THE ORIGIN OF THE CAVE FAUNA OF KENTUCKY, WITH A DESCRIPTION OF A NEW BLIND BEETLE.

BY H. GARMAN.

IT is common in writings on the origin of the cave fauna of the United States to assume that the recent formation of the caves of Kentucky is evidence of a similar recent origin of the blind animals which inhabit them. The geological evidence appears conclusive that the caves of the Green River region, and those to the northward in Indiana, were occupied during the Champlain period with water, and that their present inhabitants (at least the air-breathing species) must consequently have taken possession after the caves were elevated and the water no longer completely filled them. There can be no disputing the grounds for this belief; the geological evidence is all that could be desired for proof of a recent origin of the caves themselves. But I must beg leave to dissent from the conclusions which have been drawn from this proof, as to the recent origin of the blind animals. Conditions requisite to the development of eyeless animals are present in most parts of the United States. It seems only required that a species have no use for eyes, irrespective of the presence of light, and the eyes become reduced. Animals which burrow in the soil everywhere show a tendency to loss of the organs of vision. The moles, the worm-snakes (Carphophis), and *Cambarus bartoni* are familiar examples. Parasitic species lose their eyes, not in all cases because of a life in darkness, but because as parasites no eyes are needed. Numerous burrowing insects with poorly-developed eyes are known to occur over wide extents of territory. Beetles which live almost as exclusively in the dark as Adelops and Anophthalmus are not at all rare. Quite a list of non-cavernicolous blind beetles is known. It is to species such as these, already fitted for life in caves, that we should look, it seems to me, as representing the ancestors of cave species; certainly not to ordinary species with well-developed eyes. The originals of the cave species of Kentucky were probably already adjusted to a life in the earth before the caves were formed, and it seems probable from some facts mentioned below that they were not very different in character from the animals now living in the caves. I cannot believe that there has been anything more than a gradual assembling in the caves of animals adapted to a life in such channels. In this view of the matter the transformation of eyed into eyeless species appears to have been much less sudden and recent than has been supposed.

To take a definite example: There appears to be no imperative reason for assuming that the blind crustacean, *Cœcidotea* (*Asellus*) *stygia*, originated in Mammoth Cave. It was first discovered in caves it is true, but occurs widely distributed in the upper Mississippi Valley, is found throughout Kentucky, and is known to occur as far east as Pennsylvania. It is throughout its range a creature of underground streams, and is nowhere more common than on the prairies of Illinois (the last place in the country in which one would expect to find a cave), where it may be collected literally by the hundreds at the mouths of tile drains and in springs. In Kentucky, also, it is not more abundant in the cave region than elsewhere, being very frequently common under rocks in springs and in streams flowing from them, even during its breeding season. It is only natural that such a crustacean should have found itself at home in Mammoth Cave when this cavern was ready for its reception.

The blind fishes, again, are not by any means confined to the caves, but are widely distributed in underground waters throughout the country. *Amblyopsis spelœus* occurs in Indiana, Kentucky, and probably also in Missouri and farther south. *Typhlichthys subterraneus* occurs in Missouri, Kentucky, Tennessee, and Alabama. *Chologaster agassizii* occurs in Kentucky and Tennessee. *C. papilliferus* occurs in a spring in southern Illinois. I have had the pleasure of taking this species, and can say that the spring is evidently the outlet of an underground stream, and sends away a narrow but vigorous rill at all times of the year. *C. cornutus* I have taken, with the help of my friend, Professor B. P. Colton, in North and South Carolina, and can speak positively as to the situation in which it occurs. Like its relatives, it is a fish of underground streams, and makes its appearance at times at their mouths. Still another species appears, according to Dr. Packard, to have been observed in California. Here are widely scattered fishes with the family characters of Amblyopsis, and so probably closely resembling the eyed ancestors of the latter. They illustrate my point that there were in existence species possessing at least some of the characters of the Mammoth Cave forms when the caves became habitable; for it will hardly be supposed that all of these fishes originated in the caves of Kentucky and have become scattered since the glacial period. They illustrate, also, the point that hundreds of generations of a species may exist under the same conditions of environment as Amblyopsis and Typhlichthys, and yet not lose their eyes. Why then should these latter have had their eyes all but obliterated in the course of a few generations?

The distribution in this country of blind beetles of the genus Anophthalmus might at first thought appear to favor the idea that Mammoth Cave is a centre from which our species have been disseminated towards the East. Of our eight described species four (possibly five with *A. audax*) live in the Mammoth Cave region. Two others occur in Wyandotte Cave, only a short distance away. The single species not thus far recorded from these caves is *A. pusio* of Virginia and eastern Kentucky. It is to be remembered, however, that the large caves of Kentucky and Indiana have been much more thoroughly explored for cave animals than those of other parts of the country, and that their size and accessibility to Man have had much to do with the frequency with which they have been visited by collectors. They are simply portions of the haunts of the subterranean species which are opened up to us. One of the blind species (*Anophthalmus tenuis*) of Wyandotte Cave has now been found in Luray Cave, Virginia, a fact which gives us reason for believing that the Mammoth Cave species are more widely distributed than our present knowledge indicates. The large number of species (64) occurring in Europe points to that continent as the habitat from which all species of the genus have spread. If we accept this view of the origin of the genus then, whether the American species were introduced into this country before or after the Champlain period, it follows that our species have been but little modified by residence in Mammoth Cave, for if they had been we should find them departing more widely than they do from their European allies. They are in fact very closely related to European species. If we transfer the question of the sudden appearance of Anophthalmus to Europe, and claim still that the species are of post-glacial origin, that the eyes were lost suddenly after the Champlain period, we are met with the difficulty that here there is a gradation in both the habits and structure of the species which shows that the change may be and probably always has been gradual; for there are in existence species which live under rocks and have rudiments of external eyes.

Another aspect of this question of a sudden transformation of the species has recently been brought to my attention by some observations I have been making on the habits of these beetles, and particularly on a new species of Anophthalmus, of which a description is appended. Isolation in caves has been urged as an important factor in the development of those peculiarities by which cave animals are marked. It is assumed that the cave species are completely shut off from all relations with their out-of-door allies at an early stage in their phylogenic history. Nothing, it seems to me, can be farther from the truth. They are not even now isolated by anything except their inability to look out for themselves in the presence of their eyed enemies. *Cœcidotea stygia* is often found associated with *Asellus communis*, the eyed species from which it is supposed to have been derived. The cave cricket, *Hadenœcus subterraneus*, while occurring in the depths of caves, has always in my experience been found most abundant at the openings, where the twilight prevailing probably does not prevent the use of its well-developed eyes. It is frequently associated in such situations with its near relatives of the genus Ceuthophilus. Nor are the blind beetles confined to parts of caves in which total darkness prevails. Probably *Anophthalmus tellkampfii* is as completely adapted to a life in darkness as any of our species, and I have not yet found this species in the light; but I have found it abundant in a cave where

the rumbling of vehicles (not more than twenty feet away) passing on a road overhead could be distinctly heard. In all probability the beetles of this cave penetrate much nearer the surface than this. Some of the other species are common under rocks and wood in the shade of overhanging cliffs at the mouths of caves where they are associated with the Carabidæ commonly found in such places. The isolation, such as it is, is largely voluntary on the part of the insects, and I can see nothing in the surroundings or habits which would indicate that they have ever been more completely isolated than they are now. I believe, on the contrary, that they are more completely isolated now, from specialization, than ever before.

In short, a reconnaissance of the zoölogy of Kentucky, which the writer has had an opportunity to make during the past two years, satisfies him that the evolution of the structures which characterize our cave species is to be considered apart from the question as to the age of Mammoth Cave, and that the origin of our aquatic cave fauna is in some respects a separate question from that touching the origin of the insect fauna.

Of these matters I hope to have something further to present in the future. Of the insects I may say now that there appears to have been after the Champlain period a migration towards Mammoth Cave of cave insects from the south and east, where the continent had not been so greatly affected by changes of level as was the Mississippi valley. Some observations in my possession tend to show that cave species are now abundant in the vicinity of the mountains of Eastern Kentucky. In fact much of the eastern end of the State appears to be adapted to an extensive subterranean fauna It was a source of wonder to me during the first few months of my residence at Lexington how the rainfall disappeared so rapidly. A precipitation, which in central Illinois would have left its traces in muddy roads and swollen streams for weeks, disappears here in the course of forty-eight hours, having been swallowed up by a network of fissures in the underlying limestone and hurried down to the Kentucky River. These fissures are co-extensive with the Trenton limestone of this locality, and constitute the natural drainage system of the blue grass region of Kentucky. The wonder is not where the rainfall goes, but that any at all should remain at the surface. It early occurred to me that one might find cave animals in these fissures could he but get access to them. This can be done in some cases in quarries, and I can say as the result of preliminary exploration that some cave insects do occur here, and that at least one blind beetle is as abundant as it well could be. On a single visit to one of these opened channels I have, with the aid of a pupil, taken over one hundred specimens of the new species here described. It is without trace of external organs of vision, but like the earthworms possesses the power of recognizing light, a power which is evidently of some importance to it. It occurs in channels seemingly wherever there is food and moisture, and may be collected in the dim light near the openings. For some time I have kept forty individuals of this little beetle in my cellar where it appears to be perfectly at home, although during the day the light is never wholly excluded from its quarters. It wanders about freely, but may be sent scampering to cover by a flash of strong light. The food evidently consists of dead animal matter, such as insects and small mammals which are carried into fissures by freshets. This supply must be very great, though perhaps somewhat irregular; but this latter is a feature of the available food supply of many ordinary insects. Dead grasshoppers carried into the fissures are eagerly devoured. Food is evidently discovered by the sense of smell. In three minutes after placing a freshly killed grasshopper on the ground in one of the channels, several beetles were found at work on it. In confinement the beetles collect on such food after the manner of small ants, and eventually leave only the empty crust.

Anophthalmus horni, n. s. Somewhat depressed; smooth and shining; head, thorax, elytra, and abdomen everywhere provided with scant, erect, microscopic pubescence. Head oval; cheeks rounded; dorsal linear impressions rather deep; surface between the impressions very finely transversely rugulose; mentum tooth prominent, bicuspid. Antennæ densely pubescent excepting the thickened basal segment, which is smooth and shining, with a few hairs near its distal extremity. Thorax trapezoidal, larger than the head; sides strongly arcuate in front; sinuate behind; the hind angles acute but not produced; basal impressions deep, separated by a ridge at which the well-marked median linear impression terminates; truncate behind, but with a shallow emargination at each side separated by a wider median one; margin of contracted posterior part a trifle convex before the posterior angles. Elytra oblong oval, widest a little in front of the middle, truncate in front with the rounded humeri rather prominent; humeral margin obsoletely serrulate under a high magnifying power; striæ very evident next the suture, becoming obscure next the outer margin, obsoletely punctured, the third and fourth broken near the middle by a dorsal puncture, the sutural stria recurved at the posterior extremity of the elytron, joining the third; four rather strong punctures within each humeral margin, the second of which gives rise to one of the long setæ. Color pale fulvous, fading on posterior part of elytra to yellowish white, or cream color; curved impressions of head, edge of prothorax behind and at sides, rims about coxæ, etc., darker; length of body 3.67–4 millimeters; antennæ, 2–2.28 millimeters; length of head, 0.64 millimeter; width of head, 0.60 millimeter; length of thorax, 0.72 millimeter; width of thorax, 0.80 millimeter; width of thorax at base, 0.66 millimeter.

The species is closely related to *A. pusio*, Horn, from the Carter caves of eastern Kentucky, agreeing in size, in the absence of evident serrulation at the humeral margins of the elytra, and in the deep basal impressions of the prothorax. It differs in the size and shape of the prothorax, *A. pusio* having a very small prothorax, "not as long as the head and scarcely larger," whereas in this beetle the prothorax is distinctly larger than the head. The prothorax in *A. pusio* is as wide as long, and contracts in width somewhat gradually from the front, while in the new species this division of the body is broadly rounded at the sides, contracting rather abruptly behind. *A. pusio* is said to have pubescence only at the bases of the elytra. In this species the pubescence is rather scant, but is present on all the surfaces. The new species was discovered within the corporate limits of Lexington in the spring of 1890. It is named in honor of Dr. G. H. Horn of Philadelphia, who has contributed much towards an accurate knowledge of our species of Anophthalmus.

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THE BOTANICAL LIBRARY OF A STATION BOTANIST.

BY A. S. HITCHCOCK.

PROBABLY the most essential part of the special equipment of a botanist to an experiment station is his working library. At least a part of the work of a station should be original investigation. In order that the results of his investigation should be an addition to the sum total of the world's knowledge, it is obviously desirable that the investigator should know all that has been published on the subject up to the time he presents his own results to the public. In the scientific world results are said to be known when they are put on record; that is, when they are published. If all the results of botanical investigation were published in one periodical, it would be an easy matter to hunt up the literature on a given subject. If all the results were to be found in botanical periodicals in the English, French, or German language, our work would be less easy, but still not difficult. But, lo! where must we look for our information? In botanical periodicals in all languages. I doubt if there be a station botanist in this country who can readily read all the botanical literature published in Europe. This statement will probably hold good if we exclude the Hungarian, Polish, and Russian; and most of us are confined to French, German, Latin, and possibly Italian. But this is not the worst; we must look through the proceedings of a multitude of scientific societies, prominent ones whose proceedings are readily accessible in the larger libraries, others more or less local and little known. But even this is not the worst; we find botanical literature in periodicals or proceedings devoted to general science, or even to miscellaneous matters. Sometimes it is tucked