{15}N$ values, in order to understand the dietary behavior of the potential mothers from both ND and PT cemeteries. In addition, carbon analysis of the dentine from the same individuals would also complement our data set and provide a better understanding of weaning, especially in relation to the introduction of complementary food items.

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Supplemental Information

TABLE S1. Isotope values for 29 first permanent molars (M1): $\delta^{15}N$ for tooth dentine samples and their corresponding age group. The two sites listed are PT (Pointe-aux-Trembles) and ND (Notre-Dame, Montreal). For each burial code or individual, the age at death and sex estimations are included in the table (M: male; F: female; U: unknown sex), as well as a hypothesis for breastfeeding/weaning patterns (as discussed in the text). For further description about the osteological methods, see the text.

Site Code	Burial Code	Age at Death (in years)	Sex	Samples	Age Group (in months)	$\delta^{15}N$ (in ‰)	%N	Hypotheses about breastfeeding (BF) and weaning (W)
PT	7A2–S7	36–50	M	1	0–6	9.0	2.8	No BF
				2	6–12	9.1	2.6	
				3	12–24	9.5	2.8	
				4	24–60	9.6	2.7	
				5	60–84	9.7	2.7	
PT	7A9–C2	16–22	F	1	6–12	11.2	2.3	Gradual W
				2	12–24	10.7	2.6	
				3	24–60	9.7	1.9	
				4	60–84	9.4	2.2	
PT	7A9–S9	16–22	F	1	0–6	10.5	2.6	Early W
				2	6–12	9.5	2.1	
				3	6–12	9.7	2.0	
				4	24–60	9.2	4.1	
PT	7A9–S13	16–22	F	1	0–6	10.1	3.3	No BF
				2	6–12	10.4	2.2	
				3	12–24	10.3	1.8	
				4	12–24	10.4	1.6	
				5	24–60	10.8	1.2	
PT	7A9–S27	23–35	F	1	6–12	8.8	3.7	Gradual W
				2	12–24	8.2	3.2	
				3	24–60	8.8	3.3	
				4	24–60	8.9	2.3	
				5	24–60	7.1	2.7	
PT	7A9–S38	16–22	F	1	12–24	10.0	3.3	Gradual W and Late ^{15}N enrichment
				2	24–60	10.4	2.7	
				3	24–60	10.3	3.6	
				4	60–84	9.1	2.5	
				5	60–84	9.2	1.8	
				6	60–84	11.3	2.1	
PT	7A11–S43	>30	U	1	0–6	10.4	2.0	Gradual W
				2	12–24	11.1	2.3	
				3	12–24	10.6	2.8	
				4	24–60	10.6	2.6	
ND	4B–S1	25–40	U	1	6–12	9.0	4.9	No BF
				2	12–24	10.2	2.5	
				3	12–24	10.3	2.5	
				4	24–60	11.2	2.8	
ND	9B1–S3	12–18	U	1	0–6	13.1	2.9	Gradual W
				2	12–24	12.2	2.3	
				3	24–60	12.5	4.0	
				4	24–60	12.1	5.9	
ND	12BB–S12	8–12	U	1	24–60	9.7	0.8	No BF
				2	24–60	9.7	2.2	
				3	60–84	10.4	2.2	
ND	12BB–S13	8–12	U	1	12–24	11.8	3.2	Gradual W and Late ^{15}N enrichment
				2	24–60	8.8	3.7	
				3	24–60	9.2	2.4	
				4	60–84	9.3	6.6	
				5	60–84	11.5	2.0	
ND	12CC–S3	18–40	M	1	0–6	11.8	4.3	No BF
				2	6–12	11.6	2.6	
				3	12–24	11.7	2.5	
				4	24–60	11.7	3.6	

Site Code	Burial Code	Age at Death (in years)	Sex	Samples	Age Group (in months)	$\delta^{15}N$ (in ‰)	%N	Hypotheses about breastfeeding (BF) and weaning (W)
ND	12 D	12–18	U	1	0–6	9.6	4.0	Gradual W
				2	6–12	10.0	5.5	
				3	12–24	10.2	2.2	
				4	24–60	9.7	3.0	
ND	12DD–S2(2)	18–30	M	1	0–6	11.3	4.3	Gradual W and Late ^{15}N enrichment
				2	24–60	10.7	5.5	
				3	24–60	11.5	1.9	
ND	12DD–S5	18–40	M	1	12–24	13.6	2.5	Abrupt W and Late ^{15}N enrichment
				2	12–24	11.0	5.6	
				3	24–60	12.3	3.1	
ND	12DD–S6	12–18	U	1	6–12	10.6	3.8	Gradual W
				2	24–60	9.5	3.8	
				3	24–60	9.3	3.4	
				4	24–60	9.3	3.6	
				5	60–84	9.6	2.8	
ND	12DD–S7	18–40	F	1	12–24	11.9	4.1	No BF
				2	24–60	12.1	4.0	
				3	24–60	11.8	3.9	
				4	24–60	12.1	3.0	
				5	60–84	12.5	2.6	
ND	12DD–S10	18–40	F	1	6–12	11.6	2.7	Gradual W
				2	12–24	11.3	2.8	
				3	24–60	10.0	3.1	
ND	12EE–S1	18–40	M	1	0–6	12.6	5.6	Abrupt and early W or no BF
				2	6–12	10.8	2.6	
				3	12–24	10.8	2.2	
				4	24–60	10.4	3.0	
				5	60–84	11.0	2.9	
ND	12EE–S5	18–40	F	1	12–24	11.6	2.1	No BF
				2	24–60	11.9	2.2	
				3	24–60	11.9	2.2	
ND	12FF	8–12	U	1	6–12	11.5	2.3	Gradual W
				2	12–24	11.5	2.5	
				3	24–60	10.9	2.7	
				4	24–60	11.0	2.8	
				5	24–60	10.6	2.8	
ND	4G–S1	>40	F	1	6–12	10.3	2.1	No BF
				2	12–24	10.4	2.4	
				3	24–60	10.5	2.2	
				4	24–60	11.0	2.5	
ND	11G–S1	12–18	U	1	6–12	11.4	0.3	Gradual W
				2	12–24	11.0	1.2	
				3	12–24	10.3	0.6	
				4	24–60	10.0	0.7	
ND	4K1	18–40	M	1	6–12	10.2	2.3	No BF
				2	12–24	11.2	2.6	
				3	12–24	11.0	2.3	
				4	24–60	11.0	2.2	
ND	4K–S3	12–18	M	1	0–6	10.5	2.3	No BF
				2	12–24	10.5	2.4	
				3	12–24	10.5	2.4	
				4	24–60	10.8	2.5	
				5	24–60	11.2	2.6	
ND	11K–S4	12–18	U	1	0–6	12.8	1.6	Gradual W
				2	6–12	12.3	2.5	
				3	12–24	11.6	2.9	
				4	24–60	11.8	2.3	
				5	24–60	11.8	2.5	

Site Code	Burial Code	Age at Death (in years)	Sex	Samples	Age Group (in months)	δ^{15}N (in ‰)	%N	Hypotheses about breastfeeding (BF) and weaning (W)
ND	4L–S3	12–18	U	1	6–12	11.9	1.8	Gradual W
				2	12–24	12.5	2.4	
				3	24–60	12.0	1.3	
				4	60–84	11.4	1.1	
ND	12W–S11	18–40	M	1	6–12	11.9	1.1	Gradual W
				2	12–24	12.4	1.7	
				3	24–60	12.7	1.6	
				4	24–60	11.9	1.5	
ND	12Z–S1	18–40	M	1	0–6	8.9	2.7	Gradual W and Late ^{15}N enrichment
				2	12–24	9.3	2.6	
				3	24–60	9.4	2.9	
				4	24–60	8.7	2.8	
				5	60–84	9.6	2.8	

TABLE S2. Isotope values for 17 deciduous molars (m1 and m2): δ^{15}N for tooth dentine samples and their corresponding age group in months (F: fetal phase). The two sites listed are PT (Pointe-aux-Trembles) and ND (Notre-Dame, Montreal). For each burial code or individual, the tooth type analyzed and age-at-death estimation are included in the table, as well as a hypothesis for breastfeeding/weaning patterns (as discussed in the text). For further description about the osteological methods, see the text.

Site Code	Burial Code	Age at Death (in years)	Tooth type analysed	Samples	Age Group (in months)	δ^{5}N (in ‰)	%N	Hypotheses about breastfeeding (BF) and weaning (W)
PT	7A2–S1	1.5	m2	1	0–6	14.2	1.0	Gradual W
				2	6–12	14.0	1.7	
				3	6–12	13.9	1.3	
PT	7A2–S3	0.5–0.75	ml	1	0–6	12.3	1.6	BF
				2	0–6	14.6	2.0	
PT	7A2–S22	1–1.5	ml	1	F	11.1	1.8	BF
				2	0–6	12.0	2.3	
PT	7A2–S24	1–1.3	ml	1	0–6	13.0	1.2	Early W and/or *in-utero* stress
				2	0–6	12.5	0.7	
PT	7A2–S32	1.5–2	ml	1	F	13.2	1.0	Early W and/or *in-utero* stress
				2	0–6	12.8	1.1	
PT	7A9–S18	1.3–1.5	ml	1	0–6	11.0	1.4	Early W and/or *in-utero* stress
				2	0–6	11.7	2.1	
				3	0–6	10.4	1.3	
PT	7A9–S39	3–3.5	m2	1	0–6	9.6	1.8	No BF
				2	0–6	9.8	2.3	
				3	6–12	10.4	2.7	
				4	6–12	10.7	2.4	
PT	7A9–S53	2–2.5	ml	1	0–6	13.3	2.0	BF
				2	0–6	13.2	1.3	
PT	7A9–S55	1.3	ml	1	0–6	11.3	1.5	BF
				2	0–6	11.0	1.2	
PT	7A11–S63	0.6–1	m2	1	0–6	15.3	2.2	
ND	12AA2	0.8	ml	1	F	12.5	0.6	
ND	12AA–S5	2.5	ml	1	F	13.0	1.9	Early W and/or *in-utero* stress
				2	0–6	12.1	2.4	
ND	12AA–S6	1.5	ml	1	0–6	12.5	0.9	Early and abrupt W or no BF
				2	0–6	10.0	1.5	
ND	12BB–S4	2	ml	1	0–6	13.5	1.4	
ND	12BB–S7	2	ml	1	0–6	13.8	1.2	Early W
				2	0–6	13.1	1.0	
ND	12W–S9	1.5	ml	1	0–6	12.0	1.6	
ND	12W–S13	5–5.5	ml	1	F	12.2	2.4	No BF
				2	0–6	12.2	2.6	