

rate of expansion or contraction was 6 percent per second or more. The nearly equal left and right lever responses to the motionless circle indicate that little if any lever preference was present. A rate of change to which the monkey responds equally often with the left and right levers is used as a measure of his point of subjective size constancy. This point on the ogive can be estimated by interpolation. The point of subjective size constancy when the spiral was not rotating was 0.2 percent per second with an estimated standard error of .3. Thus, the monkey's subjective size constancy point is less than one standard error away from the objective size constancy point (0.0 percent per second).

Inspection of the results from the counterclockwise condition (squares on the graph) shows a systematic shift to the left. The point of subjective size constancy for this curve is at -1.9 percent per second, with a standard error of about .3. This means that a circle objectively contracting at 1.9 percent per second would be responded to as if it were motionless. Inspection of the results from the clockwise rotation condition (triangles on the graph) shows a marked shift to the right. The point of subjective size constancy for this curve is 3.8 percent per second, with a standard error of about .4.

These results are in the expected directions for the spiral used. The after-effect rates are not as great as the average of 5.4 percent per second obtained with human subjects (3) but they are well within the range of individual differences. These data clearly show the feasibility of measuring this type of visual motion aftereffect in the rhesus monkey, thus providing a method for the psychophysiological study of this perceptual process.

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Vegetation, Climate, and Coastal Submergence in Connecticut

Abstract. *Pollen analysis of a coastal marsh sediment at Guilford, Connecticut, indicates that there was a period of warmth and dryness preceding 3000 years ago. The subsequent increase of conifers at the expense of oak indicates a reversal that could account for decreasing rates of ice melt and rise of sea level. The record of herbaceous vegetation (grasses vs. sedges) suggests that the rise in the water table has been pulsating in character.*

In July 1960, at the request of Arthur L. Bloom, Sra. Bopp-Oeste, then working at Yale, assisted him in taking cores from a coastal marsh at Guilford, Conn. Before returning to Mexico she prepared samples for pollen analysis. Additional preparations and initial counts were made by Edna Fox, and the entire suite was re-counted by myself. The results are shown in Fig. 1, for which percentages have been calculated separately for arboreal (AP) and nontree (NAP) pollen (1).

Good counts were obtained from the basal sample at 270 cm, as indicated by heavy dots. The next 25 cm were too heavily oxidized to reveal enough pollen for counting. This oxidation may be due either to the chemical activity of ground water from the underlying sand or to the dry and warm conditions which are indicated by the high basal count of oak and grass and low count of sedge. The shift from fresh- to salt-water deposits occurs at about 95 cm.

Beginning with the 245-cm level, pollen preservation appears to have been continuous and rate of sedimentation fairly uniform. Upward from 240 cm, pine, and later hemlock, increases, while oak diminishes. Such a trend, with the intermediate rise of hickory and beech, I take to indicate a drift toward cooler and moister conditions than those shown at the base of the core. The least-square approximation of increase in pine, hemlock, hickory, and beech, combined, amounts to about 300 percent between depths of 240 and 50 cm.

The reciprocal behavior of grasses and sedges shows a recurrent pattern. Since slight rises in the water table normally favor sedges at the expense of grasses, and vice versa, the general rise appears to have been pulsating rather

than steady. Intensive study of this phenomenon along the coast might yield valuable information about climatic periodicity.

The influence of human activity is clearly reflected by the marked increase of composites and chenopods in the uppermost levels. Similar behavior of these ruderal or "weed" groups is a well-known index of clearing and disturbance in both the Old and New Worlds.

Sample Y-855, cited by Bloom and Stuiver (2) as having been dated by the radiocarbon method at 1180 ± 80 years ago, was taken at a depth of 3.8 ± 0.2 feet near the edge of this basin of peat accumulation and is our only guide to chronology. It is not an unreasonable approximation to assume that the basal interval of xeric conditions ended at some time around 3000 years ago, which correlates well with other information.

Although the long period of higher temperature known to have preceded a date of 3000 years ago was interrupted by a moister and cooler episode, about 6000 to 5000 years ago (3) it should account for rapid glacial melting and a corresponding rate of rise in sea-level. Further, Bloom and Stuiver show a reduced gradient of submergence hinged at their sample Y-1175 (3020 ± 90 years ago), which was taken at a depth of 9.1 ± 0.6 feet from nearby Clinton. This is practically the same depth as that at which the end of the xeric

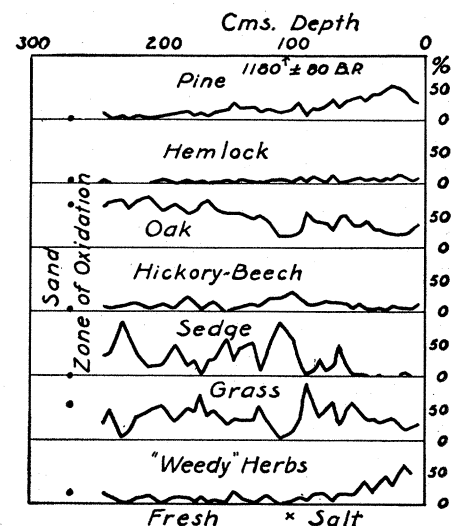


Fig. 1. Pollen diagram of important indicators in the Guilford, Connecticut, coastal marsh. Depth in centimeters is shown from right to left; percentages, calculated separately for arboreal and non-arboreal pollen, are shown vertically.

period of high oxidation is marked in our core (2.45 m, or 9.6 feet). Thus it is reasonable to assume a connection between the subsequent cooling indicated by the increase of conifers at the expense of oak, a slower rate of ice melt, and a more gradual rise of sea level.

In short, the pollen profile is consistent with the hypothesis that climatic change is responsible for the change in rate of submergence from 0.6 foot per century (7000 to 3000 years ago) to half that figure subsequently (2).

I am indebted to Bloom for the reminder that the pollen profile of the upper 6 to 7 feet of the Wellington Marsh, Medford, Mass., as reported by Knox (4), is strikingly similar to our profile. But while Knox associates pine

maxima and oak minima with xeric conditions and the converse with moist conditions for the Boston area, the weight of present information about conditions between about 1500 B.C. and A.D. 1750 supports, in my judgment, the interpretation given above for the Guilford site.

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References and Notes

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Participation of an Intermediate of Oxidative Phosphorylation in Ion Accumulation by Mitochondria

Abstract. Heart mitochondria accumulate massive amounts of Mg^{++} and phosphate or Ca^{++} and phosphate when incubated under appropriate conditions. Studies with inhibitors of respiration, oligomycin, and uncouplers of oxidative phosphorylation indicate that the energy necessary for these reactions may be provided either in the form of ATP in the absence of electron transport, or in the form of a high-energy intermediate of oxidative phosphorylation, which operates even though ATP is not produced.

The transport and accumulation of various ions by isolated mitochondria has been recently reviewed (1). It is generally recognized that oxidative metabolism supplies the energy for these reactions, but hitherto it has not been possible to discern whether ion accumulation is supported directly by the oxidative phosphorylation system or by reactions contingent on the production of adenosine triphosphate (ATP). Huijing and Slater (2) have suggested the use of oligomycin, a potent inhibitor of the production of ATP by way of oxidative phosphorylation, to distinguish between these two possible sources of energy for reactions in mitochondria. We have observed that heart mitochondria can accumulate massive amounts of Mg^{++} or Ca^{++} phos-

phate when incubated under appropriate conditions, and these reactions have been studied under the four sets of experimental conditions listed in Table 1 (systems I-IV). System I has been described in some detail (3), and we now present experimental evidence bearing on the accumulation of Mg^{++} by system II and of Ca^{++} by systems III and IV. The weight of evidence supports the view that one or more high-energy intermediates of oxidative phosphorylation can participate in the accumulation of the phosphates of both Mg^{++} and Ca^{++} .

The accumulation of magnesium phosphate proceeds best in the presence of substrate (system I). System I is inhibited by uncouplers of oxidative phosphorylation and inhibitors of electron transport but is not affected by concentrations of oligomycin which prevent the synthesis of ATP by oxidative phosphorylation (3). The addition of adenine nucleotides [especially adenosine diphosphate (ADP) and to a lesser extent ATP] lowers the observed accumulation, but this inhibition is largely overcome by addition of oligomycin (Fig. 1). That lower levels of

magnesium phosphate can be accumulated in the absence of added substrate if ATP is added as the source of energy (System II) is also shown in Fig. 1.

In system II there may be a limited contribution by endogenous substrate, but the accumulation is largely insensitive to cyanide, antimycin, and other inhibitors of electron transport. However, system II is extremely sensitive to oligomycin. This behavior can best be explained by a scheme such as that shown in Fig. 2. It is postulated that the observed ion accumulation is supported by some intermediate in the process of oxidative phosphorylation. Inhibition of ion accumulation by ADP (and a potential source of ADP such as ATP) would be expected since the high energy intermediate, which may be symbolized by HEC (for high energy compound), would be discharged during ATP synthesis from ADP—a reaction which is favored when the two processes, oxidative phosphorylation and ion accumulation, proceed simultaneously (3). Reaction II is depicted as proceeding by way of a reversal of oxidative phosphorylation (4), but other oligomycin-sensitive pathways for the utilization of the energy of ATP in the accumulation reaction cannot be ruled out.

Evidence for the participation of HEC can also be obtained from a study of the accumulation of Ca^{++} by mitochondria. Kidney mitochondria can accumulate large quantities of Ca^{++} by a process which requires ATP (5, 6), and Vasington and Murphy (6) have suggested that an intermediate such as we are considering may be involved in Ca^{++} accumulation.

Table 2. The effect of inhibitors, uncouplers, and aging on the rate of Ca^{++} accumulation. The incubation conditions are described in the legend for Fig. 3. Mitochondria designated "aged" were shaken for 30 minutes at 30°C in 0.25M sucrose containing 0.01M tris-chloride, pH 7.5.

Additive (M)	Ca ⁺⁺ bound (μmole min ⁻¹ mg ⁻¹ of protein)	
	System III (ATP + succinate)	System IV (ATP)
<i>Fresh mitochondria</i>		
No addition	0.56	0.33
Antimycin (10 ⁻⁶)	.31	.30
Dicumarol (10 ⁻⁵)	.04	.04
Dinitrophenol (2 × 10 ⁻⁴)	.05	.04
<i>Aged mitochondria</i>		
No addition	0.40	0.01
Antimycin (10 ⁻⁶)	.02	.01
Oligomycin (10 ⁻⁵)	.35	.00

Table 1. Four systems for the accumulation of ions, in heart mitochondria.

System	Ions accumulated	Energy source
I	Mg^{++} , P_i	Substrate
II	Mg^{++} , P_i	ATP
III	Ca^{++} , P_i	Substrate (+ ATP)
IV	Ca^{++} , P_i	ATP