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ON THE CYCLIC ABUNDANCE OF ANIMAL POPULATIONS [1]

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A CRITICAL EXAMINATION of cyclic abundance in animal populations reveals the fact that all such are not basically similar. In the cases of such animals as the varying hare, *Lepus americanus;* the field mouse, *Microtus montanus canescens;* the ruffed grouse, *Bonasa umbellus umbelloides,* and many others, the populations over periods of years vary regularly from relatively few to very large numbers of individuals. Each peak of abundance is followed by an interval in which there is a rather sudden decrease in numbers and this in turn by a lengthy period of increase, slow at first but accelerating with the years. Each growth period of the population should be capable of being illustrated by a sigmoid curve which is characteristic of population growths in general (Pearl and Reed, 1920). Each decline of the population should be represented by a line of steep slope. The period of years from peak to peak or from depression to depression is remarkably constant and constitutes the cycle. For the varying hare the period is approximately 9.7 years; for the mouse 4 years; for the ruffed grouse 10 years.

With these animals there may be one or more litters or broods per year and the individuals may live several years with the result that there is a mixed population through the interbreeding among the individuals of the various litters and broods. The whole population follows a cycle of growth and decline as outlined.

On the other hand consideration of the cycles in abundance of certain fishes, insects and other animals shows that it is not mixed populations that are involved but pure year-classes. One of the best examples is that of the pink salmon, *Oncorhynchus gorbuscha.* This species of Pacific salmon has a two-year life-history, that is, the individuals mature invariably at two years of age, spawn and die. In view of this invariability of maturing and dying there can be no mixed population. In some regions of British Columbia no pink salmon appear in the alternate years. In other regions pink salmon do appear in the even as well as in the odd numbered years, but the two populations must be as distinct as though they spawned in widely separated streams.

The data available on the pink salmon run to McClinton creek, Queen Charlotte islands, as published by Pritchard (1948) may be used to illustrate the year-class cycle.

As stated previously the pink salmon spawns without exception at two years of age and all individuals die. The next generation is represented first by a relatively large number of eggs deposited in the gravel of the streams, six months later by fry proceeding to sea reduced to approximately 14 per cent of the number of eggs and 18 months later by adult fish reduced by natural and fishing mortalities to approximately one per cent of the fry which went to sea. Figure 1 illustrates these features. It will be seen

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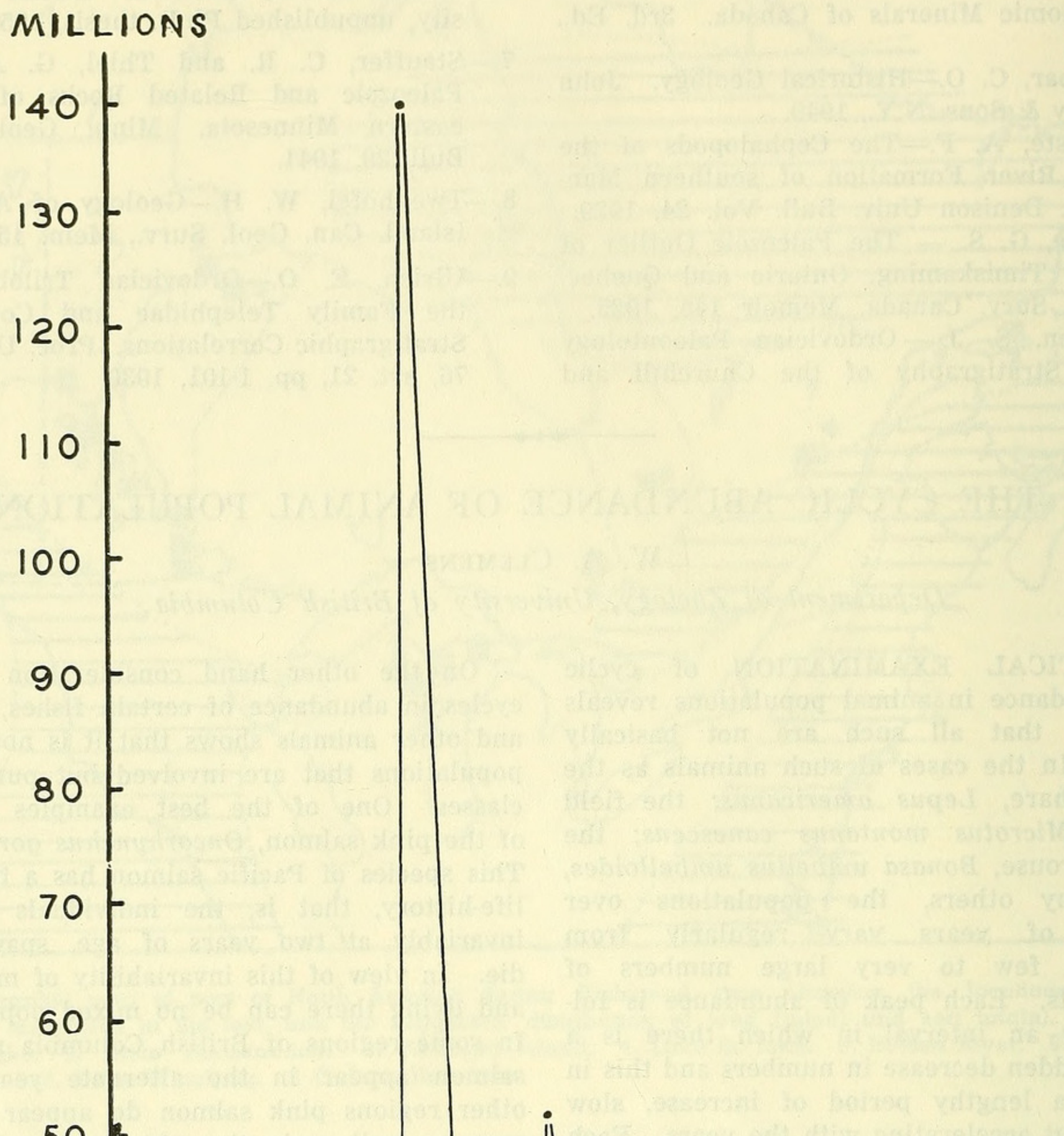

Fig. 1. Year-class fluctuations in abundance of pink salmon, *Oncorhynchus Gorbuscha,* **in McClinton Creek, British Columbia.**
• = number of eggs; + = number of fry; •• = number of adults.

that there is no regularity in the abundance of the fish comprising the year-classes either as eggs, fry or adults. While there could be a long-term cycle superimposed on these year-class cycles, it is doubtful if such actually occurs in view of the extreme variations in climatic conditions from year to year.

Coho salmon *(O. kisutch)* which, with very few exceptions, reach sexual maturity at three years of age, spawn and die, illustrate the year-class cycle.

Sockeye salmon *(O. nerka)*, which mature predominately at four years of age also demonstrate this feature. For example, the large run of sockeye every fourth year to the Fraser river in the early days was due to the fact that the fish which proceeded to the upper Fraser river areas matured almost exclusively at four years of age. For some reason the cycle 1897-1901-1905-1909-1913 was particularly successful and attracted attention. The other three year-class cycles, that is, 1898-1902-1906-1910, etc; 1899-1903-1907-1911, etc; 1900-1904-1908-1912, etc. were smaller in numbers of individuals. Since the Hell's Gate disaster of 1913, the first mentioned population has been greatly reduced in numbers and the second mentioned, the 1898-1950 cycle, has been represented by the largest numbers (Clemens, 1938). But each cycle is essentially independent of the others and each shows irregular fluctuations with no evidence of a superimposed long-term cycle of abundance.

In some regions of British Columbia sockeye individuals resulting from a given spawning may mature at three, four and five years of age (Clemens, 1935). Here, there is undoubtedly a mixture of year-classes and clear-cut year-class cycles do not exist. At the same time, it has not been possible to demonstrate mixed population cycles for these.

Other species of animals show year-class cycles. Among the insects, the seventeen-year cicada, *Cicada septemdecem,* in Canada is an excellent example. The fairy shrimp, *Eubranchipus*, with a one-year cycle, is a further illustration.

In view of the fact that a great deal of study is being given to animal populations, it has seemed pertinent to call attention to the phenomenon of the year-class cycle and to point out how it differs from that of the mixed population cycle of abundance.

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THE GREENLAND COD *(GADUS OGAC)* IN CAPE BRETON ISLAND, NOVA SCOTIA [1]

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IN 1948 and 1949 I was studying the incidence of *Porrocaecum decipiens* (Krabbe), an ascarid parasitic in the flesh of the Atlantic cod *(Gadus callarias* L.), in the Bras d'Or Lake, Cape Breton Island. On May 28, 1948, four Greenland cod, *Gadus ogac* Richardson, were caught on line trawl set in 50 to 100 fathoms of water at Lat. 46° 02'N., Long. 60° 44'W. On June 24, 1949, five Greenland cod were caught in the same locality. The following water temperatures were recorded: in 1948 at 50 fathoms, 0.5° C; in 1949 at 50 fathoms, 0.4° C and at the bottom, approximately 100 fathoms, 0.2° C. Similar temperatures were observed at the end of

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