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DISCUSSION AND CORRESPONDENCE

THE EVOLUTION OF CLIMATES: A REJOINDER

Two articles criticising and disagreeing with the writer's interpretation of the climatic history of the earth, and Dr. F. H. Knowlton's endorsement thereof, have been lately published in the *American Journal of Science*.[1]

Some of these criticisms are based upon misconceptions of the writer's interpretations and others upon a radical difference as to the source of climatic control prior to the modern era.

In "The Evolution of Climates"[2] and in previous publications the following theses are advanced:

(1) That prior to the Modern Era, of complete solar control, a dual control prevailed, in which the heating effects of solar radiation were largely intercepted by a denser and more persistent mantle of clouds than has prevailed since the Pleistocene; and that solar heating effects were principally exercised upon and above the upper surface of this cloud-sphere, and were, therefore, conservative of the lesser source beneath.

(2) That wide variations in the intensity of "The Solar Constant of Radiation" may have occurred during geologic time, but these did not directly affect climates—for the order of the distributions of temperatures and of glaciations were not conformable to solar control.

(3) That during geologic time earth heat was made available by deformations and ruptures of the crust, etc., which from time to time inaugurated activities of great heat liberating potentiality, namely, the erosion of warm crustal materials and the exposure and transformation of radioactive substances.

(4) That upon the partial exhaustion of these increments, the quickly cooling continents frequently reached low temperatures and were glaciated (*a*) in the interiors and easterly sides, as least affected by ocean influences, as in Huronian and Cretacic times; (*b*) under belts or zones of maximum anti-cyclonic circulation, as in Permo-Carboniferous time; and, later, in the final chill of Pleistocene time, under belts of maximum cloudiness and precipitation. That oceans, by reason of high specific heat, stored successive increments of earth heat and fluctuated between narrower limits than continents until Pleistocene time, when they reached glacial temperatures in polar and middle latitudes. At this stage, they ceased to yield sufficient water vapor to maintain the integrity of the previous mantle of clouds in any latitude, and the earth having lost its last available increment of its original or planetary heat, ceased to be a cooling body and became a warming body by direct exposure to and the trapping of solar radiation converted into heat by contact with the surface. That land areas fluctuated through much wider limits or, as approximately fixed by Professor Schuchert, from 110° F. to —60° F., or through 170°, while oceans fluctuated between 85° and 55°.

(5) That in this process of slow and intermittent cooling by the loss of available increments of earth heat, water was a circulating agent of high efficiency, continuously cooling land areas, and, in part, bearing the heat thus derived to the oceans; the other part became latent in water vapor.

The writer does not consider the nebular hypothesis as part of his interpretation of geologic climates and their merging into those of the Modern Era, as indicated by Professor Coleman [*l. c.*, p. 316].

No glaciation is compatible with a warm earth (Professor Coleman, *l. c.*, p. 316) and the writer nowhere claims that it is; on the contrary, he holds that the earth having been screened from solar radiation by clouds, its continents were subject to such climatic variations as the available increments of earth heat were competent to maintain inside the layers of moist air and clouds which its warm oceans were capable of sustaining. Beneath this

[1] Professor A. P. Coleman (5) Vol. 1, No. 4, 315-319. Professor Chas. Schuchert, *ib.*, 320-324. This article is abridged from a rejoinder to these criticisms, which was denied publication in that journal.

[2] Baltimore, 1922.

screen glaciations frequently occurred non-conformable to solar control; all of which, except the last, merged into a non-zonal distribution of milder climates; while the last merged into the zonally distributed climates of to-day distinctly under solar control.

A uniform and steady supply of heat from the earth's interior under the assumed screen of clouds is not held in the theory which Professor Coleman criticises. On the contrary, it is held that this supply was neither uniform nor steady, but highly variable in both supply and exhaustion.

The periods of glaciation as compiled by Professor Schuchert[3] are accepted as marking variation of climate of greater or less extent and severity in various localities and zones throughout known geologic time. None of these can be reconciled with a mild and equable climate controlled by any source or sources of heat and particularly not to a climate controlled by solar energy; for no glaciation has been recorded conformably to solar control. All were non-conformable thereto and contradictory thereof, but they can be reconciled with periods during which the available increments of the internal heat were exhausted to such an extent that land masses in various latitudes cooled below 31° F. The glaciation of tropical latitudes during Permo-Carboniferous time is particularly fatal to any assumption of solar control; for had this, or any other glaciation, been imposed under solar control it would have commenced in polar latitudes and advanced equatorward, and would have retreated poleward. No glaciation has been so laid down and none except the Pleistocene has so receded and given place to a disposition of climates distinctly zonal and as distinctly under solar control; and the fluctuating advances and retreats were at such short intervals that corresponding fluctuations in solar energy could not be reasonably assumed.

The mantle of clouds need be neither supposed nor assumed. It recorded its effects in glaciations and reglaciations in nearly a score of instances, and it recorded its failures in each interglacial epoch and in the present progressive deglaciations. By no other known means could solar energy have been intercepted to such an extent as to permit frequent glaciations of portions of the earth in latitudes which could not have been sufficiently chilled without such interception.

The writer accepts the variability of climates on continental areas from the dawn to the close of geologic time, as presented by Professor Schuchert [*Smithsonian Inst. Report,* 1914, p. 305]. This variability is well established.[4]

It is also well established in Permo-Carboniferous[5] and Pleistocene glaciations that maxima were attained along quite well-defined zonal lines.

Continental temperatures in tropical and in polar regions now vary within the limits of 110° F. and —60° F., or a range of 170° F.; and ocean temperatures range between 85° and 31° F. or through 54° F. It is a reasonable inference that during geologic climates continental temperatures had approximately the same extreme range, but the range of ocean temperatures for the greater part of geologic time, as admitted by Professor Schuchert, was between 85° F. and 55° F., or through 30° F. But it manifestly took from Proterozoic until Pliocene for oceans to pass through these extremes and only in the Pleistocene did oceans of polar and middle latitudes reach the present lower limit, with their extreme range of 54° F. The present extreme range of continental temperatures between tropical and polar latitudes of 170° F. is the same as the annual range in central Canada and Siberia, and the annual range of ocean temperatures in the same latitude is less than one tenth (1/10) of this.

The comparison of the range of ocean temperatures prior to the Pliocene of 30° F. with the present range of 54°, and the ease with which continental temperatures can range within twelve months through 170° F. supports the writer's views regarding geologic climates.

The prime and radical difference between the conclusions of Professor Schuchert and those of the writer are, as to the source of control, namely, that until oceans chilled to the temperatures marked in Pleistocene time, a dual source of climatic control prevailed, and

[3] *Smithsonian Inst. Report,* 1914, 305-306.

[4] Osborn, "The Age of Mammals," pp. 372-3.

[5] Schuchert, *ib.*, 280-282.

this control was distinctly different from the zonal climatic arrangement of to-day, as manifested by the climatic phenomena recorded in Permo-Carboniferous and in Pleistocene times. The greater part of the "plexus of problems of unparallel difficulty" presented in the Permian is involved in the attempts to fit Permo-Carboniferous glaciations and the concurrent climatic phenomena to the unproved assumption of solar control. This is true of all glaciations, and of the reglaciations following interglacial warmth which so distinctly contradict solar control that it is difficult to understand why the assumption of solar control has been held with such rigid orthodoxy. Neither critic meets the prime question of a dual versus a solar control of geologic climates.

MARSDEN MANSON

BERKELEY, CALIFORNIA,
OCTOBER 9, 1922

THE EFFECTS OF CAPTIVITY ON A SEX CHARACTER

LATE last winter I noticed a gravid female in a tank containing European brown trout at the New York Aquarium, and suggested that she be removed and stripped.

As is well known, the males of many salmonidæ, including salmon and most trout, develop a hook on the lower jaw in the breeding season, which is serviceable in their fights at the spawning grounds. Specimens with hooked jaws were therefore selected from the brown trout tank for milt to fertilize the eggs.

Then it was discovered that a hook-jawed individual might be a female. This phenomenon was unknown to us, and as far as we know has never been recorded. But we soon found that we had made no unique discovery, for about the time the brown trout eggs were changing into fry in the hatching troughs, the Aquarium received a visit from Dr. Francis G. Macnaughton of Dunshire, St. Andrews, Scotland, who has experimented largely with European trout. When the writer told him of the females with hooked jaws, he said that in Europe this phenomenon has not infrequently occurred as a result of captivity.

Precisely what effect captivity may have upon the somaplasm to bring about this curious condition, we leave to conjecture; but what a startling biological event it would be if a lioness were to grow a mane and other female animals in captivity developed the secondary sexual characters of the male!

IDA M. MELLEN

THE NEW YORK AQUARIUM

MISUSE OF THE QUESTIONNAIRE

TO THE EDITOR OF SCIENCE: A questionnaire is being mailed to "persons whose addresses are given in the book 'American Men of Science'" to ascertain "what proportion of American men of science are believers in the current religion, what proportion are not," etc. As the questions are in many cases like the famous "Will you leave off beating your mother?" probably the majority of us will ignore them. The bias of the questionnaire is so obvious, it might well be ignored were it not that we shall probably hear before many months that 97 per cent. of American men of science are utterly without religious beliefs, "as shown by a recent careful investigation." Hence I wish to make this early protest against this particular questionnaire and the possibility of drawing any reliable conclusions from the replies received.

HUBERT LYMAN CLARK

OCTOBER 25, 1922

QUOTATIONS

MOTORLESS FLIGHT IN ENGLAND

THE French airman, M. Maneyrolle, won the prize of £1,000 offered by the *Daily Mail*, by a wind flight on October 21 lasting three hours and twenty-two minutes. The notable successes registered during the recent French contests, and especially during the German contests, raised the question whether British fliers could rival the feats of their foreign colleagues, and the offer of a prize of £1,000 by the *Daily Mail* led to the organization, at Itford Hill and Firle Beacon on the South Downs, of the first British gliding contests since the war, which commenced on October 16 and continued through the week. Additional prizes were offered by the Royal Aero Club and others. The entry of British machines and pilots was