

THE NEW YORK ACADEMY OF SCIENCES.
SECTION OF BIOLOGY.

THE January meeting was devoted to reports by members who had attended the scientific meetings at New Orleans and Ann Arbor.

At the February meeting Professor Britton presided in the absence of Vice-president Crampton. Professor F. S. Lee presented the results of his recent studies on 'Acid and Fatigue.' In previous communications to the academy the author discussed the physical phenomena of fatigue and the relation to them of lack of carbohydrate. The present paper presents the results of further researches on the causation of fatigue. The physiological action on muscle of sarcolactic acid, potassium sarco-lactate, mono-potassium phosphate, and carbon dioxide has been studied in detail. All of these substances are markedly fatiguing, their action consisting in general of a diminution of lifting power and a slowing of contraction. These substances, which are produced during muscular activity, are rightly named fatigue substances. The author believes, moreover, that fatigue in many pathological states, such as diabetes mellitus, fevers, carcinoma, anæmia, various disorders of digestion and inanition, is largely due to the pathological acids that are present and produce the so-called acid intoxication of these diseases. He finds, for example, B-oxy-butyric acid, and its salts, which are characteristic of diabetes mellitus, to be fatiguing, like the physiological acid fatigue substances. Not unfrequently in pathological, as in normal, states both lack of carbohydrate and accumulation of acid are present as factors in the causation of fatigue. This is notably so in diabetes, fevers and inanition.

Dr. B. T. Terry gave a résumé of recent work on the spirochæte of relapsing fever.

Dr. C. W. Hahn called attention to the proposed biological survey for the state of New York.

M. A. BIGELOW,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A CASE OF ISOLATION WITHOUT 'BARRIERS.'

I WAS glad to see Professor J. A. Allen's article on 'barriers' in a recent number of

SCIENCE (February 23, p. 310), not only because it convinced me that we are practically upon the same standpoint, but also because it has directed my attention to a possible improvement in the expression of my views.

I have maintained¹ that in cases of a wide distribution of a species, where there are different forms (varieties) within the range, which pass into each other, no continuity of ecological (bionomic) conditions is present. The word 'continuity' apparently does not exactly express what I meant to say, and Professor Allen, in the article referred to, defines the question again, and asks whether a case, where there are no barriers of any description, and where the different conditions of the extremes of the range of the supposed species pass into each other, would fall under my definition of discontinuity of bionomic conditions. If this should be so, he believes that we understand each other.

Indeed, this is the case. As I have said in the former note, I consider this the *first step* toward complete isolation. Since I believe that species are formed gradually, by small steps, out of varieties, and that only *complete* isolation is the criterion by which it is possible to judge whether a certain form is a species or not, it necessarily follows that *complete* isolation is also attained by degrees, and the *first step* in this direction is a differentiation of external conditions within the area of an existing species. Although, in the beginning, gradual transitions are present, and although the different conditions form a continuous series from one extreme to the other, there is no *uniformity*, and I possibly should have used the latter word, instead of 'continuity.'

On account of the transitions present in such cases, isolation is not yet *complete*, and we can not distinguish *species*, but only *varieties*. But if the transitions disappear, and isolation becomes *complete*, the paramount condition is fulfilled for the distinction of *species*. In many, possibly in most cases, complete isolation is marked by more or less

¹ SCIENCE, January 12, 1906, p. 71.

distinct *barriers*,² but, as I have said before, barriers are not always necessary. Professor Allen says (p. 312), that the 'sedentary disposition of individual animals' may act as a barrier, and this is, indeed, what I am thinking of, namely, the tendency of the individual to stick to certain surroundings, to keep close to certain ecological conditions.

A case among the crawfishes of Pennsylvania may serve as an illustration.

The southwestern corner of Pennsylvania and northern West Virginia, between Chestnut Ridge to the east, the Kiskiminetas, Allegheny and Ohio Rivers to the north, and the Ohio River to the west, contains two burrowing crawfishes (chimney builders), namely, *Cambarus monongalensis* Ortm. and *Cambarus diogenes* Gir. Both are very closely allied, but they are *good* species, no transitional forms ever having been found. (Weight may be added to this by the statement that I collected, of either form, upward of 300 specimens, at 53 localities; at eight places both species were found associated.)

C. monongalensis is restricted to the area as defined above, while *C. diogenes* largely goes beyond it. But within the above boundaries both species are found everywhere, often in very close vicinity, so that their ranges, in this section, truly are *overlapping*. Moreover, I have reason to believe that their centers of origin are in this same region (southwestern Pennsylvania and northern West Virginia), in the physiographical division called the Alleghenian Plateau (more specially: between an Old Tertiary and a Late Tertiary base level, the latter lying below the plateau).

Here we have a case where two closely allied species became differentiated in the same region, their centers of origin being identical, their present areas being largely overlapping, and they actually living often side by side.

Nevertheless, there is isolation, and indeed *complete* isolation, but of purely ecological character. Both are burrowers, but *C. monongalensis* lives in and near springs with pure and cold water, while *C. diogenes* is a swamp

form, being content with any kind of water, but preferring more or less stagnant water along ditches, streams and in the river bottoms. While *C. diogenes* is not very particular, *C. monongalensis* is, and the consequence is that both species are isolated from one another, the one (*monongalensis*) occupying places in the neighborhood of springs, the other (*diogenes*) appearing a little farther down stream. A further consequence is, that both species are separated to a certain degree according to elevation: *C. monongalensis* is found generally at altitudes between 1,200 and 900 feet, while *C. diogenes* goes down from about 1,000 to 600 feet.

As has been said, at certain places, both species come into contact, and, generally, they are never far from each other. Thus we can not talk of a 'barrier' between them, in the ordinary sense of the word. Nevertheless, they are separated, but the separation is brought about by—as Professor Allen puts it—the 'sedentary disposition' of these animals, that is to say, by their ecological habits, they being restricted to certain ecological conditions, and refusing to leave them. It would be an easy thing for *C. monongalensis*, for instance, to follow down the stream at the spring of which it lives, and to settle in any swampy places farther below. But it does not do so, and, if single individuals are accidentally swept down, they do not prosper, because they do not find congenial conditions, namely, pure and cold spring water, which, in this case, seems to be essential.

This is a case of 'ecological (or bionomic) isolation,' where no 'barriers' in the ordinary sense are present. It seems that such cases are less frequent than topographic or climatic isolation, but I believe more will be discovered, as soon as attention is called to them, and I have no doubt that Professor Allen is able to quote similar cases offhand from his own rich experience. I called, years ago, attention to a case which, indeed, suggested the whole idea to my mind, namely, the case of different species of the decapod genus *Uca* (fiddler crabs), living closely associated on the coast of East Africa, but each preferring

² See C. H. Merriam, SCIENCE, February 16, 1906, p. 247 ff.

a certain 'facies,' that is to say, each possessing different ecological habits.³

Further particulars about the ecological habits, geographical distribution and life history of the crawfishes mentioned above will be given in my memoir on the crawfishes of the state of Pennsylvania, which is now ready for publication.

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PITTSBURG, PA., March 1, 1906.

FACTORS OF SPECIES-FORMATION.

TO THE EDITOR OF SCIENCE: The short note by Dr. Ortmann in SCIENCE of January 12, 1906, no less than the larger work of Gulick to which he refers, as well as much of the recent discussion of isolation as an evolutionary factor, are all rich in illustrations of the need of a simple distinction.

Unfortunately for the progress of evolutionary science among his contemporaries and immediate successors, Darwin began the title of his first book on evolution with the fateful words, 'The Origin of Species.' Around this ark of a new biological covenant the chosen people of science have waged fifty years of sanguinary warfare, and it is now a very ungracious task to convince them that the species-origination box never did contain the sacred relics of evolution. But if science is to seek truth rather than tradition, we may not close our eyes to the perception that the factors of species-formation are not at all factors of evolution.

Questions of species-formation are generally debated because of interest in evolution, though for purposes of scientific study and explanation the two lines of investigation are as completely distinct as gravitation and hydrostatics. Isolation, in one form or another,¹

³ See Ortmann, 'Crustaceen' in *Semon, Zool. Forschungsreisen in Australien*, etc., Jenaisch. Denkschr., 8, 1894, p. 67; and Ortmann in 'Bronn's Klass und Ordn. d. Tierreichs,' 5, 2, 1899, p. 1,202.

¹ Chronological isolation may be quite as effective for species-formation as separation in space, and permits species of common origin to become diverse while still occupying the same region. Many plants and insects, of tropical as well as of temperate regions, have their flowering times or

is an indispensable factor in the subdivision of species, but to evolution it contributes nothing whatever. Isolation may sometimes retard or prevent evolution, but it is not an evolutionary factor except in a minor and negative sense.² The two groups of phenomena belong to entirely different categories; stirring them together only keeps the emulsion from clarifying into the two component solutions.

Evolution is a process of organic change and development, universal and continuous, and due to causes resident in species. *Speciation*, to give the other process a name, is the origination or multiplication of species by subdivision, usually, if not always, as a result of environmental incidents. Speciation is thus an occasional phenomenon which does not cause evolution, and is not caused by evolution. One procession of organisms may be divided into two, but it does not appear that the new groups will travel in any different manner than before, nor that they will go any faster or any farther than if they had not been separated. The subdivision enables the two parts to follow different roads and to arrive at different destinations, but it does not assist the evolutionary locomotion nor give us any clue as to how it is accomplished. The evolutionary interest of isolation is that each case affords additional evidence of continuous, progressive change as the normal evolutionary condition of all groups of interbreeding organisms. The isolation of a new group is an interesting biological event, a crisis, as it were, in speciation, but it gives us no special opportunities of studying the causes of evolution. Perception of these elementary facts would have saved the writing of many books, and breeding seasons restricted to annual occasions of extremely short duration. In some groups a considerable series of years may intervene between periods of propagation, as in the bamboos and periodical cicadas.

² A more extended presentation of this distinction is to be found in 'Evolution Not the Origin of Species,' *Popular Science Monthly*, March, 1904. The paper was reprinted in revised and extended form in the Smithsonian Report for 1904, pp. 397-412, under the title 'The Evolutionary Significance of Species.'