Scanning Microscopy

Volume 3 | Number 2 Article 25

6-4-1989

Dietary Differences and Microwear on the Teeth of Late Stone Age and Early Modern People from Western Japan

Teruyuki Hojo
University of Occupational and Environmental Health

Scanning Microscopy, Vol. 3, No. 2, 1989 (Pages 623-628)
Scanning Microscopy International, Chicago (AMF O'Hare), IL 60666 USA

0891-7035/89$3.00+.00

DIETARY DIFFERENCES AND MICROWEAR ON THE TEETH OF LATE STONE AGE AND EARLY MODERN PEOPLE FROM WESTERN JAPAN

Teruyuki Hojo*

Department of Anatomy and Anthropology
School of Medicine
University of Occupational and Environmental Health
Kitakyushu 807, Japan

(Received for publication April 28, 1989, and in revised form June 04, 1989)

ABSTRACT

A small sample of human teeth from western Japan was examined under a scanning electron microscope. All were from sites of two different ages: a Late Stone Age site dating from approximately 4,000 B.P., and an Early Modern site dating from 150-200 B.P. SEM analyses reveal that the scratches on the teeth from the Late Stone Age site tend to be larger and more frequent than those on the teeth from the Early Modern site. These microwear differences may be related to dietary differences between two populations.

Key Words: Canine, Molar, Microwear, Japan, Stone Age, Early Modern, Dietary Differences.

*Address for correspondence:
Teruyuki Hojo, Univ. Occup. & Env. Hlth.
Sch. Med. - Dept. Anatomy/Anthrop
Kitakyushu City 807, Japan
Phone No.: 093-603-1611

INTRODUCTION

Dental microwear analyses have recently been used to make inferences concerning both the biometrics of mammalian mastication (Gordon 1982, 1984a, b, c, Peters 1982, Puech and Prone 1979, Puech et al.,1985, Rensberger 1978, 1986) and the patterns of tooth use in extinct mammals (Biknevicius 1986, Grine 1977, 1981, 1984, 1985, 1986, Krause 1982, Rensberger 1978, 1982, Ryan 1979a, b, c, 1981, Teaford 1985, 1986, 1988, Teaford and Walker 1984, Walker 1981).

Many investigators have noted the relatively heavy wear on the teeth of Stone Age peoples of Japan (e.g. Hojo and Ogata 1971, Imamichi 1933, Kintaka 1928, Kiyono and Miyamoto 1926, Okamoto 1929). However, all of these observations have been made at the macroscopic level, with no studies of microscopic tooth wear patterns.

For the present study, a small sample of teeth was obtained from excavations of a Late Stone Age site and an Early Modern site in the Amakusa Islands of western Japan. The Stone Age skeletons were excavated from a shell mound rich in oyster shells alone with the bones of fish and wild boars. This, in conjunction with the severely worn teeth of these specimens has been taken as an indication of a varied, pre-agricultural diet (Hojo and Ogata 1971). The people from the Early Modern times were agriculturalists with lightly worn teeth. Their diet consisted mainly of sweet potatoes, plus fish, shellfish and a small amount of rice (Hojo 1976).

The purpose of this study was to compare the microscopic wear patterns on the teeth of these people to see if dietary differences could be related to differences in dental microwear patterns.

MATERIALS AND METHODS

The teeth investigated in this study were four mandibular canines and four mandibular first molars. Two canines and two molars came from two Stone Age mandibles dated at approximately 4,000 B.P. The other teeth came from two Early Modern mandibles dated at approximately 150-200 B.P. All were excavated from sites on the shore of the Amakusa Shimoshima island, along the west part of Kyushu, Japan. In order to avoid damaging the original specimens, high-resolution replicas of the teeth were made following almost the same method as Gordon's (1982). The author used araldite-epoxy resin for casting and a low-viscosity vinyl elastomer (GC hydrophylic vinyl polysiloxane impression material, G-C Dental Industrial Corporation, Tokyo Japan).

Each replica was sputter-coated with an 8 nm film of platinum and observed under a scanning electron microscope ("ABT SX-40A") at 15kV.

RESULTS

As shown in Figures 1-8, the microscopic striations on the occlusal surfaces of the Late Stone Age teeth were long and thick from the lingual to the buccal side. On the contrary, there were very few striations on the occlusal surfaces of the teeth from the Early Modern site, and those that were present were relatively thin (see Figures 9-16). Brief examination of other teeth (e.g., P_1, P_2, etc.) revealed similar patterns of inter-group differences.

DISCUSSION/ CONCLUSION

Certainly the samples used in this study were small in number, and the results of this study must be viewed as preliminary in nature. Still, two suggestions can be made for further analyses:

1. In the absence of evidence for other forms of wear (e.g., erosion), the decrease in the amount of microwear from Late Stone Age to Early Modern times suggests a decrease in the amount of abrasives in the diet.
2. Since the size and shape of dental microwear features may be related to the size and shape of the abrasive particles that caused them (e.g., Puech and Prone 1979, Ryan 1979a, b, c), the abrasive particles in the diets of the Late Stone Age people may have been bigger than those in the diets of the Early Modern people. This contrast is similar to that documented for grazing, bone-crushing, and strictly meat-eating mammals by Walker (1980).

Acknowledgments

The author wishes to offer special thanks to Dr. Mark F. Teaford for revising this paper at his office; to Dr. Om Johari for his kindness of recommending the author to Dr. Mark F. Teaford; to Dr. Shahid S. Ashrafi for asking the author to participate in his session at the 1988 SEM Meetings; to other reviewers.

REFERENCES

Biknevicius AR (1986) Dental function and diet in the Carpolestidae (Primates, Plesiadapiformes). Am. J. Phys. Anthrop. 71:157-171.

Gordon KD (1982) A study of microwear on chimpanzee molars: implications for dental microwear analysis. Am. J. Phys. Anthrop. 59:195-215.

Gordon KR (1984a) Taphonomy of dental microwear. II. Am. J. Phys. Anthrop. 63:164-165.

FIGURE CAPTIONS

In each figure the lingual side is superior and the mesial side is to the right.

Figure 1. Occlusal surface of heavily worn mandibular canine from the Late Stone Age site.

Figure 2. Higher magnification of occlusal surface from the canine in Figure 1. More than 10 large and long striations on enamel surface and many pits on dentin surface are observed.

Figure 3. Occlusal surface of the other heavily worn canine from the Late Stone Age site.

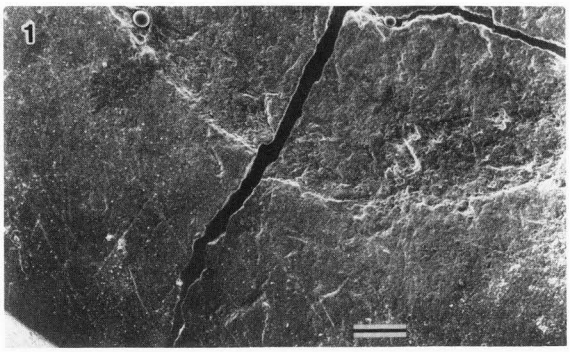
Figure 4. Higher magnification of the mesial border of dentin surface from the canine in Figure 3. Many large pits and striations are observed.

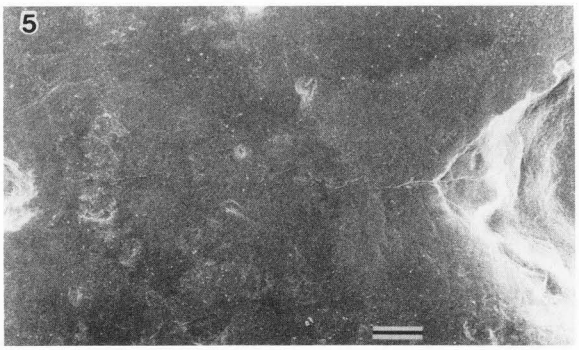
Figure 5. Heavily worn occlusal surface of the buccal side of RM_1 from the Late Stone Age site in Western Japan.

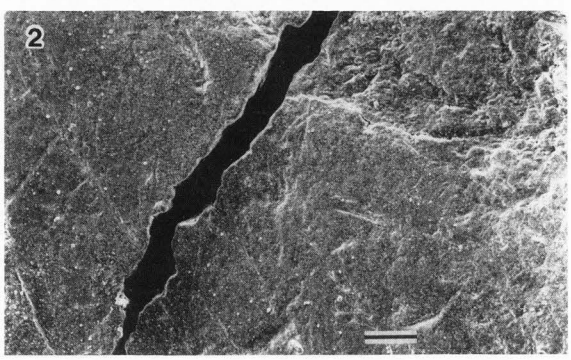
Figure 6. Higher magnification of an occlusal surface of the RM_1 in Figure 5. Note many large and long striations on the enamel surface and large pits on the dentin surface.

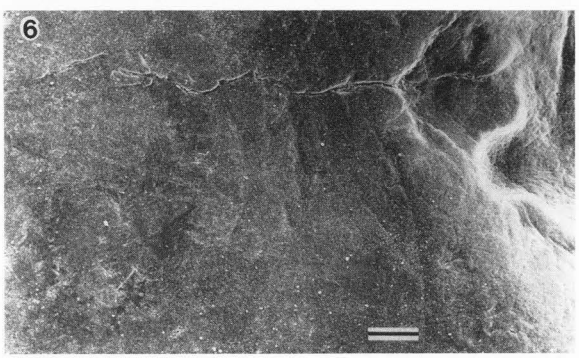
Figure 7. Occlusal surface of the buccal side of the other heavily worn RM_1 from the Late Stone Age site. Almost every part of enamel surface is worn out.

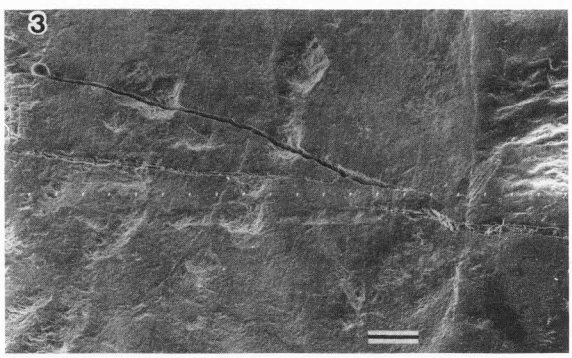
Figure 8. Higher magnification of the occlusal surface of the RM_1 in Figure 7. Again, note many large and long striations and large pits.

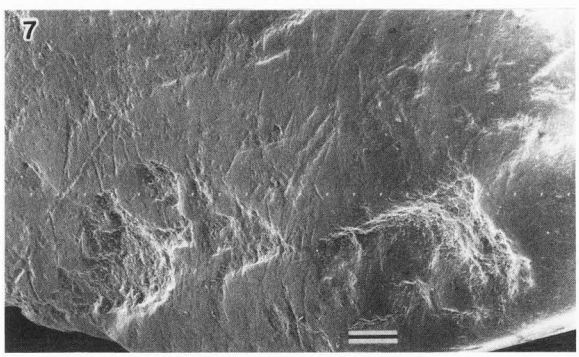


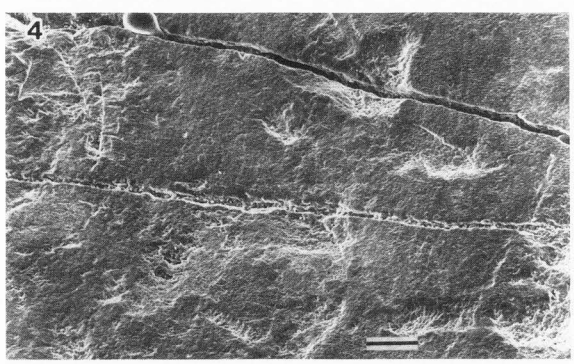


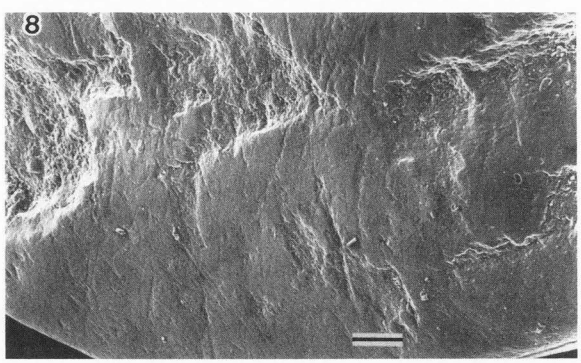




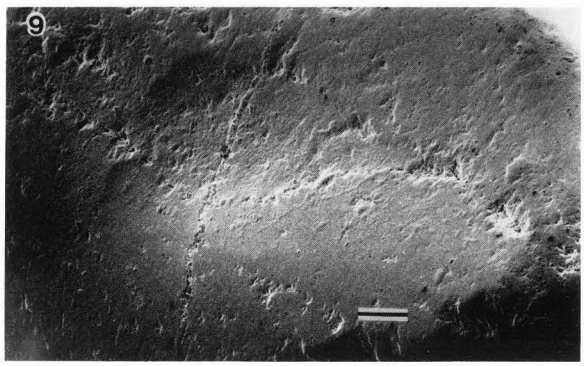


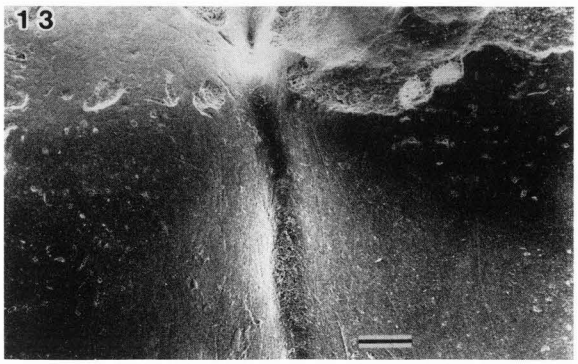


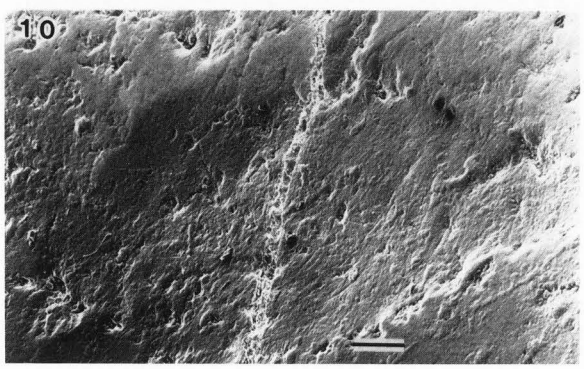


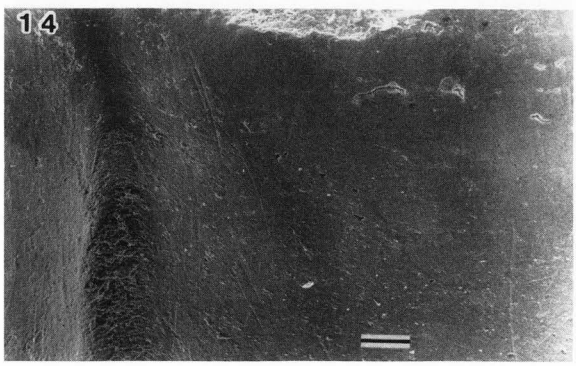


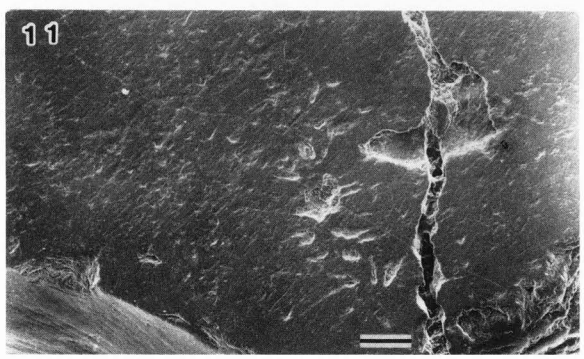
Bars equal: Figs. 1, 3, 5, and 7 : 200 µm;
Figs. 2, 4, 6, and 8 : 100 µm

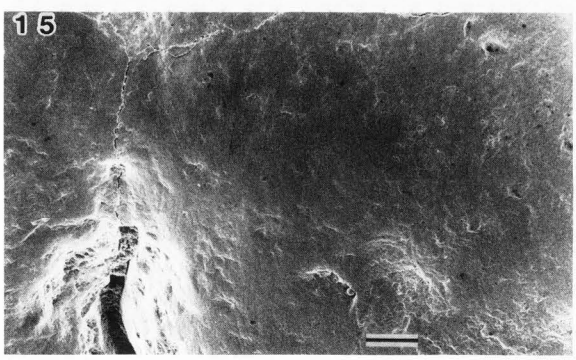


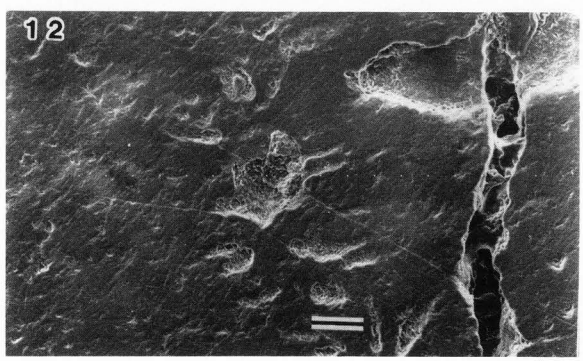


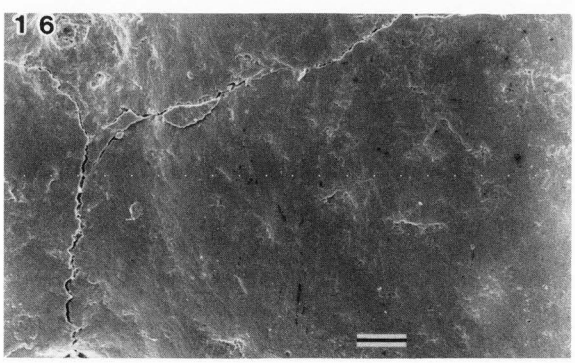












Bars equal: Figs. 9, 11, 13, and 15 : 200 µm;
Figs. 10, 12, 14, and 16 : 100 µm

Figure 9. Heavily worn occlusal surface of mandibular canine from the Early Modern site. Note many small pits and short striations.

Figure 10. Higher magnification of the dentin surface from the canine in Figure 9. Several short and thin striations with many small pits are observed.

Figure 11. Enamel occlusal surface of the other canine from the Early Modern site.

Figure 12. Higher magnification of the enamel occlusal surface of mandibular canine in Figure 11. Many short and thin striations, and two large pits among many other pits are observed.

Figure 13. Buccal occlusal surface of the RM_1 from the Early Modern site. Several thin striations with small pits are observed on the enamel surface.

Figure 14. Higher magnification of the enamel surface of the RM_1 in Figure 13. Several long striations with small pits are observed.

Figure 15. Buccal enamel occlusal surface of the other RM_1 of the Early Modern site.

Figure 16. Higher magnification surface of the RM_1 in Figure 15. Many thin striations with a large pit and small pits are observed on the enamel occlusal surface.

Gordon KR (1984b) Microfracture patterns of abrasive wear striations on teeth indicate directionality. Am. J. Phys. Anthrop. 63:315-322.

Gordon KR (1984c) Pitting and bubbling artifacts in surface replicas made with silicone elastomers. J. Microsc. 134: 183-188.

Grine FE (1977) Analysis of early hominid deciduous molar wear by scanning electron microscopy: a preliminary report. Proc. Elect. Microsc. Soc. S. Afr. 7:157-158.

Grine FE (1981) Trophic differences between 'gracile' and 'robust' australopithecines: a scanning electron microscope analysis of occlusal events. S. Afr. J. Sci. 77:203-230.

Grine FE (1984) Deciduous molar microwear of South African australopithecines. In: DJ. Chivers, BA. Wood, A. Bilsborough (eds): Food Acquisition and Processing in Primates. New York: Plenum Press, pp. 525-534.

Grine FE (1985) Australopithecine evolution: the deciduous dental evidence. In: E. Delson (ed.): Ancestors: The Hard Evidence. New York: Alan R. Liss, pp. 153-167.

Grine FE (1986) Dental evidence for dietary differences in Australopithecus and Paranthropus: a quantitative analysis of permanent molar microwear. J. Hum. Evol. 15:783-822

Hojo T (1976) A few observations on roentgenopaque transverse lines (Harris's lines) in long tubular bones of early modern people. J. Pre-Med. Sapporo Med. College 17:33-37.

Hojo T, Ogata T (1971) On the human skeletons and their artifacts excavated from the Okinoharu shell mound, Amakusagun Kumamoto prefecture. J. Anthrop. Soc. Nippon 79:70(in Japanese).

Imamichi Y (1933) Anthropological studies on the human bones from the shell-mounds of Ota, Bingo. Part I The cranium. J. Anthrop. Soc. Nippon 48 (Suppl.):161-288 (in Japanese).

Kintaka K (1928) Anthropological studies on human bones from the shell-mound of Yoshiko, Mikawa. Part I The cranium J. Anthrop. Soc. Nippon 43 (Suppl.):497-736 (in Japanese).

Kiyono K, Miyamoto H (1926) Anthropological studies on human bones from the shell-mounds of Tsukumo, Bitchu. Part II Crania (concluded) J. Anthrop. Soc. Nippon 41(Suppl.):151-208 (in Japanese).

Krause DW (1982) Jaw movement, dental function, and diet in the Paleocene multituberculate Ptilodus. Palaeobiol. 8:265-281.

Okamoto T (1929) Anthropological studies on human skulls from the shell-mounds of Nishiataka, Higo. Part I Crania J. Anthrop. Soc. Nippon 44 (Suppl.): 3-26 (in Japanese).

Peters CR (1982) Electron-optical microscopic study of incipient dental microdamage from experimental seed and bone crushing. Am. J. Phys. Anthrop. 57: 283-301.

Puech P-F, Prone A (1979) Reproduction experimentale des processus d'usure dentaire par abrasion: implications paleoecologique chez l'Homme fossile. C.R. Acad. Sci. (Paris) 289:895-898.

Puech P-F, Prone A, Roth H, Cianfarani F. (1985) Reproduction experimentale de processus d'usure des surfaces dentaires des Hominides fossiles: consequences morphoscopiques et exoscopiques avec application a l'Hominide de Garusi. C.R. Acad. Sci. (Paris) 301(II):59-64.

Rensberger JM (1978) Scanning electron microscopy of wear and occlusal events in some small herbivores. In: PM. Butler, KA. Joysey (eds): Development, Function and Evolution of Teeth. New York: Academic Press, pp. 415-438.

Rensberger JM (1982) Patterns of dental change in two locally persistent successions of fossil aplodontid rodents. In: B. Kurten (ed.): Teeth: Form, Function, and Evolution. New York: Columbia University Press. pp. 323-349.

Rensberger JM (1986) Early chewing mechanisms in mammalian herbivores. Paleobiol. 12:474-494.

Ryan AS (1979a) A preliminary scanning electron microscope examination of wear striation direction on primate teeth. J. Dent. Res. 58:525-530.

Ryan AS (1979b) Wear striation direction on primate teeth: a scanning electron microscope examination. Am. J. Phys. Anthrop. 50:155-168.

Ryan AS (1979c) Tooth sharpening in primates. Current Anthrop. 20:121-122.

Ryan AS (1981) Anterior dental microwear and its relationship to diet and feeding behavior in three African primates (Pan troglodytes troglodytes, Gorilla gorilla gorilla, and Papio hamadryas). Primates 22:533-550.

Teaford MF (1985) Molar microwear and diet in the genus Cebus. Am. J. Phys. Anthrop. 66:363-370.

Teaford MF (1986) Dental microwear and diet in two species of Colobus. In: J. Else, P. Lee (eds): Primate Ecology and Conservation. Cambridge: Cambridge University Press, pp. 63-66.

Teaford MF (1988) A review of dental microwear and diet in modern mammals. Scanning Microsc. 2(2):1149-1166.

Teaford MF, Walker A (1984) Quantitative differences in dental microwear between primate species with different diets and a comment on the presumed diet of Sivapithecus. Am. J. Phys. Anthrop. 64:191-200.

Walker A (1980) Functional anatomy and taphonomy. In: AK. Behrensmeyer, AP. Hill (eds.): Fossils in the Making. Chicago: University of Chicago Press. pp. 182-196.

Walker A (1981) Diet and teeth. Dietary hypotheses and human evolution. Phil. Trans. R. Soc. Lond. 292(B):57-64.

Editor's Note: All of the reviewer's concerns were appropriately addressed by text changes, hence there is no Discussion with Reviewers.