leno weave," meant that leno weave is another name for gauze weave or that it is a different mode of weaving. Although in writing it is possible to set off with commas or parenthesize the synonymous expression, as for example "sucrose, or saccharose, is," or to use the rather awkward and interruptive expression "that is" or the abbreviated (*"i.e."*), it seems that adoption of the Latin words combined as a single, short English word meets the demand for a conjunction which has the meaning of "is also called," "is another name for," "is equivalent to," "equals." By the use of this conjunction, "idest," the word "or" is released for use in expressing alternatives, and we may be sure of the meanings of phrases such as "Turkish idest Aleppo galls," "tannin idest gallotannic acid," "muriatic idest hydrochloric acid," "hydrobromic or hydrochloric acid," "geraniol or citronellol."

In the German language the same ambiguity exists as in English. "Oder" and "beziehungsweise (bzw.)" both may be translated (a) as the alternative "or," sometimes better using "or else," (b) as the equivalent "or," "also called" (for which "idest" is suggested), and the modified "or rather," "or to be more exact." In addition, these words have sometimes (c) the related conjunctive significance "and also," "and furthermore," "— and — respectively," and (d) "as for example."

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SPECIAL ARTICLES

THE POTASSIUM-ARGON TRANSFORMATION

MØLLER and Weizsacker[1] have calculated recently the probability that a nucleus of atomic number Z disintegrates spontaneously through the absorption of a K electron from the extranuclear system of the atom into a new nucleus of atomic number Z–1 but with the same mass number. As Weizsacker points out, the possibility of such a process raises some interesting speculations concerning the relative abundance of the noble gases and their associated alkalies. Thus besides the usual beta emission from K^{40}, namely, $K^{40}_{19} \rightarrow Ca^{40}_{19} + \beta$, there might occur, if the masses involved in the reaction turn out to be appropriate, the reaction

$$K^{40}_{19} \rightarrow A^{40}_{18}.$$

When we consider that argon is in itself a very stable element, then this reaction appears more plausible. An examination of cloud chamber photographs taken with argon shows that A^{40} has a mean life higher than 10^{12} years.

An interesting feature of this reaction is the correlation of the most abundant argon isotope with radioactive potassium. If such a reaction is energetically possible, it implies the following. First, as Weizsacker mentions, argon should be found occluded in old potassium-bearing rocks; and, secondly, the ratio of the radioactive potassium isotope K^{40} to the others K^{39} and K^{41} should depend on the past history of the sample under consideration.

Weizsacker presents evidence which indicates that the rate of this reaction may be as high as 1/3 the rate of the normal reaction, $K^{40} \rightarrow Ca^{40} + \beta$. A rate this high would require the estimates of the amount of disintegration which has occurred in geologic time[2] to be revised upwards. However, it is unlikely that it is nearly as high as 1/3. The ratio of the amount of argon in the earth's atmosphere and crust to the calcium content of the earth's crust is 1/100. If we make the assumption that part of the argon generated in the earth's crust—assumed thickness of six miles—will have diffused into the atmosphere and that both of these elements have been formed exclusively from the disintegration of K^{40}, then the ratio of their rates of disintegration must lie in the range from 1/100 to 1/700. This appears to be a more reasonable value.

Møller has calculated the rate of the reaction resulting from the absorption of a K electron. With this knowledge, it is quite easy to calculate the rate of disintegration arising from the presence of free electrons in the material. If there is one free electron per atomic volume, then the ratio of free electrons to K electrons in the nucleus should be roughly proportional to the ratio of the volume enclosed by the K shell as compared to the atomic volume, *i.e.*, roughly as $1/Z^3$. On account of the dependence of the electron concentration on external conditions, the amount of K^{40} which has disintegrated during geologic time might well have varied by a quantity of the order of 0.01 per cent. from one locality to another on the earth's crust. If such a variation in the ratio of the potassium isotopes with environment could be detected, it would furnish strong evidence for the existence of the process.

Radioactive potassium K^{40} emits two groups of beta particles with v/c values of 0.93 and 0.83, respectively. In addition, homogeneous gamma of 2 10^6 c.v. energy rays have been detected. The relative proportions of these three processes are 40, 60 and 1.08, respec-

[1] Møller, *Phys. Rev.*, 51: 84, 1937; Weizsacker, *Phys. Zeits.*, 38: 623, 1937.

[2] Brewer, SCIENCE, 86: 198, 1937.

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.