and zoological interest. It is exceedingly impressive to see an extensive archipelago, of most recent origin, inhabited by creatures so different from any known in other parts of the world. Here we have a positive limit to the length of time that may be granted for the transformation of these animals, if they are in any way derived from others dwelling in different parts of the world. The Galapagos are so recent that some of these islands are barely covered with the most scanty vegetation, itself peculiar to these islands; some parts of their surface are entirely bare, and a great many of the craters and lava streams are so fresh that the atmospheric agents have not yet made an impression upon them. Their agent does not, therefore, go back to earlier geological periods; they belong to our time, geologically speaking. Whence then do their inhabitants come from—animals as well as plants? If descended from some other type, belonging to some neighbouring land, then it does not require such unspeakably long periods for the transformation of species as the modern advocates of transmutation claim; and the mystery of change, with such marked and characteristic differences between existing species, is only increased and brought to a level with that of creation. If they are autochthones, from what germs did they start into existence? I think that careful observers, in view of these facts, will have to acknowledge that our science is not yet ripe for a fair discussion of the origin of organised beings.

Our stay in Panama has allowed us to make very extensive collections in the Bay and across the Isthmus. I was surprised to find so little difference in the character of the flora and of the terrestrial fauna between the two oceans. Marked peculiarities are only to be found among the marine animals, and even among them the American character of the Atlantic and Pacific marine fauna is unmistakable; we are not surrounded by animals recalling by their peculiarities the many groups of islands of the Pacific. I expect that our visit in Acapulco will confirm these impressions. L. AGASSIZ

CAPTAIN HALL'S ARCTIC EXPEDITION

THE *Washington Chronicle* of August 26 contains the following interesting account of the progress and position of this important expedition:—"The Navy Department has received later despatches from Captain Hall, by the way of Tydskland and Copenhagen, completing his official record up to the moment of final departure from North Greenland. These despatches, which are quite full, bear date off Tossak, Tussuissuk, N. lat. 73° 21′, W. long. 56° 5′, August 24, 1871, and are, therefore, only four days later than Hall's Upper Navik despatch, August 20, 1871, which reached the department within three months by the way of Copenhagen. The explanation of this long delay *in transitu* is that there is no regular communication between Denmark and these far-off colonies but once a year. Hall's Upper Navik despatches were timed to reach the Danish brig just then sailing, and this present letter sent back by native pilots, as he notes in concluding, may have had near a year's detention in Disco. It seems to have reached the American Minister at Copenhagen about July 30. Although thus divested of any special value as news, the present despatch is of much intrinsic interest. All on board the *Polaris*, officers, scientific corps, and men, were well and in excellent spirits. The seagoing qualities of the vessel had been tested and found admirable; the engines and machinery were in perfect working order, coal and rosin in good supply, and the ship's crew abundantly provisioned. For the long Arctic night before them they had books, games, instrumental music, &c.—in a word, everything that the thoughtful care of the department could supply, or letters of credit at Newfoundland and in Greenland furnish, had been laid in to complete their outfit, and of all this Captain Hall makes characteristic and thankful acknowledgments. Governor Elberg, of the Navik district, had accompanied the *Polaris* as far as Tossak, the extremest northerly limits of Danish jurisdiction as well as of civilised life, and was to the last moment assiduous in his exertions to further the interests of the expedition. Mainly through his co-operation Hall was fortunate enough at Tossak to make up his complement of Esquimaux dogs—sixty strong, healthy animals—a matter of almost vital importance. He likewise laid in a large supply of dog food, and considerably augmented his stock of reindeer-furs, sealskins, &c., for the adventurous voyage. At Upper Navik the expedition had shipped Hans Christian, a famous native hunter and dog-driver, with his wife and three children. Jensen, the Dane, who was under promise to join the expedition at Tossak, backed out at the last moment. Governor Elberg, of whose many kindnesses Hall speaks with full heart, awaited at Tossak the return of the native pilots, bearing this despatch to him, and it closes with the prow of the *Polaris* northward in the early morning of August 24, with a complete roster of all on board, thirty-three souls, and a fervent, hopeful prayer for success. It will be remembered that Captain Hall's previous despatches speak of his good fortune in meeting at Holsteinburg the returning Swedish expedition, and that the commander, Baron van Otter, kindly furnished him copies of log, deep-sea soundings, &c., assuring him that the season was more than usually favourable, and extremely wide iceberg-channels, &c. Of the same purport was the information received of Governor Rodolph, thirty years resident in North Greenland, who declared the year to be more favourable for any northern voyage than many years agone or to come. Acting on this information, and under discretionary power vested in him by the Navy Department, Captain Hall had abandoned the Jones's Sound route, and had decided before he left Upper Navik that after stopping at Tossak he would cross Melville Bay to Cape Dudley Digges, and from that point steam direct to Smith's Sound, thence make all possible attempts to find a passage on the west side of the Sound from Cape Isabella up to Kennedy Channels, wintering there probably in about the same latitude or a little higher than Kane's winter quarters, and thence on and up to the North Pole. The letter published in the *New York Times*, April 25, purporting to narrate a disaster to the *Polaris* and her return last February to Disco, was a *canard*. Not one word of it has ever been credited at the Navy Department. It is not believed that any disaster has overtaken the Expedition, or that any ground for apprehension exists."

*THE BLIND FISHES OF THE MAMMOTH CAVE AND THEIR ALLIES**

THE *Amblyopsis spelæus* undoubtedly has quite an extensive distribution, probably existing in all the subterranean rivers that flow through the great limestone region underlying the Carboniferous rocks in the central portion of the United States. Prof. Cope obtained specimens from the Wyandotte Cave and from wells in its vicinity, and in the Museum of Comparative Zoology at Cambridge there is a specimen labelled "from a well near Lost River, Orange Co., Ind.," which, with those from the Wyandotte Cave, is conclusive evidence of its being found on the northern side of the Ohio† as well as on the southern, in the rivers of the Mammoth Cave. I have been able to examine a number of specimens from the Mammoth Cave, and have carefully compared with them the one from the well in Orange Co., Ind., and find that the specific characters are remarkably constant.

* Reprinted from the *American Naturalist*, a sequel to "The Blind Crustacea of the Mammoth Cave." See NATURE, vol. v. pp. 445, 484.

† I have also been informed by Mr Holmes of Lansing, Mich., that *blind fishes* have been drawn out of wells in Michigan.

In 1859* Dr. Girard described a blind fish, received by the Smithsonian Institution from J. E. Younglove, Esq., who obtained it "from a well near Bowling Green, Ky." The general appearance of this fish, which was only one and a half inch in length, was that of *Amblyopsis spelæus*, but it differed from that species in several characters, especially by the *absence* of ventral fins. Dr. Girard therefore referred the fish to a distinct genus under the name of *Typhlichthys*† *subterraneus*. Dr. Günther‡ considers this fish a variety of *Amblyopsis spelæus*, and records the specimen in the British Museum "from the Mammoth Cave," as half-grown.§

By the kindness of Prof. Agassiz, I have been enabled to examine nine specimens of *blind fish without ventrals*, in the Museum of Comparative Zoology. Seven of these were collected in the Mammoth Cave by Mr. Alpheus Hyatt, in September 1859. One was from Moulton, Lawrence County, Alabama, presented by Mr. Thomas Peters; and another from Lebanon, Wilson Co., Tennessee, presented by Mr. J. M. Safford. It is not stated whether these latter came from wells or caves, but probably from wells. They are all of about one size, one and one-half to two inches in length, and are constant in their characters. Moreover, four of the seven specimens from the Mammoth Cave were females with eggs. These eggs were as large in proportion as those from *Amblyopsis*. The ovary was single, and situated on the right side of the stomach, as in *Amblyopsis*. The difference in the number of eggs was very remarkable, each of the four specimens examined having but about thirty eggs in the ovary, while in three females of *Amblyopsis* (all, however, of nearly three times the size of *Typhlichthys*) there were about one hundred eggs in each. As in both species there were no signs of the embryos in the eggs, it is not probable that any of the eggs had been developed and the young excluded, nor is it at all likely that the great variation in the number of eggs would simply indicate different ages. For these reasons, taken in connection with the absence of ventral fins, I have no hesitation in accepting Dr. Girard's name as valid for this genus, of which we thus far know of but one species, with a subterranean range from the waters of the Mammoth Cave, south, to the northern portion of Alabama. In this connection it would be most interesting to know the relations of the "blind fishes" said to have been found in Michigan. For thus far we have *Typhlichthys* limited to the central and southern portion of the subterranean region, *Amblyopsis* to the central, and the species in the northern portion undetermined.

In 1853, on his return from a tour through the southern and western states, Prof. Agassiz gave a summary of some of his ichthyological discoveries in a letter to Prof. J. D. Dana.‖ In this letter are the following remarks:—

"I would mention foremost a new genus which I shall call *Chologaster*, very similar in general appearance to the blind fish of the Mammoth Cave, though provided with eyes; it has, like *Amblyopsis*, the anal aperture far advanced under the throat, but is entirely deprived of ventral fins; a very strange and unexpected combination of characters. I know but one species, *Ch. cornutus* Ag. It is a small fish scarcely three inches long, living in the ditches of the rice fields in South Carolina. I derive its specific name from the singular form of the snout, which has two horn-like projections above."

This is the only information ever published regarding this interesting fish, and the only specimens known are those on which Prof. Agassiz based the above remarks.

The only specimen known of this second species was drawn from a well in Lebanon, Tenn., and presented to the Museum by Mr. J. M. Safford, Jan. 1854. It is a more slender fish than *C. cornutus*, but the intestine follows the same course, and the four pyloric appendages are present as in that species.

In the genus *Chologaster*† we have all the family characters as well expressed as in the blind species, though it differs from *Amblyopsis* and *Typhlichthys* by the presence of eyes, the absence of papillary ridges on the head and body, and by the longer intestine and double the number of pyloric appendages, as well as by the position of the ovary; and agrees with *Typhlichthys* by the absence of ventral fins. *Amblyopsis* and *Typhlichthys* are nearly colourless, while *Chologaster Agassizii* is of a brownish colour, similar to many of the minnows, and *C. cornutus* is brownish yellow, with dark, longitudinal bands.

Among the most interesting points in the history of this genus is the fact of its occurring in two widely different localities, *C. Agassizii* having been found in a well in the same vicinity (probably in the same well) with a specimen of *Typhlichthys*, and undoubtedly belonging to the same subterranean fauna west of the Appalachian ridge, while *C. cornutus* belongs to the southern coast fauna of the eastern side of that mountain chain, and is thus far the only species of the family known beyond the limits of the great subterranean region of the United States.

Having now given an outline of the structure, habits, and distribution of the four species belonging to the family and recapitulated the known facts, we are better able to consider the bearings of the peculiar adaptation of the blind fishes, in the Mammoth and other caves, to the circumstances under which they exist.

Prof. Cope, in stating, in his account of the blind fish of the Wyandotte Cave, "that the projecting under jaw and upward direction of the mouth renders it easy for the fish to feed at the surface of the water, where it must obtain much of its food," suggests that:—

"This structure also probably explains the fact of its being the sole representative of the fishes in subterranean waters. No doubt many other forms were carried into the caverns since the waters first found their way there, but most of them were like those of our present rivers, deep water or bottom feeders. Such fishes would starve in a cave river, where much of the food is carried to them on the surface of the stream. . . . . The shore minnows are their nearest allies, and many of them have the upturned mouth and flat head. . . . . Fishes of this, or a similar family, enclosed in subterranean waters years ago, would be more likely to live than those of the other, and the darkness would be very apt to be the cause of the atrophy of the organs of sight seen in the *Amblyopsis*."

This suggestion was undoubtedly hastily made by Prof. Cope when writing the letter which was printed in the *Indianapolis Journal*, and were it not that the article has been reprinted in the "Annals and Magazine of Natural History," I should not criticise the statement made in an off-hand letter for publication in a newspaper; for with Prof. Cope's knowledge of fishes it could simply be a hasty thought which he put on paper, when he suggests that it is because the *Cyprinodontes* have a mouth directed upwards and are surface feeders that they were better adapted to a subterranean life than other fishes, and hence maintained an existence, while other species, which he supposes were introduced into the subterranean streams at the same time, died out.

If the fishes of the subterranean streams came from adjoining rivers, why were not many of the Percoids, Cyprinoids, and other forms, that are as essentially surface feeders as the *Cyprinodontes* (many of the latter are purely "mud feeders"), as capable of maintaining an existence in the subterranean waters as any species of the latter? Neither is it necessary for us to assume that the structure of the fish should be adapted to feeding on the

* Proceedings Acad. Nat. Sci. Philad., p. 63. † Blind fish.

‡ Catalogue of Fishes in the British Museum, vol. vii. p. 2, 1868.

§ The largest specimen I have seen of *Typhlichthys* is one and seventeen-twentieths inches in length, and the smallest *Amblyopsis* one and eighteen-twentieths inches.

‖ Published in American Journal of Science and Arts, vol. xvi. (2d series) p. 134, 1853.

* Literally "bile-stomach;" probably named from the yellow colour of the fish.

surface, for not only have we in the blind cat fish described by Prof. Cope himself from the subterranean stream in Pennsylvania, an example of a fish belonging to an entirely different family of bottom feeders thriving under subterranean conditions, but the blind fishes of the Cuban caves are of the great group of cod fishes which are, with hardly an exception, bottom feeders. The fact that the food of the blind fishes of the Mammoth Cave consists in great part of the cray fish found in the waters of the cave, as shown by the contents of several stomachs I have examined, and also that one blind fish at least made a good meal of another fish, as already mentioned, shows that they are not content with waiting for what is brought to them on the surface of the water, and that they are probably as much bottom as surface feeders.

Again, in regard to sense of sight, why is it necessary to assume that because fishes are living in streams where there is little or no light, that it is the cause of the non-development of the eye and the development of other parts and organs? If this be the cause, how is it that the *Chologaster* from the well in Tennessee, or the "mud fish" of the Mammoth Cave, are found with eyes? Why should not the same cause make them blind if it made the *Amblyopsis* and *Typhlichthys* blind? Is not the fact, pointed out by Prof. Wyman, that the optic lobes are as well developed in *Amblyopsis* as in allied fishes with perfect eyes, and, I may add, as well developed as those of *Chologaster cornutus*, an argument in favour of the theory that the fishes were always blind, and that they have not become so from the circumstances under which they exist? If the latter were the case, and fishes have become blind from the want of use of the eyes, why are not the optic lobes also atrophied, as is known to be the case when other animals lose their sight? I know that many will answer at once that *Amblyopsis* and *Typhlichthys* have gone on further in the development and retardation of the characters best adapting them to their subterranean life, and that *Chologaster* is a very interesting transitionary form between the open water *Cyprinodontes* and the subterranean blind fishes. But is not this assumption answered by the fact that *Chologaster* has every character necessary to place it in the same family with *Amblyopsis* and *Typhlichthys*, while it is as distinctly and widely removed from the *Cyprinodontes* as are the two blind genera mentioned?

If it is by acceleration and retardation of characters that the *Heteropygii* have been developed from the *Cyprinodontes*, we have indeed a most startling and sudden change of the nervous system. In all fishes the fifth pair of nerves send branches to the various parts of the head, but in the blind fishes these branches are developed in a most wonderful manner, while their subdivisions take new courses and are brought *through* the skin, and their free ends become protected by fleshy papillæ, so as to answer, by their delicate sense of touch, for the absence of sight. At the same time the principle of retardation must have been at work and checked the development of the optic nerve and the eye (which probably exists externally in the young fish), while acceleration has caused other portions of the head to grow and cover over the retarded eye.

Now, if this was the mode by which blindness was brought about, and tactile sense substituted, why is it that we still have *Chologaster Agassizii* in the same waters, living under the same conditions, but with no signs of any such change in its senses of sight and touch? It may be said that the *Chologaster* did not change because it probably had a chance to swim in open waters, and therefore the eyes were of use, and did not become atrophied. We can only answer, that if the *Chologaster* had a chance for open water, so had the *Typhlichthys*, and yet that is blind.

If the *Heteropygii* have been developed from *Cyprinodontes*, how can we account for the whole intestinal canal becoming so singularly modified; and what is there in the difference of food or of life that would bring about the change in the intestine, stomach, and pyloric appendages, existing between *Chologaster* and *Typhlichthys* in the same waters? To assume that under the same conditions one fish will change in all these parts and another remain intact, by the blind action of uncontrolled natural law, is, to me, an assumption at variation with facts as I understand them.

Looking at the case from the standpoint which the facts force me to take, it seems to me far more in accordance with the laws of nature, as I interpret them, to go back to the time when the region now occupied by the subterranean streams was a salt and brackish water estuary, inhabited by marine forms, including the brackish water forms of the *Cyprinodontes* and their allies (but not descendants) the *Heteropygii*. The families and genera having the characters they now exhibit, but most likely more numerously represented than now, many probably became exterminated as the salt waters of the basin gradually became brackish and more limited, as the bottom of this basin was gradually elevated; and finally, as the waters became confined to still narrower limits, and changed from salt to brackish, and from brackish to fresh, only such species would continue as could survive the change, and they were of the minnow type represented by the *Heteropygii*, and perhaps some other genera of brackish water forms that we have not yet discovered.

In support of this hypothesis we have one species of the family, *Chologaster cornutus*, now living in the ditches of the rice fields of South Carolina, under very similar conditions to those under which others of the family may have lived in long preceding geological times; and to prove that the development of the family was not brought about by the subterranean conditions under which some of the species now live, we have the one with eyes living with the one without, and the South Carolina species to show that a subterranean life is not essential to the development of the singular characters which the family possess.

That a salt or brackish water fish would be most likely to be the kind that would contine to exist in the subterranean streams, is probable from the fact that in all limestone formations caves are quite common, and would in most instances be occupied first with salt water then with brackish, and finally with fresh water so thoroughly impregnated with lime as to render it probable that brackish water species might easily adapt themselves to the change, while a pure fresh water species might not relish the solution of lime any more than the solution of salt; and we know how few fishes there are that can live for even an hour on being changed from fresh to salt, or salt to fresh water. We have also the case of the Cuban blind fishes belonging to genera with their nearest representative in the family a marine form, and with the whole family of cods and their allies, to which group they belong, essentially marine. Further than this, the cat fish from the subterranean stream in Pennsylvania belongs to a family having many marine and brackish water representatives. As another very interesting fact in favour of the theory that the *Heteropygii* were formerly of brackish water, we have the important discovery by Prof. Cope of the Lernæan parasite on a specimen of *Amblyopsis* from the Wyandotte cave; this genus of parasite crustaceans being very common on marine and migratory fishes, and much less abundant on fresh water species.

Thus I think we have as good reasons for the belief in the immutability and early origin of the species of the family of *Heteropygii*, as we have for their mutability and late development, and, to one of my, perhaps, too deeply rooted ideas, a far more satisfactory theory; for, with our present knowledge, it is but theory on either side.

F. W. PUTNAM