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Trauma and Infectious Disease in Northern Japan

Okhotsk and Jomon

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> The cold of the Far North has been characterized as a screen serving in past times to prevent the flow of many pathological germs along with the movements of their human hosts. . . . Apparently the cold screen explains why at the time of the first European contact the Indians lacked many disease entities common to the Old World, and hence were so vulnerable to the diseases introduced by the Europeans and their African slaves.
>
> Stewart 1960: 265

Stewart was writing more than 50 years ago in order to pose a mechanism to explain the perceived lack of disease in the New World prior to European contact. Influential in developing the notion of a relatively disease-free pre-European-contact New World was Ashburn's (1947) thesis for good initial contact indigenous population health in the ethnohistorical records, coupled with the devastating effects of European-introduced diseases (e.g., typhus, smallpox, and measles, to name a few) on these same people. Stewart's (1960) hypothesis was that the northern climate, being very different from that in which humans originally evolved, was able to cold-filter out a number of disease agents (Merbs 1992), particularly considering the slow speed, measured in generations, at which early migrants probably travelled (Araujo et al. 1988). More recently Crawford (1998) noted the importance of the cold screen hypothesis with respect to parasite life cycles outside of the human body and other pathogens that are not closely related to their human hosts. Newman (1976) and Merbs (1992) have also provided support for the view that the cold screen hypothesis is still relevant in explaining disease flow into the Americas from Asia.

What is missing from the discussion are data on infectious disease loads in cold-adapted Northeast Asian populations in the past. Given that far northern Japan extends into the subarctic zone and skeletal samples are available for this region, it might be expected that the evidence for infectious disease would be limited because of an analogous cold screen effect. The purpose of this study is to (1) examine the evidence for infectious disease and trauma in Hokkaido, Japan; (2) compare these findings to other subarctic and arctic samples from Alaska; and (3) explore the implications of the observed patterning and frequency of infectious disease and debilitating traumatic lesions in cold-adapted marine foraging communities in Northeast Asia.

Methods and Materials

The skeletal samples used in this study derive from a number of Jomon and Okhotsk sites on Hokkaido and Rebun Island, Japan. Because sample sizes from individual Jomon and Okhotsk sites are small for the most part, an aggregated Jomon and Okhotsk sample form the analytical units used in this study. Listed sample sizes are indicative only; refer to the section on sample preservation below. The earliest sample (Initial Jomon, ~8000–5100 years BP, *n* = 3 individuals) is from Midorimachi, while the Middle Jomon (5100–4050 years BP, *n* = 13) is sampled at Kitakogane and Kotan-Onsen. Five sites represent the late Jomon (4050–3000 years BP, *n* = 32): Funadomari, Takasago, Irie, Usujiri, and Tenneru. One site, Misawa, falls into the Final Jomon (3000–2400 years BP, *n* = 1). The five sampled Epi-Jomon sites (2400–1400 years BP, *n* = 13) comprise Onkoromanai, Rebunge, Minami-Usu, Bozuyama, and Chatsu 4. The aggregated Okhotsk (AD 550–1200) sample is composed of individuals from seven sites: Ohmisaki (*n* = 19), Hamanaka 2 and 1 (*n* = 4), Oshonai (*n* = 3), Utoro-Jinjayama (*n* = 6), Menashidomari (*n* = 1), Pirikatai (*n* = 2), and Tomiiso (*n* = 2).

A range of other studies that have assessed paleohealth indicators in subarctic and arctic samples from the North American continent serve as appropriate (see Oxenham and Matsumura 2007) comparisons for the subarctic Hokkaido material. These comparative samples include Keenleyside's (1998) early Aleuts (3000–500 years BP, *n* = 65) and Eskimo (1,450–100 years BP, *n* = 128) as well as a late Aleut sample (14th–18th century AD, *n* = 227) (Keenleyside 2003). A study by Guatelli-Steinberg and colleagues (2004), using a composite sample of Inuits from Point Hope Alaska (500 BC–AD 1700, *n* = 21), provided another data set on enamel hypoplasia.

Summarizing Hokkaido skeletal preservation and determining actual individual sample sizes are difficult because of the curatorial methods employed (separate storage of each body element by type). Sample preservation is presented in two ways: (1) preservation of each element expressed as a percentage of the minimum number of individuals (MNI) determined for each particular element; and (2) preservation of each element expressed as a percentage of the overall MNI for the sample in question. For example, using the former method there are 25 humeri with 100 percent preservation in the Okhotsk sample where the MNI based on humeri alone is 31 (25 humeri/62 expected humeri [MNI × 2] gives a preservation figure of 40.3 percent for complete humeri). However, using the latter method, the MNI for the entire sample regardless of which element is assessed is 39 based on the preservation of cranial material. When this figure is used, the expected number of humeri is 78 (MNI of 39 × 2) with a resulting preservation figure of 32.1 percent (25 complete humeri/78 expected humeri). The first method provides information on how well particular skeletal elements are preserved with reference to themselves; for instance, while there are fewer Okhotsk tibiae preserved than expected (MNI of 28) compared to femora (MNI of 35), some 32.1 percent of tibiae are 100 percent preserved, as compared to 24.3 percent of femora. The second method allows an assessment of the preservation of each skeletal element with regard to the entire skeleton: the greater MNI for Okhotsk femora as compared to tibiae indicates better overall preservation of the femur in this sample.

Data concerning enamel hypoplasia and cribra orbitalia are summarized from previous publications in order to provide a generalized health context in which to interpret evidence for infectious disease and trauma in the samples under consideration. Methodological protocols for the identification and recording of these physiological stress indicators have been provided by Oxenham and colleagues (Oxenham et al. 2006; Oxenham and Matsumura 2007).

Only the evidence for healed lesions of a traumatic etiology are examined in this study, because of difficulties in identifying perimortem events for which bone in deceased individuals can react to postmortem trauma in the same manner as a living individual for several months after death (Weiberg and Wescott 2008). Protocols for recording and interpreting healed traumatic lesions followed Lovell (1997). Nontraumatic lesions were recorded following advice given by Buikstra and Ubelaker (1994).

Results

Preservation

Figure 16.1 summarizes the preservation of the Hokkaido samples by way of the minimum number of individuals (MNI) as calculated by each element

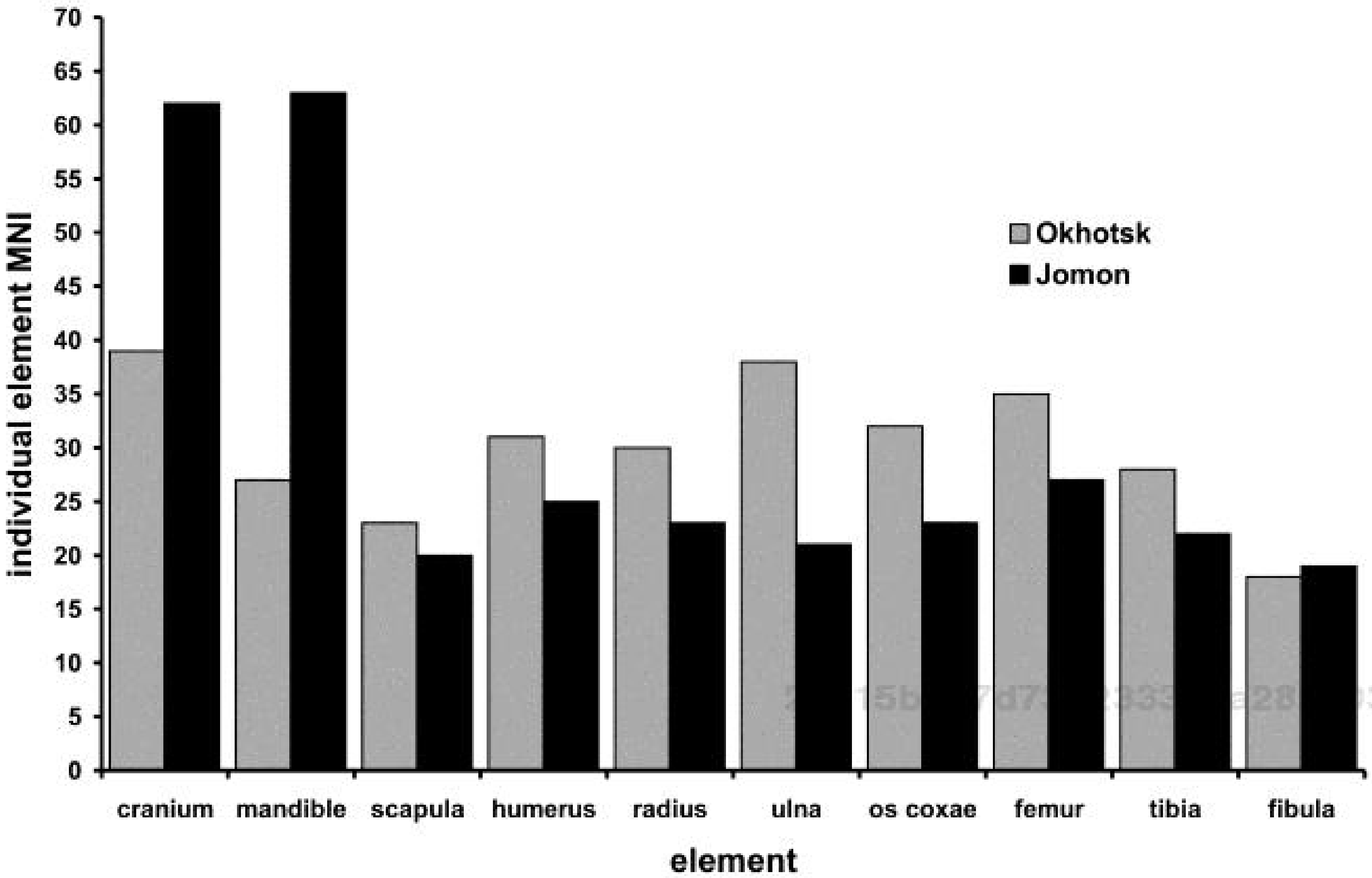

Figure 16.1. Hokkaido element preservation represented as a proportion of element-specific MNIs.

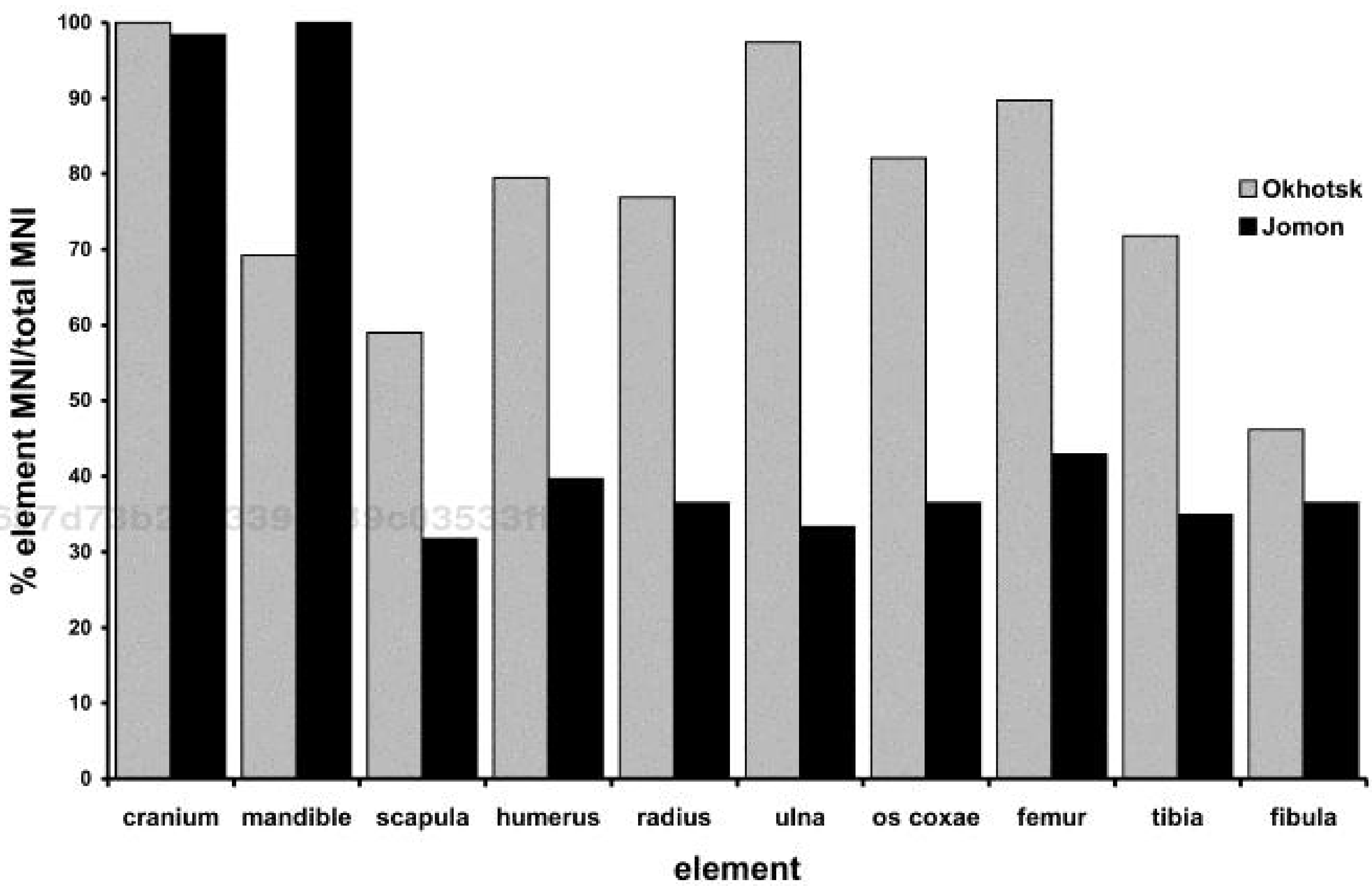

Figure 16.2. Hokkaido element preservation as a proportion of individual skeletal element MNIs in relation to the total (most common element) MNI.

separately. The maximum MNI for the Jomon sample is 63 individuals based on the mandible, while the maximum MNI for the Okhotsk sample is 39 based on the cranium. Figure 16.2 summarizes preservation as a percentage of individual skeletal element MNIs in relation to the total (most common element) MNI. There is much better representation of cranial (including man-

Table 16.1. Adult oral pathology and physiological health summary: Hokkaido and Alaskan samples

Sample	Site	CO	C LEH	I LEH	CI LEH	Reference
Jomon	Hokkaido	25/58 (43.1)	39/134 (29.1)	30/227 (13.2)	69/331 (20.8)	1
Okhotsk	Hokkaido	23/37 (62.2)	15/75 (20.0)	10/101 (9.9)	25/176 (14.2)	1
Aleuts	Aleutian Is. (early)	2/54 (3.7)	2/83 (2.4)	0/64 (0.0)	2/147 (1.4)	2
Aleuts	Aleutian Is. (late)	51/221 (23.1)	8/186 (4.3)	1/205 (0.5)	9/391 (2.3)	3
Eskimo	Pt. Hope/Pt. Barrow, Alaska	10/118 (8.5)	41/180 (22.8)	26/209 (12.4)	67/389 (17.2)	2
Inuit	Point Hope, Alaska	32/111 (28.8)				4

References: 1 = Oxenham and Matsumura 2007 (and unpublished data); 2 = Keenleyside 1998; 3 = Keenleyside 2003; 4 = Guatelli-Steinberg et al. 2004.
Note: Comparative data calculated as affected/*n*, with percentage in parentheses. Empty cell indicates that appropriate comparative data are not available from literature.
Abbreviations: CO = cribra orbitalia; LEH = linear enamel hypoplasia; C = canine; I = incisor; CI = canine and incisor combined.

dibular) remains in the Jomon sample, with most postcranial representation rather low, falling between 30 percent and 40 percent of cranial preservation. There is much better relative representation of Okhotsk elements, and while cranial preservation is highest, many postcranial elements such as the ulna (94.7 percent), femur (89.7 percent) and os coxae (82.1 percent) are almost as well represented as the crania.

Cribra Orbitalia (CO) and Linear Enamel Hypoplasia (LEH)

Table 16.1 summarizes physiological health (cribra orbitalia and enamel hypoplasia) for the Hokkaido and Alaskan samples. The frequency of cribra orbitalia is very high in comparison to the early Aleut and Eskimo samples, although the late Aleut sample shows elevated levels of cribra orbitalia. LEH, considering the combined incisor and canine data, is elevated in comparison to the Aleut samples and similar to the limited data for Alaska. The small sample reported on by Guatelli-Steinberg and colleagues (2004) shows unusually elevated levels of LEH, even in comparison to other samples from the same region and time.

Trauma and Infectious Disease

Table 16.2 presents data for Hokkaido (for two levels of preservation) on the frequency, both by skeletal element and by individual (based on MNI), of trauma and evidence of infectious disease. When the results for any level of preservation are examined, the frequency of infectious lesions in the Okhotsk sample increases in a cephalocaudal direction with no cases of cranial infection, from a low of 1.7 percent of skeletal elements or 3.2 percent MNI (based on the humerus) showing upper appendicular lesions to a high of 8.7 percent of elements or 17.1 percent MNI (based on the femur) displaying lower appendicular lesions. A similar pattern is evident for the Jomon sample, again with no signs of cranial infection, from a low of 2.2 percent skeletal elements or 4.0 percent MNI (based on the humerus) showing upper appendicular lesions to a high of 4.9 percent elements or 9.1 percent MNI (based on the tibia this time) displaying lower appendicular lesions. While the distribution of infectious lesions is similar between the two Hokkaido samples, the Okhotsk sample consistently, with the exception of the humerus, shows higher frequencies of infectious lesions measured by both skeletal element and MNI (see table 16.2 and figure 16.3), albeit not to a statistically significant degree.

While the evidence for infectious disease is nonspecific for the most part, three individuals in the Okhotsk sample display signs of osteomyelitis. Specimen OMK237a (figure 16.4) is represented by the distal half of a left humerus (no other bones associated with this individual are known to be preserved). The bone, which is extremely friable and fragile, displays evidence for osteoarthritis in the form of well-circumscribed capitulum porosity, trochlea marginal osteophytosis and enthesophytic development in the olecranon fossa. While the cortical bone of the shaft is extremely porous, the anteromedial

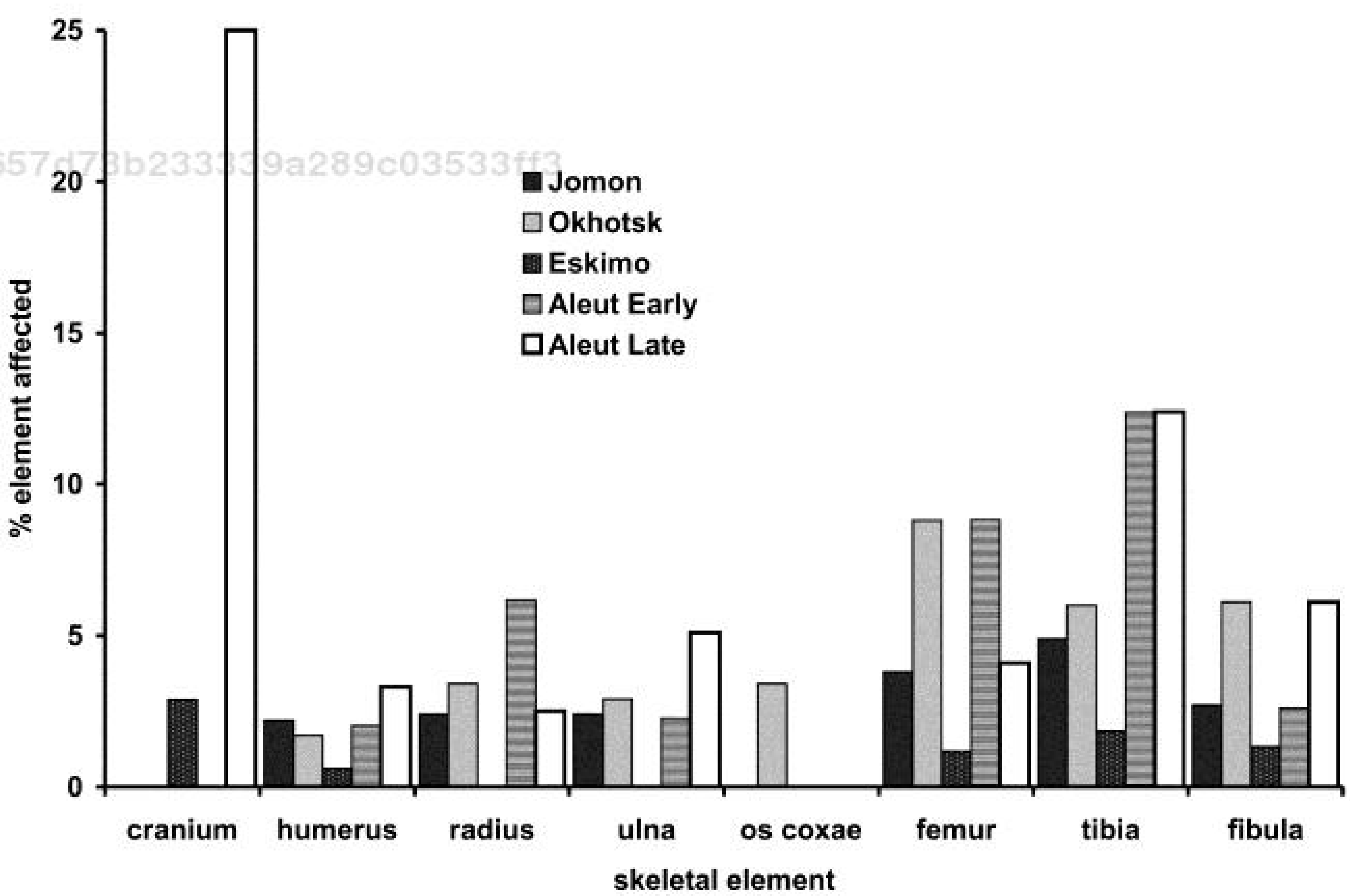

Figure 16.3. Frequency of infectious disease by element for Hokkaido and Alaskan samples.

Table 16.2. Frequency of trauma and infectious disease by skeletal element and MNI in the Hokkaido Jomon and Okhotsk samples

	Okhotsk						Jomon					
	Observed		Affected		Frequency %		Observed		Affected		Frequency %	
Bone	n	MNI	Infection	Trauma	Infection A/n (A/MNI)	Trauma A/n (A/MNI)	n	MNI	Infection	Trauma	Infection A/n (A/MNI)	Trauma A/n (A/MNI)
Cranium	39	39	0	0	0(0)	0(0)	62	62	0	0	0(0)	0(0)
Mandible	27	27	0	0	0(0)	0(0)	63	63	0	0	0(0)	0(0)
Humerus[a]	35	19	1	0	2.3(5.3)	0(0)	37	19	0	0	0(0)	0(0)
Humerus[b]	59	31	1	0	1.7(3.2)	0(0)	45	25	1	0	2.2(4.0)	0(0)
Radius[a]	25	14	2	0	8.0(14.3)	0(0)	29	16	0	0	0(0)	0(0)
Radius[b]	58	30	2	0	3.4(6.7)	0(0)	42	23	1	0	2.4(4.3)	0(0)
Ulna[a]	29	16	2	0	6.9(12.5)	0(0)	31	17	1	1	3.2(5.9)	3.2(5.9)
Ulna[b]	64	38	2	0	3.1(5.3)	0(0)	42	21	1	1	2.4(4.8)	2.4(4.8)
Os coxae[a]	26	16	2	0	7.7(12.5)	0(0)	21	11	0	0	0(0)	0(0)
Os coxae[b]	58	32	2	0	3.4(6.3)	0(0)	46	23	0	0	0(0)	0(0)
Femur[a]	39	22	3	2	7.7(13.6)	5.1(9.1)	41	21	2	0	4.9(9.5)	0(0)
Femur[b]	69	35	6	2	8.7(17.1)	2.9(5.7)	53	27	2	0	3.8(7.4)	0(0)
Tibia[a]	29	17	2	0	6.7(11.8)	0(0)	31	16	1	0	3.2(6.3)	0(0)
Tibia[b]	50	28	3	1	6.0(10.7)	2.0(3.6)	41	22	2	0	4.9(9.1)	0(0)
Fibula[a]	10	8	2	0	20.0(25.0)	0(0)	32	16	0	0	0(0)	0(0)
Fibula[b]	33	18	2	0	6.1(11.1)	0(0)	37	19	1	0	2.7(5.3)	0(0)

Note: No statistically significant differences between the two samples using Fisher Exact tests.

Abbreviations: n = number of observed elements (see notes a and b below); MNI = minimum number of individuals observed in the sample, based on most common side; Affected = number of elements affected by traumatic or infectious lesions; A/n = proportion of observed (n) elements affected (A) with a lesion; A/MNI = proportion of observed MNI affected with a lesion.

[a] Only observed elements >50% preserved.

[b] Any observed element that can be sided.

Figure 16.4. Example of osteomyelitis in the left humerus of an Okhotsk individual (specimen OMK237a). Note also area of circumscribed porosity on the capitulum.

aspect of the shaft (particularly more proximally) displays periostitis. The anteromedial aspect presents with two clusters of three lytic lesions or cloacae (first cluster 2–5 mm in diameter; second cluster 3–7 mm in diameter), while several confluent cloacae (an area approximately 13 mm in diameter) are situated on the anterior aspect of the metaphysis, just superior to the coronoid fossa.

Specimen OMK431a is represented by a complete right and left femur only. The right femur displays lesions consistent with osteomyelitis (figure 16.5). With the exception of the lateral aspect of the condyles and the proximal portion superior to the base of the lesser trochanter, the bone is extremely porous and presents scattered periosteal deposits particularly in the distal metaphyseal area (posteriorly and anteriorly), along the distal third of the linea aspera and especially large deposits along the midshaft medial to the linea aspera. On the posterior aspect of the diaphysis a large oval lesion (22 mm long and 8 mm wide) with remodelled edges extends laterally to the linea aspera and is fringed by small subperiosteal bone deposits at its proximal end and along its lateral border. A smaller lytic lesion (8 × 5 mm), also associated with subperiosteal new bone, presents just distal to this. On the anterior aspect of the diaphysis, directly opposite the two posterior lesions, a large confluent lesion (39 mm long and 19 mm wide) opening into the medulla presents with a sequestrum. A further separate small oval lesion (8 × 4 mm) presents just distally and slightly laterally (still on the anterior aspect of diaphysis) to this lesion and also includes a small section of necrotic bone and an area that communicates with the medulla.

The final instance of osteomyelitis (OMK457a) is seen in a small section of femoral diaphysis 89 mm long with a maximum diameter of 34.5 mm (figure

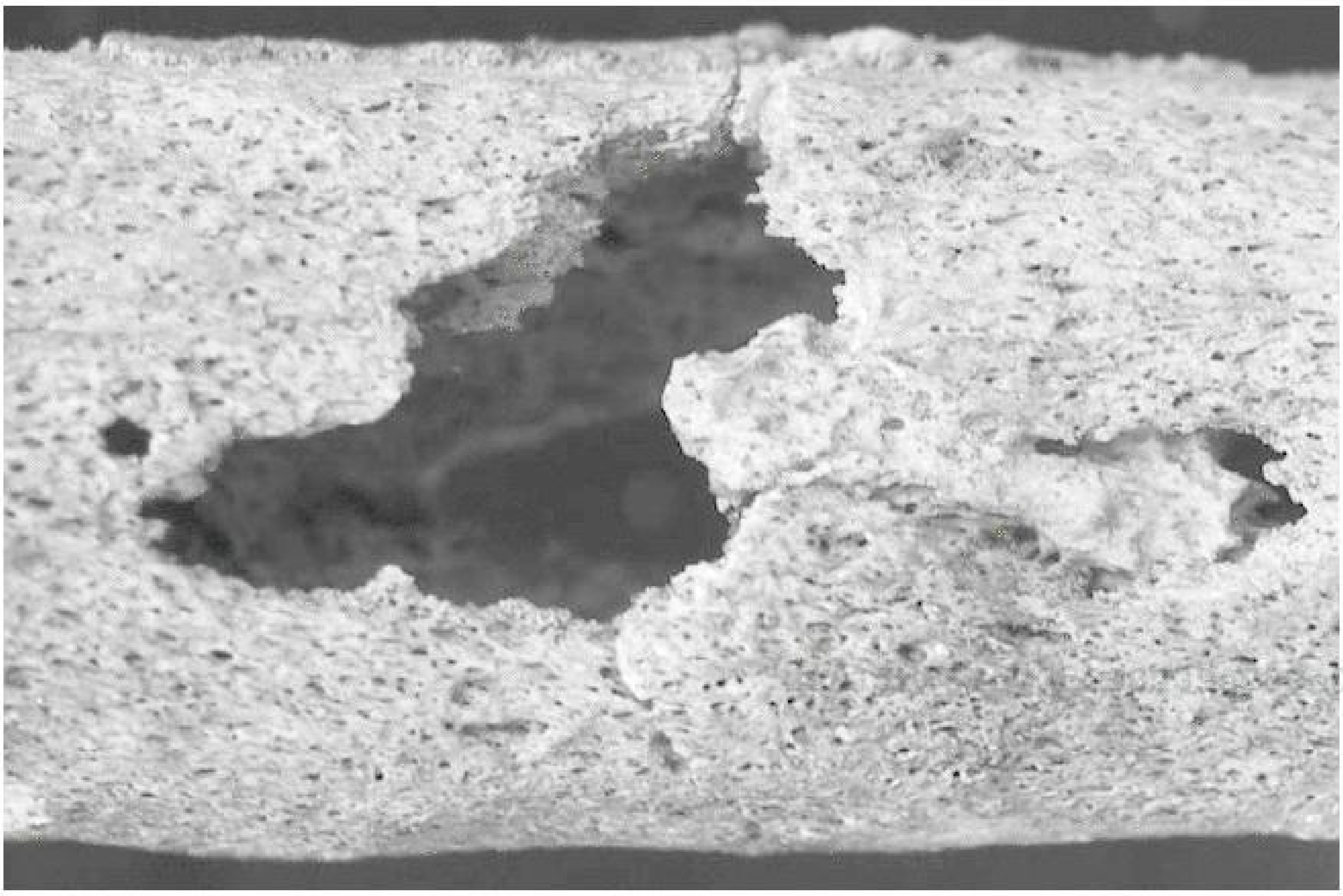

Figure 16.5. Close-up of extensive osteolytic and osteoblastic lesions in a right femur (specimen OMK431a). Note cloaca and sequestrum to right in photo.

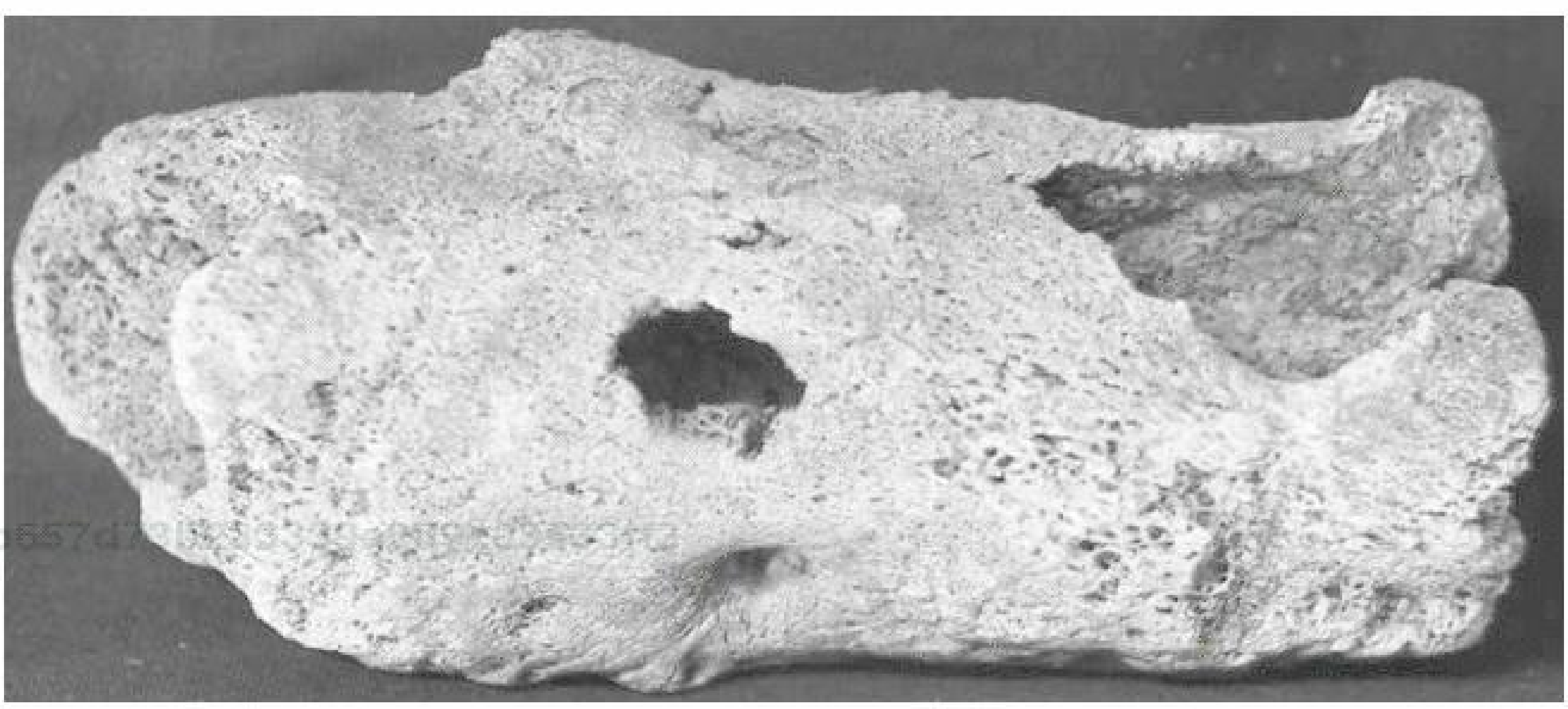

Figure 16.6. Massive osteoblastic (including endosteal) and osteolytic lesions in a short section of femoral diaphysis (OMK457a).

16.6). Extensive osteoblastic and osteolytic modification of this small section precludes identification of side or orientation. One end of the diaphysis (hereafter called A) presents with complete infilling of the medullary cavity with dense trabecular bone. The opposite end (B) is open with one side having a very thin cortical wall (~4.5 mm thick) and the opposite side having a cortical diameter of 15 mm. The thickened side of the shaft displays extensive and continuous remodelled subperiosteal bone deposits. The thin side of the shaft displays three well-circumscribed cloacae running around this side of the shaft at the same height and all communicating with the medulla. Toward bone end A there is a large opening extending about a third (31 mm) the length of the shaft and merging with the end of the shaft. Of the three cloacae, number one (the smallest) is 6 mm in diameter with bevelled sides that slope into the cortical bone; the next (central) lesion is oval (11 × 8 mm) with a combination of smooth and sharp edges; the third lesion is also oval (11 × 8 mm) and has uniformly smooth edges.

Figure 16.1 also includes comparative data on infectious lesions by skeletal element for the Aleut and Eskimo samples of Keenleyside (1998, 2003). The Eskimos display very low levels of infectious disease in general (separate Alaskan data were not reported for the os coxae) although they do follow the general pattern seen for Hokkaido with the upper appendicular skeleton being less affected than the lower. The Eskimo samples display cranial lesions, albeit at a low frequency (2.9 percent). The early and late Aleut assemblages also display a similar pattern to Hokkaido, with relatively lower levels of upper appendicular infection and the highest levels of infection in the lower appendicular skeleton peaking in the tibia (12.4 percent) for both samples. The late Aleut sample stands out in having an extremely high frequency of cranial infection (25 percent).

Keenleyside (2003) suggests that 9/51 (17.6 percent) of the instances of cranial infection in the late Aleut sample are likely due to venereal syphilis. Keenleyside (2003) also indicates that there is one possible case of tuberculosis in the late Aleut sample, with no instances of specific infectious disease noted for the earlier pre-European contact sample. While not strictly diagnosed by way of appendicular lesions, the Jomon sample includes two examples of diffuse idiopathic skeletal hyperostosis (see Oxenham and Matsumura 2007).

Regarding evidence of trauma, table 16.2 indicates that traumatic lesions were uncommon in the Hokkaido samples. Neither Jomon nor Okhotsk demonstrated cranial trauma, while the only traumatic lesions in the Okhotsk were lower appendicular, with 2.9 percent of all assessable femora (5.7 percent of MNI) and 2.0 percent of tibiae (3.6 percent of MNI) showing healed trauma. Only one instance of healed trauma in an ulna (2.4 percent of assessable ulnae, 4.8 percent of MNI) was observed for the Jomon assemblage.

Figure 16.7 includes comparative data on traumatic lesions by skeletal element for the Aleut and Eskimo samples of Keenleyside (1998, 2003) and this study (note that comparative Alaskan data were not available for the os coxae). The frequency of appendicular lesions is low in all samples examined here, and there is no clear pattern with respect to the distribution of healed traumatic lesions. The most obvious difference between the Hokkaido and

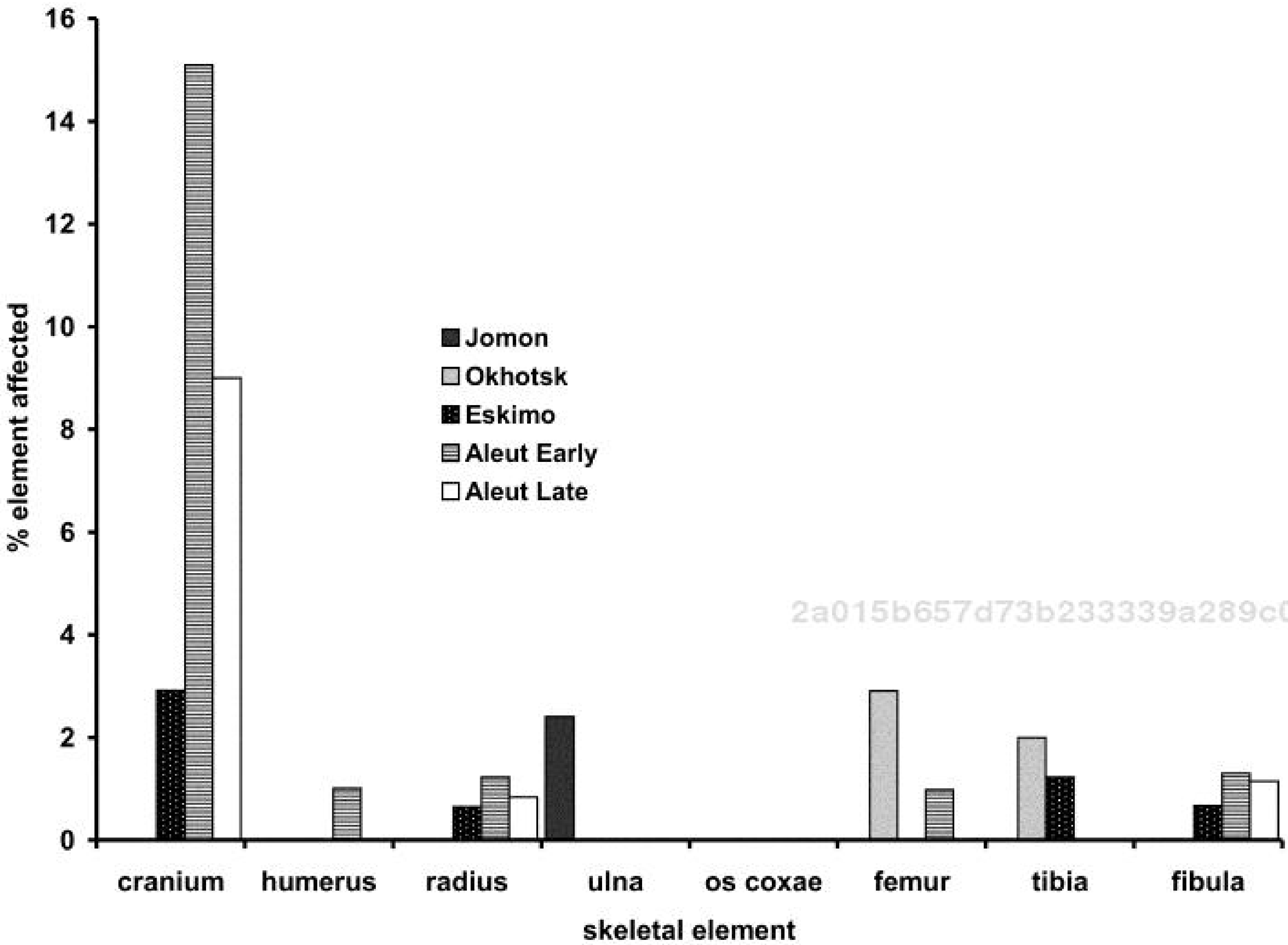

Figure 16.7. Frequency of traumatic lesions by element for Hokkaido and Alaskan samples.

Alaskan samples is the evidence for cranial trauma in Alaska: 15.1 percent of the early Aleut, 9.0 percent of the late Aleut, and 2.9 percent of the Eskimo samples displayed evidence for cranial trauma.

The most severe form of healed trauma in the Hokkaido sample occurred in an Okhotsk (probable) male (OMK429a), represented by left and right femora only (figure 16.8). Both femora are complete, with the exception of the head in the right pathological specimen. The right femur displays a healed fracture at the base of the femoral neck following the intertrochanteric line anteriorly and intertrochanteric crest posteriorly. The entire site of the fracture is well remodelled with no apparent callus. Some scattered porosity of the healed fracture site, especially superiorly, is evident where there is evidence of slightly raised sclerotic bone that shows signs of eburnation. This likely represents some form of postreparative articulation with either the acetabulum or the detached femoral head and/or neck. The lesser trochanter, while similar in size to the left femur, displays slight enthesophytic development on the anteroinferior aspect. The preserved medial condyle shows no sign of osteoarthritis while the lateral condyle is completely lost postmortem. The left femur is free of any signs of osteoarthritis or other pathology.

Figure 16.8. Okhotsk male (?) right femur displaying a healed Perthes fracture (OMK429a). Proximal end with medial view.

Discussion

Infectious disease was clearly present in subarctic Japanese populations in the past. Furthermore, with the exception of the cranium, the frequency and patterning of infectious lesions were somewhat similar to that seen in subarctic and arctic Alaska, particularly among the Aleuts. A review of the more robust literature on precontact- and contact-period Alaskan health will provide a context in which to explore the nature and perhaps underlying reasons for the evidence and frequency of infectious disease in the far north of Japan.

Prior to historic-period contact, indigenous Alaskans have been characterized as having been in fairly good health (Shephard and Rode 1996), notwithstanding evidence for a number of minor disorders and skeletal evidence suggesting an average age of 23 years (Shephard and Rode 1996). Precontact infections in the region include cystic and alveolar hydatid disease, trichinosis, amoebiasis, rabies, botulism, and brucellosis (Shephard and Rode 1996). Gastrointestinal infections do not appear to have been common, although the presence of diarrheal disease in general is implicated by the use of traditional medicines to treat such maladies (Fortuine 1989). Evidence for ear and respiratory infections remains unclear, but otitis media is suggested to have occurred, as well as possible cases of lobar pneumonia and bronchitis (Fortuine 1989; Zimmerman et al. 1981; Zimmerman and Aufderheide 1984). The issue of tuberculosis is intriguing, with historical evidence for the presence of this disease in contact-period Aleuts (Fortuine 1989), as well as skeletal lesions consistent with the pulmonary form in a contact-period Aleut sample (Keenleyside 2003).

Survival and maintenance of tubercle bacilli have long been thought to be associated with elevated population size and density. Tuberculosis is generally thought to thrive in situations of poverty and overcrowding, with its origins associated with increasing population density, sedentism, and intensified agricultural activities despite its presence in animal populations much earlier (Roberts and Buikstra 2003). Its airborne transmission, with the tubercle bacilli able to remain suspended in a closed space for long periods, is correlated, among other factors, with crowding (Rieder 1999). However, population density in and of itself has little impact on the maintenance of tuberculosis in a population. Tuberculosis can be maintained in small isolated communities (Daniel 2000), and infection is related to close contact rather than a large number of susceptible individuals. For instance, Farer (1979) argues that because tuberculosis is not a highly infectious disease, prolonged or frequent association is needed in order for the infection to be transmitted, with the greatest hazard to those individuals who are in the same environment as the infected. Although tuberculosis may require crowd conditions to evolve, the argument has been made that it can persist in smaller populations (Black 1975). Indeed, El-Najjar (1979) has used such reasoning to argue that *M. tuberculosis* could have survived the so-called cold screen of Beringia. Clearly, both tuberculosis and venereal syphilis could have been maintained, after an external introduction at least, in a subarctic environment.

Many of the Alaskan and northern Japanese skeletal samples assessed for infectious disease derive from marine-intensive foraging communities. Thompson and colleagues (2006) note that naturally occurring marine mammals can be infected with a range of pathogens transmittable to humans including *Mycobacterium* (various species) and *Brucella* species. Fish and crabs, particularly when handled/processed, pose further potential infectious threats by way of such microorganisms as *Erysipelothrix rhusopathiae* and *Mycoplasma phocacerebrale* (causes seal finger) (Thompson et al. 2006). Indeed, parasites would appear to have been a significant health concern, with past Alaskan populations known to have harbored *Ancylostomatidae* (hookworm) (Bouchet et al. 1999), *Ascaris* (a nematode), and *Diphyllobothrium* (tapeworm) (Bouchet et al. 2001), in addition to *Echinococcus granulosus* (hydatid worm) (Ortner and Putschar 1981), *Trichinella spiralis* (pork worm) (Zimmerman and Aufderheide 1984), and *Cryptocotyle lingua* (fish nematode) (Zimmerman and Smith 1975).

El Molto and colleagues (2000) argue for the presence of yaws in a small (n = 16) precontact (1,300–1,900 years BP) Aleut sample based on the presence and distribution of periosteal lesions. The same authors suggest a high frequency of venereal syphilis in a later (including the contact period) sample of 431 individuals from Point Hope, Alaska. The finding of syphilis, at least, at

Point Hope is consistent with the work of Keenleyside (2003), who suggested that the appearance of venereal syphilis in the Aleutians was coincidental with initial European contact. The epidemiology of yaws and the nonspecific nature of the periosteal lesions reported on by El Moto and colleagues (2000) make for a less than convincing case for yaws in the precontact Aleutians.

Keenleyside (1998), while acknowledging the complexity of the results for infectious disease, attributed the higher frequency of infectious lesions in the Aleut sample to lifestyle: crowded longhouse-style accommodation and poor hygiene; and soft tissue trauma-associated infections in Aleut males. In a subsequent paper (Keenleyside 2003), in which early and late (contact period) Aleut samples were analyzed, a marked increase in cranial infections was attributed to an increase in infectious disease in the contact period. While crowded housing is again posited as a contributing variable, introduced venereal syphilis is seen as an important factor. If all late-period Aleut crania are considered, then 9/204 (4.4 percent) of all individuals displayed cranial indications of venereal syphilis. Presumably a significant proportion of the evidence for appendicular infectious lesions is associated with venereal syphilis as well. Given that venereal syphilis generally only manifests skeletally in 10 to 12 percent of individuals with the disease (Roberts and Manchester 1995), it was clearly at epidemic levels in the Aleutians during the initial European-contact phase.

Despite the predictions of the cold screen hypothesis, there is and was considerable potential for relatively high infectious disease loads in subarctic and arctic populations. Based on the Alaskan evidence, the seemingly elevated level and patterning of infectious lesions in the Okhotsk sample, including at least three cases of severe chronic osteomyelitis, is arguably not unexpected for a population operating within a cold environmental zone. Further, both the Okhotsk and the Jomon of Hokkaido appear to have been physiologically compromised, as subadults at least, given the relatively high frequency of cribra orbitalia and enamel hypoplasia for subarctic populations. While the etiology of cribra orbitalia is complex (see Stuart-Macadam 1985; Ortner et al. 1999; Wapler et al. 2004) and probably multifactorial, the high frequency in the Hokkaido samples suggests a degree of depressed immunocompetence that may have facilitated elevated levels of infectious disease, particularly in the case of the Okhotsk.

However, the observation that the Point Barrow/Point Hope Eskimo samples displayed very low levels of evident infectious disease while exhibiting elevated levels of enamel hypoplasia, especially for the small sample analyzed by Guatelli-Steinberg and colleagues (2004), is somewhat counterintuitive. It is possible that the more northerly Point Barrow and Point Hope populations, while being physiologically compromised, did not share the same opportunities for encountering the pathogens associated with chronic infectious disease as did their more southerly Aleutian and Hokkaido (especially Okhotsk) neighbors.

The apparent emphasis on marine foraging (see Oxenham and Matsumura 2007) would have exposed the Okhotsk to contact with a range of marine mammals and fishes and thus the potential for infection either through the ingestion of infected marine mammal products or more directly by way of traumatic inoculation of pathogens. The Okhotsk have also been described as "the only known intrusive culture [in Japan] that remained separate from the other groups for a long period" (Hudson 2004: 290). It is believed that they originated in the Amur River basin in what is now the eastern Russian seaboard, from where they tracked down through Sakhalin Island and finally into northern and eastern Hokkaido (Hudson 2004). Their less-than-sedentary history and a subsistence economy heavily influenced by marked seasonal variations would presumably have been likely stressors associated with the development of cribra orbitalia and enamel hypoplasia, as well as facilitating the intergroup contact necessary for the exchange of infectious pathogens. While Hudson (2004) paints a complex and fluid picture of Okhotsk subsistence, settlement, mobility, and demography, the lack of absolute dates for the skeletal samples assessed in this study does not allow the evidence for Okhotsk—or for that matter Jomon—paleohealth to inform these issues specifically.

Finally, while the level of trauma is not high in the Hokkaido samples, the case of the Perthes fracture suggests that Okhotsk people, at least, were at risk of serious and debilitating injury. The examples of chronic osteomyelitis, in addition to serious healed trauma, indicate that community members with long-term poor health and/or disability were accommodated in this harsh environment. Whether this reflects on community attitudes in terms of care and compassion or survival of the disabled despite indifference is impossible to assess for the time being. What does seem certain, however, is that subarctic populations in the far north of Japan are comparable to their Alaskan counterparts in showing evidence for considerable levels of infectious disease despite the arguably ameliorating effects of a cold screening of many pathogenic organisms.

Fortuine (1989) has extensively reviewed an enormous corpus of ethnohistoric accounts of indigenous Alaskans suffering appalling types and levels of debilitating trauma and chronic infectious disease. Death and traumatic injury through misadventure, directly related to the nature of the environment and the types of subsistence activities engaged in, appears to have been very common in precontact Alaska (Fortuine 1989). While accounts of abuse and ridicule of the sick and deformed exist, there is also extensive evidence for the accommodation and care of such individuals in the early ethnohistoric accounts (Fortuine 1989). There is no reason to believe that a similar situation did not exist in the far north of Japan in the past.

Whether or not a sophisticated health-care system existed within the small, cold-adapted foraging communities of northern Japan, there would certainly have been onerous economic costs in terms of lost labor (through death and/or disability of both a temporary and a permanent nature) and redirection of resources into caring for such individuals. Despite the fact that the injured, sick, and seriously disabled could have contributed to the community in ways other than generally expected of an able-bodied individual (see Dettwyler 1991 for a discussion of this issue), their input in a strictly economic sense may not have outweighed their inability to engage in the broader range of activities necessary for survival, thus causing a net drain on the community. Finally, it is clear that cold-adapted East Asian samples should be compared to cold-adapted samples globally and not to more southerly East Asians.

Conclusions

This paper set out to assess skeletal samples from the far north of Japan for signs of infectious disease and traumatic injury. It was argued that a suitable comparison is other cold-adapted peoples, and a series of Alaskan samples were used to this end. The patterning and frequency of infectious disease and trauma were discussed in the context of the subsistence and environments these people operated in.

It was shown that despite the arguably ameliorating effect of a cold filter reducing the number of viable pathogens, infectious disease was clearly an important and debilitating factor in cold-adapted peoples in the past generally. The Okhotsk, in particular, were seen to have experienced elevated levels of chronic and highly debilitating infectious disease. Both the Jomon and the Okhotsk samples also experienced the highest levels of cribra orbitalia and a quite elevated frequency of linear enamel hypoplasia relative to other cold-adapted populations. While evidence of cranial trauma was lacking in the Japanese samples (which may indicate a lack of interpersonal violence), the frequency and patterning of postcranial trauma, while low, were comparable to the Aleutian samples from Alaska. The Okhotsk pattern may be indicative of the dangers of their environment, specifically, a focus on large marine mammal hunting. The presence of individuals with chronic infections and debilitating trauma in northern Japan would suggest that these people were accommodated at some level. Whether this accommodation was influenced by compassion or indifference, there would have clearly been economic implications.

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17

A Paleohealth Assessment of the Shih-san-hang Site from Iron Age Taiwan

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The assessment of disease from excavated human skeletal remains and inference of health status, in concert with consideration of archaeological context from which they were recovered, can reveal useful and sometimes unanticipated details about past human lifeways. Extensive archaeological work on Taiwan over the past few decades has uncovered a long sequence of prehistoric human occupation. Numerous sites have been discovered, and many of them are well studied. Nevertheless, only limited bioarchaeological analysis has been conducted on human remains from Taiwanese sites.

The goal of this chapter is to characterize the health status of an Iron Age population at the Shih-san-hang site in northern Taiwan with respect to its broad-spectrum foraging subsistence practices and the site's transitional nature in Taiwanese prehistory. The site is unique in its temporal span, length of occupation, evidence of iron-working, diverse artifact distribution, wide range of abundant faunal remains, and well-preserved human burials. Taiwan played a critical role in the Austronesian diaspora, as well as the evolution and transmission of its languages (Bellwood et al. 1995; Bellwood 2001, 2006; Hung et al. 2007). Results of this paleopathological analysis are interpreted within a biocultural framework and compared with data from temporally and geographically relevant East Asian sites, placing the Shih-san-hang community into a larger regional context.

The Archaeological Context of Prehistoric Taiwan and the Shih-san-hang Site

The prehistory of Taiwan is generally divided into five major periods: Late Paleolithic to Early Neolithic (c. >15000–5000 BP); Middle Neolithic