DISCUSSION

THE ACCURACY OF WIRELESS TIME SIGNALS

THE purpose of this communication is to give a brief account of the accuracy to be expected of the time signals offered by American broadcasting stations. No attempt will be made here to discuss the relative accuracy of the time signals broadcast by various observatories scattered over the earth, nor will the advantages and disadvantages of the differing methods used by these observatories in relaying signals be considered. Persons primarily interested in these "official" time signals will find much valuable information concerning them in the "Handbook" for 1931 of the British Astronomical Association.

The data on which the following discussion is based were gathered during the past two and a half years and include more than 500 comparisons of signals from fifteen broadcasting stations. The comparisons were made using a stop-watch which reads to fifths of seconds and a watch of fairly uniform rate. The latter was compared regularly with the time signals from the U. S. Naval Observatory at Washington, D. C., a short-wave receiving set being used to pick up the signals.

There are three common ways of announcing the time to the listening public. One is to have the announcer state that "It is now *exactly* one fifty-nine and one half, Eastern Standard Time by the celebrated Blank watch." Another method is to use a bell or a chime, preceded by an announcement such as: "When you hear the musical note, it will be exactly two minutes after two P. M., Central Standard Time." The third method is to use a superimposed tone beat every hour on the hour and, in some cases, also on the half hour. Ordinarily there is no warning that this beat is coming.

The first of these methods has been found to be the least precise in practice. Even though the announcer may place considerable emphasis on the word "exactly," such announcements are often fifteen seconds in error, and sometimes are wrong by a minute or more. A good seventeen-jewel watch set once a week by some accurate wireless time signal will prove more reliable as an authority on time than the average signal of this sort.

Signals from broadcasting stations using the second method are usually quite accurate. The name of the company sponsoring the signals has been found to be a good indication of the accuracy to be expected. One company sponsoring signals over a number of stations has provided signals which are almost never more than five seconds in error while the numerical average of their errors has been found to be slightly less than one second. Another company provides signals which are seldom less than ten seconds in error and on the average are in error by about twenty seconds. The use of a gong, bell or musical note for time announcements as inaccurate as these must be considered as misleading, if not actually dishonest. Fortunately this situation is not common in practice and one can generally rely on "gong" signals being less than five seconds in error.

The superimposed tone beats every hour on the hour ordinarily provide the most accurate time signals excepting those originating in an observatory. Some broadcasting stations using this form of signal maintain an accuracy that is really surprising, the error of their signals invariably being less than one second. In general one may reasonably expect the error of superimposed tone beats to be less than three seconds. There are, however, two criticisms to be made of this type of signal. The first has already been mentioned, namely, that the signals come without warning. The second is that occasionally a station will temporarily discontinue this service. This criticism does not apply to most stations offering this type of signal, but some stations are notoriously undependable in this respect.

These three types of signals offer a great service to the American public. There can be little doubt that their accuracy is sufficient for most purposes. Only jewelers, astronomers and perhaps a few others have need for greater accuracy and these can easily arrange to receive the time signals of some observatory.

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RECENT CLIMATE AND VEGETATION A FACTOR IN THE MOUND-BUILDING CULTURES?

WHETHER one sees much or little in the problem of ethnic identity of the mound-builders, there seems to be no question that the Hopewell culture at least represents a higher level than anything else known in the north-central states.[1] Certainly, too, the finest works and the artifacts associated with them were not being produced at the time of white exploration, whatever the blood kinship of their authors might have been. It also appears to be conceded that the flowering of these better cultures rested upon the basis of a successful maize agriculture. As mapped by Shetrone[2] the western limits of the northern mound culture are essentially those of the present corn belt, but the

[1] H. C. Shetrone, "The Mound-Builders," p. 479, 1930.

[2] *Ibid.*, p. 28.

highest expression, namely, the Hopewell, lies well toward the east in this area.[3]

Without binding oneself to the thesis of Huntington,[4] that climates virtually control civilization patterns, it may be well to note that middle western climate has been until recently much less humid as judged by vegetation than it is to-day. This fact has been developed quite independently of parallel evidence in Europe. It was first established on good floristic grounds by Gleason, whose most recent paper[5] gives an excellent summary. Meanwhile Auer,[6] in Canada, and the present writer and his students, working in Iowa and the Erie Basin,[7] have secured good confirmatory evidence from a microscopic study of recent peats. Additional confirmation is afforded by a recalculation of the results reported by Lewis and Cocke[8] for the Dismal Swamp of Virginia.

Making due allowance for all the difficulties and sources of error involved in reconstructing past climates, it may be safely stated that until a few hundred years ago the characteristic vegetation of the corn belt lay considerably to the eastward, and has since shifted west. Many other details of postglacial climate are still highly debatable, but this at least appears well enough established to merit attention from all who are concerned in interpreting biological phenomena in the United States. The westward swing of such conditions in recent centuries was accompanied by an advance of the humid deciduous forest from south and east. Did this favor cultures which lived largely by war and chase as against those more dependent on tilling the soil (without the aid of steel tools and draft animals)? Did this change become effective before or with the great interior displacement of American tribes caused by white pressure and bartered firearms from New England and Dutch New York?

Any causal explanation which the writer might advance would be mere conjecture. But the fact remains that the cultural climax of the northern maize civilization occurred toward the east of the present corn belt, and at a time when corn-belt conditions were in all likelihood east of their present location.

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[3] *Ibid.*, p. 187.

[4] E. Huntington, "Civilization and Climate," 2nd Ed. 1922.

[5] H. A. Gleason, "The Vegetational History of the Middle West," *Ann. Assoc. Am. Geog.*, XII, 39–85, 1922.

[6] V. Auer, "Peat Bogs in Southeastern Canada," *Mem.* 162, Geol. Surv., Can., 1930.

[7] Inv. Manuscript read before Syst. Sec. Bot. Soc. Am., December, 1930.

[8] Lewis and Cocke, "Pollen Analysis of Dismal Swamp Peat," *Jour. Elisha Mitchell Soc.*, 45: 37–58, 1929.

TYNDALL BEAM INTENSITY OF TURBID COLORED SOLUTIONS

MOST of the work on the Tyndall beam intensity of turbid solutions has been carried out with dispersions in colorless media, or in such a way that the absorption due to the dispersion medium could be neglected. P. V. Wells has shown (*Chemical Reviews*, 3: 331) that under these conditions the Tyndall beam intensity is a power function of the depth or the concentration as a first approximation. The writers have used the Pulfrich photometer, manufactured by Zeiss, to investigate the turbidity in a colored raw sugar, in solutions of varying depth and concentration. Under these circumstances a correction must be applied for the absorption due to the coloring matter. It was found experimentally that Wells' equation holds if there be substituted for the Tyndall beam intensity itself, the ratio between it and the percentage transmittancy of the same solution, measured in the same absorption cell and at the same wave-length. For equal concentration at varying depth, or for equal depth at varying concentration, the exponent in the formula is independent of wave-length. The detailed results of this investigation, which is being continued, will be published elsewhere.

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THE CURVATURE OF SPACE

IN an address made at the dinner in honor of Professor Einstein at the California Institute of Technology, Professor Frederick H. Seares made some very interesting remarks about the curvature of space. After explaining how Einstein has shown us that we may with advantage change some of the rules of world building, he makes the rather astounding assertion "that curved space means only a new set of rules which require that measurements be made along curved lines." The layman will no doubt exclaim, "Well, I thought they were offering me a camel to swallow, but it turns out to be only a gnat." For, of course, we can make measurements in space in any way we like. From time immemorial astronomers have measured the course of a planet or comet traveling along its orbit, be it an ellipse, parabola or hyperbola. It hardly required the insight of an Einstein to discover that fact.

To make matters still clearer Professor Seares brings up the time-honored illustration of measuring distances along the earth's surface. Of course we would naturally measure the distance from Pasadena to New York on a great circle, or more likely by the actual route traveled by our railroad train—a decidedly crooked path. But suppose we wished to use this distance as a base line to find how far away the