Communications

Origin of the Word *Climate*

According to *Webster's New International Dictionary* our word *climate* comes from the Greek κλίμα, which meant "inclination, the supposed slope of the earth toward the pole." Several editions of *The Encyclopaedia Britannica* make essentially the same statement but add, "or the inclination of the earth's axis."

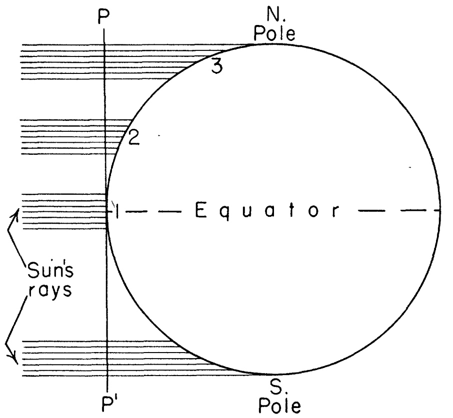

Fig. 1. This relationship of the sun's rays to the equatorial plane is an average for a full year.

A current textbook of geology states categorically that the word *climate* commemorates one of the oldest scientific discoveries, that the earth's axis is inclined to the ecliptic. Which of these two widely different interpretations has the better basis?

My good friend G. Lincoln Hendrickson, Professor Emeritus of Latin and Greek Literature, kindly examined early writings for clues to an answer. Ptolemy of Alexandria, the well-known mathematician and astronomer of the second century A.D., divided the world into κλίματα, a succession of zones from the equatorial region poleward, differing in the obliquity of the sun's rays to the earth's surface within the several zones. Ptolemy inherited this concept from earlier scholars; Eratosthenes, of the third century B.C., probably was the true inventor. His κλίματα were not conceived as contiguous zones but as a series of average latitudes. Hipparchus, of the second century B.C., tried to replace this rough concept by a more definite idea of latitudes. No doubt he saw that a change in latitude means a change in atmospheric conditions as well as in length of day. Probably the present meaning of *climate* developed gradually; but it is significant that divisions into torrid, temperate, and frigid zones still are made formally by parallels of latitude, although climatic belts in the modern sense are highly irregular in form.

The globular shape of the earth was common knowledge among Greek scholars from an early date, and presumably the general concept represented in Fig. 1 would have been acceptable to Hipparchus. On the average the sun's rays come to us parallel to the equatorial plane, or perpendicular to PP'. Bands with equal cross section are spread more and more, on the curving surface of the earth, with increasing distance from the equator. To the Greeks, belts 1, 2, and 3 would have been in different *climates,* on the basis of the angle between the solar rays and the earth's surface. Differences in the angle are the primary reason for different climatic conditions in the modern sense also. The inclination of the earth's axis has only a secondary, modifying effect on climates.

Analysis, then, favors the interpretation that the Greek κλίμα referred to the increasing slope of the earth's surface away from the equator. Perhaps the rival theory, that the inclination of the earth's axis was intended, has arisen from the literal translation of the Greek term.

My attention has been called to an exhaustive study of "the seven climates. . . ." in a book by Ernst Honigmann, published in Heidelberg by Carl Winter, 1929. This work was reviewed by George Sarton in *Isis,* **14**, 270, (1930). The evidence presented in this book strongly supports the conclusion given here on the origin of *climate.*

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Occurrence of Mutarotase in Animals: Its Proposed Relationship to Transport and Reabsorption of Sugars and Insulin

Mutarotase previously demonstrated in molds (*1*) occurs in animals. One milliliter of a centrifuged homogenate of 1 g organ per 4 ml phosphate buffer $0.025M$ pH 7.1 was diluted to 25 ml with buffer, and the mutarotation rate constant K of 0.21 g of a freshly dissolved sugar was measured at 24°C in the photoelectric polarimeter #2, described by Keston and Lospalluto (*2*), attached to the Beckman DU spectrophotometer. D-xylose (A), d-galactose (B), arabinose (C), and d-glucose (D) were found to be substrates of rat kidney mutarotase, the ratio K catalyzed/K uncatalyzed being, respectively, 1.6, 4.2, 1.9, 4.3. L-rhamnose (E), d-mannose (F), and d-arabinose (G) were not substrates, and this ratio was 1.0 for these sugars. K (uncatalyzed) for the seven sugars mentioned was, respectively, 0.23, 0.12, 0.31, 0.071, 0.30, 0.34, and 0.30 min^{-1}. Sorbitol (H), mannitol (I), sucrose (J), and raffinose (K) cannot mutarotate and were unaffected. Phlorizin (0.9 mg/ml) was strongly inhibitory (about 90 percent) for all substrates. Rat liver contained about one-third as much per gram as kidney. Other organs and blood plasma contained little or no activity. Kidney extracts from hog, rabbit, chicken, rat, beef and lamb contained large amounts of activity. The enzymic nature of the activity is indicated by its nondialyzability, thermolability (destruction at 60°C for 2 min), and optical specificity.

Of the sugars and derivatives studied here only mutarotase substrates have been reported to be "actively" reabsorbed by kidney (A,B,D) (*3*) or transported across cell membranes in response to insulin (A,B,C,D) (*4*). The nonsubstrates are reported not to be reabsorbed (H,I,J,K) (*3*) or thus transported (E,F,G,H,J) (*4*). Furthermore, phlorizin inhibits mutarotase at concentrations found in kidney (*5*) in "phlorizinized" animals. In such animals glucose reabsorption and oxidation (*6*) are blocked. The phosphorylation theory of glucose reabsorption is considered defective in that too high concentrations of phlorizin are required to inhibit kidney phosphatases.

A unitary theory of sugar transport applicable to transport of sugars into cells in response to insulin and reabsorption of sugars by kidney follows. Mutarotase in kidney catalyzes interconversion of various forms of sugar toward the equilibrium mixture during passage of the blood filtrate down the tubules. A preferentially absorbed form (PAF) of sugar passively diffuses into blood, where it must be present in lower concentration. As the filtrate continues down the tubule more PAF is produced by action of the enzyme and reabsorption proceeds. Since blood returning to the kidney must contain lowered concentrations of PAF, the theory demands that it be the same form that penetrates into cells in other parts of the body. Since insulin controls the transport of many sugars across cell membranes (*4*), mutarotase activity may be related to this action of insulin. PAF is probably neither the alpha nor the beta form of the sugar, since these are unquestionably present in sufficiently large amounts in many experimental situations where sugar transport occurs in response to insulin prior to addition of the hormone. It is suggested that PAF is a form of low abundance similar to or identical with the polarographically demonstrable mutarotational intermediate (*7*). Mutarotase, by controlling the rate of formation of a form of low abundance that penetrates into cells or that is a substrate for other enzymes, would control an important rate-limiting step in carbohydrate metabolism. Significantly, since the mutarotational system is going toward equilibrium, it is exergonic, the tubules are not required to expend energy, and the transport process although enzymatically controlled cannot properly be referred to as an "active" one.

Spontaneous uncatalyzed mutarotation could conceivably contribute to sugar transport to some degree in proportion to its rate and might become more important in organisms where metabolism or filtration rate is extremely slow. Fructose mutarotates at a much higher rate than glucose, and this may be a factor in its more effective utilization in diabetics.

The proposed theory suggests an involvement of mutarotase in diabetes mellitus and renal and phlorizin diabetes.

Experiments are in progress that are intended to elucidate a relationship between mutarotase and insulin.

Mutarotase occurs in animals, particularly in kidney, and is strongly inhibited by phlorizin. Sugars that are "actively" absorbed by kidney or transported across membranes into cells in response to insulin are mutarotase substrates. A unitary theory relating mutarotase to insulin and to sugar transport and reabsorption is described here.

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Fire and the Australopithecines

In 1948, Raymond A. Dart [*Am. J. Phys. Anthrop.* 6, 259 (1948)] announced that the so-called "man-apes" of South Africa, the Pleistocene Australopithecinae, were fire-users. Dart's claim rested on the supposed evidences of fire, in the form of ashes and charred bones, found at Makapan in association with the fossil remains of a newly-discovered variety of Australopithecine, which he consequently dubbed *Australopithecus prometheus*. Whether or not the Australopithecines actually employed fire is an important question when assessing their zoological status.

Owing to an unfortunate alteration, my brief report of Kenneth P. Oakley's studies of the geologic dating of the Australopithecinae [*Science* **119**, 863 (18 June 1954)] conveyed the erroneous impression that Oakley was inclined toward the view that these animals actually made use of fire; whereas, in fact, his position was quite the contrary. The printed sentence of my report, "Nor does the evidence support claims that the Australopithecines made any sort of tools, although they may have used ready-to-hand tools and weapons *or may have been fire-users*" (italics mine) should correctly read "Nor does the evidence support claims that the Australopithecines made any sort of tools (although they may have used ready-to-hand tools and weapons) *or were fire-users*" (italics mine).

Oakley's [*Am. J. Phys. Anthrop.* **12**, 9 (1954)] full statement on this point follows:

> The doubtful evidence of fire in the *Australopithecus* layer at Makapan is still *sub judice*, and even if confirmed could most readily be accounted for by a natural grass fire outside having ignited inflammable bat-guano at the entrance to the cave—there are in fact records of comparable fires having occurred in recent times.