

adult Ephemerae obtained in this way. There proved to be six species only, all belonging to different genera. It is felt that satisfactory taxonomic descriptions can only be made when the larvae of many species in each genus are available for comparison, so workers in other parts of the country are invited to send collections of living ephemerae larvae to Wray Castle to be bred in the laboratory.

Several species of caddis-flies and stone-flies have been reared and also 10 species of dragon-flies. Although keys for the identification of dragon-fly larvae exist, they depend on small numerical differences, and it seems desirable to examine many examples of each species to confirm the validity of such differences. This work on aquatic larvae will be continued during the coming year.

PROGRESS OF THE SALMON INVESTIGATION.

by K. R. Allen.

The salmon investigation has now been in progress for almost three years. During this time the work has been concentrated on the river Eden and its tributaries in order to find out as much as possible about the habits and growth of the salmon under the conditions prevailing in this river. This stage of the work is now almost ended and certain definite conclusions have been reached which are being tested by comparison with the conditions obtaining in other rivers.

Well-marked seasonal changes have been found to occur in the growth of the young salmon and these are probably closely related with the seasonal changes in the temperature of the water. In figure 8, the length of the fish and the average temperature of the water are plotted over the two years which the typical Eden salmon spends in fresh water; the graphs represent averages of several sets of figures which will be published fully at a later date. It will be seen that growth is most rapid about June, and then gradually falls off until it ceases in October. From then no growth takes place until about April, when it recommences comparatively suddenly. Comparisons of these results with the seasonal fluctuations in the temperature of the water suggests that the young salmon grow best at temperatures between 10° and 14° C. (50-57°F.), while outside this range of temperature growth is

slower or does not take place at all. If the temperature of the water in which the fish are living rises above 14°C, growth slowly falls off and finally ceases, and when the temperature falls again to a suitable value there is a considerable lag before the growth recovers. Below 7°C, also no growth takes place, but in this instance when the temperature of the water rises growth recommences immediately and there is no lag period.

If these conclusions are applied to the results obtained in the Eden it appears that the falling off in the rate of growth which takes place in July and subsequent months is due to the high temperature of the water at this time. When the temperature falls in the autumn the lag period prevents any growth taking place until the temperature has fallen below the lower limit for growth, and consequently there is no second growth period in the autumn. Throughout the winter the low temperature prevents any growth occurring, but as soon as the temperature rises in the spring growth recommences. Investigations have also been made into the amount of food found in the stomachs of the young salmon, and it is found that this shows seasonal fluctuations closely following the rate of growth. The amount of food present in the stomach of a fish may be regarded to a great extent as a measure of the rate at which it is feeding, and therefore it appears that the rate of growth and the rate of feeding show very similar seasonal fluctuations. From these results it seems that the climate has a great effect on the total growth rate of the salmon in fresh water, since this must depend largely on the length of the period during the year in which the temperature of the water is between 10° and 14° C. Therefore it is desirable to compare the Eden results with those obtained from other rivers showing the greatest possible climatic differences.

For this reason work has been commenced on the river Thurso in the extreme north of Scotland, where it is hoped that the climate will show considerable differences from that of the Eden. So far three collecting visits have been made to this river, and it is intended during the coming year to visit the river sufficiently often to make possible the construction of growth curves similar to those obtained on the Eden. It is also hoped to investigate the influences of other factors on the growth of the young salmon by studying them in streams in the same area which show different physical and chemical conditions.

Three streams in the Thurso watershed have been selected. Two of these, the Sinclair Burn and the Sleach Water, are very peaty and

acid, flowing through the hills, while the third, the Halkirk Burn, is a neutral stream flowing through low-lying agricultural land. The two peaty streams show considerable physical differences, the Sinclair Burn being rapid and stony with few and shallow pools, while the Sleach Water is a slow-running stream, with many deep pools, and flows over a sandy bottom. The following table shows the average size of the fish in each of these three streams and in the Eden at the end of their first and second summers.

Stream	Length after	
	1 Summer	2 Summers
Halkirk Burn	6.6 cm	11.4 cm
Sleach Water	6.6	11.4
Sinclair Burn	4.8	9.4
River Eden	7.9	14.0

It will be seen that the fish in the Halkirk Burn and the Sleach Water show identical rates of growth, which are somewhat less than that in the Eden, but greater than that in the Sinclair Burn. Analyses have shown that the Sleach Water and the Sinclair Burn are chemically practically identical, and very different from the Halkirk Burn, which in this respect closely resembles the Eden. This suggests that the chemical nature of a stream has little or no direct effect on the rate of growth of fish living in it. It seems probable that the amount of food available has a great effect on the rate at which the fish grow, and in this case this appears to be correlated with the physical nature of the stream. It is hoped that from a further study of conditions in these streams it will be possible to interpret these differences in rate of growth more fully.

Experiments have been started in the laboratory in order to study directly the effect of temperature on the growth of young salmon and thus to test the conclusions which have been reached in the field. It has been found that fish taken out of cold water at a time when they are

not growing, and placed in tanks at a steady temperature within the range best suited for growth, and given abundant food, grow as fast as fish in the river at that temperature.

Work has also been started on the relation between the length of a fish and the length of its scales, in order to determine whether the ratio between those lengths remains constant throughout life. It appears that in very young fish the scales are relatively small, but grow relatively faster during the first two years, so that at the end of this time the ratio between scale length and fish length is the same as that for adult fish. If this result is confirmed by further work, modification will have to be made in the usual method of calculating the length of a fish in its young stages from the scales of the adult, since this method assumes that the ratio between fish length and scale length remains constant throughout life. It appears that the lengths of salmon at the end of their first year calculated on this assumption are about 40% too small.

III. ADMINISTRATION.

THE OFFICERS.

The Association's officers have remained unaltered during the year, except that most of the duties of the Hon. Laboratories Director, Dr. W. H. Pearsall, and of the Hon. Secretary, Professor P. A. Buxton, were taken over by the Director during the summer of 1937. The Association's sincere thanks for all the hard work undertaken during past years was expressed to these officers by the Council, and their appointment as joint Honorary Secretaries for the coming year is recommended to the Annual General Meeting. The Council has also expressed its special gratitude to Mr. H. Stanley King, the Association's auditor and accountant, for the time and energy he and his staff have devoted to the Association's financial affairs during recent years.