tional Review, 1901, follows up the subject conservatively:

> Questions of erecting the Bureau of Education into an executive department, with a seat in the Cabinet, as was proposed by Senator Hansbrough's bill, introduced into the Fifty-sixth Congress, or of organizing it on the same plane as the Department of Labor, are not necessarily involved, and may wisely be postponed until public opinion on the subject is better informed and more clearly formulated. All immediate necessities could be met by an amendment of existing law that should provide for a bureau of education with two divisions: a division of statistics and reports, to do the work now done by the bureau; and a division of supervision and administration, to take up the oversight of the school systems of Alaska, of the white residents in Indian Territory, of Porto Rico and of the Philippine Islands.[14]

With our eyes opened by foreign needs in this era of a new nationalism, would it not be well to turn them upon our greater domestic educational needs and the needs of our own white children for developing the bureau as shown by the subject we have in hand. Some sense of such needs stirred this association a year ago to appoint a committee consisting of Presidents Van Hise and Jesse to draft a memorial to enlarge the function of the Bureau of Education.[15] Without an amendment to the act establishing the Bureau of Education, might it not find authority with comparatively small addition to its expenditures, to act in place of, or in conjunction with, the delegacy above proposed? The law says it shall 'aid the people of the United States in the establishment and maintenance of efficient school systems and otherwise promote the cause of education throughout the country.' Let it federate and coordinate our present school systems. Let it endorse and promulgate national standards. Local systems and institutions would be free to accept them or not; indeed, national inspectors might complement state and institutional inspectors; the national inspectors visiting upon invitation and without authority, as indeed is the case with the majority of state inspectors. The national inspectors could validate the work of local inspectors for remote parts of the country. The individual colleges would upon occasion, now in this, now in that subject, be at liberty, as they now are even in the most highly developed accrediting systems, to give examinations to an entering student.

In fine, the proposals of this paper apply the doctrine of evolution. We grow from the systems we now have. We correlate them. We leave liberty to each institution and group of institutions to favor the system or lack of system it may have. All that is asked is an open-door policy instead of an exclusive one. Ultimately the best system or combination of systems will survive. In the meantime, there will be a germinal genuine American system looking toward a national one in harmony with our new nationalism.

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[14] *Educational Review*, Vol. 21, 1901, p. 528.

[15] *Transactions and Proceedings*, National Association of State Universities of America, 1904, p. 23.

EFFECTIVE PROTECTION FOR THE LOBSTER FISHERY.

The main biological facts concerning the lobster are now well in hand, and form a logical basis for the protection of the fisheries of this animal.

In restricting the size of marketable lobsters the following methods are entitled to consideration by the legislator who regards the question upon its scientific merits alone: (1) partial protection of young and adult, with emphasis upon the young; (2) partial protection of adult and young, with emphasis upon the adult. Such regulations may be supplemented by various other prohibitions, relating to close seasons, the destruction of 'berried' females and the sale

of broken lobster meat. We are now mainly concerned with the restrictions placed upon the fisherman in dealing with lobsters which enter his traps. The protection of the young alone, or what is the same thing, unrestricted slaughter of adults, would be equivalent to slaying the goose which lays the golden eggs and must be ruled out at once, for to get young we must have eggs, or, what is the same thing, adults which produce the eggs, and the more of them the better.

Protection of the adult alone is neither practicable nor desirable, for the markets should be supplied with animals of fair size, and the period of sexual maturity fluctuates between rather wide limits. It would, moreover, be folly to permit the unlimited sacrifice of the young of all sizes which could be enticed into the traps, although the fishery might be better able to stand such a drain than the wholesale sacrifice of adults.

The keepers of domestic animals practise what may be described as 'a judicious protection of the adult.' That is, the relative proportion of young to adults being known, a balance can be struck and maintained, or any desired ratio between them established. In marine animals like the lobster, this ratio between young and adult is an unknown and unknowable quantity, and this is why comparisons drawn between domestic animals, which are under human control, and the invisible inhabitants of the depths of the sea are likely to be misleading. No selection or balancing of numbers is possible in the way that the poultryman or ranchman maintains the integrity of his flocks or herds. The lobster is seldom seen except when caught in a trap and brought to the surface. The fishermen follow the lobsters in their movements to and from the shores, and when the animals which enter their traps become smaller and fewer, or cease altogether, they begin to wake up to the highly probable fact that the wild 'flock' has been exterminated. Yet the fisherman is not to blame for this, since the laws have sanctioned what practically amounts to an indiscriminate slaughter of the adult.

Thus we are left to choose between the methods given above. In the first, where the fullest protection is given to the young, the aim has apparently been to allow the adult to breed at least once before it is sacrificed. But this desirable end is frequently not attained because, as will be seen later, many animals pass the legal limits—nine to ten and one half inches—before becoming sexually mature. This method has been given more than a fair trial, and has proved sadly lacking. The second method, as stated above, essentially means protecting the adults permanently beyond a certain size, and the young up to a certain limit. Between these two permanently protected classes stand the immature or adolescent and the smaller adult animals, which alone it would be permissible to destroy. This plan was first proposed in 1901 by Dr. George W. Field.[1] He advocated a reversal of the existing policy of protecting chiefly the young, by placing the weight of restrictive laws upon the adult animal above a certain size, when it is becoming most prolific, and, therefore, most valuable to the fishery. This may be described as partial protection of the adult and young, with emphasis on the adult, and it must be admitted that such a method has all the weight of biological fact and sound common sense on its side. In the abstract of his report which was published in this journal,[2] the various remedies which have been tried in vain to instil new life into the waning fisheries are ably

[1] Report to the Massachusetts Commissioners of Fisheries and Game, 1902.

[2] SCIENCE, N. S., Vol. XV., pp. 612–616, April 18, 1902.

discussed. In this connection it is profitable to read also the discriminating remarks of the late Capt. Joseph W. Collins, in 1903.[3]

The existing laws for the regulation of the lobster fisheries (see method 1 above) are designed, as we have seen, to shield mainly the young, since they give but partial protection to the adult animal, it being illegal to possess, sell or destroy any lobster under nine or ten and one half inches in length, or any female beyond these limits, with external eggs. The larger limit of ten and one half inches is in favor in most of the states. Dr. Field would protect the young up to a certain length, as nine inches,[4] permit the capture of all adolescents and adults between nine and ten and one half inches, and permanently protect all adults beyond this size. That is, he would reduce the protection afforded the young, but greatly enhance that given to adults.

I formerly advocated the retention of the ten and one half inch law, and opposed any reduction of this standard, because under the present methods (see No. 1 above) this would cut out nearly every vestige of protection afforded adult animals, which, as was pointed out, is very little at best. On the other hand, I am heartily in favor of reducing the legal size-limit of marketable lobsters to nine inches, provided the larger adults are placed in a permanently protected class.

In dealing with the zoological side of the question the facts which chiefly concern us are: (*a*) the period of maturity of adult lobsters; (*b*) the number of eggs borne by the females, or the size of the broods, and (*c*) the frequency of spawning, or succession of broods.

I have found that the period of maturity is very variable as regards both age and size, female lobsters coming into the bearing condition between the size limits of approximately seven to twelve inches in length. Comparatively few animals lay eggs before reaching a length of nine inches, when their broods are still relatively small, while on the other hand the reproductive period is seldom deferred to the eleven- or twelve-inch stage. When ten to ten and one half inches long the female lobster has, as a rule, reached her first reproductive period, and many have carried two or three broods. We thus see why, according to present methods, by simply reducing the legal length-limit, we rob the adult of the very meager protection which it now enjoys.

The number of eggs produced increases with surprising rapidity from the very beginning of sexual maturity, the first batch of eggs being relatively small, whatever the size of the lobster. The average number of eggs produced by lobsters eight inches long is approximately 5,000, at ten inches 10,000, at twelve inches 20,000, and at fourteen inches nearly 40,000. Out of 532 animals examined at the ten-and-one-half-inch stage the smallest, largest and average number of eggs borne were 5,000, 36,000 and nearly 13,000. Lobsters fifteen and sixteen inches long have been taken off Cuttyhunk Island in Buzzard's Bay, for the use of the hatchery at Woods Hole, bearing nearly 100,000 eggs, all of which shows how rapidly the value of the lobster as a breeder increases after the nine- or ten-inch length is attained.

The male lobster matures as early as the female, and possibly somewhat earlier. It is certain that the female lobster may be impregnated at any time, and by more than one male; the sperm, moreover, possesses great vitality. As a rule the female lobster lays her eggs every other year, that is, the

[3] 'Report upon a Convention held at Boston, 1903, to secure Better Protection of the Lobster,' Boston, 1904.

[4] This in my opinion is much better than his earlier suggestion of six to ten inches.

reproductive cycle is not a one-year but a two-year period.

With respect to reproductive ability, and of the females in particular, we may divide the lobsters in the ocean into three classes, as follows: (1) young and adolescents mainly, from swimming larva to the nine-inch stage; (2) intermediate class—adolescents and adults—nine to ten and one half inches long; (3) adult class mainly, from ten and one half inches and upward in length.

The existing laws from New York to Maine vary but little, the legal length-limit being placed at nine or ten and one half inches; in some cases females in spawn are also protected, and there is a close season in Rhode Island.

In the Dominion of Canada and the maritime provinces the legal size varies from eight to ten and one half inches, while in the former territory seven distinct close seasons of varying limits are maintained in certain geographical districts, extending from late spring to midsummer on the one hand, and from winter to spring on the other (beginning May 30 to August 10 and ending December 15 to May 25). Notwithstanding these and various supplemental regulations, the fishery in the dominion has steadily declined. This is not surprising in view of the fact that in 1903, according to the official reports, 855 canneries were operated on the coast, and that, as a Canadian commissioner admitted, the canneries can legally use almost everything in the form of a lobster which the fisherman catches.

In general, both in the states and in the provinces, reports of an increased yield of the fishery should be construed as an evidence of decline, for it can be shown that the greater yield is due to one or more of the following functions: increase in the number of traps and efficiency of the gear, in the number of fishermen, in the time of the fishing season, and in the area of the territory covered. While the number of lobsters caught may increase, the size and weight of the individual animals steadily diminish.

The tendency in past and present legislation has been to protect classes 1 and 2 as named above, in addition to female lobsters with eggs attached to the body. This is accurately described as protection of the young, and partial protection of the adult. It may sound very well, but weak spots appear upon a closer analysis. Class 1, the beginning of the series, in the course of nature must be recruited mainly by class 3, that is, from eggs of the largest producing adults, and by the very class which under present conditions is being wiped out. This policy shifts the duty of maintaining the first class upon class 2—or upon the small producers—a task which it is theoretically unable to bear, as well as practically incompetent to sustain, if one can draw any conclusions from the reports of the fisheries. No doubt there are many experienced persons who are ready to maintain that the present laws are good enough when properly enforced, but there is no way of getting over this grave defect.

The decline in the lobster fisheries is clearly due to the fact that more lobsters are being annually destroyed than are being reared in the course of nature. You can not get lobsters without eggs, and the egg-producers belong chiefly to class 3. It is further said that the protection of the female in spawn should remedy this defect. In reply to this we have to consider the fact, which I have demonstrated beyond reasonable doubt,[5] that the female lobster lays her eggs but once in two years. Consequently we should not expect to find more than one half of this class with external

[5] 'The Reproductive Period in the Lobster,' U. S. Fish Commission Bulletin, 1901.

eggs at any given time. This at once reduces the protection designed by such a law by one half, and the other half shrinks almost to the vanishing point, since between the climax of the period of hatching (June 15) and that of the spawning period (August 1) there is an interval of about six weeks when the majority of all adult females are without eggs, whether old or new, and therefore derive no benefit from such laws. Nor is it possible to ignore the fact that it is an easy matter for any fisherman to strip off the eggs from the female, and place her among his 'counters.'

In dealing with all such questions every one should avoid the common error of assuming that because any animal produces a large number of eggs, there must be a large number of adults reared from those eggs. This form of egregious logic is altogether too common among fish culturists in both England and America. On the contrary, the teachings of biology compel us to draw a very different conclusion. As I have elsewhere pointed out, the essential question—*what is the ratio between the number of eggs hatched and the number of young reared,* is strangely neglected.

An egg represents a chance of individual survival, and where the chance of survival is slight, the number of chances is increased. Vast numbers of eggs invariably mean certain destruction to all but a remnant of the host. I have also shown that a survival of two lobsters in every 10,000 hatched would be a large allowance, two in twenty or thirty thousand being, without doubt, nearer the truth. This further fortifies the conclusion that the vast numbers of eggs required to recuperate the first class can not be expected from the second class, but only from a permanently protected body of adults in full reproductive vigor. When the adults are permanently protected they form a growing class, since they will constantly receive as recruits all those animals which successfully run the gauntlet beyond the prescribed limit.

Those who object to a change of policy and to the adoption of method 2 given above might affirm that if class 3 has been practically exterminated, and if we proceed to wipe out class 2, soon there will be no more lobsters. This may be a serious objection, but on general principles we are assured that the change ought to be made, and made generally wherever the lobster is trapped; the sooner it is done, the better. No doubt if the legal length of the lobster were reduced from ten and one half inches to nine inches, the market supply would be increased for a number of years, and this might be followed by a stringency, but there would be a growing protected class at work all the time, and this would be bound to tell favorably in the end.

Many fishermen, accustomed for a lifetime to look upon the larger lobsters as their legitimate prey, would doubtless rebel against what might seem to them as opposed both to nature and to their own interests, but this would settle itself in course of time. Certain changes would be necessary in the construction of traps—in limiting the size of the funnel or the distance between the slats—but these would not entail serious expense.

To apply the principle of protecting the adult I should favor fixing the limits of length between which it would be legal to sell and destroy lobsters at eight to ten inches, permanently protecting all above and below these sizes. It might be an easier step from present conditions to set these limits between the nine- and ten-and-one-half-inch stages, which I am informed by Dr. Field is the plan favored by the department of fisheries and game in Massachusetts. This is not a vital matter so long as the principle of protecting the adult is maintained, and this is best done

by placing the bar close to the average period of beginning sexual maturity, or approximately at the ten or ten-and-one-half-inch length.

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February 12, 1906.

SCIENTIFIC BOOKS.

Congress of Arts and Science, Universal Exposition, St. Louis, 1904. Edited by HOWARD J. ROGERS, A.M., LL.D., Director of Congresses. Vol. I., Philosophy and Mathematics. Boston and New York, Houghton, Mifflin and Co. 1905. Pp. ix + 626.

On account of its comprehensiveness of plan, the large attendance of foreign scholars of the first eminence, and the picturesqueness (in several senses) of its attendant circumstances, the Congress of Arts and Science of the St. Louis Exposition was doubtless the most memorable and impressive scientific gathering ever held in America—as it was certainly the most creditable and original thing connected with the exposition. The more permanently valuable of its results will come less from the preservation of the papers read than from the stimulating influence of the actual assembling of so many great specialists for the comparison of methods and conclusions; from the informal discussions of workers in kindred fields, over restaurant tables or in the barracks where so much learning was housed in the midst of amateur soldiers, flying-machines and blanket-Indians; from the closer acquaintance brought about between scholars of a dozen different nations; and from the manner in which the congress brought home to the consciousness of a part of the world not hitherto adequately awake to such ideas the dignity of productive research, its central place amongst the functions of universities, and the primacy of its office in relation to all the work of modern civilization and to the increase of all forms of human power and wealth. For all this American men of science are in no small measure under obligations to all concerned in the organization and management of the congress—especially to the officials of the exposition, to the exposition's committee on congresses, to the boards responsible for the determination of the plan and scope of the congress, and to the foreign scholars who entered into the plan, often at considerable sacrifice of personal comfort and convenience. Much mention of personalities would be invidious; but it appears that the most distinctive features of this congress are to be credited to Mr. F. J. V. Skiff, director of exhibits, who insisted 'to the executive committee of the exposition that the congress work stand for something more than an unrelated series of independent gatherings,' and induced the committee to appropriate a sum sufficient to make practicable a project so extensive; to the late Mr. F. W. Holls, who suggested the idea of selecting and remunerating the speakers; and to Professor Münsterberg, whose imagination conceived the detailed plan finally adopted, and whose energy provided much of the driving power that made it possible to carry the plan through.

The present volume, the first of eight, contains a large amount of prefatory matter: a history of the congress by the editor of the series, Dr. H. J. Rogers; a paper on 'The Scientific Plan of the Congress' by Professor Münsterberg; and the eloquent opening address of the president, Dr. Simon Newcomb, on 'The Evolution of the Scientific Investigator.' Then follow the proceedings of 'Division A' of the congress—sixteen papers in philosophy and eight in mathematics—covering the field of what is called 'Normative Science.'

Münsterberg's classification of the sciences for the purposes of the congress has already been pretty widely criticized. No imaginable scheme of arrangement could fail to have its own special disadvantages. But there undeniably seems to be a supererogatory amount of perversity, and a needless sacrifice of practical convenience and naturalness of connection, in an arrangement which, *e. g.*, widely separates esthetics from psychology, theoretical from experimental physics, the philosophy from the history of religion, while bringing an edifying but rather preachy exposition of