SOME PALEONTOLOGICAL INFERENCES AS TO THE LIFE-HABITS OF THE AUSTRALOPITHECINES

DURING the last several years the fortunate discoveries of Dr. Robert Broom have thrown considerable light upon the nature of those odd and somewhat humanoid South African primates who first came under scientific attention through the researches of Dr. Raymond Dart. Dr. Broom's finds of adult specimens have served to authenticate completely the original and much debated child fossil *Australopithecus africanus* as well as to establish the existence of more than one type of these apes. Furthermore, they apparently range over a sizable portion of Pleistocene time.

Although intense debate raged over the possible life habits of *Australopithecus africanus,* most of the discussion of the later discoveries has been purely osteological in nature, with the purposes of taxonomy in view. Hence, although Dr. Broom's final monograph has not yet appeared, some tentative suggestions as to what may be inferred in regard to the habits of these curious man-apes seem justifiable. It may serve to clarify, in some degree, the extent to which Dr. Dart's original thesis as to the terrestrial habits of these apes is capable of substantiation.

At the time of the original *africanus* discovery at the Taungs quarry, much was made of the fact that the skull had seemingly been derived from the breccia filling an old passage in the limestone cliff from which the fossil was derived. This was viewed by some as an indication that *Australopithecus,* though not a culture-producing animal, was a cave-dweller and essentially of terrestrial habits. This view has been regarded somewhat dubiously by Sir Arthur Keith[1] and others. It was suggested instead that the fossil might have become embedded along the face of the cliff, which, due to certain discharges from neighboring springs, was growing. Hence, its entombment might have been of an accidental nature. This fact, of course, would militate against acceptance of the idea that *Australopithecus* was necessarily a cave-dweller.

Broom's discovery of the new species, *Paranthropus robustus,* in a mass of breccia which had once formed the floor of a cave at Kromdraai near Sterkfontein, his location, in addition, of *Plesianthropus transvaalensis* in similar cave deposits of Middle Pleistocene age near Krugersdorp must inevitably be regarded as a well-nigh conclusive demonstration of the cave-dwelling propensities of the Australopithecines. We are forced by Dr. Broom's discoveries to contemplate the existence of ground-dwelling apes who, unlike the arboreal or semi-arboreal great apes of to-day, sought refuge among rocks and caverns. One discovery of this nature might be dismissed as accidental. Successive discoveries of similar type imply a more or less habitual use of these sources of refuge.

A number of years ago it was thought in some quarters that when our first human precursors abandoned the refuge of the trees and ventured into the plains only the most formidable, huge and aggressive species would survive the dangers of this open and cursorial existence. Now most certainly some of the human fossils such as *Meganthropus*[1a] do suggest the existence of such forms. On the other hand what do we encounter among the Australopithecines? Apes whose reduced, humanoid dentition would have frightfully handicapped them as fighters and whose size, though by no means inconsiderable, was certainly not gorilloid and which would have been of no great value in fighting off such plains-loving carnivores as the great hunting cats. The anthropoid brain capacity does not suggest that these apes had become effective tool-users, even if for the sake of argument we grant that they were capable of greater instrumental sagacity than their existing arboreal relatives. Yet seemingly they survived over a long period as terrestrial omnivorous hunters whom Dr. Broom, on the basis of certain limb fragments, believes may have been at least mainly bipedal.

The reduced canines and lack of diastemata between the two upper lateral incisors and the canines all testify to a dentition ill adapted to the crushing of tough rinds and fruits. It is a poor fighting equipment as well. Gregory, a number of years ago, expressed the view that "the conditions in which the tips of all the lower teeth are reduced to the same level and the diastemata are closed . . . is connected with . . . obvious changes in habits of feeding and of fighting. . . ."[2] We may well suspect under these circumstances, and particularly in view of Dr. Broom's insistence on the basis of an *os capitatum* referred to *Plesianthropus* that the latter had a human-like opposable thumb, that the Australopithecines had become increasingly skillful in the manipulation of food by the hands. Moreover, the reduced canines would have made the males less formidable antagonists, and it may be at least a reasonable inference that they were perhaps more socially agreeable and less combative than the males of some of the existing great apes.

It is by no means unlikely that, if the Australopithecines had indeed given up an arboreal existence for the ground, they were moving in small hordes or packs.[3] Such animal groups often have a combined

[1] "New Discoveries Relating to the Antiquity of Man," pp. 45–46. New York: W. W. Norton & Company, Inc.

[1a] F. Weidenreich, *Far Eastern Quarterly,* Nov., 1942, p. 62, 64.

[2] W. K. Gregory, "Origin and Evolution of the Human Dentition," p. 502. Baltimore, 1922.

[3] A view shared by Broom, *Nature,* 148: 10–14, 1941.

power of intimidation and "bluff" which can not be generated by a single individual or family group. Perhaps groupings of this sort, with some faint instrumental inclinations of a dim "eolithic" nature, may successfully have pursued small game and the young of larger mammals. Cliff and cave refuges may have contributed to their survival.

Their odd continuance into times late enough to have brought them in contact with more advanced and truly human forms is by no means their least interesting feature. What curious reactions must have been observable if either group ever encountered the other—the savage first men and these living fossil ancestors of the Pliocene, still apes but more human than any now alive. Was it man himself who swept them out of existence? Probably we shall never know.

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"DORMANT" VERSUS "ADVENTITIOUS" BUDS

A RECENT note by Diehl[1] on the sprouting of a staghorn sumac (*Rhus typhina* L.) log begins thus: "Sprouting of adventitious buds in logs or twigs of woody species freshly cut . . ." With no other comment concerning the origin of the sprouts in sumac, the implication is that they, too, are *adventitious*. As the species grows in New York State, however, most and perhaps all of the sprouts found on older stems have arisen from dormant buds.

It would seem profitable to restrict use of the term *dormant* or *latent* to buds formed in the axils of leaves (including scales) on the young annual shoots. These buds then persist in a dormant condition for an indefinite time with only sufficient elongation of their steles to keep the buds outside of the enveloping xylem. *Adventitious* buds, by contrast, arise outside of the normal phyllotaxy. It is recognized that adventitious buds, once formed, may also remain dormant, as is true of the root initials in the bark of willow stems. Where the origin is in doubt, or an inclusive term is desired, *epicormic* is advantageous and non-committal.

A considerable amount of unnecessary confusion has arisen from the loose or mistaken usage of the term "adventitious," particularly when the origin of the buds or sprouts in question has not been known. Foresters frequently have been at fault in this respect, but they are not alone. A popular botany text[2] makes the statement "They [adventitious buds] also give rise to the common water sprouts of apple trees and other species," although, as a matter of fact, water sprouts in apple are clearly from dormant buds.[3] Similarly, the stem sprouts of oak[4] and probably most hardwoods of the northeast,[5] as well as pitch pine[6] (*Pinus rigida* Mill.), arise in general from previously existing dormant buds, rather than adventively. In the trunk and branches of apple true adventitious buds do occur rarely in the bark but their usual origin in hardwood stems is from callus masses. A familiar example is the abundance of adventitious shoots from the callus on a cut stump of beech (*Fagus grandifolia* Ehrh.).

This question of terminology is not wholly academic. A large proportion of the northeastern hardwood forest is of sprout origin, and sprouting following thinning or pruning is of concern to both foresters and horticulturists. Reliance on literature requires that terms be specific.

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1 W. W. Diehl, SCIENCE, 96: 2498, 448–9, November 14, 1942.

2 J. Hill, L. Overholts and H. Popp, "Botany," p. 138. New York, 1936.

3 V. T. Stoutemeyer, *Iowa Research Bull.*, 220: 308–52, September, 1937.

4 E. R. Roth and B. Sleeth, *U. S. D. A. Tech. Bull.* No. 684: 4, October, 1939.

5 M. Büsgen and E. Münch, "The Structure and Life of Forest Trees," pp. 73–74. New York, 1931.

6 E. L. Stone, Jr., and M. H. Stone, *Am. Jour. Bot.*, 30: No. 4, 1943.

ACIDITY AND ACTIVITY OF SULFONAMIDES

RECENT work[1] has shown that a definite correlation exists between the bacteriostatic effectiveness and acid ionization constants of sulfonamides. The functional form of this relationship indicates that the drug activity is the resultant of two opposing tendencies, one of which increases effectiveness as the pK increases and the other of which decreases effectiveness. In view of the current opinion that sulfonamide activity is due to the blocking of an enzyme system,[2] it was considered advisable to examine the available data from the point of view of the general concepts of acidity[3] and the law of mass action. Interestingly enough, this fundamentally simple approach leads to qualitative and quantitative predictions which are in good accord with the available facts.

Qualitatively speaking, one would expect the compound of intermediate pK in a group of sulfonamides of widely varying pK to be most effective in producing bacteriostasis, from the following considerations. If the sulfonamide, HD, is a weak acid, then the anion, D^-, may be treated as a base. Similarly, the enzyme, or protein, P, can combine with OH^- and hence may be considered an acid. If P is an acid and D^- is a base, compounds of the type PD^- may be formed. If we assume that the activity of the drug depends on

1 Bell and Roblin, *Jour. Am. Chem. Soc.*, 64: 2905, 1942.

2 Woods, *Brit. Jour. Exptl. Path.*, 21: 74, 1940; Fildes, *Lancet*, 238: I, 955, 1940.

3 Lewis, *Jour. Franklin Inst.*, 226: 293, 1938.