tively.[3] Since the energy of the gamma rays is not equal to the energy difference of the two beta rays, it is probable that the radiation accompanies the absorption of the K electron to form A^{40}. The value of 1 per cent. for its occurrence fits in well with the value of 1/100 to 1/700 calculated from the abundance ratio as both may very well differ by a factor as large as 2 or 3 from their true values. Moreover, if these gamma rays accompanied either one or both of the beta groups, their frequency of occurrence should be equal to the frequency of the beta emission instead of 1/60 or 1/40 of that.

For the dual process, the energetics of the system practically requires that the process be accompanied by either gamma or neutrino radiation. Let E_A and E_p represent the energy of the ground state of the nucleus of A^{40} and K^{40}, respectively: if E_K is the energy of the K electron of mass m, then provided no radiation is emitted

$$E_p + E_K + m\,c^2 = E_A.$$

The chance that a level of the argon nucleus satisfies this requirement is vanishingly small. The most probable transition is

$$E_p + E_K + m\,c^2 = E'_A + y$$

where E'_A represents an excited or ground state of the argon nucleus and γ the energy of the radiation emitted by the electron as it is absorbed into the nucleus. Knipp and Uhlenbeck[4] have computed the probability of the production of gamma and neutrino radiation by an electron leaving the nucleus. The calculations for the dual process where the electron is absorbed by the nucleus is essentially the same. These considerations indicate that the dual process should be accompanied by radiation. The fact that the gamma radiation is homogeneous forces us to adopt one of the two following conclusions: (a) A single excited state E'_A exists 2×10^6 e.v. above the ground state E_A. The excited state E'_A lies slightly below the ground state of potassium E_p. However, if such a situation occurs among the nuclear energy levels, then it is hard to see why the alternative electron transition directly to a lower state does not take place. (b) If such a level E'_A does not exist, and the gamma radiation is emitted through the dual of the process investigated by Knipp and Uhlenbeck the energy dissipated per disintegration through neutrinos must be constant. This concept is in contradiction with the theory of beta ray emission.

The observations, presented above, concerning the ratio of the abundance of A^{40} and Ca^{40} on the earth's surface and the production of gamma rays accompanying the disintegration of K^{40} constitute strong evidence for the occurrence of the dual process in the disintegration of K^{40}.

The author appreciates the opportunity of cooperating with the members of the Fertilizer Research Division of the Bureau of Chemistry and Soils, especially Dr. A. K. Brewer, in the solution of this problem.

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[3] Bocciasetti, *Atti. accad. Lincei*, 17: 830, 1933.
[4] Knipp and Uhlenbeck, *Physica*, June, 1936.

EXPERIMENTAL MODIFICATION OF THE SEXUAL CYCLE IN TROUT BY CONTROL OF LIGHT

THE work of Rowan,[1] Bissonnette,[2] Cole[3] and others on the manipulation and control of the sexual cycle in birds is well known. Bissonnette[4] further extended his work to include mammals. As far as is known the modification of the sexual cycle in fish by similar means has not received any attention.

Sheep, deer and some plants are known to become sexually active when the length of the daylight period is decreasing in duration. Brook trout *Salvelinus fontinalis* normally spawn in New Hampshire during October, November and December. A selected group of these fish were stripped on December 17, 1936, and then placed in aquaria where they were held for experimentation. A late spawning strain of fish was deliberately selected for study and experimentally exposed to an artificial light cycle which was designed to simulate the total number of hours of sunlight to which the fish were exposed during the average year at 44° latitude. Starting on February 20, 1937, the daily light period was increased gradually one hour per week until eight hours of light were added to the normal daylight period. The light hours were then gradually decreased until the normal day was reached. The accompanying figure graphically portrays the experiment. Calculations were based on U. S. Sunshine Tables[5] for 44° latitude.

A 25-watt mazda lamp and a 16 cp. carbon filament lamp were suspended over each aquarium. The lights were automatically controlled by an electric time switch. After the added light reached eight hours the period of illumination was gradually (approximately one hour per week) reduced to the normal day, and then the experimental aquarium was covered in increasing amounts each week until the equivalent of an eight-hour day was produced. On August 12, 1937, all the experimental male fish were found to contain copious quantities of spermatozoa and could be

[1] Wm. Rowan, *Proc. Boston Soc. Nat. Hist.*, 38: 6, 147–189, 1926.
[2] T. H. Bissonnette, *Physiol. Zool.*, 5: 1, 1932.
[3] L. J. Cole, *The Auk*, 50: 284, 1933.
[4] T. H. Bissonnette, *Jour. Exp. Zool.*, 12: 4, 1935.
[5] U. S. Dept. Agr. *Sunshine Tables*, Part II, W. B. No. 805, 1923.

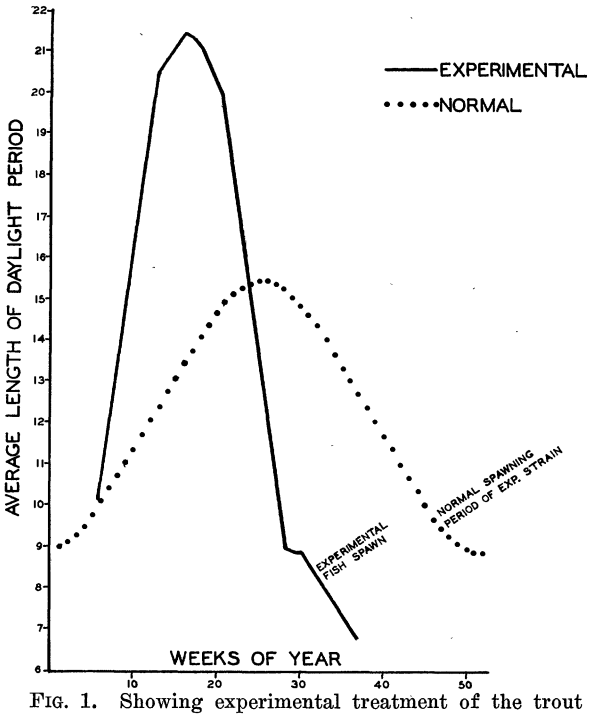

FIG. 1. Showing experimental treatment of the trout by modification of the diurnal light period.

stripped in the usual hatchery manner. The female fish were not quite ripe. Male fish in the wild commonly ripen as long as two or three weeks before the females. The first eggs were taken from the female fish on August 31, 1937, which is approximately three months before the usual spawning time of the particular strain of trout used in the experiment. Control fish which were kept under similar temperature, food and water conditions with the exception of light manipulation showed no evidence of sexual activity.

Similar experiments were carried out on rainbow trout which were induced to spawn in December, 1936, by gradually increasing the average length of day. Rainbows *Salmo irideus* normally spawn in March in New Hampshire, but the degree of hybridization with fall spawning strains was not known, so the data were not published at that time.

It is not known definitely from the completed experiments if it was necessary to add light to the brook trout to induce spawning or if merely diminishing the daylight period would have been sufficient. It is also possible that a combination of the two methods might be most efficient, but it is evident that the sexual cycle of fish, like those of mammals and birds, can be manipulated by controlling the length of day.

The practical value of inducing early spawning in rainbow trout by this method is evident in that most of the strains of these fish in New Hampshire do not spawn until spring and the fry are too small to plant with any degree of success in the streams by fall, which necessitates the expense of carrying the fish through the winter.

The experiments will be fully reported elsewhere.

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VARIATION OF DACTYLOMETRA QUINQUECIRRHA[1]

IN order to attack the problem presented by the Scyphozoan medusa, *Dactylometra quinquecirrha*, L. Agassiz, in the many variations known to exist in its wide geographic range and especially in the Chesapeake Bay, where maturing in the "Chrysaora" stage, it occurs abundantly as two distinct varieties, life history studies of this common sea nettle have been in progress at the Chesapeake Biological Laboratory for three years. In the course of the studies, the organism has been reared, for the first time, through its entire life cycle from the egg, which was fertilized in the laboratory, to the resulting medusoid. The conditions under which this has been accomplished have been as simple and as nearly natural as possible.

The males and females may be easily distinguished when mature by the color of the gonads, which is greyish brown in the female and pink in the male. Fertilization has been determined to occur in late summer under both experimental and natural conditions. This takes place at night between seven and twelve o'clock under laboratory conditions. The process of cell division is rapid, and the following day free-swimming, pear-shaped planula have been developed.

At the end of the third day, the planula attaches itself firmly to the bottom. It is now ninepin-shaped. The tentacles are developed in a ring just below the mouth, and appear as simple outpushings of the body of the animal. After the formation of the first four tentacles, four invaginations are produced, which become the four taenoli or gastric septa of the scyphostoma. The tentacles increase in number until in approximately three weeks there are sixteen of them. Some few individuals may bear twenty tentacles.

The scyphostoma undergoes little change, other than that of size, from late fall until early the following summer. It is practically colorless, showing at times a faint pink, which becomes more intense at the time of strobilization, that is, in the early summer.

The process of strobilization in *Dactylometra quinquecirrha* differs from that of *Aurellia* and other similar forms for which knowledge is available, in that the number of discs produced appears to be fairly constant and does not exceed six. The ephyra produced as a result of this process have eight bifurcate arms, on every one of which there is a tentaculocyst.

[1] Preliminary note.