ternal viscera and in their actions manifested an understanding of it in preparing for future events. Now Virgil disdained such supercheries, patching out the superstitions of the time when they were universal, for use at a time when they were employed only to sway the minds oppressed by ignorance and credulity. He concluded that it was the rarefaction and condensation of the atmosphere which agitated the bodies of twittering birds and bellowing cattle,

et laetae pecudes et ovantes gutture corvi.

It was the "Jupiter Uvidus" who rarefied the air and condensed it, so no reverence was lost. When the winds of heaven blew the ethereal disturbance was conveyed to the minds of men, the subtle pneuma gliding past their hearts, and governed the flights of the birds of the air[4] and the tossing heads of the beasts of the field. We are unable still to add much to this except our indifferent skepticism, but we should remember we have as yet hardly lifted a corner of the veil of the ignorance which prevails in modern science as to the atmospheric influences exerted on living beings. We know nothing of the changes in the psychical state by virtue of which the animal does this or that. We put them all down to heat and cold, "dense and rare" and Virgil did as much.

Virgil's pantheism was the pantheism of his day and that it filled the air all around him we can see in his youthful poem, the Culex. The whole theme is the feeling of the gifted boy that the poor gnat which he destroyed at a blow was a possessor like himself of a shred of the soul of the Infinite. It was the sting of the insect which was the interference of God and it saved the sleeping shepherd, in whose name Virgil sings, from the venom of a spotted snake. This philosophy Virgil found in his youth and it dwelt with him through life, but it in no way distinguished him from his contemporaries, however well it fitted in with the beliefs of Dante's time. It is seen in the work of his earlier manhood in the way he speaks in his bucolics[5] of the bees and the phenomena they exhibit as an evidence of the workings of the universal mind. I believe we call it instinct now, though perhaps there has been little left of that term in the recent overturn in biology. We find the mystic theory at the maturity of his marvelous powers in the Aeneid[6] where the hero, visiting his father in Hades, learns from him the nature of creation, how even in the beginning, Anchises says, "heaven and earth and the flowing fields of the sea and the blazing sun, the moon and the Titanian stars are animated by the spirit within them." Unless we keep before us this saturation of the ancient mind with this philosophy, far beyond the point of our own vague thoughts, we will find it difficult to understand how so many, indeed nearly all, clear minds of antiquity adopted vitalistic doctrines as a part of their science. Even Aristotle, deeply analytical as was his mind, saw no skulking, no begging the question in his use of the "entelechy."

However, as we have seen, even Virgil's poetic mind had a touch of practical materialism and he placed the density and the rarefaction of the air in between the cawing of crows and the divine mind. As it was these which explained for him the state of the weather and the fluttering of the birds, so it is the rarity and compactness of the soil which tells the farmer whether the field is adapted to grape growing or wheat culture. The same words—densa and rara—are used for the soil as for the air.[7] But there is something more to be learned from an examination of the soil than this and it is by a method curiously in accord with a part of the modern technique of soil analysis, rudimentary though it is. There is a touch of his wonderful art in its description which I will not attempt to give. A salt and bitter earth is bad for fruits and it is not helped by plowing. To make a test of the condition, put the bad soil carefully ground up into a basket or sieve and through it filter sweet water from the spring. As the drops of water emerge on the wicker work of the primitive filter their quality may be tested by the tongue. The acidity or the alkalinity of the soil is thus betrayed to one of the senses, that of taste, instead of by the visible reactions of the modern test tube. The richness, the "fatness of the soil," betrays itself to the sense of touch as it is exercised between the fingers when it is finely pulverized. Such beginnings then as were possible for scientific endeavor Virgil records and his theory of atmospheric pressure was singularly near the results obtained by the barometer as to the processes of nature which precede atmospheric disturbances more evident then than now to the unaided senses.

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[4] Georgicon I. 417–422.

[5] Georgicon IIII. 219–222.

[6] Aeneis VI. 724 seq.

[7] Georgicon II. 226–228.

TRANSITION ZONES

THE thesis here presented is that the indefinite territory existing between two faunal areas should be considered primarily as a transition zone, not as a unit faunal area or sub-area.

A faunal area may be defined as an area characterized by certain animals and thus differentiated from other faunal areas characterized by other animals. The arctic, temperate and tropic zones are so characterized and may be treated as primary faunal

areas and their subdivisions again as secondary faunal areas. This concept is a very useful one and works out especially prettily in mountainous regions where high altitudes give the same like conditions as high latitudes and are associated with the same forms of life. In America, high latitude conditions and high latitude birds, for instance, follow the mountain ranges towards the equator, a fact that is brought out prettily in a map showing the tongues and islands of high latitude life near the mountain tops and bands of temperate life below on the mountain side.

The first point that the writer desires to make here is that, however interesting it is to plot such latitude-altitude zones in a mountainous country, they do not necessarily constitute sound faunal areas or units in problems of zoogeography. The reason is simple enough, for they are based almost entirely on temperature, whereas precipitation and topography are equally important factors in determining the kinds and dispersal of life. With these three determining factors working variously together or opposed, it is not a theoretical necessity that large faunal areas can be predicated and subdivided in any system that will be a matter of fact rather than a matter of opinion. It so happens, however, that they can be.

Take now the United States and Canada. It would seem to the writer that the primary faunal areas in this region are three; Canadian, Carolinian and Western; Canadian and Carolinian based on latitude, their boundaries modified by altitude; the Western sharply separated from the Carolinian to the east by the precipitation factor and less sharply from the Canadian to the northeast by the topography factor. Canadian and Carolinian areas are uniform with uniform faunas. The Western area, due to its topographic variety and resultant temperature and precipitation variation, is exceedingly varied and may be advantageously divided into minor areas, as has been done.

In the East, the Canadian to the north, and the Carolinian to the south are uniform faunal areas, but between the two lies an irregular transition zone of varying width (as here understood more or less synonymous with the "Transition Zone" of current latitude-altitude zonal divisions of mammals and birds). The ordinary climatic controls seem here to be subordinated to various minor topographic influences which are hard to predicate. For instance, of two related birds of the genus *Vermivora,* near the Atlantic coast, one, *V. chrysoptera,* breeds in broken transition country to the north; the other, *V. pinus,* southerly in the coastal plain edge of the Carolinian; whereas, going to western Pennsylvania, *V. chrysoptera* breeds in typical Carolinian broken country and *V. pinus* north of it in less broken country. This transition zone is not entirely an intermingling of Canadian and Carolinian forms. In birds, for instance, certain forms are peculiarly characteristic of it. Endemic forms in a transition zone, however, do not make it a faunal area. It is, and should be considered as, a transition zone between faunal areas.

A transition zone which has considerably influenced the writer's viewpoint on this problem is one affecting marine, not land, animals. Off the Atlantic coast of our middle states the Continental Shelf extends out some miles with depths increasing gradually. Then, at about 50 fathoms, it rounds off abruptly into the deep sea. As regards fish life, the inshore waters are here the meeting place of two definite shore faunas, a northern North Atlantic, and a southern American coastal faunal area (with species of shore fishes which differ from the shore fishes of Europe or elsewhere). The deep sea beyond the edge of the Continental Shelf harbors fishes of an entirely different sort and should be considered as a deep sea faunal area. The catch brought up by a beam-trawler from 65 fathoms or somewhat more on the slope from the Continental Shelf into the deep may comprise certain species, notably the spined dogfish, and likely *Poronotus,* the sea robin, in late fall, characteristic of the shore area. With them may come the bright red, grotesque *Peristedion* or deep-water sea robin, obviously from the adjacent deep-sea area. There will also be certain species endemic to this narrow strip of sloping bottom, namely, the tilefish, *Zenopsis* (allied to the John Dory of Europe) and *Catulus retifer* (related to the European dogfish). All three are shore derivatives rather than deep-sea derivatives, but, strangely enough, not represented in the faunal areas of shore fishes adjacent. Dory and dogfish represent the southern European shore fauna, and the tilefish perhaps has its nearest shore relatives in the Blanquillos of the Pacific coast. Why are these fish present in this transition zone? One viewpoint only seems to explain it—that between the shore fauna inside and the deep water fauna outside is in some way a favorable locality for foreign species to gain a foothold. With this in mind, we have the following hypothesis concerning transition zones—that they are lines of weakness which representatives of outside faunas may penetrate and where they may establish themselves.

To return to the land faunas of America. Is there any indication of such penetration in the transition zones between the faunal areas postulated? There are certain things which may be so interpreted. It will be noted that the prairie chicken from the west reached the Atlantic coast in a transition latitude and established a race on Martha's Vineyard. Further north or further south it must have penetrated through country more strongly held by the ruffed grouse on the one hand or the bobwhite on the other.

Eastward extension of prairie forms in the latitude of the transition zone south of the Great Lakes is a phenomenon in line with this hypothesis. Also, certain eastern birds cross the prairies and penetrate surprising distances to the northwest in the ill-defined and broken transition zone there existent between the western and Canadian faunal areas, a notable example being the eastern kingbird, which breeds at least in eastern Washington. The prairie area of the Mississippi Valley (as differentiated from the dry plains area west of it) is a transition zone between the east, with sufficient, and the west, with insufficient, rainfall. In the main, its bird fauna is either eastern or western, but it does not lack species almost exclusively confined to it, such as Bell's vireo, a summer resident, or Harris's sparrow, as a transient species.

In conclusion, the writer wishes to point out his concept that between two faunal areas there is normally a transition zone. To consider this also as a faunal area and use it as a unit in zoographical discussions can lead only to complication and confusion. Looked at as what it is, a separate phenomenon, it will repay analysis and study.

J. T. NICHOLS

THE AMERICAN MUSEUM
OF NATURAL HISTORY

THE INTERNATIONAL CRITICAL TABLES

THE Board of Editors of International Critical Tables met in Washington, D. C., for a three-day session beginning on August 16 for the purpose of selecting the cooperating experts who will be invited to assume responsibility for critically compiling the various classes of data to be included in the tables. It is estimated that some three or four hundred cooperating experts will be needed and the selection will be made largely on the basis of recommendations received from the corresponding editors and their advisory committees from the principal countries of the world. Several sessions of the board will be required before the complete list can be made up. Invitations to act in the capacity of cooperating experts will be issued from the editorial office as fast as action is taken by the board and, from the responses thus far received, a full measure of cooperation is expected from the chemists and physicists of the world in making this undertaking a success. In dividing the subject-matter for purposes of assignment to the cooperating experts, the editorial board has endeavored to make each assignment of such a magnitude that it can be reasonably completed in a year's time without proving too great a burden upon any expert and if each one associated with the work will cheerfully accept and carry out his share and responsibility, the combined result of the labors of all who cooperate in the work will be invaluable to science and industry.

The scope of the work is so great and the fields to be covered so varied in character that only through the joint labors of a large number of experts will it be possible to bring the undertaking to a successful conclusion in a reasonable time. The International *Annual* Tables is now in its twelfth year. It has demonstrated the possibility of preparing through international cooperation an annual abstract of the results of the world's researches in quantitative measurement. The purpose of International *Critical* Tables is to take an account of stock of our present quantitative knowledge of material things and to publish in convenient form the result of expert criticism of this knowledge. The practicability of further effective international cooperation on scientific projects will doubtless be judged largely by the degree of success obtained in these efforts.

The International Union of Pure and Applied Chemistry and the International Research Council have given the weight of their authority and influence to International Critical Tables. American industries will supply the necessary funds. It remains only for the scientists of the world to contribute their time, energy and expert knowledge to insure the successful completion of the undertaking. Science itself is international. The preparation of the record of scientific achievement in quantitative measurement should also be international. If the results of scientific research are to be utilized most efficiently, they must first be made easily accessible. To make these results accessible so that they may be utilized to the best advantage is as much the duty of men of science as are the researches which produce them, and the task of rendering these results readily accessible requires the cooperation of the same types of expert knowledge as have been employed in producing them.

As rapidly as appointments of cooperating experts are made and accepted, announcement thereof will be made in the scientific and technical press.

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