https://doi.org/10.17895/ices.pub.9459

INTRODUCTION

BY

JOHAN HJORT AND A. BÜCKMANN.

GENERAL IDEAS

BY

JOHAN HJORT.

FROM all the various areas of the wide sphere of our international co-operation valuable contributions have been made to the promotion of the study of the problems of growth and growth-rate. These voluntary activities may be accepted as evidence of the existence of a widespread interest in the countries co-operating, and a closer study of the individual articles reveals a general consensus of opinion that growth studies can, in all cases, be taken as the keynote of the problems for the study of which this Council was formed: the study of the populations of marine animals in their relationship to human industries at sea.

From this point of view all the authors of the articles are equally interested in the growth of animals as a biological problem, as well as in the importance of growth for the renewal of those populations which form the basis of human industries. This approach to the problem calls to mind the exceedingly remarkable historical fact, that human interest in the study of growth phenomena was first connected with the study of populations. As we all know, Malthus distinguished between a constant and a limited, or restricted, growth, and by this distinction he raised the problem of the relationship between growth and the "means of subsistence", a problem which was re-stated many years later by Claude Bernard in the terms of the life of an organism within its specific milieu or environment. The experimental work of Pasteur and Liebig — to mention only the most outstanding pioneers — paved the way for all the achievements in modern times of biochemistry, experimental agriculture, medicine, and also of the new science which we are in the process of evolving, the science of marine biology.

In all these branches of natural science we can discern a common method of procedure, beginning with an investigation of the manifold factors which influence the development and fate of individual living beings, followed by the discovery of the specific influence of a physical, chemical, biological, or industrial character which, in special circumstances, may change the course of events, the rate of growth of individuals or populations, and which, therefore, was styled by Liebig the "master reaction", the condition which, in a given situation, causes and controls the events in the living world, "la manifestation vitale", to use the words of Claude Bernard.

Of great general interest are the modern discoveries of biochemistry, according to which growth must be considered as a result of balanced reactions between the organism or the population and the factors of the environment. In addition to the means of subsistence we must also take into account the influence of the organism on the structure of the environment. The density of the population may affect the growth of the individuals and thereby the average growth of the population. These important conceptions and discoveries lead us to the new understanding of the balanced reactions between two or more populations of different species. A special case of this general experience is the dependency of a human population on populations of plants or animals which, by their annual renewal, fulfil the human needs. Most interesting is a comparison of the mathematical symbols which illustrate, on the one hand, the growth of a population of organisms, such as bacteria or yeast cells, in a limited environment, the effect of which may be symbolized by their rate of growth, and, on the other, the growth of a human industry based on the catch of animals in all those cases in which the human activity is the dominant factor and therefore, by its excessive increase, may use up its own means of subsistence and thus even seal its own deathwarrant. By

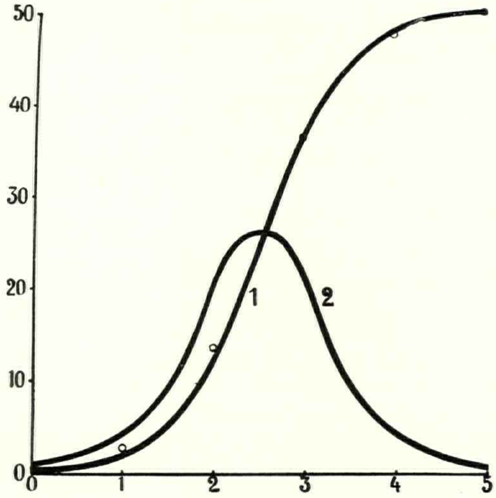

Fig. 1. The sigmoid curve: 1, growth of a colony of bacteria under limited conditions 2, rate of growth.

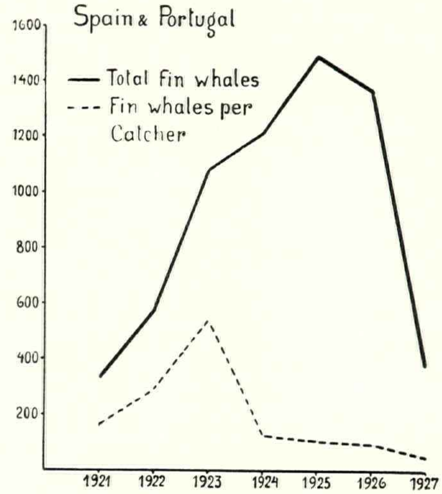

Fig. 2. Fluctuations in the number of fin whales caught off the coast of Spain and Portugal: Solid line — total number of fin whales. Broken line — fin whales per catcher.

comparing two Figures (Figs. 1 and 2) we may demonstrate the analogy between a growth in a limited environment (of bacteria) and the expansion of a human activity (whaling) dependent on a limited population of animals. This comparison of events in nature (Fig. 1) and the fate of a human industry (Fig. 2) leads us to the fundamental and general idea of an optium catch, the state of affairs in which the dominant factor is the increase of the human population, which must adjust itself to a limited growth, if a lasting situation, an equilibrium, a permanent human activity, is ever to be attained.

The scientific elucidation of this relationship between human activity and the wealth of nature is certainly of the greatest human value. It illustrates what Malthus called the prescribed bounds, the limited possibilities which all men instinctively expect to be faced with in their work.

Of no less importance is the scientific experience of such reactions between the activities of man and nature, where the deciding factor hides in the natural events which are independent of, or very little influenced by, any effort on the part of the human population. The investigations of the coastal fisheries in the North-Eastern Area proved some 30 or 40 years ago that the enormous fluctuations which had taken place for centuries in the fisheries in these waters were independent of the activities of the fishermen. The statistics of the Norwegian cod and herring fisheries of the last decades of the nineteenth century illustrate the truth of this statement by the enormous fluctuations which they reveal in the catches of the fishermen, and also in the number of the fishermen themselves, who

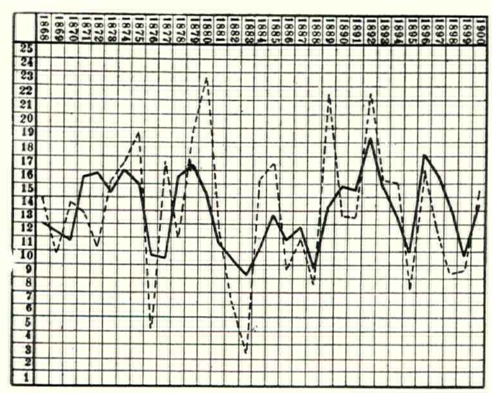

Fig. 3. Cod Fisheries off Northern Norway, 1868—1900. Broken line — number of cod in millions. Solid line — number of fishermen, in thousands.

were compelled to adjust themselves numerically to natural events (Fig. 3).

The final victory of the revolutionary point of view, that these statistics really correspond with, or symbolize, events in nature, or that the fluctuations in the catches of the fishermen undoubtedly have their origin in fluctuations in the stock, was attained on the introduction of the system of analysis of the age and growth of the fish in the catches. A comparative study of the age of the fish within the year-classes led to the possibility of a prognosis based on the experience of the conformity within the length of life of the different year-classes when independent of human activities. With the success of such a prognosis the value of these biological methods for the study of populations would appear to have been experimentally verified.

The fact that the fluctuations in the relative number of the different year-classes have been demonstrated as parallel or contemporary in wide areas is of the greatest practical importance for the creation of a general method, adapted to the study of the effect of human influence on the density of populations in the sea. In the North-Eastern Area, where a number of growth-types may be distinguished within the large field of distribution of the herring and cod populations, the fluctuation in the relative strength of the year-classes was found to correspond in time within the whole field from the south-western to the north-eastern parts of Norway, and as far as the herring population is concerned this correspondence was even demonstrated in Canadian waters. A similar simultaneity of fluctuations in the different haddock populations of the northern North Sea was demonstrated by the interesting work of Harold Thompson[1]).

Compared with this experience growth appears as a very different problem. While the study of fluctuations may extend over wide areas, that of growth demands a material of individuals collected from the most restricted environment. The aim of this research must be to describe as closely as possible the area within the sea in which a uniform growth, a uniform type of growth, may be observed in all the individuals belonging to the same species within the area. In all the contributions which have been submitted to this meeting, from all areas this view has been maintained either in general terms or in actual descriptions of characteristic types of growth. From the Southern North Sea, the Belts, the Baltic, Iceland, the Norwegian coastal waters, most striking examples have been quoted of variations of growth from one part of the sea to another. And it may be considered of great interest for the study of our methods of research that the statement is often made that the difficulties of attaining to a general understanding of the growth phenomena have more than once been ascribed to the fact that the fish in the sea moves from one environment to another. Even marking experiments must therefore be considered inadequate for the problem of obtaining an exact picture of the changing influences to which the animals in the sea may be exposed by their horizontal and vertical movements during the different periods of their life. For this reason a comparison between the growth of animals in the sea and that of plants on the land, such as trees, have been suggestive and confirmed the general conviction of a close correspondence between the growth of all organisms and their environments. Most remarkable are the analogies between the changes in the rate of growth, on the one hand of plants under experimental cultivation of the soil, and on the other of fish like the salmon and trout, which are known to move from the one kind of environment to the other.

[1]) The Haddock of the North-Western North Sea. Rapp. et Proc.-Verb., Vol. LII, 1928.

From these general observations the following conclusions may de drawn regarding the methods of marine biology:—

While growth problems demand a material from the most restricted or uniform environments, the study of the composition of the stock with regard to its year-classes may be extended over wide areas. Through a combination of the study of growth and of age composition in the catches of the fishermen the discovery has been made that the spawning shoals consist of a great number of different types of growth, which therefore may all be considered as belonging to a common stock or population. In spawning areas specific in their geographical location this heterogeneous population creates the new generations or broods, the individuals of which will be dispersed over a multitude of minor environments and therefore be exposed to a great variation of important physical, chemical and biological factors which will decide their individual rates of growth.

It is evident that the study of the influence of fishing on the stock or population of marine animals will require observations extended throughout a series of years. Growth studies within a limited area may in this way illustrate the changes of growth in correlation with the density of the individuals as influenced by the catches of the fishermen. Statistical studies of material, preferably collected from the spawning shoals, and based on length measurements or weights, and amplified by age analyses of minor representative samples, may illustrate the changes in the average mortality within the population in correlation with variations in the intensity or effectivity of the fishing operations within the area of distribution of the population under observation.

In his report on "Fluctuations in the North Sea Haddock Stock" Harold Thompson[2]) states that "more than three-quarters of the original numbers of a brood seems to be removed before the end of the fourth year. No reserve of older fish is allowed to accumulate to tide over bad times". Similar experience is made in several other areas of the sea, and in recent years signs of the growing influence of fishing on the average mortality of the cod populations have now even been reported[3]) from the North-Eastern Area.

[2]) Rapp. et Proc.-Verb., Vol. LXV, 1930.

[3]) See the following contributions from the different areas.