Determining Season of Death of Archaeological Fauna by Analysis of Teeth

GENERAL

Seasonality of site occupation is a common concern in northern archaeology, and any faunal remains recovered should be analysed in an attempt to provide data useful for its determination. Conclusions reached in the past on the subject of seasonality have been based on data concerning composition of species, age composition of mammalian remains based on tooth eruption or epiphyseal closure ages, or traits such as antler retention or loss in cervids. The present paper constitutes a report on the successful adaptation to archaeological samples of an ageing technique widely applied in wildlife management: the "reading" of annual growth layers in mammalian teeth. Since teeth are often the most common, and usually the most identifiable, faunal remains from archaeological sites, the information resulting from a judicial use of the technique should supplement data concerning seasonality gathered by other methods and act as an independent check against them.

THE METHOD

In many mammalian species, growth of dentin (mineralized tissue around the tooth's pulp cavity) and cementum (a mineralized deposit laid down around the outside of the tooth below the gum line) continues for many years after the tooth erupts.[1] Detection and reading of the deposition layers caused by this process of mineralization is accomplished either by grinding the tooth down into a thin section and observing it under a microscope[2]; or, more commonly, by decalcifying the tooth in an acid solution, cutting 10-20 micron thick sections of the tooth; staining, usually with hematoxylin; mounting on a slide and viewing under a microscope.[1,3]

Variation in the rate of dentin-cementum deposition is a seasonally-related phenomenon in many northern mammals, and results in the deposition of annual layers analagous to tree rings, which appear light and dark under a microscope. Annual layers have been found in caribou *(Rangifer tarandus)*[4,5], moose *(Alces alces)*[6,7], red deer *(Cervus elaphus)* [8], white- and black-tailed deer *(Odocoileus)*[9,10,11], pronghorn antelope *(Antilocapra americana)*[12], red fox *(Vulpes vulpes)*[13], black bear *(Euarctos americana)*[14,15,16], grizzly bear *(Ursus arctos)*[17], pinnipedia (seals, etc.)[2,18-22], and some other species.[1]

With the decalcification and staining techniques, each annual layer appears under transmitted light as a wider light-staining band and narrower dark-staining band. These bands are visible in the dentin and cementum of the teeth of pinnipeds, but generally only in the cementum of artiodactyls. The dark-staining band is laid down in the ringed seal *(Phoca hispida)* from March through June, which corresponds with the animals' period of fasting and moult.[18] In the harbour seal *(Phoca vitulina)* the dark-staining band is deposited during late spring and early summer[2], which is the time of moult and fast in this species also, although the exact time varies with latitude. If the pattern of moult and fast coinciding with formation of dark-staining band holds for the harp seal *(Phoca groenlandica)*, its formation in this species would be expected in late February and in March. A dark-staining band forms in the tooth cementum of caribou between December and April[5], and of other northern artiodactyls probably also during the winter.

Wildlife managers are usually interested in using this information to estimate ages to within half a year, but archaeologists can interpret it for wider purposes. With a stained thin section, one reads the outermost layer of the cementum and/or the innermost layer of dentin. If deposition of the dark-staining layer of a caribou, for example, was in progress at the time of death, then the animal was killed sometime during the five months of December through April. If a light band was being deposited, then determination of date of death depends on a subjective judgement of the thickness of that light band. If the band is very thin, then death occurred within a few months of the end of deposition of the dark-staining band; or, if the light band is of approximately the same thickness as previously deposited light bands, then death occurred within a few months prior to the start of formation of another dark-staining band. Since the exact width of the light bands varies slightly from year to year and generally tends to decrease with age, a high degree of precision in the estimation of band width is unwarranted in view of the amount of error inherent in the process. Season of death can, however, be determined with reference to time of formation of the dark bands: a span of 3-4 months after dark-band formation if the next light band is very thin; a span of 3-4 months before dark-band formation if the light band is approaching the width of previous light bands; and a span of 3-4 months midway through the year if the light band is about half the size of preceding light bands. The variation in band width within one animal, even within one tooth, makes it impossible to be more precise.

Seal teeth can be read easily, because dentin age can be checked against cementum age, while the teeth of cervids require a little more care, such factors as damaged or eroded cementum and faint auxiliary bands complicating the procedure.

APPLICATIONS

The utility of the technique just described was tested through application to early historic (*i.e.*, late eighteenth to early nineteenth century) and protohistoric archaeological samples from Okak Bay, Labrador (57° 30′N, 62° W) and comparison with ethnographic descriptions of the early historic settlement pattern and seasonal cycle there, with favourable results. Okak Bay was the subject of an archaeological survey, in which the present author participated, undertaken during the summer of 1974 under the direction of Mr. Steven Cox of the Department of Anthropology of Harvard University. It is 20 km long from east to west, and situated in an area of rugged relief at the northern limit of the forest on the Labrador coast. Wooded cover within it is restricted to its sheltered western and southern slopes. A 20-km-long group of islands extends seaward from the bay mouth.

There is enough ethnographic data for the contact-era Labrador Eskimo of Okak Bay [23-26] for the settlement pattern of the early historic inhabitants to be outlined. "Winter villages" around the north end of Okak Island — the largest island, situated in the mouth of the bay — were occupied during the fall, the winter and, occasionally, the late spring. In the fall (October and November) these villages were the base for hunting harp seals on their southward migration, and any Greenland right whales *(Balaena mysticetus)* or humpback whales *(Megaptera novaeangliae)* that appeared. In the winter they were base camps for hunting ringed seals at breathing holes in the landfast ice, and making short journeys out to the edge of it (the *sina*) in order to hunt walrus *(Odobenus rosmarus)*, ringed seals and other seals. Seals basking on the ice were hunted from the winter camps in the late winter and early spring, the time when the teeth of ringed seals get their dark-staining lines. Before the ice broke up in June, some hunters moved to spring sealing camps on the outer islands to intercept the harp seals during their northward migration. (They appeared in the area just after the ice broke up and did not penetrate deeply into the bay.) Other hunters left at the same time for summer camps on the inner islands and along the bay where they hunted seal before and after the ice broke up, and caught arctic char *(Salvelinus alpinus)* afterwards. The people at the spring camps on the outer islands would return to the winter villages by boat in early summer, then go to their summer camps.

A sample of bones from the Labrador Eskimo sites on the outer islands contained high proportions of bones of walrus (hunted throughout the winter and into the spring) and, as expected, harp seal, but no teeth suitable for sectioning. A bone sample from a probable summer camp on one of the inner islands which contained bird and seal bones and mussel shell, also included teeth of seal (*Phoca* sp.) with the light band in some cases just forming, and in others fairly well formed, a fact which confirmed that occupation had occurred in late spring and/or summer (June-September). A sample of teeth from the winter-house area on Okak Island included ringed-seal teeth with the dark-staining band forming, and some *Phoca* sp. teeth with the light-staining band just beginning to form or fully formed — confirming occupation during the basking-seal season of late winter to early spring, into the late spring, and during the winter breathing-hole season.

The main advantage in a technique of reading the annual layers of teeth in archaeological faunal analysis lies in the fact that it can be employed with isolated teeth, and hence may be applicable to sites, the samples from which are not amenable to any other means of determining seasonality. Also, the annual layers in the tooth can be counted to determine age at death, information useful in analyses based on a minimum number of individuals, and also for estimating the amount of food provided by carcasses. However, there are two major limitations to the employment of the technique. First, the teeth used must be in good condition, with their organic component intact. An attempt to decalcify fragments of zebra *(Equus burchelli)* and hartebeest *(Alcelaphus buselaphus)* teeth from the 18,000-year-old site of Lukenya Hill near Nairobi[27], which were of known low collagen content, ended in the complete dissolution of the samples. However, teeth from the Abri Pataud, a 20,000 to 35,000-year-old Upper Palaeolithic French site [28] are being successfully read by this technique, although they are delicate when decalcified. The other disadvantage is that the technique cannot be used for the estimation of ages to within less than a few months to half a year. However, the present author feels that its value is such that it should be used in conjunction with the more standard techniques for the determination of seasonality. It can be an effective check on these other methods, and a valuable technique when nothing else is available.

ACKNOWLEDGEMENTS

The author was supported in his work towards this paper by grant no. 150 of the Arctic Institute of North America. Mr. Steven Cox received grant no. GS 42896 of the U.S. National Science Foundation.

Arthur Spiess
Department of Anthropology
Harvard University
Cambridge, Mass. 02138
U.S.A.

REFERENCES

[1]Klevezal, G. and Kleinenberg, S. 1969. *Age Determination of Mammals from Annual Layers in Teeth and Bones.* (Translated from Russian). Jerusalem: Israel Program for Scientific Translations.

[2]Mansfield, A. and Fisher, H. 1960. Age determination in the harbor seal, *Phoca vitulina* L. *Nature,* 186:92-93.

[3]Miller, F. 1974. Biology of the Kaminuriak population of barren-ground caribou, Part 2. *Canada, Canadian Wildlife Service, Report* no. 31.

[4]McEwan, E. 1963. Seasonal annuli in the cementum of barren-ground caribou. *Canadian Journal of Zoology,* 41:111-13.

[5]Miller, F. 1974. Age determination of caribou by annulations in dental cementum. *Journal of Wildlife Management,* 38:47-53.

[6]Sergeant, D. and Pimlott, D. 1959. Age determination in moose from sectioned incisor teeth. *Journal of Wildlife Management,* 23:315-21.

[7]Wolfe, M. 1969. Age determination in moose from cemental layers of molar teeth. *Journal of Wildlife Management,* 33:428-31.

[8]Lowe, V. 1967. Teeth as indicators of age with special reference to red deer *(Cervus elaphus)* of known age from Rhum. *Journal of Zoology,* 152:137-53.

[9]Erickson, J., Anderson, A. E., Medin, D. E. and Bowden, D.C. 1970. Estimating ages of mule deer: an evaluation of technique accuracy. *Journal of Wildlife Management,* 34:523-31.

[10]Gilbert, F. 1966. Aging white-tailed deer by annuli in the cementum of the first incisor. *Journal of Wildlife Management,* 30:200-02.

[11]Ransom, A. 1966. Determining age of white-tailed deer from layers in cementum of molars. *Journal of Wildlife Management,* 30:197-9.

[12]McCutchen, H. 1969. Age determination of pronghorns by the incisor cementum. *Journal of Wildlife Management,* 33:172-5.

[13]Allen, S. 1974. Modified technique for aging red fox using canine teeth. *Journal of Wildlife Management,* 38:152-4.

[14]Willey, C. 1974. Aging black bears from first premolar tooth sections. *Journal of Wildlife Management,* 38:97-100.

[15]Sauer, P., Free, S. and Browne, S. 1966. Age determination in black bears from canine tooth sections. *New York Fish and Game Journal,* 13:125-39.

[16]Stoneberg, R. and Jonkel, C. 1966. Age determination of black bears by cementum layers. *Journal of Wildlife Management,* 30:411-14.

[17]Craighead, J., Craighead, F., Jr., and McCutchen, H. 1970. Age determination of grizzly bears from fourth premolar tooth sections. *Journal of Wildlife Management,* 34:353-63.

[18]Smith, T. 1973. Population dynamics of the ringed seal in the Canadian eastern arctic. *Canada, Fisheries Research Board, Bulletin* no. 181.

[19]Hewer, H. 1960. Age determination of seals. *Nature,* 187:959-60.

[20]Laws, R. 1952. A new method of age determination for mammals. *Nature,* 169:972-3.

[21]Laws, R. 1962. Age determination of pinnipeds with special reference to growth layers in the teeth. *Zeitschrift für Säugetierkunde,* 27:129-46.

[22]Scheffer, V. 1950. Growth layers on the teeth of pinnipedia as an indication of age. *Science,* 112:309-11.

[23]Elton, C. and Ashburner, P. Extracts from the periodical accounts, Moravian Mission diaries, ships' logs, and the Reichel reports, 1790-1917. (Unpublished manuscript on microfilm, Stefansson Collection, Dartmouth College, Hanover, N.H., U.S.A.

[24]Hawkes, E. 1916. *The Labrador Eskimo.* Ottawa: Queen's Printer (Geological Survey Memoir no. 91, Anthropological Series no. 14)

[25]Hutton, S. 1912. *Among the Eskimos of Labrador.* London: Seeley, Service and Co.

[26]Tanner, V. 1944. Outlines of the geography, life and customs of Newfoundland-Labrador. *Acta Geographica Fenniae,* 8 (2v.).

[27]Gramly, R. and Rightmire, G. 1973. A fragmentary cranium and dated later stone age assemblage from Lukenya Hill, Kenya. *Man,* 8:571-9.

[28]Movius, H. L. Jr. (ed.) *Excavation on the Abri Patau, Les Eyzies (Dordogne).* Cambridge, Mass.: Harvard University (American School of Prehistoric Research, Peabody Museum, Bulletin no. 30)