upper limits of altitude for those breeding montane bird species that are restricted by temperature? This question could easily be tested by examining summer minimum temperatures at birds' altitudinal ceilings and by comparing the polewards decrease in ceiling with that in temperature.

Third, might there be a ceiling similar to the 2.5 rule for increased metabolic rates in response to variables other than low temperature? Winter is not necessarily the period of highest energy expenditure for a bird; expenditure also peaks when parent birds are feeding young and perhaps during moulting. It is intriguing, as Root notes, that avian energy expenditures during reproduction and those averaged over the whole year also seem to be low multiples of the basal metabolic rate (up to 4 times and 2.6–3.2 times, respectively).

Of course, Root does not claim that all range borders are set by temperature. She shows that some coincide closely with isotherms, some with contours of other environmental variables, and others do not coincide with any environmental contour. J.W. Terborgh (*Ecology* **66**, 1237–1246; 1985), studying the world's most species-rich avifauna, that of the equatorial Andes, showed that about two-thirds of bird altitudinal limits there are set by interspecific competition, and less than one-sixth are set directly by physical gradients like that of temperature. Terborgh's finding supports Hutchinson's distinction between the realized niche of a species (that compressed by competition and predation) and its fundamental niche (that permitted by its physiology). The more species-rich the fauna, the narrower on the average will be the realized niche compared with the fundamental niche.

The limits of the fundamental niche are not achieved in practice by most Andean bird species, and the same may also be true for some temperate-zone congeneric species pairs with abutting ranges (for example, various pairs of chickadees and jays in North America). Will the ratio of resting metabolic rate at northern winter boundaries or altitudinal ceilings to basal metabolic rate in these competition-limited species be much less than 2.5? □

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Anthropology

Early teething troubles

Paul G. Bahn

RECENT studies of grooves in ancient human teeth have led to a widespread consensus that the toothpick may be one of the earliest tools devised by humanity. Although this idea is not new, it is controversial. Similar grooves had been found and reported[1] in 1911 at the French Middle Palaeolithic (200,000–35,000 years before present (BP); Neanderthal period) site of La Quina, and interpreted as the result of constant use of toothpicks. But others have attributed the grooves to chemical erosion. The new studies[2–4] strongly suggest that picking one's teeth is indeed one of humanity's oldest habits.

The grooves generally occur along the junction between the cementum and the enamel, mostly on premolars and molars (both upper and lower), and have a semi-circular or trough-like shape, with longitudinal and parallel striations. In some cases the grooves are bordered by ridges of reactive cementum, probably produced as a response to the irritation caused by the tool. The earliest known examples of the phenomenon occur in upper premolars of *Homo habilis* at Omo (Ethiopia), dating to 1.84 million years ago[2]. Several cases in *H.erectus* and archaic *H.sapiens* are known from the Middle Pleistocene (700,000–130,000 years BP) at sites such as Zhoukoudian (China), Rabat (North Africa), Atapuerca (Spain) and in the Soviet Union[2–4].

The most thorough investigation has been carried out by Frayer and Russell[5] on Neanderthal teeth from Krapina, Yugoslavia, which date to the Middle Palaeolithic. Their microscopic examination of shallow grooves on 14 teeth from 10 individuals (aged between 16 and 27) reveals that they existed only on erupted permanent teeth, almost exclusively on premolars and molars, and most commonly on third molars. The same phenomenon has also been reported on isolated teeth from other Middle Palaeolithic sites: not only La Quina[1] but also Hortus (France) and Gibraltar[2,4]. Other European Upper Palaeolithic (35,000–130,000 years BP) cases are known, particularly in the skeletal material from the Grimaldi caves (Italy)[6], where the grooves are more common in upper teeth than in lower and, as usual, in back teeth rather than incisors.

The grooves persist in Europe through the Mesolithic, Neolithic and Bronze Age, and into history. In the New World too, they have been found as far back as the 7th millennium BP in North America, and in the 10th millennium in Peru[3].

There are alternative explanations for the phenomenon — root caries (dental erosion, where bacteria attack the tooth surface); gritty saliva being propelled between the teeth; and fibre processing. None of these, however, really fits the evidence. Taphonomic erosion would not cause ridges of reactive cementum, root caries would not extend onto the enamel surface, and gritty saliva would probably affect the front teeth as well, while fibre processing might affect them even more than the back ones. The consistent location of the grooves; the longitudinal polish and striations, suggesting a prolonged back-and-forth movement of an inflexible probe; and the similarity of the prehistoric grooves to those documented in historical and modern populations including Amerindians, Australian Aborigines, Canary Islanders and Upper Dynastic Egyptians, are all factors that argue for the toothpick interpretation of the data.

Why were toothpicks used by early humans? Oral hygiene is known even among some non-human primates[7]; but it is thought that the presence and depth of some prehistoric grooves reveal a prolonged repetitive activity. Some ascribe this to attempts to relieve problems such as gum irritation, but others[6] speculate that it may have been a largely unnecessary, non-functional pastime that was cultural rather than practical. □

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100 years ago

A MOVABLE ZOOLOGICAL STATION

IN Bohemia, much attention has been given for more than twenty years to the study of the fauna of ponds and lakes, but the work has been rendered difficult by the impossibility of the organisms being examined instantly in their habitats. Last year, a little movable station, suitable for real biological work was presented to the Committee for the Physical Exploration of Bohemia; and there is good reason to hope that the use of this structure may be attended by important scientific results.

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