DISCUSSION

RELATIONS OF BIOCLIMATICS TO THE OTHER SCIENCES

As the result of long-continued studies of natural phenomena with special reference to life, climate, seasons and geographical distribution, manuscripts have been prepared for two volumes on a new science of bioclimatics.

This science is new, or at least different from any other branch of the natural sciences, in that it is based on the bioclimatic law and related laws and principles, and that it deals with fundamental principles, systems and methods of applying knowledge of facts and evidence on any subject of life, climate, weather, seasons, geographical distribution and related subjects as recorded in the literature of any branch of science or economic practice related to human interest in general and to local, regional, continental or world agriculture in particular.

Bioclimatics does not, therefore, occupy the field of any branch of the sciences, or duplicate any line of teaching or economic research, but is intended simply to give the results of research on, and the interpretation of, fundamentals which apply alike to all, and to present by means of examples, tables, maps, charts, systems of classification and methods of procedure, by which they may be applied by any research specialist to help solve his specific problems, and especially to serve as a guide to the coordination of certain features of his results, in such a way as to make them available for direct comparison, not only with results attained by other specialists in the same branch of science but with those related to the same general subject in any other branch, and thus contribute to the development of a coordinate system of comparable results for general study and interpretation.

As is well known, the present complexity of major and minor branches, divisions and sections of the natural sciences, with innumerable lines of general and intensive specialization and each developing a more or less different technical language, the old-time naturalist and philosopher has been crowded out of the field and picture. There is no longer any possibility for the naturalist or philosopher, or for any one in a given science, to keep up with or even comprehend the advancements that have been made within recent years in all the sciences.

With the present lack of coordination of methods, or results, with any comprehensive system of laws and principles it is utterly impossible for any one to make a broad comprehensive study and correct interpretation of even the most outstanding results in the major sciences.

It must be generally recognized, therefore, that there is urgent need of some fundamental plan by which the results of various lines of research, relative to a broad subject like agriculture, can be coordinated with some system of basic principles and methods by which comparative study and interpretation can be made towards solving some of the really big problems in agricultural research and economic practice.

The principal object in the development of the science of bioclimatics has been to contribute to this need, and it is believed that it has been attained, at least to the extent of serving as a basis for further development towards an ideal system.

The system as developed is based on certain fundamental laws and principles which apply alike, or in a similar way, to any line of research in any science requiring a general or specific consideration of the basic elements of time, temperature and distance in the relations between life, climate, seasons and geographical distribution.

Thus taking any minor or special subject, as for example a given species of injurious beetle as representing the major science of biology, the major branch zoology and its division entomology, order Coleoptera, the family Scolytidae as a special field of research, forest entomology as the special section of economic entomology, and the southern pine beetle as the insect; every detail in the study of its seasonal activities or seasonal history involves elements of the fundamental laws of cause as manifested in the motions of the earth and the energy of the sun, and of effects in time and the seasons, climate and weather, distribution by distance in degrees of latitude, longitude, and feet of altitude, events in the seasonal development of the insect and its host plant, are all coordinate elements of the causes and effects of a bioclimatic complex. The normal temperature of the year and of the warmest and coldest months of the nearest meteorological station indicate the local type of climate and type of bioclimatic zone, the dates and periods of the seasonal events of the insect and its host plant indicate the type of season, the geographic position of the local area in which the insect occurs will indicate its latitude and altitude distribution, while its control depends on the selection of the proper time in the season for the application of control measures, which will differ with distance north, south, east or west of a given local area, as it will with higher and lower altitudes in the same general area.

Thus, this or any other form of life represents the ultimate effects of all of the major and minor laws and factors of cause, or of the causation complex, from the motions of the earth and the energy of the sun down to the local climate, weather, seasons and zonal type, and the ecological type of its immediate

environment. So that, in order to know about a single form of life, it is necessary to know about the laws and principles which have governed its origin, evolution, survival and dispersal within its present geographical limits, and its present relations to all other forms of life coming within the same zone of climatic influence. In fact, "to know all about any one thing in nature it is necessary to know all about everything," which, of course is far beyond the capacity of the human mind individually or collectively. When, however, it is known from the accumulation of knowledge and special original research that there are certain fundamental major and minor laws and factors of nature, the effects of which are represented on the surface of the earth by the phenomena of life, seasons, weather and their variation in character or type with geographic distance, and that with the development of a comprehensive system of coordinate bioclimatic elements and of principles and methods of application the records of the bioclimatic elements of any geographic position can be analyzed, the major and minor bioclimatic zones and the zonal, climatic, seasons and weather types it represents can be interpreted. So that a large part of the essential knowledge on which to base specific scientific research on any form of life or any related subject can be made available to the research specialist. In other words, the specalist can take the preliminary interpretations of the fundamental laws and principles, which are represented alike by all of the elements of the local phenomena, and begin his work where his immediate problems of supplying additional information begins.

ANDREW D. HOPKINS
PARKERSBURG, WEST VIRGINIA

PERIGLACIAL PHENOMENA IN THE PUGET SOUND REGION

IN the Arctic and sub-Arctic lands and also in the high mountains intensive frost action produces distinctive structures in the surface soil. These "reticulated" or "cellular" soils have been described from many localities by me and by many other observers.[1] The published discussion of this subject by Bryan[2] and a recent conversation with him have recalled to my attention observations made some years ago in the Puget Sound region. Here on the prairies in the vicinity of American Lake, southwest of Olympia, Washington, are gravel outwash plains of the earlier ice advance. These localities were outside the border of the last (Wisconsin) ice and, therefore, must have endured a periglacial climate. The most significant features are segregations of gravel and soil that have a reticulated pattern. Over large areas the surface is divided into approximately equidimensional patches of soil nearly clear of stones that are separated from each other by narrow strips of gravel and boulders having an open texture and little or no interstitial soil. As a general rule the soil patches stand higher than the boulder septae. In many places the margins of the boulder septae are higher than their centers. Major lines of boulder concentrations persist for long distances and branch up slope in characteristic drainage arrangement. In other words, one accustomed to the Far North finds here, under a present genial climate, a thoroughly familiar set of features, identical in every respect with the products of sub-Arctic frost rearrangement of mixed alluvial materials.

There are also areas in which the gravels are hidden by broad parallel ridges of black soil. These were developed at the time of glacial recession but are not indicative of any peculiarities of the climate of the time. Such ridges are normal forms of deposition from broad sheet-flow of silty or turbid water and are developed as readily in warm climates as in cold. Flood deposits in the alluvial valley of the Mississippi of both modern and fairly ancient origin show these same forms. The unusual dark color of the ridge soils of the Puget Sound region is the result of the growth and decay of the common brake.

The existence near Olympia of reticulated soils that testify to the existence of a Wisconsin periglacial climate should lead to search for other similar phenomena within the area and to further use of such criteria in the interpretation of the earlier glacial deposits along lines of attack similar to that already initiated in the Central States.[3]

HENRY M. EAKIN,
Senior Scientist (Geologist)
MISSISSIPPI RIVER COMMISSION,
VICKSBURG, MISSISSIPPI

METER IN COMPOSITION

IN the issue of SCIENCE for October 30 is an interesting note by G. S. Fraps on "Hybrid Words." In closing, he says: "The English language would be in better shape if some people knew less Greek and Latin." Perhaps it would be better to say that the English language would be in better shape, if everyone, especially scientists, knew more of these languages and would be more careful and less pedantic in using the very little they usually know. Hybrids of all kinds offend good taste. Even the lovable

[1] "The Yukon-Koyukuk Region, Alaska," U. S. Geol. Survey Bull., 631, pp. 75–82. 1916; B. Hogbom, "Uber die geologische Bedeutung des Frostes," Geol. Inst. Uppsala, Bull., vol. 12, pp. 258–390, 1913; W. Salomon, "Arctische Bodenformen in dem Alpen," Heidelbergen Akad. Wiss. Naturw. Kl. Sitz-Ber., Pt. 5, pp. 1–30, 3 pls., 1929.

[2] Kirk Bryan, "Glacial Climate in Non-glaciated Regions," etc., *Amer. Jour. Sci.*, 5th ser., vol. 16, pp. 162–164, 1928. Also "New Criteria Applied to the Glacial Geology of Southeastern Massachusetts," *abst.*: Geol. Soc. Amer. Bull., 1932.

[3] G. F. Kay, "Origin of the Pebble Band on Iowan Till," *Jour. Geol.*, vol. 39, pp. 381–385, 1931.