pants. By this method of research, much time and labor would be saved, and more positive and enduring results would be secured.

In concluding, let me call your attention also to the fact that we do not yet possess a history of anthropology, and that broad-minded contributions to the history of our science are an urgent necessity. Goethe has said somewhere that the history of science is the science itself; and I believe, further, that only by a correct appreciation of the development of our science are we able to be just towards our fellow-workers and ourselves. Now that so many of our prominent leaders, like Brinton, Powell, Cushing, Virchow, Bastian and Ratzel, have passed away, whatever we may personally think of the value of their work and its influence upon future generations, it is our duty to come to an objective understanding of their activity and aspirations, and to write the pragmatic history of anthropology in the life and labors of its most conspicuous representatives.

BERTHOLD LAUFER

SCIENTIFIC BOOKS

THE MISSION FOUREAU

Documents Scientifiques de la Mission Saharienne, d'Alger au Congo par le Tchad. Par F. FOUREAU, chef de la mission. IIme fasc., Orographie, Hydrographie, Topographie, Botanique; IIIme fasc., Geologie, Petrographie, Paléontologie, Esquisse Ethnographique, notes sur la faune, Prehistorique, Aperçu Commercial, Conclusions économiques, Glossaire. Index. Atlas. Paris, Masson et Cie. 1905. 4to, 1210 pp., maps and ills.

While the Mediterranean and mid-African colonies of France have been for some time fairly well known, the efforts to connect them by a line of geographical exploration had been rendered ineffectual by the difficulties and dangers of the route through the desert, and the hostility of the natives. Several expeditions met with disaster and were exterminated by the fanatical population.

Finally the expedition organized and carried out by Foureau in 1898 to 1900 met with success. This happy result had been well earned, because Foureau had already given twenty-three years to Saharan exploration under the auspices of the Ministry of Public Instruction. In 1898 his itineraries already amounted to 21,000 kilometers, of which more than 9,000 km. were in previously unexplored country.

In 1894, M. Renoust des Orgeries left to the Société de Géographie a considerable sum of money, to be devoted to the geographical development of the French colonies. Out of this legacy the society devoted 250,000 francs to the purpose of the Sahara Mission, a sum to which the government added not only funds but an escort of 250 picked soldiers under the command of a most competent African officer, Com. Lamy, who fell during an attack by an African chief, in the very moment when the success of the expedition was assured.

With the concurrence of men of science, the commander of the expedition has prepared this report, which by the assistance of government and various scientific societies, is now published in magnificent style by the Société de Géographie, with a preface by Alfred Grandidier.

Together with the reports indicated by our synopsis of the title, the work is replete with well-executed maps, sketches, plans of towns, views and everything which could be of use to future explorers, including minute notes as to the presence, amount and quality of water, pasturage, cultivated land, wild animals, etc. If one is startled by the frequent notation, along the river, of the presence of 'oyster banks,' hundreds of miles from the sea, reflection recalls the colonies of the fresh-water *Ætheria* to which these notes undoubtedly refer.

The mass of information in this encyclopedic work, it is, of course, impossible to summarize. A few notes may, however, have interest for the reader. While a large portion of the herbarium suffered from termites and the wreck of a canoe, nevertheless a good number of plants are recorded; and numerous

small photographs reproduced in half tones in the text give excellent ideas of the manner in which many of the trees and shrubs appear in their natural state. M. Bonnet has made the most of the botanical material which was saved, and the record of native names for the various plants is remarkably full.

The expedition started from Biskra and traveled almost due south about 1,260 geographical miles to the settlement of Zinder, in the Damergou country, when they diverged to the east until Lake Chad was reached, passing round it by the north and east, whence they followed up the river Chari in a southeasterly direction, crossing from its headwaters to the Obangwe, an affluent of the Congo, down which they proceeded to the sea. The rocks encountered in the northern Sahara were largely: first, cretaceous limestones of Cenomanian age; then Devonian and a little Silurian, more or less interspersed with crystalline schists. In the middle of the Sahara the schists and granites prevailed, mitigated by patches of volcanic character. To the southeast of Lake Chad, more volcanics were encountered, and, on the upper reaches of the Chari River the schists, granites and diorites again occupied the field. Excellent views of the rocky and sandy desert with its characteristic dunes abound in the text. The first discovery and recognition of Silurian rocks, with *Climacograptus,* appears to be due to this expedition. M. Emile Haug has carefully worked out the Paleozoic fossils as well as the remains of some Cretaceous vertebrates, Selachians, fishes and reptiles, including two new species of *Ceratodus,* referable to the Albian.

The native Tuaregs of the northern Sahara are well described by Foureau, who shows how their predatory habits naturally result from the state of semi-starvation in which they exist, and which leads them to travel even 700–800 kilometers to make a raid, of which the chief result for them at best can be but the securing of a few camels and a few full meals of meat. They have an alphabet and system of writing of their own, but very few of them, those chiefly among the women, know how to use it. The correspondence and business of the most wealthy among them is done chiefly in Arabic, by Arab scribes from Touat, who act as secretaries. Those who can write are fond of inscribing the characters on rocks; and few are the suitable blocks of smooth stone in the vicinity of their trails which do not bear some inscription. They are great and fluent liars, but among themselves do not steal, and, within the tribe, observe the law of the cache. They are monogamists, and their women enjoy great liberty, and possess powerful influence which they seem not to abuse.

The Tuaregs dress in voluminous garments. They cover the whole body and head, and veil the lower part of the face, usually with a strip of blue cotton, so that the eyes alone are visible. This practise, perhaps originally adopted to shield the skin from the ardent reflections from the arid soil, has become almost a religious observance. The influx of slaves and wives from the negro races to the south, the Arab and Egyptian blood derived from the east, have made these people almost incredibly mixed in blood. Careless in their observation of the rules of the Koran, regarded almost as infidels by the orthodox Mohammedan, they are, when it is a question between them and strangers, fanatically bigoted Moslems.

M. Hanay has devoted much consideration to the prehistoric remains of the stone age collected by the expedition, many of which are illustrated by admirable heliotypes. In his summary the commander of the expedition pleads for the native people that they should be allowed to practise the rites of their religion in peace; and has very little to say in favor of the results accomplished by the French missionaries, in the regions to which the latter have had access.

On the whole the work is a mine of material for the geographer, geologist, naturalist and ethnologist, and reflects the highest appreciation of the labors of those who have succeeded in bringing so arduous an expedition to a happy and successful conclusion.

W. H. Dall

The Crawfishes of the State of Pennsylvania. By ARNOLD E. ORTMANN, Ph.D. Memoirs of the Carnegie Museum, Vol. II., No. 10.

There are two groups of animals which seem destined, on account of their abundance, extensive North American range, plasticity and educational utility, to become classics in the literature of American zoology. One of these groups is the Garter Snakes (*Thamnophis*) and the other the Crawfishes (*Cambarus*). The importance and utility of these groups does not seem to be generally recognized. It is therefore of special importance that Ortmann's recent comprehensive treatment of the Pennsylvania species of crawfishes should be generally known.

In his introduction Ortmann mentions his extensive explorations of the state, in which he traveled over 11,000 miles, and discusses his methods of collecting and finally gives a historical summary of the Pennsylvania species. This section is followed by the taxonomical and chorological portion of the paper, which includes a key to the species, with detailed description of each, full records of the occurrence of each species in the state and elsewhere, and a critical summary of the geographic range of each species. The detailed character of these records makes the work of special value to students of other localities as well as those of Pennsylvania.

The section devoted to ecology and geographic distribution discusses the subject of habitat preference, geographic origin and distribution, ecological relations (burrows, chimneys, etc.), and shows that there are three types of habitat preferences: (1) Those frequenting the larger rivers; (2) those frequenting small streams; and, (3) those frequenting springs and swamps. The river species are *Cambarus limosus, propinquus* and *obscurus*. These species are not completely restricted to these conditions, but occur also in any large permanent body of water, a habitat rarely found in Pennsylvania. The small or mountain-stream species is *C. bartoni*.[1] This form avoids large streams and tends to push up stream into the head-waters, and further shows a preference for cool waters. The spring and swamp or burrowing species are—*C. carolinus, monongalensis* and *diogenes*. These species, says Ortmann, are always found at a certain distance from the open water, although often in close proximity to streams, ditches and ponds; but not in them under normal conditions. Ground water seems to be a dominant factor in their environment. It may be suggested that the amount of oxygen and carbon dioxide in ground waters, as well as a low temperature, may be intimately related to the habitat preference of these species. (This would be an interesting problem for an experimental study.) The haunts of the various species are discussed, including the shape of the burrows and the construction of the chimneys. The deeper parts furnish winter, and the upper parts summer quarters. The chimney is simply the by-product of the burrow.

The geographic relations of each species are summarized and discussed in detail; not only with regard to origin in the state, but also their general geographic origin and migration routes. The determination of these routes has required a knowledge of the history of the streams or drainage modifications in Pennsylvania and the adjacent regions. The original distribution of *limosus* seems to have been influenced by canals and mine drainage. This species is of special interest because it belongs to an isolated group both morphologically and geographically. The allied species occur in Missouri, Illinois, Kentucky, etc., and its most apparent route is through pre-glacial streams in the now glaciated region; while a northward route, from the south along the Coastal Plain is dismissed as unlikely. Ortmann concludes that *limosus* is a Tertiary type which was driven south along the Atlantic Coastal Plain, and within the interior, into Indiana and Kentucky, while the species was exterminated from the intervening region. It might be suggested that the preservation of this group of species at the extreme northern part of the Coastal Plain on the Atlantic coast, and the upper part of the Missisippi Embayment

[1] In southern Michigan (Ann Arbor) this species is abundant in small brooks flowing through open meadows and thus illustrates the habitat variability of this species.

may indicate a former southern, rather than northern connection. The southern route would give a continuous lowland habitat, and although it might mean competition with related species now, it does not follow that formerly there was such competition. Geologically speaking, both the glaciated region and the Coastal Plain are recently populated areas.

The geographic relations of *C. propinquus* and var. *sanborni,* and *obscurus* are discussed as a unit on account of their close affinities. Their history is quite involved on account of the complex histories of the streams they occupy. These closely related forms are representative of different parts of the Ohio system: *obscurus* of the upper Ohio, *propinquus sanborni* of the middle, and *propinquus* of the lower Ohio drainage. These respective sections of the Ohio are considered by physiographers as formerly parts of independent drainage systems which later became fused to form the Ohio, and consequently there was an opportunity for differentiation while the streams were separated. Even now while occupying the same system they show only a limited tendency to fuse. Their glacial preserve was apparently in the more south-central parts of the Ohio system, not far from the ice margin.

The species *bartoni* has the most extensive range in Pennsylvania, which is in decided harmony with its preference for small, rapid, and cool streams—such as abound in the Appalachians. This is apparently a preglacial species which has extended its range in postglacial times to the northeast along the Appalachians, across various drainage lines—rather than along them. This is probably due to its tendency to frequent head waters, where divides themselves frequently migrate, and on account of the tendency and ability of this species to wander overland and thus 'migrate' the divides and around obstacles in streams, such as cascades or low falls. Such facts as these clearly emphasize the need of a detailed knowledge of the ecological relations of such animals before due weight can be given to the biological evidence suggesting physiographic changes.

This species becomes dwarfed in eastern Pennsylvania, a fact of much interest. There are so many conditions which may cause dwarfing that it would be of considerable interest to know what conditions have been operative here. The variety *bartoni robustus* is larger than the typical form and in Pennsylvania is confined to the extreme northwestern part, where the two forms occur together or separately. The general relations might be expressed thus: the largest form (var. *robustus*) occurs in the extreme northwestern part of the state, associated with or separately from a smaller form (*bartoni*) which alone occupies the intermediate eastern area of the state, and a still smaller or dwarfed form occupies the eastern part of the state. Thus there is a more or less progressive dwarfing to the eastward, if these forms prove to be intimately related.

C. carolinensis is restricted to the southwestern part of Pennsylvania, is a species of southern Appalachian range, and appears to prefer the higher altitude and clay soil of the Old Tertiary baselevel.

C. monongalensis also occurs only in the southwestern part of the state. This is a subterranean or burrowing species, even avoiding small streams, and thus it is not remarkable that the Ohio and Allegheny rivers have proved a barrier to its northward extension. The Youghiogheny and Monongahela rivers seem to have been traversed indirectly by the migration of a divide during the glacial period.

The range of *diogenes* is exceptional in that it occupies a narrow strip of the Coastal Plain along the Delaware river, is absent from all the central portion of the state, and occurs again in the southwestern part. Such discontinuity certainly suggests divergence as to origin. Ortmann is inclined to consider this species of Allegheny Plateau origin. A comparison made between the present range of *diogenes* and *limosus* shows that both exhibit a discontinuity of range between the eastern and western parts of the state, and both occupy the Coastal Plain. These facts suggest to Ortmann a retreat from the north before the glacial ice. Here again it may be

suggested that detailed investigation of the Coastal Plain may favor the hypothesis of a northward extension from the south. Such a possibility may be favored by a route across the Appalachians which seems to have been very generally overlooked as a highway—the Kanawha River Route—which reaches south into North Carolina. This is a stream with a remarkable history whose biological significance is worthy of detailed investigation, not only from the standpoint of aquatic invertebrates, but also of higher groups as well. (This is perhaps particularly true of birds.) In view of the antiquity of this route it seems very improbable that animals should ignore it.

In considering the crawfish characteristic of the natural physiographic regions of the state certain interesting correlations are evident. The Coastal Plain possesses two species, *diogenes* and *limosus;* the Piedmont Plateau and Great Allegheny Valley, which form a unit, are characterized by *limosus* and *bartoni;* the Allegheny Mountains by *bartoni,* with an invasion along the Susquehanna by *limosus* and an isolated colony of *obscurus*—both are due, Ortmann thinks, to the influence of man. A map of the state showing the location of past and present canals would greatly aid one in understanding the extent of this influence. The Allegheny Plateau, on account of its proximity and drainage into the great interior glacial preserve, has the most varied crawfish fauna—six species: *propinquus, obscurus, carolinensis, monongalensis, diogenes* and *bartoni.* It is thus seen that most of the species have invaded the state from the westward and that there is a marked attenuation of the fauna to the eastward.

The life histories of the species are considered in detail, the seasonal life history may be outlined as follows; a fall mating, a spring spawning season, an early summer season when the males are in the first form. The species which follow this cycle include, provisionally, *obscurus, propinquus* and var. *sanborni, limosus* and *diogenes.* These forms comprise what Ortmann calls the 'warm water' type and have a restricted breeding season. A second class includes those species which breed and spawn practically the year around, the 'cool water' type, and includes *bartoni, monongalensis* and probably *carolinensis.*

In *obscurus,* eggs are laid in April, hatch in May or June, and by September or October the crawfish are 40 to 55 mm. long, and the males are in the first form, the females are mature and copulation takes place from September to November. The winter is passed without change, and in April the females spawn and in June moult, the males having moulted in May. The fall moult ranges from August to October, and a second breeding season follows, and in the following year a third, after which they survive the winter, the males dying perhaps in early spring, and the females in June. They may thus reach the age of three years.

On account of the almost continuous breeding season of the 'cool water' species it is difficult to recognize broods and thus determine the detailed life history.

At present the known economic relations of crawfish are rather limited. They are used as food to a limited degree, especially about cities, but are very generally used as bait, hence the confusion which fishermen are likely to introduce into the problem of the original range of species. As scavengers they may be very beneficial, and occasionally dams may be injured, but these subjects have received but little attention by the public or naturalists. Their enemies include a wide range of animals, especially among the vertebrates.

The final section of Ortmann's paper is devoted to a discussion of the relation which this study of Pennsylvania species bears to the problems of evolution; mutation and isolation in particular. Ortmann criticizes de Vries's statement that species are formed only by mutation. He then considers in detail the evidence for marked variation or mutation among the Pennsylvania species and concludes that the differences between them are very constant and the variations slight, adding that "Anything that looks like a 'mutation' in de Vries's sense is entirely unknown." Even the differences between well-defined species "are so slight that they can not be regarded as representing 'mutations,' that is to say, sudden leaps in a progressive

direction." Rather than mutation Ortmann looks to isolation as the important factor and summarizes his position as follows:

1. The normal case is when two closely allied species, possessing identical or nearly identical ecological habits occupy separated areas, which lie close together but do not overlap. * * *

2. Whenever allied species are found in one and the same locality (overlapping), isolation becomes apparent in the following forms:

(*a*) The two species have different centers of origin, that is to say, they were separated formerly, but occupied the same territory subsequently. * * *

(*b*) If the centers of origin are more or less identical (absolute identity is hardly possible), the two species always differ ecologically, and although living at the same localities, prefer different surroundings. * * *

So much for the general results of Ortmann's investigations, but such an outline does not throw into the foreground some of the features of the work which deserve special mention. This paper is devoted to the fauna of a limited area, and contains several of the elements which go to make up an ideal treatment of a local fauna. Not only is there an abundance of detailed facts, supplemented by a critical review of former records, but a very serious attempt is made to understand the meaning or significance of the details presented. Thus Ortmann's efforts to *interpret* and *correlate* the mass of facts is particularly commendable and is a marked departure from the usual annotated lists. He sees clearly that many of the facts to be explained involve a knowledge of the conditions which formerly existed and consequently he turns to a study of the determining conditions. The present work is also an important lesson on the value of a knowledge of the ecological relations of animals in the study of their relationships and geographical distribution, and clearly illustrates the difference between the older 'orthodox' zoogeography and the newer ecological phase.

Some suggestions may be mentioned which offer opportunities for improvement or expansion in future work. While the details of the environment of the burrowing species are described fully, the same information is needed for the brook and river habitats; and such descriptions can be supplemented to advantage by photographs of representative situations. We need detailed maps showing the occurrence of crawfishes, in a manner similar to the mapping of plant societies by ecological botanists. The composite system of mapping used is not very satisfactory and would have been greatly improved had fewer species been placed on the map, and still more, if topographic maps had been used as a base. County and stream names are of great advantage on maps devoted to detailed faunal studies, and especially when the details of distribution are not expressed on the maps.

Ortmann does not seem to recognize, in more than a general way, the need of formulating the conditions which compose the most favorable (optimum) habitat, so that throughout the geographic range of a species the modifications of the habitat may be followed as definitely as structural and functional modifications (habits, etc.), so that eventually perhaps such relations may be correlated. In this connection it should be mentioned that the ecological observations are very largely from western Pennsylvania and should be extended over a larger area. But to do this the necessary time for *field study* as well as for *collecting* must be available. The importance of the laws of habit, habitat and environmental change is so great that it is very desirable that field students and institutional authorities see the real importance of these studies.

While reading this memoir a need has been felt for definite criteria by the aid of which some estimate could be made of the degree of primitiveness or specialization of forms. Further, if the general bearing of mutation is to be tested or used to the best advantage in the interpretation of the problems of habits, habitats and geographical distribution (of both plants and animals), it seems necessary to formulate criteria by means of which mutations can be recognized in nature (at least with some degree of probability), without recourse to pedigree cultures. Here, as when attempting to determine centers of origin, great care is necessary to avoid arguing in a circle.

Much confusion, both to the students of distribution and of pedigree cultures, has resulted from this lack of formulated criteria. Some may question the possibility of such criteria.

After such detailed studies, in which special emphasis has been placed upon geographic origin, one naturally expects certain criteria, perhaps more or less peculiar to the ecological relations of crawfishes, to be formulated, but such are not stated.

Two important papers should perhaps be mentioned in this connection, as they are not listed in the bibliography: Harris, 'An Ecological Catalogue of the Crayfishes belonging to Genus Cambarus' (*Kans. Univ. Sci. Bull.*, Vol. II., pp. 51–187, 1903), and Steele, 'The Crayfish of Missouri' (*Univ. of Cincinanti Bull.*, No. X., pp. 1–54, 1902).

A certain amount of statistical data could have been used to advantage. As this method of measuring variation, used with judgment and moderation upon critical phases and at critical localities, will aid such investigations. For example, if representative lots of *bartoni* from the northwestern, central and eastern parts of the state had been measured, the rate of dwarfing could have been determined. A similar comparison between the western and eastern variation of *diogenes* would be of value. Such variations as these are very common and signify to some that very frequently the *species is too large a unit* for the study of geographic distribution, that local variations or races are of great importance and that in further investigation the forms peculiar to definite habitats should receive recognition and detailed investigation.

In conclusion it should be said that such excellent work, perhaps the most important general zoological work yet published by the Carnegie Museum, should be continued, as the subject has reached such a degree of development that to stop now would be unfortunate, to say the least. The region to the south and west should now be considered, not only because of its proximity to Pittsburg, but primarily because it is apparently in that direction that a most wonderful evolution of crawfishes has taken place, or is taking place. Then with the modification of original conditions through the 'improvement' of streams for navigation, water power and supplies, the construction of canals, contamination by industrial refuse and sewage, we have additional urgent reasons for an early continuation of such investigations so that 'vanishing data' will be preserved for future generations. The Carnegie Museum is not a provincial institution, and does not necessarily limit its activities to the state of Pennsylvania, and it is hoped that this work will be continued, as the present study has clearly shown that the most important part of the problem still awaits detailed investigation.

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SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Comparative Neurology and Psychology for March contains a report of the convocation week meetings held in New York city during the winter, including abstracts of most of the papers read before the various societies in the fields of neurology and animal behavior. The leading article is a memoir on 'Light Reactions of Volvox,' by S. O. Mast. The light reactions were studied under rigidly controlled conditions in the 'light grader' devised by the author. Among other results, it was found that the direction of motion in *Volvox* is regulated by the relative light intensity on opposite sides of the colony regardless of the ray direction. Orientation is not the result of 'trial and error' reactions, as in *Stentor, Euglena* and other forms. *Volvox* colonies make no errors in this process. There is no evidence of motor reaction in a *Volvox* colony, taken as a whole. Orientation is, however, brought about by motor reactions in the individuals which constitute the colony. Weber's law holds approximately for the light reactions of *Volvox*.

The American Naturalist for April has for its leading article a discussion of 'The Geographic Distribution of Closely Related Species,' by Robert G. Leavitt. The question is considered from a botanical standpoint and the author's conservatively stated conclusions