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CROWN HEIGHT AND ATTRITION IN THE AUSTRALOPITHECINAE

ABSTRACT. — Anatomical crown height (ACH) and the severity and pattern of occlusal and interproximal attrition were recorded for teeth of A. africanus and A. robustus. There was a negative and highly significant correlation between ACH and attrition for each tooth ($r = -0.56$ to -0.96), and crown height for the two species was significantly different ($p < 0.05$) with attrition scores held constant. From the regression equation $y = bx + a$, the range of ACH values for any degree of attrition was calculated for each tooth in both species. These values provide standards for establishing the affinities of unidentified early hominid teeth.

KEY WORDS: Crown height — Attrition — Australopithecinae.

INTRODUCTION

The morphological differences present in the teeth and jaws of the Australopithecines are considered to reflect differences in evolutionary status and behavioral strategies rather than allometric differences in body size (Robinson 1956; Leakey 1976; Walker and Leakey 1978; Howell 1978; Wallace 1975; 1978; Tobias 1980; 1983; Stack and Wood 1980; Walker 1981; Wood 1981; Johanson 1980; Johanson and White 1979; Johanson et al. 1982; White et al 1981; Ward and Molnar 1980; Kay 1981). Differences in the size and morphology of the teeth, and size ratios of anterior to posterior teeth have been repeatedly referred to in these reports. However, all studies of tooth size, especially those in which sample sizes are small, are hampered by the presence of attrition on the teeth. This reduces crown height and mesiodistal dimensions by an unknown factor, so that measurements based on attrited teeth are unreliable. They are usually omitted from calculations of tooth size, which further limits numbers available for comparison.

Attrition can be scored for increasing degrees of severity (Murphy 1959a, b; Smith 1972). Enamel facets appear on tooth surfaces as they make contact with one another and increase in area as the convexities wear down. This is followed by dentine exposure of increasingly large areas of the tooth. These become hollowed out since dentine is softer than enamel. Gradually, as more dentine is worn away, secondary dentine is exposed, and finally the pulp cavity is also exposed. Each stage of attrition can be scored (Murphy 1959a, b) and shows a negative correlation with crown height. In a series of studies recently carried out using these variables, correlations of $r = 0.5$ to $r = 0.85$ were found for different teeth. Forthermore, when homologous teeth of different populations, with crown size differences of 5—10 % were compared, no differences were found in the slope of attrition (Mann 1983; Smith et al. in prep.).

Differences in dental morphology between different species of Australopithecines are, however, much greater than those between different populations of *Homo sapiens*. *A. robustus* has thicker enamel and flatter cusps as well as larger teeth than *A. africanus* (Robinson 1956; Sperber 1974; Grine 1981; White et al. 1981). In comparing crown height and attrition in *A. robustus* and *A. africanus,* a difference should then be present, with more tooth material lost per increment of attrition in *A. robustus* than in *A. africanus.* That is, the regression slope of *A. robustus* for crown height on attrition, should be flatter than in *A. africanus.*

In order to test this hypothesis, the present study of crown height and attrition was carried out. It is proposed, that if the regression of crown height on attrition proves to be markedly different in *A. africanus* and *A. robustus,* then the regression formulae may be used to quantify differences between them and to provide standards against which isolated specimens may be compared.

METHODS AND MATERIALS

This study was carried out on the teeth and jaws of *A. robustus* and *A. africanus* present in the collections of the Transvaal Museum, Pretoria and Department of Anatomy, University of Witwatersrand, Johannesburg. For each tooth the anatomical crown height was measured on the buccal surface of the tooth along a line parallel to its main axis. The incisors and canines, were measured from the cemento-enamel junction to the incisal edge. The premolars were measured to the tip of the buccal cusp, and the molars were measured to the tip of the mesiobuccal cusp. Attrition was scored for the occlusal surface of the incisors and canines. The buccal and lingual cusps of the premolars were scored separately and so were each of the main molar cusps (mesiobuccal MB; mesiolingual ML; distobuccal DB; and distolingual DL). A six point scale was used (Smith 1972) where 1 = no attrition; 2 = attrition of enamel facets more than 1 mm in diameter; 3 = dentine exposed on cusp tips; 4 = cupping of dentine; 5 = secondary dentine exposure and 6 = pulp exposure or wear to the root.

RESULTS

The mean values and range of measurements obtained for crown height are shown in *Figure 1* together with mean values for attrition scores. Since many specimens were represented by less than three teeth, this table cannot be used to compare crown height or attrition patterns along the tooth row. It does however show the extent of interspecies differences in the range of values obtained for crown height, mean crown height and attrition. The maximum values recorded for crown height give the anatomical crown height of unworn teeth. In the molars and premolars, these values are greater in *A. robustus* than in *A. africanus.* In the canines and incisors, crown height is greater in *A. africanus.*

The mean score for attrition in the mandibular teeth of *A. africanus* is greater than in *A. robustus.*

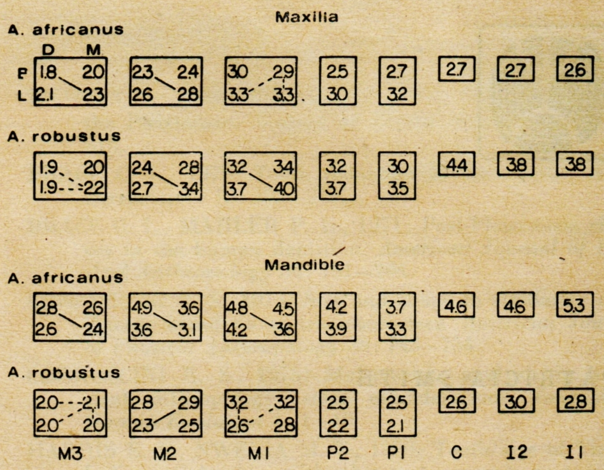

FIGURE 1. *Mean attrition scores of individual cusps.* Key M = mesial; D = distal; B = buccal; L = lingual

The pattern of attrition of individual cusps is also different. In the lower first molar of *A. africanus,* the distobuccal cusp has the highest attrition score, and the mesiolingual cusp the lowest score. In the lower first molar of *A. robustus* the attrition scores for both buccal cusps is similar, and that of the distolingual cusp lowest *(Figure 1).* The lower second and third molars also show interspecies differences in attrition patterns. There is more attrition distally than mesially in *A. africanus* as compared with *A. robustus* where attrition is more evenly distributed over the tooth surface. In the maxilla, *A. africanus* molars have more attrition on the lingual cusps than on the buccal cusps. In *A. robustus* there is less difference between attrition scores for all four cusps, and the second and third molars have more attrition mesiobucally than distolingually. The reverse relationship is true of *A. africanus.*

Attrition scores for the mesiobuccal cusp plotted against crown height gave negative and highly significant correlations ($r = -0.5$ to -0.9) for all teeth from canine to second molar *(Figure 2).* The first and second incisors could not be analyzed in this way because of the small number of specimens. The slope resulting from the regression equation ($y = bx + a$) is steepest in *A. africanus* for the molars and premolars and shallower for the canines. That is, for similar grades of attrition, more tooth subtance (crown height) was lost in *A. robustus* cheek teeth than in those of *A. africanus.*

DISCUSSION

Differences in attrition patterns of *A. robustus* and *A. africanus,* have been reported by a number of investigators. Robinson (1956) reported on the presence of small pit-like fractures in the enamel of *A. robustus,* that he considered due to the presence of large quantities of grit in the diet. Grine (1981) verified these observations in a scanning electron microscope study of tooth surfaces. He found that teeth in *A. robustus* had deeper scratches and more pits than teeth of *A. africanus.* Wallace (1975, 1978) commented on the reverse bevel of occlusal wear facets of teeth in *A. robustus.* He attributed this to the presence of a more anteriorly positioned mandible in this species than in *A. africanus* or *Homo.* He also commented on the absence of helicoidal wear patterns in either *A. africanus* or *A. robustus.* Wallace (1975) emphasised that these differences in attrition patterns were present even in juvenile specimens showing slight wear facets, and so were not related to differences in severity of attrition. Similar conclusions were reached by Grine (1981), who reported that even in deciduous molars, the buccolingual slope of occlusal attrition differed between *A. africanus* and *A. robustus.*

Tobias (1980) stated that helicoidal wear patterns, absent in the Australopithecines, were present in *Homo habilis,* and could be considered diagnostic of *Homo.* This he attributed to differences in the shape of the upper dental arch. He concluded that the presence of a helicoidal wear pattern in the third molar region was associated with the narrowing of the upper arch. He considered this one of the many morphological differences between *Australopithecus* and *Homo.* This conclusion was questioned by Osborn (1982) who claimed that helicoidal wear patterns were present not only in both *A. robustus* and *A. africanus,* but also in the Dryopithecine specimen from Mobutu. Osborn emphasized that, as pointed out earlier by Campbell (1925), Ackerman (1953) and Murphy (1959a, b; 1964), attrition patterns change throughout life. They depend on chewing patterns, arch relationships, and the range and direction of chewing movements, as well as the buccolingual inclination of the teeth in the jaws.

The results presented here demonstrate a marked difference in attrition scores of homologous teeth in the two species. This factor must then be taken into consideration when considering differences in attrition patterns. Those cusps in contact most frequently wear down fastest, so that differences in attrition of the cusps increases as the severity of attrition increases. Even for the maxillary teeth, where attrition scores were most severe in *A. robustus,* attrition patterns differed. There was relatively more attrition on the buccal cusps of *A. robustus.* These results support earlier hypotheses proposing a fundamental difference in chewing patterns and/or arch relationships between the *Australopithecinae.* Neither species showed a reversal in the rank order of attrition in the third molar cusps, from buccal to lingual, as would be expected were there a helicoidal wear pattern present.

The findings obtained here then agree with

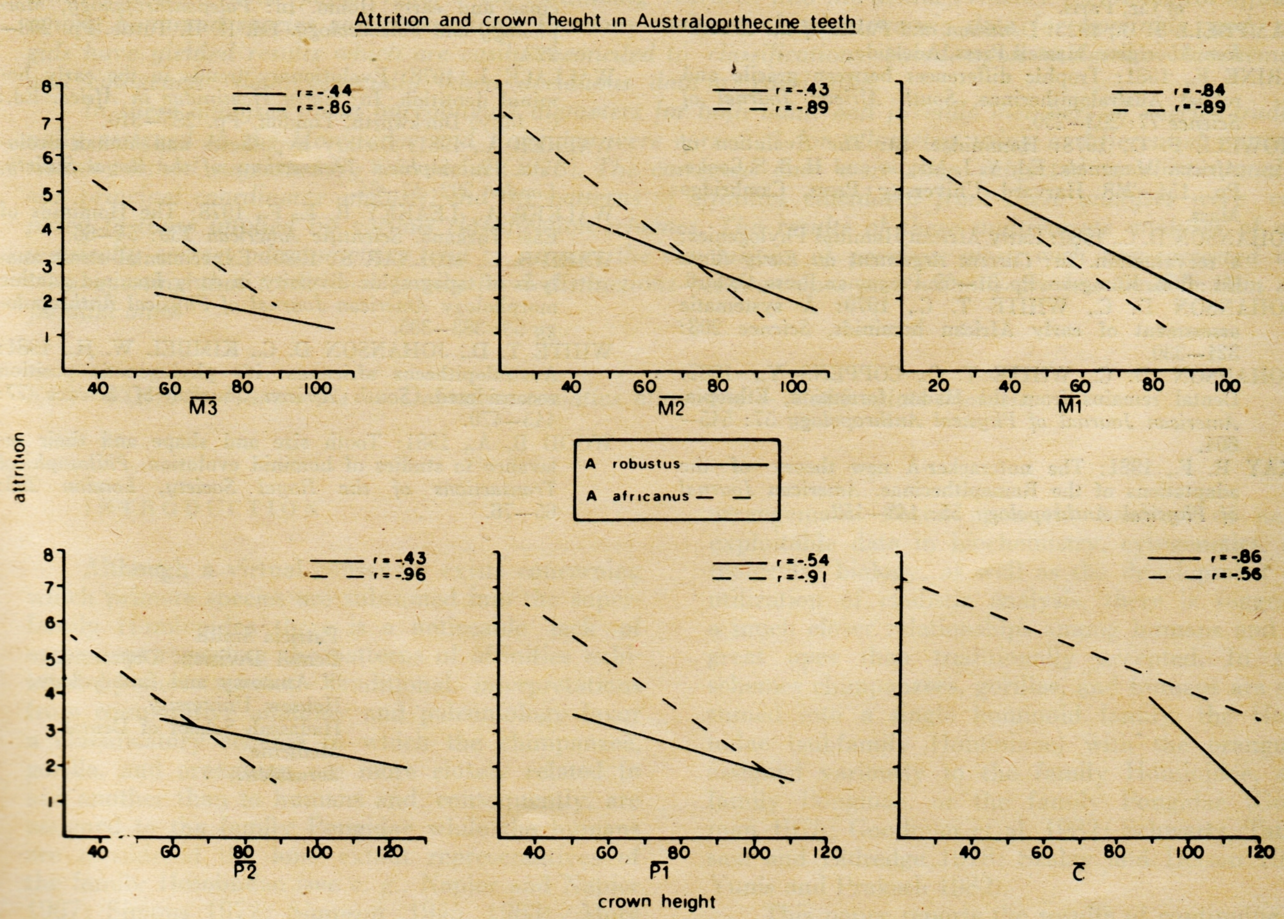

FIGURE 2. *Regression lines calculated from the regression of crown height on attrition.*

those of Wallace (1975) and Tobias (1980), rather than with those of Osborn (1982). However, this needs to be investigated in more detail, and a study is now underway to compare attrition scores and patterns of attrition for different stages of wear (Smith in prep.). The findings obtained in this study provide a means of quantifying these interspecies differences in the relationship of crown height to attrition. It is hoped that these findings may prove of value in identifying isolated teeth.

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