

same manner as the bones, wherever the blue sands are exposed. Bison bones, some of them burned, were found in hearths, together with artifacts. While mammoth bones were also found in these same deposits, and in some cases at levels of as much as three feet above some of the artifacts, none of the mammoth bones appears to have been burned. Furthermore, it should be noted that we have made no mention of finding any objects made of ivory at any of these locations.

PLATE XX shows three levels of the blue-gray, bone-bearing sands. Hearths in these deposits that held water at one time can be explained in a number of ways, the most obvious and likely one being that the hearths were built along the edges of the water, or during seasonal or longer periodic fluctuations of climate. When the water-holes contracted or dried up, fires were made further out in the middle of these sands. In any case a change of climatic conditions is indicated by various lines of evidence, and on the basis of the types of artifacts found in these basins, and on the palaeontological and geological data, we believe man was contemporaneous with the extinct bison in this region and probably also with the mammoth.

Before inquiring when this was we should consider a number of other factors, particularly those of a geological nature.

GEOLOGICAL ESTIMATES

In any investigation such as we are attempting, the use of certain geological terms is unavoidable, and since there is a wide range of interpretations of these, it is important to consider their use, and to adopt some definitions for them, which will at least make their meaning consistent in this paper. These words are: Pleistocene (Glacial), Post-Pleistocene (Post-Glacial), Pluvial, Post-Pluvial, and "Recent." It is recognized that there are many difficulties in the way of defining such expressions as these, as there is no agreement amongst glacialists as to when, for example, Post-Glacial time began, but it is obvious that some arbitrary time-scale will have to be constructed into which we may try to fit our archaeological evidence for man's antiquity on this continent.

Let us consider these terms and try to find out how some of the authorities upon the subject define them. Pleistocene may be considered synonymous with Glacial. Usage of the various divisions of the Pleistocene is not uniform in this country, but we shall take here the names used largely by the United States Geological Survey with certain changes as given by Thwaites.²⁷

²⁷ Thwaites, 1934, p. 72.

PERIOD	EPOCH	STAGE	SUBSTAGE
Quaternary	Recent		Later Mankato or Late Wisconsin (5th Wisconsin)
	Pleistocene	Wisconsin	Early Mankato or Late Wisconsin (4th Wisconsin)
			Cary or Middle Wisconsin (3rd Wisconsin)
			Tazewell or Early Wisconsin (2nd Wisconsin)
			Iowan (1st Wisconsin)
			Sangamon Interglacial interval
			Illinoian
			Yarmouth Interglacial interval
			Kansan
			Aftonian Interglacial interval
		Nebraskan	

Post-Pleistocene or Post-Glacial offers a wide range of interpretation. One interpretation may be based on drift deposits, another on erosional processes, or the rate of migration of the flora in reoccupying a given region. Some authorities assume that the Port Huron morainic system marks the beginning of Post-Glacial time; others mark this period by the recession of the ice beyond some other fixed point. Still others measure Post-Glacial from that time since the temperature has been approximately as it is today in the greater part of the once glaciated area. It will be well to look into the opinions of those best qualified to express themselves upon the subject, having in mind that all such time estimates can be only approximations at best.

We first consulted some of the earlier estimates that have been published from time to time, and then, in order to secure the latest information upon the subject, we wrote to eighteen or twenty geologists in the country, asking for their interpretations as to (1) the duration of the Wisconsin, (2) the time elapsed since the beginning of the Post-Glacial, and (3) the time since "Recent" began. These questions, though formulated in the most arbitrary way, were designed to arrive at the time factors involved in recent geological history.

The obstacle to closer agreement seems to lie in the different approaches to the problem, and in not being able to construct common definitions to which time estimates can be applied.

All of those to whom we wrote asking for light on the subject of glacial chronology answered our letters. Most of those replying deferred their

opinions to one or more of a group of four whom they considered authorities on the subject. These four were: Antevs, Kay, Leighton, and Leverett. Therefore, correspondence was carried on with these four till it was possible to make up for comparative purposes the four tables shown on PLATE XXII.

From the table on PLATE XXII it is evident that little is known about Post-Glacial time, and it is hard to make comparisons of the estimates since the results represent different approaches to the problem. Antevs has adopted the Swedish chronology which he has reason to believe correlates quite well with the field work on varves that he has done in America. This probably represents as accurate an estimate as can be had at this time. Antevs, therefore, starting with "early Late-Glacial" gives:

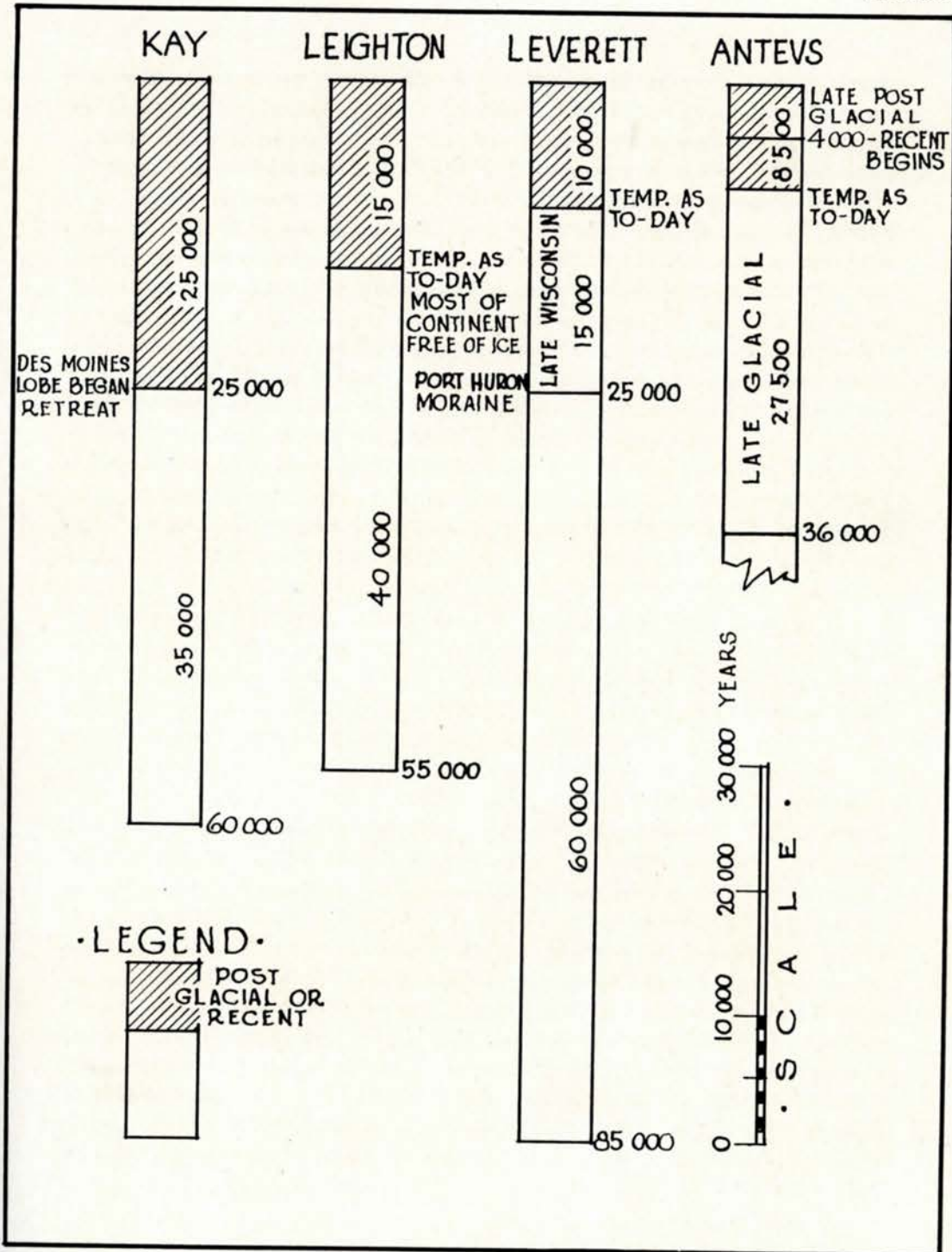
	Late 4,000	Modern Recent
Post-Glacial 8,500	Middle 3,500	Temperature distinctly higher than today
	Early 1,000	Temperature as today
	Younger 6,000	
Late Glacial 27,500	Middle 10,000	
	Early 11,500	Climax of last glaciation

Whether these estimates will fit the geological evidence in America so accurately can only be determined by more field work, and whether the estimates in the east may not have to be changed somewhat for the western part of the country is another problem for future work. Antevs²⁸ is inclined to believe that present climatic conditions were ushered in earlier in the Southwest than in the northern states, and estimates the time at from 15,000 to 10,000 years ago, instead of the 8,500 given in his chart.

In PLATE XXII three of the estimates show no division of Post-Glacial and Recent. However, for archaeological purposes such a scheme as Antevs uses is more acceptable.

So far we have been considering the glaciated regions, but it seems reasonable to assume that during the glacial stages, when such marked changes took place all over the world, there must have been great climatic changes in the unglaciated regions as well. In fact, evidence is forthcoming from

²⁸ Antevs, 1935, p. 309.



LATE GEOLOGICAL TIME ESTIMATES

Note: unshaded portion in three columns at left represents time from beginning of last glacial stage to beginning of Post-Glacial. For discussion of Iowan as substage of Wisconsin, see Thwaites, 1934.

many parts of the world to prove this, though in some cases it is still obscure because of insufficient field work. Antevs considers "Pluvial" to be about the same as Late Glacial, but referring to desert belts and ranging from 10,000 to 25,000 years ago, "Post-Pluvial" corresponding to Post-Glacial. These terms have come to be used more commonly abroad than here. There is evidence in the Great Basin regions of North America that seems to support the theory that when the northern part of the continent was glaciated there were correspondingly high stages of the Lakes of the Great Basin. There is also evidence that the retreat of the ice was not regular, but that there were oscillations which occurred in Post-Glacial times. The later Lake Agassiz may correspond to such a re-advance of the ice after the Wisconsin had begun its main retreat. Complete references to this question can be found in Thwaites's recent outline.²⁹

The evidence for a world-wide correlation of the main glaciations seems to be accumulating rapidly. Though there are many obvious difficulties in the way of an exact correlation, it is generally recognized that a large part of the earth's surface was covered with ice at approximately the same time.³⁰

Likewise evidence is appearing in many places that indicates periods of greater rainfall than at present. At the Bristol meeting of the British Association for the Advancement of Science in 1930 there seems to have been, according to the report issued by the Association, considerable discussion along this line. Professor H. J. Fleure,³¹ in suggesting that the Riss and Würm may have been episodes of one general glaciation, and the Günz only a preliminary stage of the Mindel, stated that J. W. Gregory had long ago suggested that European glacial maxima corresponded with equatorial pluvial maxima. He further pointed out that Leaky had brought forth evidence in recent years for the same conclusion. The first major Pluvial period is thus correlated with the Günz and Mindel glaciations of the Alps, and the second major Pluvial with the Riss and Würm glaciations, the long interval being the equivalent of the Mindel-Riss Interglacial.

A number of other points were brought out at this meeting of the British Association which it seems well to refer to at this time. Brooks called attention to the fact that there were certain events which stood out as of more or less world-wide occurrence, and not as local fluctuations: (1) the Bühl advance, with which the Magdalenian culture was correlated, coming after the Achen retreat, with which the Aurignacian-Solutrean cultures were correlated; (2) the warm, dry period of the climatic optimum about

²⁹ Thwaites, 1934, pp. 9, 70, 85, etc.

³⁰ Daly, 1934.

³¹ Fleure, 1931.

5,000 to 3,000 B.C. and the Sub-Atlantic wet period of about 850 B.C. The Solutrean of Europe, it was shown, corresponds to the dry period, one of general drying up of lakes, culminating in absolute desiccation, with the Magdalenian beginning the Post-Pluvial wet phase. On meteorological evidence, the report states that Simpson and Brooks have demonstrated that each pair of glacial periods with the intervening warm interglacial phase should coincide with a pluvial period in unglaciated regions, that there should be two major pluvials to correspond to four major glacial periods, and this, it is pointed out, Leaky substantiates in Kenya. These African pluvials, according to this same report, are preceded and followed by periods of intense desiccation, which no doubt compelled great human migrations, as for example, the Aurignacian into Europe following the retreat of the ice in the north.

Simpson³² discusses the main variations of climate with variations of solar radiation, and in summing this up says:

- “(I) Each cycle of solar radiation, if of sufficient amplitude, produces:
 - (a) In non-glaciated regions away from the glaciated regions one pluvial period and one dry period;
 - (b) In glaciated regions two advances of the ice, separated by a warm-wet interglacial epoch; and a cold-dry interglacial epoch.
- (II) The pluvial period in non-glaciated regions coincides in time with the two glacial epochs and the intermediate warm-wet interglacial epoch.
- (III) The dry period in non-glaciated regions coincides in time with the cold-dry interglacial epoch.”

FOLSOM AND RELATED ARTIFACTS

As is inevitably the case when a new name comes into use to describe some specialized object of human workmanship, a good deal of confusion develops as to exactly what is meant. This has happened in the case of certain specialized stone artifacts first discovered at Folsom, New Mexico, a few years ago. The fact that these artifacts were found at from four to thirteen feet below undisturbed deposits associated with the bones of bison, pronounced by palaeontologists as an extinct species, has given these spearpoints a respectable antiquity. Any spearpoint today which remotely resembles these Folsom points is immediately considered by those not familiar with the subject as ancient, no matter where found, so that the word “Folsom” has come to be synonymous with age and no longer seems to refer solely to the particular type of artifact found near Folsom, New

³² Simpson, 1934.