

provides the added means required for the joint investigation in conjunction with the Mount Wilson Observatory, a department of the Carnegie Institution of Washington.

It is hardly necessary to say that this liberal action is most heartily appreciated by the Trustees of the California Institute, who are thus encouraged to continue and to extend their policy of developing fundamental research in science and engineering.

GEORGE E. HALE

#### RESEARCH IN THE NORMAN BRIDGE LABORATORY

IT is a great honor to me to have been requested to address you on this memorable occasion and I have many good reasons for being interested in to-day's proceedings. In the first place, I have been so kindly and warmly welcomed by the scientific men of the institute that I feel almost as if I belonged to them and as if I also were going to have a share in the facilities for scientific research that have now been put at their disposal.

In the second place, I have for a long time admired Professor Millikan's important work, and I have now some idea of his great energy and activity, wondering how he can do all he does. I therefore heartily rejoice at this splendid opportunity being offered him to work on his favorite subject. He is going to have a laboratory that is worthy of him as was his wish, with Professor Noyes and his chemists and with the Mount Wilson Observatory close at hand.

But apart from these personal feelings the great development that has been inaugurated here to-day has my warmest sympathy. This would have been the case even if I never had come to this country. I am happy to say so. Indeed, even when separated by oceans, physicists form a kind of fraternity spread all over the world. It is true that the ties that unite them have not at all times been equally strong and that they have to a certain extent been severed in the disastrous period through which the world has passed. But, though we recognize that this could hardly be otherwise, we sincerely hope that in the end the feeling

of good comradeship, such as is natural among men who have before them a great and important common task, will again prevail. It can not be too much emphasized that the understanding of Nature's secrets, that the use of knowledge of forces of greater urgency, and that much remains to be done, will join all workers. Certainly each individual worker will do his best to follow his own inclinations and to act according to his special abilities, and it is highly desirable that the research work of each nation bear the mark of its mentality and national aptitudes but by mutual aid and co-operation, one stimulating the other, all can be blended in one great effort.

I am deeply convinced that it must be so and therefore I feel that Dr. Norman Bridge, who is so generously promoting scientific research in this country, deserves the warm thanks, not only of Americans, but of scientific men.

And now when he takes off his evening dress, and has returned to his every-day life, Professor Millikan will set to work in his laboratory. You know what he can do, what marvels he can achieve with a single oil drop, determining, more certainly than ever was done, the electric charge and the manner and the number of the smallest particles of which matter consists. This afternoon we heard from him how he has been able to extend his investigations to ultra-violet invisible rays of the very smallest wave lengths. He is planning to send up high in the atmosphere instruments which, when safely returned to the earth, will tell about radiations which exist at great altitudes and of which he wants to trace the origin, either of the earth or the heavens. And when the high tension laboratory is ready, he and his fellow workers will bombard matter with electrons moving with a velocity comparable with that of light and they will try to knock to pieces the atoms of our elements and to see what becomes of them.

In all this they will work with Professor Noyes of the Gates Chemical Laboratory and with the astronomers of Mount Wilson. If some effect can not be found on the earth they will look for it in the sun and if there is some new and not wholly understood phenomenon in solar physics, it will be reproduced and in-

vestigated in the Norman Bridge Laboratory.

Mr. Chairman, it is a great pleasure to me to express the best and most hearty wishes for the good success of the work that has now been set on foot.

H. A. LORENTZ

### BIOTIC AREAS AND ECOLOGIC HABITATS AS UNITS FOR THE STATEMENT OF ANIMAL AND PLANT DISTRIBUTION

MORE precision in the statement of animal and plant distribution has become an urgent need. A specimen labeled "California" or "Africa" is obviously of little value in a critical study of distribution. But, though less obviously at fault, a record giving merely a city or county as a locality is still not of the greatest use. A number of distinctly different kinds of life conditions occur within a short distance of most towns, and in the western parts of the United States the life conditions within a single county may range from desert to moist forest and even to perpetual snow. Unless the life conditions under which a species lives are known we can gain little insight into the factors which govern its distribution.

A knowledge of the life conditions under which a species lives can not be obtained from a statement alone of geographical localities, no matter how exactly these may be given. Even a record of the precise acre on which a specimen has been taken means little unless the environmental conditions of the spot also are stated. Exact geographical records are necessary, but mention alone of a locality is not enough, and a complete record must include a statement of the environmental conditions as well as the locality.

Some sort of classification of the environmental conditions must, of course, be adopted if the conditions under which a species lives are to be stated concisely and with precision. Although I do not intend to propose here any new system of classification, either for environments or for biological distribution, I do wish to call attention to some of the units on which a classification must be based.

The units of biogeographical classification which I believe will prove most generally useful are two in number: (1) a unit of geographical extent forming a natural life area (faunal or floral area), and (2) the habitat or ecologic community. The statement of the faunal or floral areas and the habitats or communities in which a species is found, together with records of geographical localities, should give very accurately both the geographical distribution and the conditions under which the species exists.

Biogeographers have long made use of floral and faunal areas for the classification of distribution, and the importance of this unit of distribution is generally conceded. Some ecologists employ practically the same concept under such designations as "climatic formation" and "climax formation." The best term available to include the concept of both floral and faunal areas seems to be biotic area. A *biotic area*, then, may be defined as a geographic district, characterized by an assemblage of species and of ecological characteristics differing from those found in adjacent areas. A biotic area will usually, though not always, be also a climatic area, and will often be a distinct physiographic area as well.

The animal species found in a biotic area constitute a *fauna*; the plant species found in the same area constitute a *flora*; and the combined animal and plant species of the area may be termed a *biota*.

It has been generally presumed that the units of classification for ecological distribution and the units of biogeographical classification belong to different categories and can not be used together. However, I see no reason why the unit of ecological classification, the ecologic community, may not, for the exact statement of distribution, be combined with the unit of geographical distribution, the biota as above defined. In fact, I firmly believe, after considerable experience in the use of this combination in the field, that it forms an excellent method of stating distribution.

By this method each biotic area is considered to be made up of a number of *ecologic habitats*, the animals and plants of each habitat forming an *ecologic community*. The community