

# Jacobs Journal of Physiology

Review Article

## Trees, Tusks, and Roots Relating to Human Health and Teeth

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Received: 10-22-2015

Accepted: 10-28-2015

Published: 01-06-2016

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### Abstract

The gist of this article discusses the effect of trees and roots on human health and teeth. The further people are removed from natural wooded environs, the worse is the prevalence of anti-social behavior in that society. The calming therapeutic effect of nature on mentally disturbed individuals is deconstructed and explained through evolution. Human health and oral hygiene, the miswaak, detergent chews, archaeology and selected animals that use their teeth to survive using trees, are considered. The purpose of this article is two-fold. [1] This article discusses trees and their relationship to human health, and [2] appraises herbivores and selected animals, namely the elephant and the beaver who use their teeth and trees to survive, and considers tree- and other roots in relation to general health, human teeth and oral hygiene.

**Key words:** Age; Archaeology; Calculus; Detergent-Chew; Health; Miswaak; Roots; Teeth; Trees

### Background

Most trees grow with distinct morphology being earth bound, anchored with roots which are contiguous with a trunk and spreading branches supporting foliage. Both the whole tree above ground and the underground roots impact human health. [1] Photosynthesis occurs in nature, whereby all green plants synthesize oxygen from atmospheric gases. This occurs with trees in combination with intact arboreal physiology. Because there is less human domestic land encroachment, fewer automobiles, mechanized traffic and polluting people in the countryside, there is usually less air impurities in undisturbed rural settings from vehicle-exhausts, humans and machines. The study of Arboriculture reveals a beneficial impact of trees on the environment and surrounding fauna and flora. Not only do trees provide a whole variety of niches from shady locations below to the canopy area above, they also provide a source of food and nutrition for insects, animals and humans. The whole tree may be used in one way or another, as a resource for use by mankind. Fruits and nuts are well established as tree crops, with the apple being notorious for its apparent effect on teeth. [3] The fewer trees there are in a city or suburb, the more is the likelihood of criminal behavior. The absence of trees and na-

ture is directly proportional to prevalent crime. The more the presence of growing plants in a living area, the less is the likelihood of anti-establishment behavior. Use of nature as therapy has a calming resuscitating and refreshing effects on personalities and mood disposition. The calming therapeutic effect of nature on mentally disturbed individuals is generally acknowledged, and explains why after removing them from sterile urban situations, and placing them into natural environments with natural ecosystems, fauna and flora, with hydro- and geophysical terrestrial features, a general improvement of mental health is obtained. Trees sustain wide biodiversity, and plants, shrubs and flowers flourish independently in nature. [1]

Trees lay down annular rings of xylem and phloem cells as wood. The wood is essentially a storage product of modified energy derived from sunshine. The wood annular rings are a reliable method of determining the age of the tree, but also the thickness of each seasonal ring reflects the weather conditions when the wood was being formed. Similar techniques have been tried with human teeth, but measuring cement lines on tooth roots is not a reliable method for human age determination. [4] These properties render special trees unique qualities, and these are exploited when the fibres in

the roots or branches are prepared and used as natural tooth brushes. See comments on "The Miswaak" below. [3] In archaeology, teeth are also used as an indirect method of assessing diet, the weather and various vicissitudes of living and the environment during tooth growth. [9].

## Aim

The purpose of this article is two-fold. [1] This article discusses trees and their relationship to human health, and [2] appraises tree- and other roots in relation to oral health and human teeth, and discusses selected herbivore animals, namely the elephant and the beaver that use their teeth to eat trees to survive.

## Trees, Roots and Teeth

### Urban Health and Trees

The calming therapeutic effect of nature on mentally disturbed individuals after removing them from sterile urban situations, and placing them into natural environments with natural ecosystems, fauna and flora, with hydro and geophysical terrestrial features, is a known fact among psycho-therapists. Being placed into situations with the full spread of trees, plants, rock and earth formations, the presence of water, flowing, pooled or accumulated, sunshine, open skies with cloud formations with wind, will act as a tranquilizer for the most restless spirits and troubled minds. Modern town planners have most roads converted to arboreal avenues when possible by planting lining trees on the sidewalks. Parks are most desirable in towns and cities and having many trees in them is mandatory for users. Various rituals are held by primitive people who intertwine superstitions with the healing effect of nature. That these rituals involving trees are sustained, shows they do have some effect, regardless of whether the enshrined ritual accompanies the exposure or not. [1] Using nature as behavioral therapy and mood modification is but one strategy in managing distress in dentistry; other refinements for coping strategies are discussed elsewhere. [5] The biochemistry of trees while similar in many respects, do differ in chemical concentrating and physical properties. **Less known is that tree roots, tree-twigs and vegetable roots are widely used as adjuncts for oral hygiene.** [2] Roots of other plants are beneficial for oral hygiene, and are eaten and exploited as a 'detergent chew'. The notion is that a tough chew removes bacterial biofilm from the teeth that contributes to gum disease formation decay reduction. [6-9]

### Oral Biofilm

Globally, tooth decay and gum disease is the most prevalent disease affecting mankind. These oro-dental afflictions are mediated by oral microbial biofilms, often referred to as 'oral plaque.' Not all biofilms are the same. Oral bacteria adhere

to the teeth surfaces and undergo a variety of physiological changes. Early biofilm is mainly aerobic, is constituted by mostly Gram positive, non-motile, exotoxin producing organisms enmeshed in a matrix of extracellular polysaccharide. **The biofilm acts as a dynamic ionic exchange gradient for ion transport. With induced acid environments, the biofilm matrix allows more rapid cationic exchange, and results in decalcification of calcified tooth hydroxyapatite.** Easily metabolized monosaccharides (like fructose, glucose and galactose) or disaccharides (like maltose, sucrose and lactose) are intra-oral acid producing substrates when metabolized by biofilm microbiota. The dental decalcified areas are subsequently vulnerable to bacterial attack and cavitation, facilitating cavity formation. As the bacterial plaques progress, over a period exceeding three or more weeks, the constituents change to a mature biofilm. The mature biofilm 'climax community' is mainly Gram negative, anaerobic, predominantly motile endotoxin producing and is invasive to soft tissue, specifically the periodontal ligament which attaches the teeth to the alveolar bone, as well as the bone and surrounding gingiva. Gum disease as gingivitis, is complicated in vulnerable mouths and periodontitis follows. **Both gingivitis and periodontitis as oral diseases are caused initially by stagnating biofilm.** Gingivitis affects over 90 percent of the population; for periodontitis to develop local precipitating factors include stagnation foci with development of deep gingival pockets, and sustained poor oral hygiene, and all must be present. Systemic predisposing factors like selected genetic pre-dispositions, diabetes mellitus, reduced resistance, or viral infections, all can act as co-factors in facilitating the development of periodontitis in at most 30 percent of people, but more typically below 10 percent of most populations. [6-11] Stagnation of biofilm is the major contributor to initiating gum disease and consequently to control and prevent decay and/or gum disease oral hygiene practices disturb or preferably remove the biofilm. [6-9, 12-14]. Without oral bacterial biofilm no gum disease develops. Research on gnotobiotic animals confirms this. [15, 16]

### The Miswaak

Patients often allow religious rituals to influence their personal practice of oral hygiene. These rituals affect their oral health, and the Muslim religion encourages adherents to practice oral hygiene through the use of a miswaak. There are about 450 million Muslims in the world, and the miswaak, because of Islamic religious directives ubiquitous availability and cheap cost, is widely used in the Uma. **The miswaak (sometimes spelled miswak) is a generic term for a cut piece of fibrous root, or frequently a branch, from a suitable plant.** One end is peeled; the exposed fibres are splayed, and used to scrub the teeth. In principle the use of a miswaak is sound, but it does have disadvantages over modern oral hygiene paraphernalia. Due to the wide variety of roots and plants used, and the various methods of preparation (from totally dehydrated roots, to freshly cut moist stems) there is a huge range of hardness,

brittleness and effectiveness. Some plants have saponins in their sap and other chemicals in the latex which are claimed to be beneficial as whiteners, to be cariostatic or antibacterial effective. These claims have not been adequately researched or investigated due to the lack of consistent reliability of the properties and characteristics of miswaaks used. Miswaak properties will vary according to the changing weather and environs in which they grow. Also the use of miswaaks have been causally related to abrasion of teeth as cervical damage, and the natural lack of consistency of hardness of the miswaak fibres makes it unreliable.[3] Modern commercially available tooth brushes and pastes are strictly controlled with constraining properties, specifications and requirements on abrasiveness with thoroughly researched approved methods to maximize benefits from use. These data in general are lacking for the miswaak, but dental health care workers with this information, should be able to manage a Muslim patient with more targeted advice, greater empathy, explanation and understanding for oral hygiene.[2,3, 18-20]

### Detergent Chews

This term refers to the notion that eating foods which require much mastication will remove biofilm. Root vegetables as, are most popular to achieve this. The low frequency of tooth decay and periodontal disease in primitive societies lends some credibility to this notion. Consequently selected fruits and root vegetables are said to be good 'detergent chews', in the belief that as the consumed food removes biofilm with consequent advantages of decay and gum disease reduction. After biting out a piece of food, most people tend to favor mastication on the posterior of the jaws, and fragment the food bolus in the molar and premolar areas during mastication. Consequently biofilm removal is quantitatively more on bulging tooth surfaces of the posterior jaw segments than on the incisors and canines. [20] Cooking softens most vegetable and fruit fibres and the detergent effect when biting and masticating is lost. Raw roots, selected vegetables and fruits are preferred for this. Consumed fresh fruits embrace apples, crisp pears and other firm-bodied fruits like the Chinese apple-pear. Other vegetables considered good detergent chews include raw sugar cane, raw cabbage, raw celery stems, and root vegetables incorporating carrots, turnips, parsnips, radishes and kohlrabi. **The major oral health challenge arises from common areas of stagnation of oral biofilm.** [22, 26] Detergent chews do not remove all the biofilm from vulnerable areas on teeth. The most vulnerable areas on erupted teeth which allow for biofilm collection and stagnation are: the pits and fissure of the crowns, the cervical margins at the gingival edges and the interproximal locations adjacent and under the contact areas. [21-26] These are the areas which develop decay, and gingivitis frequently starts under the interproximal contacts and in the inter-proximal gingival col.[26] Consequently, modern hygiene practices encourage not only proper brushing, often with

power assisted toothbrushes, but also thorough interproximal dental flossing to disrupt the stagnation of accumulated plaque. [22-24] Pit and fissure sealants dramatically reduce occlusal caries, as does flossing reduce gum disease and interproximal initiation of decay.

### Archaeology

When viewing evolution of hominids going back over 25 million years to prosimian and anthropoid apes, these forbears spent much time in trees before changing their gate to upright. The hominid phylogeny may have started in trees, but as evolution progressed, they preferred the jungle ground before traipsing across the bushy and grassy savannahs as bipedal hominoid Proconsul Pongids and/or Ramapithecusoids. Accordingly it is easy to conceive that *Homo sapiens sapiens* seems to have retained some archetypal 'throw-back' of deep rooted evolutionary behavioral DNA, which allows modern man to derive a sense of well-being when among nature's plants and trees. [28] Man's forbears were omnivorous and both survived on meat and vegetarian foods. During mastication of vegetable foods, minute remnants of consumed vegetation as microscopic phyto-fragmented particles became encased in attached biofilm, which calcified to form attached calculus on teeth. **The attached calculus has survived for millennia, and it is feasible to scrape tartar samples off fossil teeth and determine what vegetation was part of palaeontological hominid diets. The consumed evidence of ancient trees and roots are all there on the teeth!** [29]. Extraction of these fossilized **phytoliths** from dental calculus of early hominids show morphological characteristics of plants, and have stable carbon isotopes. The teeth also reveal dental micro-wear texture as paleo-environmental evidence. Mankind's forbears consumed diets which probably included harder foods, derived from both dicotyledons (revealed by evidence of for example, tree leaves, roots, fruits, wood fragments, tree bark and pollen grains ) and monocotyledons (for example, grasses and sedges). [29-31]

### Herbivores Using Teeth the Beaver

This iconic rodent animal of North America of the genus *Castor* survives and thrives because of its unique adaptation of its teeth. The beaver incisors are fronted with sharp enamel and are continually erupting; the incisors are specialized in shape, and combined with powerful masticatory muscles bite out chiseled chips and shards of wood from tree-stems. This way they fell trees and toll them to the water as building material. Beavers have typical rodent molars with three molar teeth in each quadrant used to grind their food. This amphibious rodent with a broad, flat, oval scaly tail, palmated webbed hindfeet and a coat of soft water resistant fur, is well adapted to living partly in water and on land. The animals build complex huts from felled tree branches and twigs, all cemented together with mud. The inside den is accessible from under water and shared by family groups. They hibernate in these lodges, raise

their young in winter and live off small twigs, roots and plant-shoots harvested during autumn. These wooden beaver island constructions are usually built in locations where the sound of running water is heard. The resulting structure is added to regularly and can enlarge considerably to produce natural dams and waterways. [32] ***Consequently wetlands fauna and flora flourish, with a wide array of fish, birdlife and land animals all becoming more prevalent, thanks to the beavers incisors wood-chomping from trees.***

## Elephants

Extinct Mammoths are the forbears of these animals. These huge four legged thick skinned animals of the order Proboscidea come in two main species, the African and the Indian elephant. The African variety is a larger more robust animal than the Indian variety. ***They both grow bilateral large upper canine teeth, called tusks,*** which emerge from the mouth on either side of the trunk, and protrude outward anteriorly. Tusks are highly prized for their beauty, their rarity and their voluminous tough dentine. The dentine is called ivory, and is used for jewelry, ornate carvings and other artwork masterpieces. [33] In previous centuries, ivory was in great demand for construction of high quality pianoforte keys, and billiard/snooker playing balls. The tusk in the Indian elephant does not grow as large as those prevalent in the African elephant. Some elephants have a longevity which can reach seventy years, and their tusks will continue to erupt and grow throughout their lifetime. Consequently the African elephant grows tusks to huge sizes, often curved and nearly as long as the elephant's legs. The tusks make formidable defense weapons, and are also used to up-root trees, to gain access to the roots and tree-canopy foliage. Tusks have been recorded at over two meters (about ten feet) long, weighing 100 kilos (220lbs). [32] Elephants have large variegated molar teeth to grind their vegetarian diet, but when these are reduced from attrition after reaching old age, the animal essentially dies from malnutrition, as it cannot masticate and grind the ingested food. The elephant diet is strictly vegetarian, and they will eat almost all vegetation as foliage, grasses, bushes and/or trees. In the wild they live in families led by a matriarch elephant.

## Discussion

Trees continue to contribute to the well-being of mankind. Rainforests in Brazil, Central Africa, India, Russia, Europe and Indonesia are being continually being stripped for timber, agricultural, industrial and urbanization purposes. To compensate for this rampant deforestation, informed communities are encouraging replacement by planting numerous trees, which is so essential to provide arborisation benefits on the planet for future generations.

The religious concept of oral hygiene in principle was presaged by the use on the miswaak, but in contemporary society the

miswaak has been replaced with modern tooth brushes and flossing. Miswaak use will be replaced as information, education and increased living standards spreads out globally.

## Stagnating biofilm

Remains as the main cause of gum disease, and gum disease remains among the most prevalent causes of premature tooth loss in mankind. Oral bacteria are part of the human biome and controlling oral plaque stagnation from an early age ensures people keep their teeth for life.

## Modern diets

Exhort people to eat more fruit and vegetables. Dietary fiber is low in contemporary diets and including more fruits and vegetables as detergent chews would increase dietary fiber content and contribute to oral hygiene. However eating only foods deemed to be detergent chews is not adequate and should not replace proper oral hygiene techniques of brushing and flossing.

## Archeology Using Paleobiology

The techniques show calcified biofilm on teeth retain clues as to what the diet was when the teeth were functioning. Particles as small as pollen grains become entombed in calcium and when retrieved tell accurately from where the pollen grain derives.

## Beaver

The fur was used to make hats, and sustained an enormous fur industry in the 19th and 20th centuries in North America, particularly Canada. Beavers were hunted to near extinction in the USA until better synthetic fibers were discovered. Today (2015) beavers are used to reclaim wet lands and recovery of ecosystems supporting wildlife is on the increase throughout North America.

## The Elephant

Even though **ivory** trade is now (2015) banned world-wide, illegal trading in poached ivory persists. Poachers are killing elephants at such a rate; elephants have become a threatened species. Techniques exist to locate precisely where the animal was killed, and follow up of discovered contraband ivory hopefully will put an end to illegal poaching. Because ivory is essentially compact natural dentine it is made up of calcified channels housing cellular extensions from pulpal odontoblasts; accordingly ivory contains some water, and to avoid ivory cracking from dehydration shrinkage, ivory needs moisture. Jewelled ivory pieces when stored must be kept in hydrated conditions. Worn ivory seems to absorb moisture from the human body and is less prone to crazing and cracking.

**Concluding Remarks**

Teeth in the animal kingdom are used for biting off bits of food, and mainly mastication, but also for transport (the sea-lion and walrus use their tusks for locomotion), fighting protection (most cats and predatory animals), hunting for prey, and also for injecting venom with bites (like snakes). The relationship between **trees, roots, human health and teeth**, may seem odd to some, but they are all related to the existence and betterment of living for humans. This appraisal provides a different viewpoint to clarify how biofilm may reflect dietary contents in fossilized calculus, how early origins of oral hygiene practices started the notion of using plants as detergent chews, and how trees contribute to mankind's well-being. The importance of teeth to two other animals, the beaver and elephant, are deconstructed to show how teeth are important to these herbivores.

**References**

1. Nilsen K, Sangster M, Gallis C, Hartig T et al. Forests , Trees and Human Health and well being.2011, 1-19.
2. Touyz L.Z.G, Khan M.N, Goga E. A note on the Miswaak. *Dias-tema*. 1985, 13: 34-36.
3. S Darwish. The management of the Muslim dental patient. *British Dental Journal*. 2005, 199(8): 503-504.
4. Touyz L.Z.G. Management and coping strategies of stress and distress in Dentistry. *Journal of Dentistry and Management*.
5. Touyz L.Z.G. Demystifying Apples and Teeth. *Jnl Of Dental Health and Research*. 2015.
6. H. Renz, R.J. Radlanski. Incremental lines in root cementum of human teeth —A reliable age marker? *HOMO - Journal of Comparative Human Biology*. 2006, 57(1): 29-50.
7. Heinrichs J E. The role of calculus and other predisposing factors. 170-192. In Carranza's *Periodontics*. 10 Edition. Eds Newman, Carranza, Klokkevold & Carranza. Saunders/Elsevier.
8. Socransky SS, Haffajee AD. Microbial mechanisms in the pathogenesis of destructive Periodontal diseases. A critical assessment. *J Perio Res*. 1991, 26: 195-201.
9. Eke PI, Dye BA, Wei L, Thornton-Evans GO, Genco RJ. CDC Periodontal Disease Surveillance workgroup. Prevalence of periodontitis in adults in the United States: 2009 and 2010. *J Dent Res* . 2012, 91(10): 914-920.
10. Kolenbrander PE . Oral microbial communities: Biofilms, interactions and genetic systems. *Ann Rev Microbiol*. 2000, 54: 413-437.
11. Beaglehole R, Benzian H, Crail J, Mackay J. The oral health atlas: Mapping a neglected global health issue. FDI World Dental Education & Myriad Editions. 1st Ed. 2009, 1-120.
12. Pihlstrom BL, Michalowicz BS, Johnson NW. Periodontal diseases. *The Lancet*. 2005, 366(9499) : 1809-1820.
13. Biofilm/Adhesion: *Archives of Oral Biology*: 58(10) 2013.
14. Schwarcz J. Wollaston's test helped free us from 'stone age'. 2009, The Montreal.
15. Gordon HA, Pesti L. The gnotobiotic animal as a tool in the study of host microbial relationships. *Bact Rev*. 1971, 35(4): 390-429.
16. Coates M E .In: The germ free animal in research. Passim. Coates EM , Gordon HA and Wostman Eds. Academic Press NY.
17. Haffajee ADD, Bogren A, Hasturk H, Feres M, Lopez NJ e al. Sub-gingival microbiota of chronic Periodontitis from different geographic locations. *J Periodontol*. 2004, 31(11): 996-1002.
18. Lamont RJ & Yilmaz O. In or out: the invasiveness of oral bacteria. *Periodontol 2000*. 2002, (30): 61-69.
19. Loesche WJ. Bacterial mediators in Periodontal diseases. *Clin Infect Dis*. 1993, 16 Suppl 4:5203-5210.
20. Broadbent JM, Murray W, Boyens JV, Poulton R. Dental plaque and oral health during the first 32 years of life. *J Am Dent Assoc* . 2011, 142(4): 415-426.
21. Watson RM. Masticatory ability : cineradiographic observations. *J Dent*. 1972, 1(2): 54-62.
22. Marsh PD. Contemporary perspective on plaque control. *Br Dent J*. 2012, 212(2): 601-606.
23. Renzo A, Vasquez C , Conde E, Grender JM, Cunningham P et al. An Eight-Week Clinical Evaluation of an Oscillating-Rotating Power Toothbrush with a Brush Head Utilizing Angled Bristles Compared with a Sonic Toothbrush in the Reduction of Gingivitis and Plaque. *J Clin Dent*. 2015, 3: 80-87.
24. Schneiderman E, Colón E, WhiteDJ , St. John S . A Profilometry-Based Dentifrice Abrasion Method for V8 Brushing Machines Part II: Comparison of RDA-PE. and Radiotracer RDA Measures. *J Clin Dent*. 3: 61-65.
25. Ghassemi L, Vorwerk A, Cirigliano W, Hooper P et al (2015) Clinical Effectiveness Evaluation of a New Whitening Denti-

frice. *J Clin Dent* . 3: 6671.

26. Cawson RA, Binnie WH, Barrett AW, Wright JM. Oral Diseases. Clinical and pathological correlations Third Ed. Dental caries, its sequelae, regressive changes . 3.1 - 3.14. Gingivitis and Periodontitis 4.3 - 4.16.

27. Cochrane DL, Kalkwarf KI, Brunswalvold MA. In *Plaque and Calculus Removal*. Passim . Quintessence.

28. Jelinek J. In: *The Evolution of Man*. Part I. The position of Man and his ancestors within the zoological system. Hamlyn Publishing.

29. Henry AG, Ungar PS, Passey BH, Sponheimer M. The diet of *Australopithecus sediba*. *Nature*. 2012, 487, 90-93.

30. Fiorenza L, Benazzi S, Tausch J, Kullmer O et al. Molar Macrowear Reveals Neanderthal Eco-Geographic Dietary Variation. *PLOS One*. 2011, 18, 6(3).

31. Brahic C. Early human relative ate bark, fruit and leaves. *New Scientist*. 214( 2871): 12-24.

32. Gudenian H, Ward S. Editors: In *"The New Oxford Illustrated Dictionary"* . The Beaver p 130. The Elephant P 542. Bay Books & Oxford University Press. 1976.

33. Touyz L Z G. Teeth Tusks and other Odontogenic Conundra. *A Dental Miscellany*. *Probe and Mirror*: 17(4): 11.