disease. This direct evidence relates chiefly to transgressions. A transgression is defined by Hachey[7] as "a periodic movement, of variable amplitude, of Atlantic waters of tropical origin, bringing a momentary encroachment of these waters upon the waters of polar origin and especially upon the continental waters."

A review of the available information regarding transgressions and related phenomena is readily available in the Proceedings of the North American Council on Fishery Investigations, 1921–1930, No. 1, Ottawa, 1931. This report relates directly to fisheries, and the changes in environment are discussed chiefly with reference to the abundance of fish, yet some of the observations are of interest. For example, "The year 1927 was a year of strong warm transgression. Its influence on the banks was disastrous, and it is still (1931) being felt. Since that date the equilibrium has not yet been re-established. . . . During the last four years the fishing operations carried on by sail boats have constantly decreased because cod have less and less been frequenting the shallow grounds, because these have been too seldom inhabitable."

In view of Setchell's theory regarding the importance of temperature on the abundance of eel-grass, it should be further noted: "One point already cleared up is that poor fishing seasons correspond to extensive warm transgressions, that is, to mass invasions of the banks by genuine Atlantic waters, whereas in normal years it is only the slope water, driven by the tropical waters, that conflicts there with the continental waters of polar origin."

There is a known rhythm both in the transgressions themselves and in the catch of fish which some students of the problem believe to be related to the changes in temperature brought about by the transgressions. Table 1, taken from page 46 of the report cited, is

TABLE 1
THE YIELD OF NEWFOUNDLAND FISHERIES GROUPED TO ELIMINATE AS FAR AS POSSIBLE THE INFLUENCE OF IMPROVED EQUIPMENT

Maxima ..		1887	1900–01	1910	1918	1926
Minima ..	1882	1893	1904–05	1913	1921	1929

intended to show the yield of Newfoundland fisheries so grouped as to eliminate to a large extent the influence of improved equipment. It is obvious that each alternate minimum, that is, 1893, 1913 and 1929, coincided with or just preceded a recorded period of eel-grass scarcity in the North Atlantic.

The same coincidence appears, of course, in relation to the transgressions—see 7, Fig. 1, which shows the magnitude and periodicity of the various components. Among others there is a "transgression with a period of 9¼ years and whose maximum occurred last in 1930." Transgressions of this period agree closely with the minima of yield of Newfoundland fisheries already noted. Each alternate transgression of this period, that is, those which coincide with the extreme north declination of the moon, 1894, 1912 and 1930, coincide closely with the recorded periods of eel-grass scarcity.

All this is, of course, highly speculative and based on mere fragments of evidence. On the other hand, is it not inherently much more probable that the wasting disease of eel-grass is related to some such environmental change than that it is caused by some recently introduced or created parasite? At least, it would appear well worth while to study the biology of eel-grass in relation to its environment during the probable period of increase through the next decade and especially during the next period of wasting, which is apparently due about 1949 or 1950.

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[7] H. B. Hachey, SCIENCE, 83: 349–350, April 10, 1936.

REGARDING THE GENERAL NATURE OF CATHEPTIC ENZYMES

CATHEPSIN is a proteolytic enzyme found in many animal tissues and is representative of a group of proteolytic enzymes called "catheptic enzymes" or "papainases," since papain, the enzyme of the melon tree, is the oldest member of this group. The catheptic enzymes possess one significant property in common, namely, they may be activated by hydrocyanic acid, hydrogen sulfide, sulfhydril compounds (*i.e.*, glutathione) and many other substances.

The catheptic enzymes have been the subject of searching inquiry which has led to the following conclusions:

(1) Like pepsin and trypsin, the catheptic enzymes are supposed to attack only genuine proteins and high molecular weight degradation products of proteins. Little is known about the individual specificities of the catheptic enzymes, pepsin or trypsin. It is widely held that the specificity of these enzymes is adapted to substrates of high molecular weight.[1]

(2) The catheptic enzymes from various sources have been investigated with regard to their homogeneity and each one of them is supposed to contain only one protein-splitting enzyme.[2]

(3) Nearly all the activators have reducing properties. Furthermore, by moderate oxidation it is possible to inactivate active catheptic enzymes and to regenerate the activity by reduction. Several investigators concluded from these facts that the activation

[1] W. Grassmann and F. Schneider, *Ergebnisse der Enzymforschung,* 5: 79, 1936; C. Oppenheimer, "Die Fermente und ihre Wirkungen," The Hague, 1936.

[2] W. Grassmann, *Ergebnisse der Enzymforschung,* 1: 129, 1932; E. Waldschmidt-Leitz, A. Schäffner, J. J. Bek and E. Blum, *Zeits. Physiol. Chem.,* 188: 17, 1930.

consisted in a reduction of the enzyme; the inactive enzymes were supposed to contain disulfide groups which were reduced by the activators to sulfhydryl groups.[3]

Recently it has been possible to synthesize substances of low molecular weight which are split by the following catheptic enzymes: cathepsin, papain, and bromelin of the pineapple. Reports on the substrates of papain have already been published.[4] The present authors have found that cathepsin from pig liver splits the following substrates: Carbobenzoxy glycyl-*l*-glutamyl glycine amide, Carbobenzoxy leucyl glycyl glycine, Carbobenzoxy diglycyl glycine and Carbobenzoxy triglycyl-*l*-leucyl glycine. It was further found that bromelin splits carbobenzoxy glycyl-*l*-glutamyl glycine amide and carbobenzoxy triglycyl-*l*-leucyl glycine.

It is thus possible to study the activation and specific action of each catheptic enzyme with the aid of synthetic substrates of known structure. The possible detailed investigation of cathepsin is of some significance in human physiology in view of its rôle in intracellular protein metabolism.

The application of the synthetic substrates has already yielded the result that cathepsin, papain and bromelin each consists of two partial enzymes with quite different specificities and different behaviors toward phenylhydrazine. One of the enzyme components of cathepsin, papain and bromelin is inactivated by phenylhydrazine, the other enzyme component is not. It is remarkable that the three hitherto investigated catheptic enzymes, the origins of which are so different, show the same activation phenomena and reveal themselves to be dual enzyme systems with analogous properties of the partial components. It seems probable therefore that the dual enzyme system is necessary for the physiological task of this group of enzymes, and that it is related to the mechanism of activation.

This expectation finds support in the following observations: When, in a non-activated preparation of cathepsin, one of its partial components is combined with phenylhydrazine, simultaneously the other partial component of the enzyme is decisively activated. The experiments with papain[5] and bromelin show quite analogous results. These and other experiments speak in favor of an interdependence of the two partial enzymes of each catheptic enzyme and prove that activation and inactivation can be performed without resorting to oxidation-reduction processes.

At present the following hypothesis seems therefore to be the most probable interpretation of the dual enzyme system of catheptic enzymes: Catheptic enzymes are systems of two enzyme components which are in combination with each other and thus mutually inactivate each other. The process of activation thus involves a dissociation of the inactive dual enzymes into its two component enzymes having different specificities. The known natural activators which effect the dissociation and thus the activation of catheptic enzymes are oxidizable and lose through oxidation their ability to effect the dissociation. In metabolism the activity of catheptic enzymes may thus be influenced by the oxidation-reduction potential of the milieu through the medium of oxidizable activators.

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[3] T. Bersin, *Ergebnisse der Enzymforschung*, 4: 68, 1935; L. Hellerman and M. E. Perkins, *Jour. Biol. Chem.*, 107: 241, 1934; A. Purr, *Biochem. Jour.*, 29: 5, 1934.

[4] M. Bergmann, L. Zervas and J. S. Fruton, *Jour. Biol. Chem.*, 111: 225, 1935; M. Bergmann, L. Zervas and W. F. Ross, *Jour. Biol. Chem.*, 111: 245, 1935; M. Bergmann and L. Zervas, *Jour. Biol. Chem.*, July, 1936; M. Bergmann, L. Zervas and J. S. Fruton, *Jour. Biol. Chem.*, in press.

[5] M. Bergmann and W. F. Ross, *Jour. Biol. Chem.*, 111: 659, 1935, and July, 1936.

CONCENTRATION AND PARTIAL PURIFICATION OF BACTERIOPHAGE

A PROTEIN preparation which possesses the properties of bacteriophage has been isolated from lysed staphylococcus cultures. 1×10^{-10} mg of this preparation will cause lysis when added to growing staphylococci cultures. During the reaction more of the bacteriophage protein is formed. The loss in activity of a solution of the protein is proportional to the denaturation of the protein at various temperatures and at different pH. The protein is adsorbed by susceptible living or dead bacteria to the same extent as is the bacteriophage activity. Neither the protein nor the bacteriophage activity is adsorbed by resistant bacteria. The rate of diffusion of the protein is the same as that of the active agent and the diffusion coefficient is 0.02 cm²/day, corresponding to a molecular weight of about 500,000.

The protein is not digested nor is the activity decreased by trypsin or papain. Chymo-trypsin inactivates the preparation and this inactivation is accompanied by the formation of protein insoluble in one quarter saturated ammonium sulfate. There is no detectable hydrolysis of protein during this reaction.

The ultra-violet absorption spectrum agrees with that calculated from Gates' inactivation experiments with ultra-violet light and bacteriophage.

The method of preparation is briefly as follows: Culture media used was prepared by extracting 2½ kilo dried yeast with 200 liters boiling water. The media was adjusted to pH 7.6 and 37° C. and inoculated with staphylococci and a small amount of bacteriophage. Sterile air was