

ADDITIONAL OBSERVATIONS ON THE RETARDATION OF THE DEVELOPMENT OF THE OVA OF THE SHAD.**BY JOHN A. RYDER.**

The following data supplement and confirm in a somewhat remarkable manner the arguments put forth by the writer in an article on the retardation of the development of the eggs of the shad, published in this Bulletin, pp. 177-190, 1881. The facts there recorded were the results of experiments carried out with the help of apparatus specially designed to artificially lower the temperature of either the air or water in which the eggs were hatched. The value of the present series of observations depends entirely upon the fact that no artificial means were resorted to for the purpose of lowering the temperature, but that the eggs experimented upon, obtained, as they were, as early as the 9th day of April were, in consequence of the then prevailing low temperature of the water, subjected to no extraordinary or artificial condition arising from the use of a complex water-or air-cooling apparatus. The temperature of the water of the Potomac during the progress of the incubation of the eggs in question was at times as low as 48° Fahr., but as a rule the water then in use in the McDonald hatching jars, the apparatus utilized in the experiment, fluctuated only between 50° and 56° Fahr., and even then very gradually, as the variation during any one period of twelve hours was rarely more than 1° Fahr. There was a gradual but very slight rise in the temperature of the water from the beginning to the end of the experiment, which covered seventeen days. This gradual rise was covered by six or seven degrees Fahrenheit, as already stated. The average temperature of the water for the whole period was 53 $\frac{3}{4}$ ° Fahr., which, as we see, was only a little above the "danger point," 52° Fahr., if we may so call it, as indicated by my observations made in association with Messrs. McDonald and Clark last year. The results of this experiment have shown us that it is possible to retard the development of shad ova so as to prolong the period of incubation for a period five times that normally occupied in the process in the height of the spawning season, or for almost fifteen days. During my somewhat extended observations on the eggs of this species, no such length of time of incubation has been recorded, nor has any one, to the best of my knowledge, recorded the fact that under such conditions of temperature the progress of the evolution of the embryo was perfectly normal, as was the case in the instance now to be described. Several persons have insisted that shad ova developing in too low a temperature would be found to be imperfect, especially the eyes, which, it was said, did not apparently develop at all. The lowest temperature in which I have seen shad ova develop normally was 49° $\frac{1}{2}$ Fahr., as recorded in my report of the experiments during the spring of 1881. Neither in those nor in the

embryos which are the subject of this paper was any abnormality observed in the development of the eyes or optic vesicles.

Now for the history of the progress of the experiment and the ova. The latter were taken at one of the Potomac stations organized upon the plan proposed by Colonel McDonald. They were impregnated on the 9th of April at 7 p. m., and brought to the Armory on trays and spread out on damp cloths by spawn-taker Jones. They were placed in one of the McDonald jars on the morning of the 10th of April, but, unfortunately for the fullest fruition of our hopes, during the night, owing to an accidental occurrence or to the meddlesomeness of some irresponsible busy-body, too large a supply of water was turned on, causing the largest proportion of the eggs to be thrown out by way of the escape pipe of the jar. What were then left, amounting to probably two or three thousand, had to suffice for the material for this account of their development.

On the 11th of April, the temperature of the water was 57° Fahr. It had been about the same or a little lower on the 9th and 10th; the water of the Potomac, from which they were obtained at Ferry Landing, was on those dates as low as 48° Fahr. On the 12th, the thermometer indicated a temperature in the hatching apparatus ranging from 50° to $51^{\circ}.5$ Fahr. On the 13th, the temperature ranged from 51° to 52° Fahr. This was the fourth day, and sketches taken from the eggs at this time showed that the blastoderm was just about to close, a condition ordinarily attained in a temperature of 74° Fahr., in somewhat less than 24 hours. On the 14th of April, the temperature was 52° to 53° Fahr.; on the 15th, 53° Fahr.; on this, the sixth day, the tail began to bud out. On the 16th, the temperature was the same as on the previous day, and the tail had, by this time, the seventh day, grown to about one-third the length of that of the just-hatched embryo. On the 17th, the temperature was $53^{\circ}.5$ Fahr.; on the 18th, $51^{\circ}.5$ to 52° Fahr.; on the 19th, 53° to $53^{\circ}.5$ Fahr.; development still normal. On the 20th, the temperature ranged from 53° to 54° ; on the 21st, 55° to $55^{\circ}.5$ Fahr., and about this time, or on the twelfth day, the eyes began to show the first signs of pigmentation, becoming a shade darker than hitherto, verging toward brown. On the 22d, the temperature of the water was 56° , falling to $55^{\circ}.5$ Fahr.; on this, the thirteenth day, a few began to hatch; the eyes were now fully pigmented and normal in their development. On the 23d, the temperature of the water was $55^{\circ}.5$ to 54° Fahr. On the 24th, the temperature was from 54° to $54^{\circ}.5$ Fahr. During the 23d and 24th days of April, the hatching continued, most of the embryos having ruptured their inclosing membranes on the 24th of April, or the fifteenth day of incubation. On the 25th, the temperature ranged between $54^{\circ}.5$ to 55° Fahr., and on this date, or the sixteenth day, a few of the ova still remained unhatched. On the 26th, the temperature was 55° Fahr., all of the ova were now hatched, and no abnormalities of any sort were noticed. The embryos, however, were for

the most part lost, owing, as I think, to the circumstance that the water was allowed to flow too rapidly and violently through the hatching jar.

The behavior of the hatching jar was most admirable, but would have been still better had there been a larger quantity of eggs put into the apparatus. The most meritorious feature of the apparatus is the almost entire non-development of the saprolegnious fungus, which causes so great a mortality in some other forms of hatching contrivances in which all of the ova are not in continual movement. The very gradual, gentle, and continual rolling movement of the ova upon each other in the jar apparently prevents the spores of the fungus from adhering. The cleanliness of the apparatus is also to be commended, whereby the use of skim nets for cleaning is dispensed with, while the material of which it is made—glass—enables one to watch the progress of development very satisfactorily from the outside of the jar with a hand-glass or pocket lens of moderate power.

On the seventeenth day of the experiment the hatched embryos were in the condition of those normally developed at 70° to 75° Fahr., the yolk being ovoidal, clear, and plump. At the rate at which the development progressed, it would take five times as long to absorb the bulk of the yolk of an embryo at a temperature of 53°.75 Fahr. as at 75° Fahr., or about 25 days. This period, added to the prolonged time of incubation at 53°.75 Fahr., would cover a space of forty days, or more than twice the time required to carry embryo shad to the farthest confines of Europe. The probability therefore is, that we have exceeded the lowest temperature practically required for this purpose; 55° Fahr. being a much more favorable and less dangerous temperature than that prevailing during the successful experiment of which we have just given a detailed account.

WASHINGTON, *April 26, 1882.*

GROWTH AND SPAWNING OF GERMAN CARP IN ALABAMA.

By A. G. BARNES.

[Letter to Prof. S. F. Baird.]

It will perhaps interest you to have a report from my German carp. Those received January 12, 1881, are now 20 inches in length. The first indications noticed of their breeding were in March last (the nineteenth day). A lot of eggs, found attached to the grass, was taken and placed in a tub, and the young were seen on the seventh day afterwards—the weather cool and wet. Again, on 2d instant I saw them depositing their eggs. A lot of these eggs placed in a tub hatched out on the fourth day—the weather warm and pleasant—the water during the day indicating about 70°. Those hatched 26th March are now 1½ inches in length.