DISCUSSION AND CORRESPONDENCE

PRESSURE ENERGY IN AN INCOMPRESSIBLE FLUID AND BERNOULLI'S PRINCIPLE

PROFESSOR E. H. KENNARD in SCIENCE for September 11 gives a correct statement of the "energy transfer" formulation of Bernoulli's principle, but it seems to me that he is mistaken in his contention that the "pressure energy" point of view is absurd.

In an open body of incompressible liquid under the action of gravity the potential energy per unit volume of a given portion of the liquid is, of course, partly dependent on gravity, and it is permissible to think of it as partly due to pressure. The first part of the potential energy per unit volume is equal to hdg where h is the height of the given portion above a chosen reference level, d is the density of the liquid, and g is the acceleration of gravity; and the second part of the potential energy per unit volume is equal to the pressure p of the portion of the liquid.

Let us take the pressure at the surface of the liquid as zero so that the pressure p at any point in the liquid may be thought of as gauge pressure. Then to carry unit volume of the liquid from the surface to a place where the pressure is p an amount of work equal to p must be done in overcoming the forces exerted on the unit volume by the surrounding liquid. This work has been handed on to other portions of the body of fluid (it does not reside in the portion of fluid which has been carried from A to B), but the location of what we choose to call potential energy is never a matter for consideration. The notion of potential energy is legitimate when the work done to effect a change of configuration is a function only of the change of configuration.

It is, of course, entirely proper to consider where the work done on a portion of fluid to carry it from A to B has gone to, that is to say the energy aspects of a fluid in motion can be formulated on the basis of transfer of energy in the fluid, and there is some advantage in this method because it involves definite things which are ignored in the method in which we assign potential energy due to pressure to each portion of the fluid. Potential energy is always an idea which makes up for things ignored.

WM. S. FRANKLIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN an article on Bernoulli's theorem (*SCIENCE*, Sept. 11, 1925) Dr. Kennard objects to the name *pressure energy* for the so-called pressure head, and especially to the idea that a pound or a cubic foot of liquid carries pressure energy with it along a tube of flow.

The validity of the objection can not be tested conclusively by deriving the theorem from the principle of energy, because this involves the point in question. Let Bernoulli's theorem be obtained as an integral of Euler's equations in the case of irrotational, frictionless, stream-line flow; it is then merely a mathematical affair awaiting any useful and usable interpretation. Two of the terms in it are kinetic and position energy, one depending on the velocity and the other on the position of the element of liquid. The third term is energy and since it depends on pressure the name pressure energy is surely not inappropriate. Every one of the three terms varies with the mass and the position of the element; therefore each quantity of energy may at least be regarded as belonging to and traveling with the element.

Pressure energy in this sense is distinctly different from compression or elastic energy. For example, if a rod is to be used for transmitting a push P with a possible displacement p, the pressure energy possessed *by the rod* is Pp; this is like potential energy Wh. If P shortens the rod an amount e the compression energy is ½Pe. Similarly, when energy is transmitted by water flowing through a horizontal pipe, the input, omitting the kinetic energy, is p/w ft-lbs per lb, the friction loss is h_f ft ft-lbs per lb, and the output is thus $(p/w - h_f)$ vAw ft-lbs per sec. where v is the velocity of flow, A the section area of the pipe, w the specific weight of the water, and p the pressure (force per unit area) at the input end of the pipe. Problems solved in this way become simple exercises in book-keeping on the energy transactions of a pound of water.

Dr. Kennard's value of 46 ergs should be 23 ergs, because the average pressure is half of 1.031×10^6 dynes per cm.^{2}

R. F. DEIMEL

STEVENS INSTITUTE OF TECHNOLOGY

A FOSSIL FISH OF THE FAMILY CALLICHTHYIDAE

IN the fresh waters of South America north to Panama may be found small catfishes (*Hoplosternum punctatum* Meek and Hildebrand) of a peculiar type, the sides of the body covered with a double series of vertically elongated plates. They were revised by Mrs. Marion Durbin Ellis in 1913, and since then not much has been added to our knowledge. When recently collecting fossil insects in the green Tertiary rock at Sunchal, Province of Jujuy, Argentina, I was fortunate in finding the first fossil representative of the family. Although it is at least sev-

eral millions of years old, it appears to belong to the living genus *Corydoras,* and may be known as *Corydoras revelatus* n.sp. It is 27 mm long from end of snout to base of caudal fin, the total length at least 31 mm; depth at base of dorsal slightly over 9 mm; width of orbit 2 mm; orbit from top of head 1.8 mm, from end of snout 3.5 mm; lateral plates numerous, certainly over 20 in each series; dorsal spine very strong, anal spine weak. In the deep body, arched profile of head, and rather large eye it resembles *C. paleatus* (Jenyns), a species discovered by Darwin on the voyage of the *Beagle.* The eye appears to be placed lower down, but this may be the result of crushing. The opercular plate agrees with that of *C. paleatus* and other species, having the lower posterior margin concave. The dorsal spine is very heavy, suggesting *C. armatus* (Günther), but there is no evidence that the soft rays are prolonged to a point.

The discovery of this fish, together with that of the accompanying insects, shows that the variegated green and red shales of this part of Argentina belong to the Tertiary, possibly late Tertiary, and are of freshwater origin. This is a matter of considerable importance as the age of the beds was somewhat in doubt. The discovery of fossil insects in these rocks is due to Mr. Geo. L. Harrington; my wife and I visited the locality and obtained many species.

Corydoras still lives in the same region; thus *C. micracanthus* of Regan was discovered at Salta.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

TOBACCO AND TOMATO MOSAIC

(1) LONGEVITY OF THE VIRUS OF TOBACCO MOSAIC

IN February, 1920, I received from Dr. H. A. Allard for comparative tests a small bottle of expressed juice from mosaic-diseased tobacco plants. It was unfiltered and protected from contamination by a layer of toluene. A small portion only was used at the time and the remainder tightly corked and set aside.

On May 25, 1925, four healthy plants were inoculated by rubbing two leaves of each with a small portion of the preserved juice. Two check plants were treated similarly, using sterile water. The plants were kept in a good light in the laboratory. On June 15 each of the four plants was definitely mosaic-diseased, while the two check plants were perfectly healthy, as they have remained to date.

On June 25 four other healthy plants six weeks old were similarly inoculated and left in the greenhouse, while check plants were again treated with sterile water. On July 10 each of the four inoculated plants was showing excellent mosaic symptoms, while checks were healthy.

It is therefore a fact that the expressed juice of mosaic-diseased tobacco plants retained *in vitro* over five years is still infectious.

(2) STREAK OF TOMATO IN QUEBEC A "DOUBLE-VIRUS" DISEASE

Mr. T. C. Vanterpool, working in my laboratory, has been studying "streak or stripe" disease of tomato since 1923. Diseased plants and those artificially inoculated with "streak virus" often tend to outgrow streak symptoms in the upper straggling part of the plant, but they always present mosaic symptoms in those parts. Further, the virus of tomato streak inoculated into tobacco always gave mosaic, and a transfer from that tobacco often reproduced streak in tomato. The possibility of double inoculation was therefore considered, and the following summarized facts cover the work done this season in both greenhouse and field.

Healthy tomato plants inoculated with a mixture of viruses from mosaic-diseased tomato and potato, or tobacco and potato, develop streak in about fourteen days. Mosaic-diseased tomato plants inoculated with virus from mosaic-diseased potato develop streak. Virus from diseased potato gave rise to doubtful mosaic in healthy tomato. Juice from a tobacco plant showing mosaic after inoculation with tomato and potato mixed virus developed streak when inoculated into healthy tomato.

Combinations of bean mosaic and raspberry mosaic viruses with tomato mosaic virus gave negative results.

From the above results it may reasonably be concluded that in Quebec streak or stripe of tomato is not a disease caused by *B. lathyri* but is a disease resulting from double inoculation, *i.e.,* with virus of potato mosaic and tomato mosaic (tobacco mosaic in this case being considered the same as tomato mosaic). Further work may show that other host plants function as potato, and more work is required to determine the proportions of the two juices necessary to develop streak of tomato.

B. T. DICKSON

DEPARTMENT OF BOTANY,
MACDONALD COLLEGE,
QUEBEC, CANADA

SEX CHANGES IN BIRDS

IN Science News Service, as printed in your issue of SCIENCE, March 6, 1925, appears an article relating to the changing of sex in pigeons. The observations of Dr. Oscar Riddle, of Carnegie Institution of Wash-