as the train enters on to the track-circuit the battery is short-circuited and the one relay drops, making the contacts, and the signal commences to operate, and continues to do so until the train reaches the crossing. As soon as the train reaches the second track-circuit the other relay drops and engages in the interlocking-device, and does not drop on to the contacts. Then, as the train leaves the first track the relay picks up and breaks contact, and although the second track is de-energized the relay cannot make contact, as it rests on the interlock.

Load cells of 500-amp.-hour capacity are used for the track, two cells in parallel being connected up to the track, voltage being 0·5 volt. The local battery consists of Gordon, Burnham, or Leclanche cells, from 10 to 15 volts being used, and generally two batteries are paralleled to be on the safe side. All the wires on recent installations are carried in wooden trunking.

Following on the description, the difficulty of installing warnings at crossings in station-yards will be appreciated. Where the yards are in close proximity to the crossing it is continually occupied, causing an almost continuous operation of the warning-signals by trains in the vicinity, many of which may never reach the crossing. The almost continuous operation soon causes the signal to be disregarded, and it ceases to afford any protection.

Finally, it would appear that nothing except the bridge will afford absolute safety; and, further, that the greatest protection against accidents is the carefulness of the drivers of road vehicles themselves. Warning-signals may help in the case of careful drivers, and are useful at blind crossings, but, unless combined with a careful lookout, will not prevent accidents. Gates and crossing-keepers are, from experience, less efficient than the warning-signals.

The liability to accident increases with the speed, and therefore the question of humps or circuitous routes to the crossing, forcing a reduction in speed, needs very careful consideration. Public opinion and publicity generally has also been found to be a very useful factor in impressing the necessity for a careful lookout to be kept.

In Belgium, after the war, crossing-keepers were abolished at a large number of level crossings. The economy resulted in a saving of three and a half million francs per annum. Special warning-posts were erected, and the civil authorities asked to warn people to take care. There were a certain number of complaints, but scarcely any accidents resulted. The practice is now well established, and the public have become educated to the arrangement. Busy crossings are, however, still guarded.

In Roumania a considerable number of crossings are not guarded at all, but it is found that nearly all accidents occur at guarded crossings, the reason given being that drivers, knowing a crossing to be guarded, cross it without troubling to look.

In France negotiations are under way to dispense with crossing-keepers and leave crossings unguarded. Warning-signals are not being considered, on account of the cost.

In Italy there were seventeen thousand crossings and seventeen thousand crossing-keepers. In consequence of the eight-hour day the staff had to be increased by nearly one-third; and, as the expense cannot be faced, legislation is being prepared to allow level crossings which are not concealed to be unguarded. Road signs are to be erected at unguarded crossings, and the provision of warning-signals at some crossings is being considered.

THE ECONOMIC VALUE OF "WHALE-FEED."

Research by G. Stuart Thomson, B.Sc., and Geo. M. Thomson, F.L.S., F.N.Z.Inst.

Every summer large shoals of a bright-red shrimp are met with in the sea round the coast of New Zealand. This animal, popularly known as "whale-feed," is a swimming stage in the life-history of a crustacean technically known as *Munida gregaria*. It belongs to the family Galatheidae and the suborder Anomura, and is therefore allied to the porcelain-crabs and hermit-crabs of the New Zealand coast. The species is not confined to New Zealand, but is widely distributed throughout the temperate seas of the Southern Hemisphere. Most of the early voyagers, such as Dampier and Cook, met with it on the Brazilian coast. Darwin, in the *Voyage of the "Beagle,"* reported it from the sea round Tierra del Fuego, where, he says, "I have seen narrow lines of water of a bright-red colour, from the number of Crustacea, which somewhat resemble large prawns. The sealers call them 'whale-feed.' Whether whales feed on them I do not know, but terns, cormorants, and immense herds of great unwieldy seals derive, on some parts of the coast, their chief sustenance from these swimming-crabs." It is not likely that whales feed on them, but from the immense shoals which occur in the seas round New Zealand, usually for several months of the year, it is certain that they constitute one of the commonest articles of food to the sea-birds and fishes of these seas. At the Portobello Marine Fish-hatchery the swimming form has been taken from the stomachs of the following fishes: Smooth-hound (*Mustelus antarcticus*), spined dogfish (*Squalus fernandinus*), warehou (*Seriolella brama*), red cod (*Physiculus bacchus*), hapuka (*Polyprion prognathus*), tarakihi (*Dactylosparus macropterus*), Maori chief (*Nothothenia macrocephala*), kelp-fish (*Coridodax pullus*), blue cod (*Parapercis colias*), spotty (*Pseudolabrus celidotus*), parrot-fish (*Pseudolabrus miles*), ling (*Genypterus blacodes*), and leatherjacket (*Pseudomonacanthus scaber*). Large deep-sea specimens (ground form) are commonly found in the stomachs of fish taken in depths down to 150 fathoms, though apparently they are most common between 20 and 30 fathoms.

Life-history.

Very little is known about the life-history either of this or of any other crustacean found in New Zealand. As far as has been observed, the female *Munida* extrudes its eggs in May or June. These are of a bright pale-green colour, and they are carried till the end of September or beginning of October, when they hatch out. The newly hatched larva is figured in the *Bulletin* of the Portobello Fish-hatchery (pp. 104–5). The subsequent development is scarcely known, but as early as the first week of November the free-swimming stage has been met with. At this time the individuals are very small, and contain very little pigment, the total length being about 20 mm., and that of the maxillipeds about 11 mm. These larvae have undergone many developments in the course of growth, and have lived for the greater part of the time at or near the bottom of the sea. As far as can be judged from the hatching-time, this free-swimming stage is assumed in about a year. It is very improbable, judging from the development of allied forms, that larvae hatched in September or October can reach this stage in a month or two. When the larvae begin to swim freely the individuals gather together in schools of varying size. Small schools, consisting of a few thousand individuals, may be one or two yards across, but sometimes the aggregation is so great that vast shoals are met with, which colour acres of the sea-surface a bright red. These shoals extend for many miles. On their first appearance the specimens are small and almost transparent, except for a little red pigment, and they swim about independently. Gradually they congregate more and more till the large shoals are formed. These shoals move apparently in an erratic manner, but when any danger threatens them the mass of individual shrimps tends to move like one body, wheeling and curving like a flock of starlings on the wing.

OCCURRENCE.

Specimens of *Munida* have been taken in Otago Harbour in every month of the year, but the swimming stage known as "whale-feed," which is the only one which can have any commercial value, occurs chiefly from November to April. The occurrence is very erratic. This is shown by the records of the last few years, showing their occurrence in Otago Harbour: 1918—first appearance early in December. 1919—first appearance on 16th November; they were still abundant on 5th March, but disappeared about a fortnight later. 1920—first appearance on 9th December. 1921—first appearance on 2nd December. 1922—first appearance on 7th November.

COMMERCIAL VALUE.

In an average season such enormous quantities of these shrimps occur that at times they are thrown up on the beaches in millions. Masses of them, several inches deep, are thus heaped on the shore, and for weeks fill the air with an offensive smell. When collected and carted on to the soil they form a good manure.

During the course of development of the shrimps the body-tissues contain a varying amount of oil. Probably just before and during egg-formation the quantity of oil is greatest, but at this period most of the animals have gone to the bottom of the water, and it is only in a few of the swimming specimens that eggs are found. An attempt was made to collect specimens during every month of the year when they were available, and to ascertain the following facts in regard to them: (1) The quantity of oil present; (2) the nitrogen content; (3) the percentage of phosphoric acid. The extremely erratic occurrence of the organism during the last few years has, however, made it difficult to carry out the idea.

Before recording the results of the analyses made it is of interest to note what has been done elsewhere in attempts to utilize Crustacea for other purposes than for food. In his report on "Aquatic Products as Fertilizers," in the *Bulletin of the U.S. Commission of Fish and Fisheries* for 1904, Mr. Charles H. Stevenson says:—

"One of the most curious of the marine products used for fertilizer is the horseshoe-crab (*Limulus polyphemus*), which is found in abundance on the Atlantic coast, and especially on the shores of Delaware Bay. It has been used as a fertilizer for at least a hundred years. The crabs are taken during May and June, when large numbers visit the shallow waters for spawning purposes. They are secured by picking them up at night on the shore either by hand or with pitchforks, or they are taken in pound nets constructed especially for the purpose. In 1880 the total catch in Delaware Bay amounted to 4,300,000 in number, worth $16,300; but the industry has steadily declined since then. These crabs weighed about 2 lb. each, and their value ranged from $4 to $8 per ton. In preparing them for fertilizer the entire crabs are sometimes merely stacked in piles until they putrefy and become somewhat dry, when they are broken into fragments and composted with muck, lime, or other suitable materials. Two or three small factories exist at which the crabs are dried and ground while green, and then mixed with sodium sulphate or sulphuric acid. The product sells for $15 to $25 per ton, and is an excellent fertilizer for grain and fruits. The output in 1880 approximated 1,950 tons; in 1890 it was reduced to 880 tons; and in 1901 it was still further reduced to 500 tons. . . .

"When lobsters were canned on the coast of Maine a desirable grade of fertilizer was made from the shells and other refuse from the canneries. This refuse was sold at a nominal price to the factories, or given away for the hauling. The farmers collecting it would usually dry and grind it, and then spread it on the land. Considerable quantities are thus used to-day near the lobster-canneries in Nova Scotia and New Brunswick. . . .

"The shells of shrimps produced in the fisheries of California and Louisiana are used to a considerable extent for fertilizer, which is employed by the Chinese not only on the Pacific seaboard but also on the Orient. The shells are removed from the dried shrimps and sold at about $5 per ton. In California they are especially valued in strawberry and vegetable culture, while in China their principal use is as fertilizer for rice: from 360 lb. to 400 lb. is commonly applied to each acre. It has also been used in wheat-growing, being spread broadcast on the land after the first ploughing."

In Europe various crustaceans are used as fertilizer, but no figures are available as to quantity produced or prices. Fritsch, in his work on *The Manufacture of Chemical Manures*, says: "Crab guano approaches fish guano. It is prepared from a species of sea-crab or lobster, of which there is enormous consumption on the coast of the North Sea. They are steamed, the substance pressed, then it is roasted on plates, and finally reduced to fine powder by grinding, like fish guano. It is in the form of a bright-yellow powder mixed with fragments of shells, and contains on an average 8 per cent. of nitrogen and 3 per cent. of phosphoric acid. . . . To appreciate the value of these manures it must be borne in mind that the greater part of their nitrogen exists not under the form of readily decomposable gelatine, but as a horny substance (chitin) which, moreover, always retains a certain amount of fat. These manures therefore act slowly; if spread in autumn they decompose sufficiently in winter to become active in spring, supposing always that they have not been buried too deeply."

CHEMICAL EXAMINATION.

Mr. W. Adams, curator of the Portobello Fish-hatchery, collected a large number of samples of specimens for us at different times. They were weighed out in lots of about ¼ lb. each, and placed in wide-mouthed bottles covered with gauze, and allowed to dry in air. The loss of weight varied from 50 to 70 per cent., according to the length of time since capture. No doubt during this process a certain amount of nitrogen would be lost also, and a considerable alteration would take place in the fatty portion, while the shells of the animals—composed chiefly of chitin—would suffer little change. Owing to this alteration during slow drying we found it advisable to discard the analyses of most of this material and to deal with fresh specimens.

As already stated, the erratic nature of the occurrence of "whale-feed" during the last three years has prevented us from giving monthly values of the different ingredients. The following figures represent, therefore, the averages of several analyses:—

Composition of comparatively fresh Specimens.—Total moisture, 69·69 per cent.; dried material, 30·31 per cent.

Analysis of Dried Material.—Volatile matter, 91·49 per cent. (containing 7·19 per cent. nitrogen, equivalent to 8·73 per cent. ammonia); ash, 8·51 per cent.

Analysis of Ash.—Phosphoric anhydride, 1·7 per cent.; lime, 4·2 per cent.; alkalis (by difference), 2·61 per cent.

Estimation of Oil.—Ether extract, 14·17 per cent. of dried material; oil, 8·2 per cent.

Working from these figures we find that 1 ton of freshly gathered "whale-feed" would yield 679 lb. of dried material, from which could be extracted 55·7 lb. of oil. The residue would contain 48·8 lb. of nitrogen (equivalent to 59·2 lb. of ammonia) and 1 lb. (0·98 lb.) of phosphoric anhydride (equivalent to 2·14 lb. of tricalcic phosphate).

The value of such material is somewhat difficult to estimate. We are informed that the oil, extracted by benzine, would be worth in the wholesale market about 4s. per gallon; 55·7 lb. of oil (equivalent to 6·2 gallons) would therefore be worth £1 4s. 9d. Soluble nitrogen, as in ammonium sulphate, at present is estimated at £1 5s. per unit; and phosphoric anhydride in superphosphate at 8s. We consider it safer, however, to take £1 and 6s. 6d. respectively as a more reasonable estimate of value. At these rates the 48·8 lb. of nitrogen is worth £2 3s. 7d., and the small quantity of phosphoric anhydride only 3d. The total value, then, of the products from a ton of fresh "whale-feed" is probably about £3 8s. 7d.

It is clear from these figures that it would never pay to treat "whale-feed" as a commercial source of oil and manure, except occasionally perhaps in the immediate neighbourhood of a suitably installed plant for dealing with fish-offal. The capture of the fresh material would require the use of finer-meshed nets than are usually employed by any New Zealand fishermen. The handling of the fresh material, and the subsequent treatment of it—drying, oil-extraction, and grinding—would probably cost, at present prices of labour, plant, &c., not less than £2 per ton, and this would leave a margin of only £1 8s. 7d. per ton. It has further to be remembered that such a plant would only be available for treatment of "whale-feed" when there was a scarcity of fish—a contingency not very likely to happen, for when "whale-feed" are abundant fish are usually abundant also. We would further point out that already the production of nitrogenous manure in the frozen-meat industry of the Dominion is greater than the demand. From all these considerations we are of opinion that there is very little commercial value in "whale-feed" under present conditions.

LIFE-HISTORY OF THE NEW ZEALAND GRAYLING, *PROTOTROCTES OXYRHYNCHUS.*

By W. J. PHILLIPPS, F.L.S., F.R.G.S.

THE present paper contains a review of all published matter concerning the migrations and habits of the indigenous grayling, together with a number of new observations, collected, for the greater part, during a visit to the west coast of the South Island. There can be no doubt that before the introduction of trout the grayling was the most common fresh-water fish in many parts of New Zealand. It is now rarely seen except in isolated streams and rivers remote from settled areas. From a locality near Featherston the Dominion Museum recently secured two specimens which were taken in a hole in the river together with quinnat salmon, and considered to be the young of that species.

The grayling figured on the next page is taken from a drawing by J. Buchanan published to illustrate a paper by Hector (1871, p. 133). As the figure is a good representation of the species, it has been reproduced with a slight alteration to the shape of the profile of the head. On several occasions the author has been given unsolicited information regarding the existence of a second species of grayling in the streams of the west coast of the South Island. It was generally described as differing from the common species in having a dark-slate back, and pink and yellow on the sides.

The following illustrates the present state of our knowledge of the migrations of the New Zealand grayling:—

JANUARY.—Ascend the Hutt River in immense shoals; females gravid (*Hector*). Commonly taken up-stream (*W. B. Braddon, C. Chitty, members of Westland Acclimatization Society, and others*).

FEBRUARY.—Make their appearance in Maitai River, Nelson (five miles from mouth) (*Rutland*). Common up-stream, Westland (*J. McKay and others—as in January*).

MARCH.—Go up to spawn: Nelson (*Rutland*). Becoming very fat and full of ova; disappear this month: Waikato (*C. Chitty*).

APRIL.—Upokororo plentiful: Bay of Plenty (*Mair*). Have taken examples in Hokitika River estuary: Westland (*W. B. Braddon*).

MAY.—Two specimens taken in deep hole in Turanganui River, Featherston, and presented to Dominion Museum.

JUNE.—Appear up-stream, Nelson; smallest 6 in. to 7 in., largest about 12 in. Ready to spawn (*Rutland*).

JULY.—Have taken specimens up-stream: Westland (*W. B. Braddon*). Disappear from minor tributaries and seek deeper water: Nelson (*Rutland*).

AUGUST.—No definite note of appearance.

SEPTEMBER.—Young taken; Hokitika, migrating up-stream with whitebait (*W. B. Braddon*).

OCTOBER.—Young taken with whitebait: Westland (*W. B. Braddon and others*). Half-grown and adult fish appear at mouth of Maitai River, Nelson (*Hector*). Run up Waikato River (*C. Chitty*). Commence running, Taranaki streams (*W. H. Skinner*).

NOVEMBER.—In rivers in large numbers: New Plymouth (*W. H. Skinner*).

DECEMBER.—To be taken up-stream in large numbers (*J. McKay, W. B. Braddon, C. Chitty, and others*). Disappearing from rivers during this month: New Plymouth (*W. H. Skinner*).