acid, and of preparations with high bacterial potency but relatively little chick activity makes it necessary to determine which or how many of these compounds are used directly and the possible interrelationships between these compounds.

Summary. The addition of 25γ of synthetic folic acid per 100 grams of our basal ration prevents the reduced growth, poor feathering condition, and low hemoglobin and hematocrit values consistently obtained when the basal ration is fed to chicks. More than 25γ are needed when the diet contains sulfasuxidine. Evidence for the possible indirect action of folic acid is summarized.

Vitamin C or whole liver powder gives a slight response in the presence of adequate amounts of synthetic folic acid.

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Fluctuations in Abundance of Marine Animals

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The starfish (*Asterias forbesi* Desor) is at times a source of serious injury to the mollusk fisheries of southern New England. The precise extent of the damage done by this pest is extremely difficult to assess, but the cost of efforts at control provides some indication of the magnitude of the problem. The oyster growers of Connecticut alone are conservatively estimated to spend an average of $100,000 per year in combating starfish on their private beds; and approximately $75,000, independent of Federal grants, was paid out for the removal of starfish from public bottoms by the authorities of Massachusetts and Rhode Island during the decade from 1932 to 1942.

It has long been recognized by oyster growers that the amount of trouble caused by starfish is not constant but rises from time to time to the proportions of a plague. Until the present, however, no attention has been given to the pattern of these fluctuations. Evidence here presented in part (Fig. 1) seems to demonstrate that troughs and peaks of abundance of starfish have alternated at seven-year intervals, since 1852 at least, in synchrony throughout the region from New York to Cape Cod. The regularity of these changes during the past hundred years suggests that potential damage from starfish may be expected to decline to a minimum around 1950 and to increase thereafter to a peak during the years around 1957. It is believed that ability to foretell in a general way the times of danger from starfish may effect considerable direct and indirect savings to the New England oyster industry, by permitting a more efficient planning of the use of vessels, oyster stock, and oyster grounds.

Adequate statistical information upon starfish is not available. Definition of periods of scarcity and of abundance of starfish upon the oyster beds has, nevertheless, been found possible by the systematic employment of semiquantitative data, the value of which for such purposes has not heretofore been generally appreciated. These nonnumerical data are derived from statements concerning relative amounts of trouble with starfish at various points in southern New England, contained in reports of public commissions, trade journals, newspapers, periodicals, private memoranda, etc. As examples of such statements, the *Norwalk Gazette* for 3 July 1858 reports that "the star-fish are eating up the oysters in the beds of New York harbor . . . [and in consequence the] proprietors have petitioned the state to remit the usual taxes . . ."; and the Reports of the Rhode Island Commissioners of Shellfish for 1859 and for 1861 state that "during the past year [1859] a very large quantity of the oysters planted upon the private oyster beds [of Narragansett Bay] have been destroyed by the star fish . . . [so that] the past two years have been . . . years of want . . . ," and that "for some time prior to . . . 1860 the increase of the star-fish had been very rapid, until, in that year, they became so numerous and so destructive as to render an entire abandonment of the ground necessary."

One hundred and eighty-five such statements have been collected, tabulated chronologically, compared, and evaluated in terms of "Many," "Few," etc. Although these evaluations are necessarily subjective, the indications upon which they are based are in general quite unequivocal; and although the reliability of individual indications might be questioned, there is in general a close agreement between independent statements from the same as well as from different parts of New England during the same period. A summary of the evaluations is presented graphically in the lower half of Fig. 1. The upper half of the figure shows the quantities of starfish caught annually by an oyster company in Connecticut, 1892–97, and by one in Rhode Island, 1908–38.

Nonnumerical data on starfish are obviously in-capable of defining absolute differences between different periods or stations of observation, but they do deal directly with immediate trends in the degree of trouble experienced. The available numerical data are for limited times and localities only and are not corrected for variations in fishing effort, but they do show clearly that there were great and real changes in the quantity of starfish taken from certain oyster beds. The general agreement between the two types of record seems to justify the conclusion that cyclical changes in the population of starfish have actually occurred. It will be seen from Fig. 1 that these changes have been of such regularity that, by successively adding 14 years to a given date (for example, 1858, 1872, 1886, 1900, 1914, 1928, 1942), the entire record can be traversed without loss of phase. The long (14-year) period of the cycle, its high degree of regularity, and the fact that the cycle concerns a marine invertebrate, are all unusual features.

The data here described do not allow distinction to be made between changes in abundance and changes in distribution, but there is considerable evidence to support the hypothesis that there is a close relation between amount of trouble with starfish and magnitude of the general population of this animal. Calculations concerning the stock of starfish suggest that the biomass during average peak periods may be of an order 20 times as great as that during average troughs; and that the peak populations may reach or surpass the tremendous average density of 1,000 pounds per acre on the half million acres where the species is common in southern New England (a density of about the same order as that during the unique outbreak of the same species in Chesapeake Bay in 1936–38). Knowledge of this regular pattern of violent changes in the stock has opened the way to new conceptions of the natural history of the starfish and the problems of its control, to be reported in forthcoming publications.

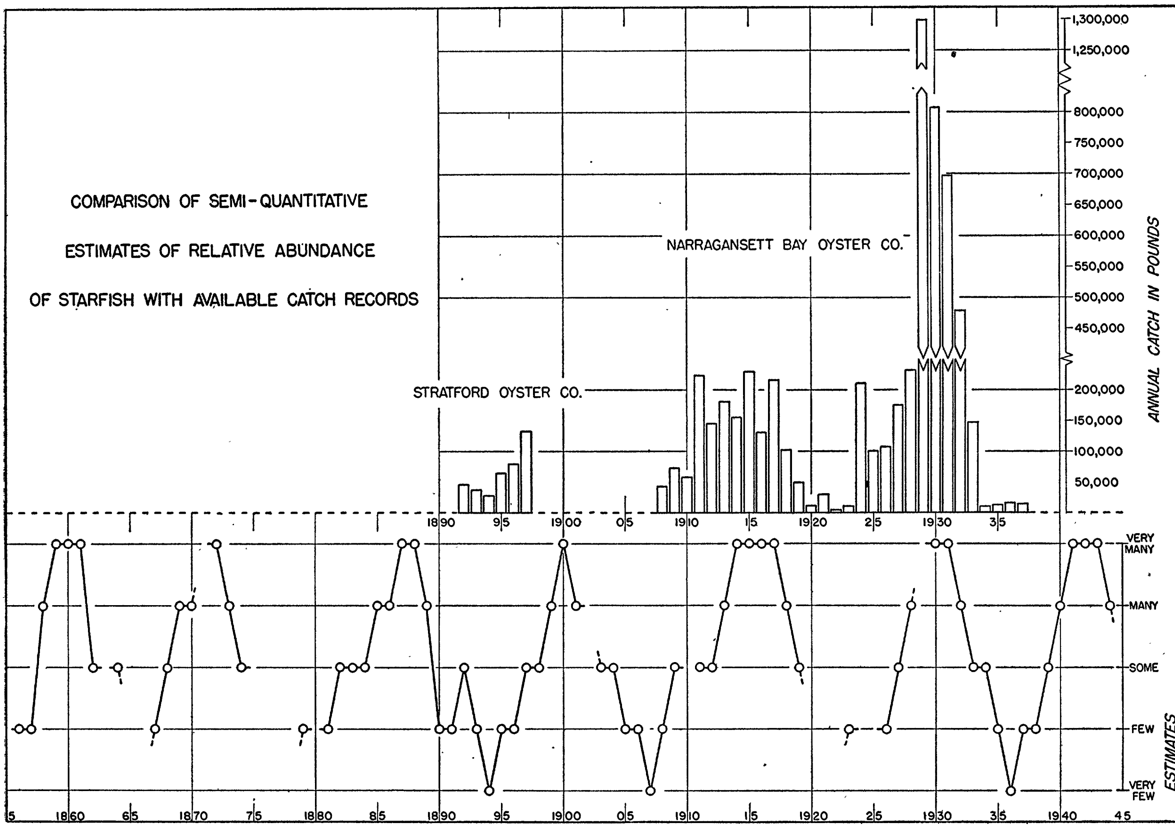

FIG. 1

Lack of long-term continuous statistics upon abundance is not limited to such relatively obscure forms as the starfish. Indeed, available numerical information by no means excludes even the possibility that regular patterns of natural fluctuation might exist in various commercially important populations, such as those of crab, lobster, shad, croaker, etc. For example, the catastrophic declines in production which have been a repeated feature of the modern crab fishery in Chesapeake Bay have often been interpreted as the result of overexploitation; and the statistics of the shad catch are at present generally regarded as showing that overintensive fishing has been the major cause of a disastrous reduction in the stock. However, surveys now in progress, similar to that described above for the starfish, suggest that periodic scarcities of crabs and of shad have occurred throughout the history of these fisheries;[1] and it is by no means certain as yet that these changes have either been closely correlated with human activities or entirely irregular in period.

The dynamics of American marine ecosystems are little understood. For example, it is not known whether Chesapeake Bay could simultaneously support stocks of all of the various fishery animals at the maximum levels to which they have individually attained at various times. Clues to significant population interrelationships might conceivably be obtained from comparison of the changes in abundance, both local and general, of a wide variety of forms over long periods of time. Nonnumerical data may afford a means of making such comparisons, which are otherwise not feasible in any near future.

Hyaluronidase Inhibition by Sodium Salicylate in Rheumatic Fever

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The predominating role of the mesenchyme tissues in rheumatic fever and the permeability changes that are known to occur in its evolution point to interrelationship of several characteristics of rheumatism and the spreading factors of connective tissue, whether of bacterial or endogenous origin. On the other hand, no clear explanation has been presented for the mechanism of sodium salicylate or related drugs in rheumatic fever, although the arresting of the inflammatory process and the regression of symptoms are not the effect of bacteriostatic action.

Rheumatic fever is a disease of the mesenchyma characterized not by the virulence of the etiologic organism but by its invasiveness, especially in youth. In accordance with Bensley (*1*), the connective tissue in formation passes through the following stages: edema → gelatinous ground substance → argyrophilic fibers → collagen in the adult stage. In the early stages, diffusibility in the ground substance is favored to the extreme, while the collagenous fibers that characterize adult connective tissue retard diffusibility, the ground substance having been replaced by the fibers. The importance of the spreading effect of hyaluronidase on connective tissue is based on the observation of Meyer and Palmer (*6*) who pointed out that the principal substrate of connective tissue and mucoid structures is hyaluronic acid, which composes practically entirely the regions affected by rheumatism, such as articulations and synovial fluid.

Durán-Reynals (*3*), McClean (*5*), Kendall and associates (*4*), and especially Crowley (*2*) have observed that several microorganisms including more than 200 strains of hemolytic streptococci produce or possess hyaluronidase. The hyaluronidase of bacterial origin or from testicular extract, used in our work in a 1-per cent dilution, with Evans blue 1-per cent solution in humans or India ink 1:2 for rabbits, increases the spread of dyes by means of enzymatic activity hydrolizing the hyaluronic acid present in the ground substance, decreasing the viscosity, and thus favoring the passage of liquids, exudates, and pathogenic microorganisms. Its action may be divided into the following stages: (a) decreasing acetic acid coagulation of the substrate, (b) decreasing viscosity, and (c) hydrolizing of hyaluronic acid with the release of glucosamine and reducing substance.

In a total of 96 experiments on 24 albino rabbits it was observed that the spread area of India ink with hyaluronidase was six times greater than with saline. The oral or intravenous administration of sodium salicylate inhibited by 57 to 66 per cent the spreading effect of hyaluronidase; the degree of inhibition varied with the dose of salicylate administered. Sulfadiazine did not reduce the activity of hyaluronidase, but appeared to enhance its effect with inflammatory reactions in the center of the area in several groups.

[1] Thus, in the case of the Hudson shad run, what may have been a general scarcity during the 1830's has been noted by DeVoe (*The market assistant*, 1867, p. 200): "This shad-fishery [Cortelyou's fyke-nets in the Narrows] has been gradually decreasing since the year 1824, so that now [1838] it is scarcely worth attending to. . . . All the fisheries in New York harbor are nearly destroyed and the fish which now supply the markets of the city are brought from the distance of sixty, eighty, and even a hundred miles. . . ." Again, during the latter third of the century, "Great complaint and dissatisfaction were encountered everywhere [on the Hudson], the fisheries having fallen off immensely. . . . There never before had been so few shad taken and the retail price in market rarely fell below seventy-five cents for fish which ten years ago [1858] were sold for ten and fifteen cents apiece . . ." (*Report of the Commissioners of Fisheries of New York*, 1869, pp. 9–10). During the late 1870's and 1880's there followed what appears to have been a gradual renewal of abundance, which was credited at the time to hatchery operations stimulated by the preceding scarcity. A fresh decline and a fresh recovery have followed in this century.