

In view of the difference in technique it is, unfortunately, impossible to compare the weights of the two populations.

Throughout this paper Bogorov uses the term "biomass" to connote the "quantity of substance in a living organism at a given moment." Biomass was determined by periodic measurements of raw (wet) and dry weights. Stage V and adults only are considered. The Plymouth material shows the same sudden and marked rise in weight in mid-April and the decline in the autumn as recorded for L. Striven. Whilst in L. Striven Stage V were, for the greater part of the year, heavier than either males or females, those from the Plymouth area were usually lighter. The wet weight of Stage V, however, was very considerably less, thus agreeing with the L. Striven results (l. c., p. 804).

Bogorov is able to recognize three well-defined biomass types, which he names the spring (May), the summer (June—September) and the autumn—winter (October—April) types. Further, he believes that these types arise from three periods of breeding.

These three types are recognizable also by their size, the largest being those of the spring, the shortest those of the autumn—winter period. At first sight it would seem that the autumn—winter stock should be the biggest, since it is known that the length of *Calanus* varies inversely with temperature. Bogorov points out, however, that the spring *Calanus* are hatched and developed in the cold winter water of 8—9°C., whilst the autumn—winter stock were developed in the warm water characteristic of the end of autumn (15—16°C). In other words, the size attained and the temperature conditions prevailing during development are inversely proportional.

The author makes the interesting observation that the greatest biomass occurs at a time when *Calanus* are most numerous, and concludes that "conditions favourable for the rise in biomass, are at the same time optimal ones for the development of great numbers of individuals."

He includes a brief comparison of the *Calanus*-type found in the Barents Sea with that from the Channel, and this section will appeal to those interested in the problem of local races.

A. C. G.

**F. S. Russell.** "The Vertical Distribution of Marine Macroplankton XII. Some Observations on the Vertical Distribution of *Calanus finmarchicus* in Relation to Light Intensity." Journ. Mar. Biol. Assoc. N. S., Vol. XIX, No. 2. Plymouth, 1934.

This paper contains two departures from this author's previous practice and enables a more rigid test to be applied to his theory of optimum illumination than has previously been the case. The new features are, firstly, measurement of light intensities beneath the sea surface simultaneously with tow-nettings and, secondly, the use of a number of nets attached at different levels to one warp, enabling the various depths to be sampled at one and the same time.

The present account, which relates to adults of *C. finmarchicus* only, lends considerable support to the author's views on the importance of the degree of illumination in vertical distribution, but tends once more to indicate the complexity of the problem.

Russell's earlier work showed that differences in day-time behaviour of *C. finmarchicus* were to be expected during different seasons of the year, but that such differences were to be related to variations in the size of the

individuals composing the populations sampled. This point comes out clearly in the present experiment. He had also shown that females were tolerant of higher light intensity than were males; this, too, is confirmed. Further, when on July 21st two series of observations were made, the second, in the late afternoon, showed adult female *Calanus* to be much more markedly concentrated at the surface when the illumination was less than 24.7 than had been the case at 2.30 p.m. when the illumination was in excess of 80.8 thousands of metre-candles. Again, on August 12th, when once more two series were taken, the maximum number of female *Calanus* at 11.0 a.m. occurred at a depth of 7.5 metres, whilst in the afternoon there were more individuals at 13.8 than at 7.0 metres *but* the vertical illuminations at a depth of 0.5 metres were 24.4 and 31.6 thousands of metre-candles respectively.

Despite general confirmation of his theory the author is compelled to state, p. 579, that "it is difficult to decide on the optimum conditions [of illumination] except within wide limits." This may be illustrated by the following figures. On July 21st, in the early afternoon, female *Calanus* were living right up to the surface; the next day the surface was avoided at 11.45 a.m. and the greatest numbers occurred at a depth of 8.1 metres. The conditions of illumination, however, were approximately the same, namely 80.8 and 72.8 thousands of metre-candles at a depth of 0.5 metres.

Russell points out that such discrepancies may be the result either of the animals' increased adaptation to a higher light intensity throughout a day, or to their inability to keep accurately to their optima on days when the degree of illumination is constantly changing.

The actual measurements of light intensity were the work of Dr. W. R. G. Atkins and those who may wish to study this aspect in greater detail should consult the original paper (Phil. Trans. Roy. Soc. London, Ser. B, Vol. 222, 1933).

Russell points out that this experiment was in the nature of a preliminary one, and further communications on the same lines will be awaited with interest.

A. C. G.

**S. M. Marshall, A. G. Nicholls and A. P. Orr.** "On the Biology of *Calanus finmarchicus*. V. Seasonal Distribution, Size, Weight and Chemical Composition in Loch Striven in 1933, and their Relation to the Phytoplankton." Journ. Mar. Biol. Assoc. N. S., Vol. XIX, No. 2, Plymouth, 1934.

It is impossible in a short review to give this account the consideration it merits. It is a paper which should most certainly be read in the original by all planktologists. The authors deserve great credit for having given so detailed an account of the biology of *Calanus finmarchicus* but perhaps even greater for having published, in May 1934, data relating to the year 1933.

The aspects dealt with include the following:— seasonal distribution of all stages in the life history from egg to adult, recognition of the times of breeding and duration of various broods, records of length of all copepodite stages and of dry weight, protein and fat content for Stages V and VI. To this list may be added records of the phytoplankton, notes on vertical distribution, observations on the seasons at which females were found to be carrying spermatophores and on the ripeness of the ovaries, and, lastly,