memorial lecture by the Right Honorable Viscount Lee of Fareham on "Radium as a Therapeutic Agent —the Case for National Control."

PROTECTION for the great scenic Wawona Highway in Yosemite National Park was assured when President Hoover signed a proclamation on August 13 authorizing the addition of certain public and private lands to the park area. The proclamation covers approximately 8,785 acres, of which 5,061 acres are public domain and 3,724 acres are in private ownership, subject to all valid existing rights. Half of the purchase price of the private holdings along the road most important to its proper protection has been donated to the Government, and the Department of the Interior has been authorized by Congress to match this donation with federal funds. The Wawona Highway, which is now open to public use with the exception of the tunnel section through Turtleback Dome, runs from the south end of the Yosemite Valley to Mariposa Grove. Though it originates and ends within the park boundaries, the roadway runs for a considerable distance east of Mariposa Grove outside the park limits. The new boundary authorized by the President will bring this important highway entirely within the park boundaries, add a highly scenic area to the park, and greatly improve its boundary line from an administrative angle. It will increase the total area of the park to more than three quarters of a million acres. The Wawona tunnel, 4,230 feet long and regarded as a great engineering achievement, is 95 per cent. completed. Under the Emergency Relief Act of 1932 an allotment of $251,000 has been made to this project for permanent surfacing. This work will shortly be under way, and by next season a hard-surface road between Yosemite Valley and Mariposa Grove will be available to motorists. The approach road from Fresno to the new Mariposa Grove entrance is also being greatly improved with state and forest highway funds.

MEMBERS of the American Chemical Society have received from its secretary a letter dated November 21, asking their individual cooperation in maintaining the society at least at its present membership during 1933. Among the many letters received in reply is one from the president of the society, Dr. L. V. Redman, which is printed in *Industrial and Engineering Chemistry*. Dr. Redman writes in part: "I was very happy to receive your letter of November 21, urging the members of the society to see that the society did not suffer a contraction in 1933. I can hardly express to you the satisfaction which I have felt in the fine showing of the American Chemical Society in this year 1932—doubtless the worst year of the depression which we will have. We are at the bottom and beginning to turn the corner upward, but as you point out, it is just possible that we, as a society, may lag through 1933 unless there is every effort put forward by individual members to maintain the quality and number of members in the society. Without any doubt American Chemical Society journals are the best value of any commodity sold in the world. I know of no $15 which can bring such a record of results to a man's desk as does his membership in the American Chemical Society, and it would be absolutely unbelievable if it were not a fact. Any modern man who even dares to think that he is chemical in his outlook and hesitates about giving $15 for the journals is certainly not worthy to be called a chemist, or even a man who sympathizes with chemistry. If any man has even a mild interest in chemistry he ought to be willing to pay $15 to get so complete a record of the world's chemical work per year. At first I hesitated to say the world, and yet when you consider how complete our abstracts are, it is not an exaggeration."

DISCUSSION

THE ANCESTRY OF ECHINI

DURING the past three years a discussion has been going on which, while primarily of interest to students of Echinoderms, is really of great importance to all who are concerned with problems of phylogeny or the principles of evolution. For this reason, I beg for a little space in the columns of SCIENCE in which to call attention to the matter.

For many years students of Echinoderms and paleontologists in general have regarded the Ordovician fossil Bothriocidaris as the ancestor, or at least near the ancestral stock of the Echini. Recently, however, Mortensen, the eminent Danish zoologist and one of the foremost authorities on Echini, has decided to the contrary.[1] He has put forth the proposition that Bothriocidaris "can not be considered as an Echinoid at all" (p. 109), but "must be included in the class of the Cystoidea, not in that of the Echinoidea" (p. 111). He reached this conclusion after a critical study of seven specimens of Bothriocidaris, all the material available. It should be noted that Dr. Mortensen frankly advocates the hypothesis that primitive echinoids had pluriserial interambulacra, not the monoserial arrangement found in Bothriocidaris.

Naturally, so revolutionary a suggestion aroused

[1] *Vid. Med.*, 86: pp. 93–122, 1928.

the interest of all students of Echini, and there soon appeared a paper, "In Defense of Bothriocidaris," by Professor H. L. Hawkins, of Reading.[2] In his usual entertaining and convincing style Hawkins discusses Mortensen's paper in some detail and is satisfied that the Danish authority has quite failed to make a case. Some months later, Dr. R. T. Jackson, the author of the "Phylogeny of the Echini," one of the most accurate and carefully reasoned publications dealing with phylogenetic problems ever issued, entered the discussion of "The Status of Bothriocidaris."[3] This paper takes up with the greatest care and in the most courteous way each one of Mortensen's arguments and concludes with a clear summary of the 18 points on which Jackson bases his conviction that Bothriocidaris represents an ancestral stock for the Echini. His view is based on the close similarity of characters occurring in adult Bothriocidaris, as compared with those found as stages in development in the young of all later Echini.

Of course Mortensen could not ignore such opponents. He promptly renews the attack in a reply, "Bothriocidaris and the Ancestry of Echinoids,"[4] in which he presents new and valuable data derived from the study of seven additional specimens of the much discussed fossil. But the argument is virtually an elaborated reassertion of that in his first paper.

Next in the field is the eminent paleontologist of the British Museum, Dr. F. A. Bather, universally recognized as an authority on Echinoderms in general and as an exceedingly keen and skilful debater. Bather[5] discusses the question "What is Bothriocidaris?" admitting at the start that it is a question he has hesitated to answer. His final conclusion is that "Bothriocidaris was an echinoid which left no descendants," but he endorses Mortensen's position that Echini arose from an ancestral stock with irregular, polyserial interambulacra. The last contribution to the discussion is a second paper by Professor Hawkins, "The First Echinoid."[6] In this article Hawkins discusses the evidence for and against the monoserial and the polyserial condition of the interambulacra in the ancestral stock of Echini and concludes that the monoserial arrangement is the primitive one and that Bothriocidaris shows the nearest approach to that primitive stock of any echinoid known.

It has been suggested that since the opponents of Dr. Mortensen in this debate have hitherto all been paleontologists, it would be of interest, and perhaps of value in this discussion, to have the opinion of some other student of Recent Echini. As I may claim some familiarity with the group, I might then justify this communication on that ground. But there is a more important matter involved in the discussion than merely the ancestral stock of the Echini, and that is the principle of "stages in development" as fundamental in the discussion of phylogenetic problems. This principle, elaborated, if not originated, by Hyatt, and convincingly used by Jackson (his pupil), impresses me as of supreme importance. It is apparently recognized by Hawkins, particularly as applied to embryological development, but Bather (in this particular discussion) ignores it and Mortensen does not seem to have any appreciation of it. I can not pretend to such a grasp of the principle as Jackson has, but I hope I comprehend it sufficiently to use it correctly. It involves not merely the familiar idea that "ontogeny repeats phylogeny," but beyond that, throughout life, even in old age, each individual is repeating stages through which its ancestors passed. The clearness with which these stages are shown varies greatly in different groups, due to acceleration or retardation of development (or other factors). The Echini are a peculiarly satisfactory group in which to study stages, as the character of the test is such as to preserve and reveal them to an extraordinary degree.

In his "Phylogeny of the Echini," Jackson has been to the greatest pains to record and explain these stages, and has shown in that and in his other publications how supremely important they are for a correct understanding of phylogeny.[7] These arguments, which seem to me so weighty, Mortensen fails to appreciate, and hence he is impervious to Jackson's carefully reasoned presentation of the case for Bothriocidaris. Bather's statement that Bothriocidaris "left no descendants" seems to me based on a similar failure to give due weight to Jackson's argument. Hawkins at least gets the main point, but I must dissent emphatically from his suggestion that Echini may have been derived from holothurians. In my opinion, the holothurians are derived from some echinoid-like ancestor and are not a primitive group.

Mortensen's stress on the radial position of the madreporite as an argument against the echinoid nature of Bothriocidaris is overdone; the point does not seem to me weighty. His statement as to the absence of genital plates and pores merely shows that the genital openings in so primitive an echinoid were probably temporary and *between* the plates of the apical system; such temporary genital pores are found along the sides of the rays in many sea-stars. Finally, Mortensen's emphasis on the absence of a lantern is invalidated for me by one of his own figures (1930, p. 325, fig. 14); the fragments shown

[2] *Geol. Mag.*, 66: pp. 71–79, 1929.
[3] *Bull. M. C. Z.*, 69: pp. 481–512, 1929.
[4] *Vid. Med.*, 90: pp. 313–352, 1930.
[5] *Pal. Zeits.*, 13: pp. 55–60, 1931.
[6] *Biol. Rev.*, 6: pp. 443–458, 1931.
[7] For similar data in other groups see C. E. Beecher, 1901, "Studies in Evolution."

seem to me surprisingly like fragments of a lantern and teeth. The absence of a lantern in fossils of so primitive a type as Bothriocidaris would not seem to me surprising in view of the usual absence of any trace of a lantern in many (if not most) specimens of fossil Echini where yet one is known to have existed. These fragments figured by Mortensen are to me quite suggestive of the occurrence of a fairly typical lantern in Bothriocidaris.

I must give it then as my decided conviction that Mortensen's new data on Bothriocidaris strongly confirm the old view that that interesting fossil really represents an ancestral stock for all Echini, and amply justify Jackson's system of classification in the group.

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NUTRITIONAL REQUIREMENTS OF TROUT

DURING the past summer an agreement was executed between the U. S. Bureau of Fisheries, the New York State Conservation Department and the New York College of Agriculture at Cornell University for the purpose of conducting on a cooperative basis experimental studies in fish culture relating especially to fundamental problems of nutrition and physiology of fishes. Complementing, and to a certain degree paralleling, studies of fish feeding conducted at the bureau's experimental fish culture stations, the new undertaking will deal particularly with the digestibility of various nutrients by trout, the vitamin requirements essential to an economical and successful ration, and with enzymotic and other physiological and metabolism studies.

These investigations are under the direction of Dr. C. M. McCay, of the Animal Nutrition Laboratory at Cornell University, and are conducted in the bureau's hatchery near Cortland, New York, where the bureau will furnish suitable hatchery facilities, including the hatchery building and such rearing ponds as are needed, the stock of eggs and part of the feeds necessary for rearing fish. The New York State Conservation Department is providing the necessary funds for the compensation of the technical assistants involved in this work and for special apparatus and feeds needed for the experiments. The State College of Agriculture provides necessary laboratory facilities at Cornell University for experimental work and analyses not readily conducted on the hatchery premises. The bureau will incubate the eggs and will rear the surplus fish not needed for experimentation, which surplus at the end of the season will be available for filling applications for stocking adjacent waters. However, fish production will be subordinated to a vigorous prosecution of the scientific investigations in order to find ways of cheapening the operation costs in the several hundred hatcheries scattered throughout the nation.

Feeding experiments with brook trout were started at the Cortland experimental hatchery during the month of August and are being run by A. V. Tunison, who was formerly in charge of similar work in Connecticut. The feedstuffs that are being studied at the present time are dry buttermilk, cottonseed meal, peanut meal and a number of dry skim milks. These are the dry foods that have proved the most promising during the five preceding years during which similar research was carried out by Dr. McCay in Connecticut. In the present study the tests have been made more rigid than formerly by studying only feedstuffs of which origin and processing are known. This has been made possible through the cooperation of the producers' associations such as the American Dry Milk Institute. A series of dry skim milks, made by different methods, are involved in the testing.

Since one of the most important problems in using dry feeds is that of physical composition, a series of special binders are being tested. These binders are dextrins similar to those found in corn syrup. The method of preparation of each of these compounds from corn starch is known. Preliminary work indicates that one of these dextrins is quite superior to the others, but it is too early to anticipate which one of the dry skim milks will prove the most satisfactory. The spray process milk is better when only physical composition is considered.

All earlier work has shown that trout will grow well upon dry skim milk alone for twelve to fourteen weeks. After such a preliminary growth period they die quite rapidly unless this diet is supplemented with raw meat. In order to develop a concentrate of this raw meat factor some method of assay must be established. For this work the policy of feeding dry skim milk for three months has been adopted. After this period, when the body reserves are exhausted, special preparations will be fed as supplements to determine if they are as potent as raw meat in permitting the trout to continue growth and life. This method of testing is similar in principle to that now employed in measuring the vitamin A potency of cod liver oil.

In addition to studies upon brook trout two experiments are being run with groups of brown and rainbow trout in order to secure growth curves under identical water and feeding conditions. All earlier studies have shown that trout upon full feed increase their body weights during the growing season by a constant percentage. This is true of none of the higher animals, since they all grow very rapidly when young and gradually cease to grow as they approach adult size. Only two growing seasons have been