CHAPTER 11

Diminution of the Canine Teeth

"Canine tooth size reduction is one of the few defining features of the hominin clade…and is recognized as a signal of important behavioural and adaptive changes". "[S]ubstantial reduction in male canine crown size and loss of significant dimorphism probably occurred near the origin of hominins"
[Ward, et al., 2010, pp. 3334, 3336].

Introduction. As the epigraph states, diminution of canine tooth size is a trend in hominin evolution which began close to the onset of our lineage. Its subsequent progression during millions of years indicates it was associated with a behavior that brought reproductive benefits for an extended duration of time. Because size reduction commenced so early and followed a course that is seemingly unique among the anthropoids, it has become a marker of hominin status [Richmond, et al., 2001; Haile-Selassie, et al., 2004; Brunet et al., 2005; White, et al., 2009a; Ward, et al., 2010].

As the canines began to shrink, there were also changes in their shape. Simultaneously, the premolars and molars enlarged (Chapter 6). It now seems possible to account for the evidence with an explanation based upon use of hand-held weapons coupled with changes in diet. The basic idea (to be developed below) is that hominin canine teeth became reduced in size because their long, dagger-like form, exaggerated in males, lost the ability to promote reproductive success by use in threat and fighting. They were rendered obsolete for this function due to the development of a new mode of combat involving hand-held weapons. Natural selection then favored smaller canines with a new shape that improved the processing of food.

Canine teeth in anthropoids. In anthropoids, the length of canines (crown height) and their gender size dimorphism is strongly associated with fighting between males [Greenfield, 1992; Plavcan and van Schaik, 1992, 1997a, b; Plavcan, 1993, 2000; White, et al., 2009a]. They are significantly larger in males of species that engage in combat to gain reproductive advantages. The enlarged canines function as weapons both in fights among males and conflicts with predators when their length and sharp tips (particularly in the upper jaw) facilitate puncturing and slashing [Greenfield and Washburn, 1991; Greenfield, 1992; Plavcan and van Schaik, 1992; Plavcan, 1993]. The smaller adult female canines and the deciduous canines of both sexes exhibit incisor-like traits, indicating selection for dental functions other than fighting [Greenfield, 1992].

In chimpanzee males, the canine teeth are large, conical, sharply pointed, and project well beyond the incisors and premolars, as shown in Figure 10. There is a wide diastema (gap) in the mandibular and maxillary arches to accommodate them during occlusion. A facet of wear develops on the crown of the maxillary canine from contact with the third premolar in the opposing jaw. In modern humans, the situation is quite different. The canines are relatively small, incisiform (incisor-like), the tip is blunt, prominent gender dimorphism is lacking, no diastemata are present, and the canines wear down from the tip to the level of the premolars [Le Gros Clark, 1964; Aiello and Dean, 1990].

Paleontological evidence of canine evolution in hominins. Specimens of the earliest putative hominin, *Sahelanthropus tchadensis* from Chad, are dated near the estimated time of hominin origins (7 Mya). The crown of a mandibular canine tooth is short, compared to its counterpart in modern chimpanzees. (This suggests that the canines might have lengthened in chimpanzees after their divergence from hominins). The pattern of wear is consistent with the absence of a functional canine/third premolar (C/P_3) honing complex, by which apes sharpen the distal edge of the upper canine [Brunet, et al., 2002, 2005].

Remains of *Orrorin tugenensis* from Kenya (6.0-5.8 Mya) include an upper canine tooth said to be "short" but "large for a hominid" with a pointed apex recalling those of female chimpanzees [Senut, et al., 2001].

Canine teeth of *Ardipithecus kadabba* from Ethiopia (5.7 Mya) are shorter and more incisiform than in apes [Haile-Selassie 2001] although one upper canine lies at the margin of the female chimpanzee distribution [Haile-Selassie, et al., 2004]. A small facet occurs on a left lower P_3, indicating a C/P_3 honing complex. There is no evidence of this feature in subsequent hominins.

Ar. ramidus (4.4 Mya) also from Ethiopia, had canines that are more incisor-like and protrude less than in chimpanzees [White, et al., 1994; Semaw, et al., 2005]. They are similar to those from female apes. Gender size dimorphism is not apparent [White, et al., 2009a]. *Ar. ramidus* canines have thin tooth enamel and are large relative to the premolars and molars [Ward, et al., 1999b]. The lower canines retain a more apelike morphology than do the uppers, and are unlike those in other anthropoids insofar as the height of the maxillary canine crown is less than that of the mandibular [Suwa, et al., 2009b].

Figure 10. Male anthropoids, such as the chimpanzee shown here, use their long, pointed canine teeth as weapons for threat and fighting [from Young, 2010]. Diminution of human canines, which began early in hominin evolution and continued during four million years, is likely due to the origin and subsequent selection of a more effective way of fighting—the bipedal use of hand-held weapons. The shrinking canines became adapted to another function: food processing.

Fossils of *Australopithecus anamensis* (4.2-3.9 Mya) have been found in Kenya, [Ward, et al., 1999, 2001] and Ethiopia [White, et al., 2006]. All australopithecines, beginning with *A. anamensis*, have a thicker enamel layer on their teeth than earlier hominins, with that in robust species being especially thick [Ward, et al., 1999b]. *A. anamensis* upper canines are the same size or slightly smaller than those in *Ar. ramidus* [Ward, et al., 1999b, 2001] and gender dimorphism is reduced [Ward, et al., 2001; White, et al., 2009a]. Diastemata are still present, but there are changes in the maxillary canine-mandibular P_3 relationship. Both teeth are shorter mesiodistally, canine tooth crowns are more symmetrical in profile, third premolars are broader, canine roots are smaller, gender dimorphism is further reduced and molar crowns are higher [Ward, et al., 2010]. Two maxillary canines from Ethiopia are at or above the upper range of size in *A. afarensis*; the remainder are within that range. When the canines are compared to the postcanine dentition, *A. anamensis* has relatively larger canines than *A. afarensis* [Ward et al., 1999b, 2001].

A. afarensis is known from Ethiopia and Tanzania, 3.8-3.2 Mya [White, et al.,

1993; Haile-Selassie, 2010]. In this hominin the canine teeth are further reduced in size [M. G. Leakey, et al., 1998; Ward, et al., 1999; Kimbel, et al., 2006]. The crown tips were blunted as they came into occlusion [Greenfield, 1992]. There are some diastemata between the lateral incisors and canines, but they are less common than in earlier hominins [Johanson and White, 1979; White, et al., 1981; Greenfield, 1992]. The maxillary and mandibular canine teeth project slightly beyond the tooth row; their roots are large and long [Johanson and White, 1979]. Gender size dimorphism is reduced, but exceeds that in *H. sapiens* [McHenry, 1991b]. The shape of the canine crown is more incisiform in *A. afarensis* than in *A. anamensis* [Kimbel, et al., 2006] and there is less wear on the anterior teeth [Ward, et al., 2010]. *A. garhi,* a 2.5 Mya hominin from Ethiopia, had canines similar to those of *A. Africanus* [Asfaw, et al., 1999].

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