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NOTES ON MARINE PLANKTON.

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Read June 8. Published August 10, 1914.

In the Clare Island reports which have been already published, most of the animals which make up the marine plankton of the district have been dealt with under the systematic groups to which they belong, but a separate consideration of their relative abundance and local distribution seems to be required. The following notes are meant as a summary of the observed facts of the constitution of the plankton rather than as a discussion of the causes of the abundance or scarcity of the constituent species. Indeed, it seems probable that no general rule will cover all the circumstances, but that each individual case will require separate investigation.

The Phytoplankton of the district, which will probably furnish the key to the distribution of the more highly organized forms, is almost unknown. The few records of marine planktonic diatoms given in Part 16 of the Clare Island reports contain almost all the information which is available. The flagellate *Protozoa* and the other minute forms of animal and vegetable life, which make up the Nannoplankton, have never been studied, but there is no doubt that they play here, as elsewhere, a very important *rôle* in providing food for the early larval stages of most of the littoral forms with free-swimming larvae, as well as of the holoplanctonic species.

Coming to the larger forms, such as may be taken in tow-nets of a mesh of about ·5 mm. square, a fair amount of information is available, based chiefly on tow-nettings made when the Department of Agriculture's Marine Laboratory was stationed at Ballynakill. In considering these gatherings it is convenient to divide the plankton into three fairly distinctly marked groups, corresponding to three regions which may be roughly separated by position, depth, salinity, and temperature of water. In a wider view these groups would all fall under the heading of Boreal Neritic.

The *open sea* is the outermost of these regions, and represents the water which lies to the seaward of the large islands which fringe the coast—Inishkea,

Achill Island, Clare Island, Inishturk, and Inishbofin. It has no clearly defined western boundary, but gradually passes into the main body of the Atlantic; for convenience, however, it may be put as ten miles wide.

The *intermediate off-shore region*, which lies between the larger islands and the mainland, shares in the characters both of the open sea and of the bay and harbour region, next to be defined, but seems to be sufficiently distinct to deserve separate consideration.

The *bay and harbour region* is made up of the waters of the deep, sheltered inlets which are characteristic of the western coast-line of Mayo and Galway. It includes Ballynakill Harbour, Killary Bay, Inishlyre Harbour and the Clew Bay Archipelago, and the more enclosed portions of Blacksod Bay.

In the open-sea region the conditions are comparatively uniform. The water is of a fairly high salinity, varying between 34·3 and 35·0 per thousand, and the temperature, though occasionally rising above 16·0° C. at the surface in August, the warmest month, has an approximate annual range of from 8·0° C. to 10·0° C. in the bottom layers, and seldom falls below 8·0° C. at any level. The Copepoda are the most uniform constituents of the plankton in this region, the characteristic species, almost always present, being *Calanus finmarchicus, Metridia lucens, Pseudocalanus elongatus, Parcalanus parvus, Centropages typicus,* and *Oithona similis.* Occasionally oceanic species are drifted into this area, but only in very small numbers. The most frequent of these are *Clausocalanus arcuicornis, Ctenocalanus vanus, Calocalanus styliremis, Oithona spinifrons,* and *Oncaea conifera.* There also occur species derived from waters nearer shore, such as *Parapontella brevicornis, Isias clavipes,* and *Temora longicornis.* The Schizopoda are represented by shoals of *Meganyctiphanes norvegica, Nyctiphanes Couchi,* and *Thysanoessa inermis,* which probably have their centre of distribution farther to seaward. These shoals are fed upon by the mackerel which gather on the coast in winter and early spring, the stomachs of the fish being usually found to be crammed with the crustaceans. The small larvae, from the nauplius stage to a length of about ·5 mm., are more abundant than the adult Euphausians, or perhaps more easily captured. Among the Amphipoda *Euthemisto compressa* and *Parathemisto oblivia* are characteristic, while *Hyperia galba* occasionally appears in large numbers in company with shoals of the medusa *Pelagia perla.* The Cladocera *Evadne nordmanni* and *Podon intermedius* are frequent, the latter having a restricted range shorewards. The Coelenterata are not numerous, and do not occupy much space in the tow-nettings. The species most regularly present is *Pleurobrachia pileus,* and there also occur frequently, drifted from seaward, *Pelagia perla, Muggaea atlantica, Galeolaria* sp. *Cupulita Sarsi,* and *Leuckartia octona* (= Tiara pileata).

Philadium temporarium, Phialidium cymbaloideum, and *Obelia nigra,* arising within the region, are common in summer and autumn. *Limacina retroversa* is the most plentiful of the mollusca, and is nearly always present in larger or smaller numbers. *Clione limacina* is scarcer, and the larvae of the bottom living Gastropods and Lamellibranchs only occur occasionally in small numbers, the conspicuous larva of Lamellaria being most frequently recorded. Amongst the worms *Sagitta bipunctata* is usually common, and *Tomopteris helgolandicus* frequently occurs.

The larvae of the Decapod Crustacea are common. Not many of these have been identified, but Porcellana larvae are very frequent, and the larvae of Nephrops have been seen. Other forms, which occur too seldom to be of much importance, are the Trachelifer of Jaxea, the Phyllosoma of Palinurus, and the Lysioerechthus of Squilla. Throughout the summer the larvae of Echinoderms are a noticeable feature in tow-nettings. They are usually minute Ophioplutei and Echinoplutei, but occasionally the large bipinnaria of Luidia is seen.

The Tunicata are represented by *Salpa fusiformis* and *S. mucronata,* the latter sometimes being present in immense shoals, drifted from seawards, notably in August, 1903; occasional specimens of *Doliolum tritonis,* which also comes from seaward; and, in small numbers, *Oikopleura dioica.*

The general features of the open-sea plankton may be indicated by giving particulars of two typical tow-nettings:—

*3½ MILES W.S.W. OF SHARK HEAD. 1ST AUGUST, 1901.

Surface, middle, and bottom tow-nets.

Pleurobrachia pileus *f.*	Metridia lucens *v.c.*
Siphonophora indet. *m.*	Centropages typicus *v.f.*
Medusae ceterae *c.*	Centropages hamatus *v.f.*
Auricularia *v.f.*	Isias clavipes *v.f.*
Tomopteris helgolandicus *f.*	Temora longicornis *v.f.*
Sagitta bipunctata *f.*	Acartia Clausi *f.*
Polygordius larvae *v.f.*	Oithona similis *v.f.*
Larval Polychaeta *f.*	Oithona spinifrons *v.f.*
Cyphonautes *f.*	Nyctiphanes couchi *f.*
Evadne nordmanni *f.*	Larval Decapoda *v.c.*
Calanus finmarchicus *v.c.*	Lamellaria larvae *v.f.*
Pseudocalanus elongatus *m.*	Doliolum tritonis *v.f.*
Paracalanus parvus *v.f.*	Larval fish *v.f.*

* *v.c.* = very common, *c.* = common, *m.* = moderate, *f.* = few, *v.f.* = very few.

10 MILES W.N.W. OF CLEGGAN HEAD. 10TH MAY, 1904.

Surface, middle, and bottom tow-nets.

Cupulita Sarsi *v.f.*	Acartia Clausi *c.*
Medusae ceterae *v.f.*	Oithona similis *f.*
Tomopteris helgolandicus *l.*	Larval Euphausiidae *c.*
Sagitta bipunctata *v.f.*	Larval Anomura *f.*
Calanus finmarchicus *c.*	Cyphonantes *f.*
Pseudocalanus elongatus *m.*	Oikopleura dioica *m.*
Paracalanus parvus *m.*	Larval fish *v.f.*
Metridia lucens *f.*	Fish eggs *c.*
Isias clavipes *v f.*	

Taken as a whole, open-sea gatherings are characterized by the comparatively small number of species which occur in them, both the average number of species present and the total of all the species observed being much fewer than in collections made either in the open ocean, in waters of high salinity, *e.g.* thirty miles or more seaward, out of reach of shore influences, or in shallow water in bays and harbours, where the proximity of the shore is the governing factor. On the other hand, with regard to the number of specimens present, the region under consideration is of very great importance, for it is the main breeding ground of a few species of Copepoda which in spring and early summer multiply with such rapidity that they far outnumber all the other forms present, and constitute what has been called a monotonic plankton, which appears at first to consist exclusively of one kind of organism. The most abundant species, in this respect, is *Calanus helgolandicus*, which, from May to August, over the whole of this region, is the outstanding feature of every gathering. Next in abundance is *Metridia lucens*, sometimes occurring in company with *Calanus* and sometimes in unmixed shoals. It is widely distributed over the North Atlantic, but appears to find surroundings suitable for rapid reproduction only in the more coastal regions. *Pseudocalanus elongatus* is also frequently found in great numbers, sometimes alone, but more usually in company with shoals of Calanus. Pseudocalanus and Metridia are seldom, if ever, found associated in the absence of Calanus. This area, which might be distinguished as the Calanus belt, seems to be continuous along all the west coasts of Ireland and Scotland.

The intermediate off-shore region which lies between the larger islands

and the mainland has a planctonic fauna, made up, for the most part, of species which are also found either in the open sea or in the bays and harbours. In general the fauna most resembles that of the open sea with the addition of some typically shore forms. The large shoals of *Calanus helgolandicus* are as noticeable here as they are outside, and *Pseudocalanus elongatus* and *Temora longicornis* are also often present in immense swarms. This region has, however, some species which seem to find their optimum conditions in it, e.g. the Medusa *Aurelia aurita*. The Mysids *Gasterosaccus spinifer*, *G. Normani*, and *Anchialus agilis* and the Copepods *Corycaeus anglicus* and the pale form of *Altheuta interrupta* are also characteristic. This region is liable to be invaded by shoals of oceanic organisms, such as *Pelagia perla*, *Salpa mucronata*, and *S. fusiformis*, and in small numbers Velella, which generally escapes notice till it is stranded on some sandy beach.

In the bays and harbours the physical conditions are very different from those of the outside waters. The salinities vary from day to day according to the rainfall and wind, a heavy rainfall on land being followed by a marked drop in the salinity of the water, while after a prolonged dry period the saline concentration, owing to evaporation, may become very high. Observations made in 1903 at Fahy Bay, Ballynakill, a land-locked inlet almost cut off from the sea at low water, showed that the average monthly salinity (hydrometer determinations) in June, the driest month, rose above 35·00 per thousand both at the surface and at a depth of one fathom, and in September fell to 32·50 per thousand at the surface and 33·40 at one fathom. In 1901 the mean monthly salinity of the surface ranged from 38·40 per thousand in July, to 32·75 in November.

The variations in temperature are also very great. The observations at Fahy Bay in 1901 give a monthly mean range, at the bottom, i.e. 1–2 fathoms, of from 6·5° C. in March to 14·0° C. in July, the mean surface temperature for the same months being 6·3° C. and 14·4° C. The maximum and minimum temperatures recorded at the surface were 5·25° C. and 17·3° C., and at the bottom 5·25° C. and 15·75° C.

The plankton of the bays and harbours is characterized by the large number of species which are only temporarily planctonic, most of them in their early stages, such as the larvae of Mollusca, Decapoda, Cirripedia, and Annelids, others which are sessile or reptant during their early stages, but become pelagic when mature, others in which a free generation alternates with an attached one, as is the case with many of the Medusae, and some which are quiescent at the bottom during the day, but swim upwards at night, such as many of the Harpacticid Copepods, Cumacea, Amphipods, and Schizopods.

A few typical gatherings from different localities will illustrate the common features of this plankton.

BALLYNAKILL HARBOUR, 6TH FEBRUARY, 1901.

Larval Polychaetes *c.*
Pseudocalanus elongatus *v.c.*
Temora longicornis *v.f.*
Centropages hamatus *v.f.*
Parapontella brevicornis *f.*
Isias clavipes *v.f.*
Acartia clausi *v.c.*
Acartia discaudata *v.c.*
Oithona similis *m.*
Oithona nana *v.f.*
Cyclopina littoralis *m.*
Cyclopina gracilis *v.f.*
Idya furcata *f.*
Harpacticus chelifer *m.*
Harpacticus flexus *v.f.*
Thalestris harpactoides *m.*
Dactylopusia tisboides *v.f.*
Dactylopusia vulgaris *f.*
Diosaccus tenuicornis *f.*
Larval cirripedes *m.*
Amphipods *f.*
Cumacea *v.f.*
Macromysis flexuosa *v.f.*
Larval Decapods *m.*

KILLARY HARBOUR, 17TH AUGUST, 1901.

Medusae *v.c.*
Pseudocalanus elongatus *v.f.*
Paracalanus parvus *f.*
Centropages typicus *f.*
Centropages hamatus *c.*
Temora longicornis *c.*
Isias clavipes *c.*
Acartia clausi *m.*
Acartia discaudata *f.*
Oithona similis *f.*
Oithona nana *c.*
Cyclopina littoralis *v.f.*
Cyclopina gracilis *v.f.*
Longipedia coronata *m.*
Peltidium crenulatum *v.f.*
Alteutha interrupta *v.f.*
Podon polyphemoides *c.*
Podon Leuckarti *v.f.*
"Trachelifer" larva *v.f.*
Larval crustacea *v.c.*
Lamellaria larva *v.f.*
Fish eggs *f.*

BALLYNAKILL HARBOUR, 23RD OCTOBER, 1903.

Pleurobrachia pileus *v.f.*
Phialidium temporarium *f.*
Phialidium cymbaloideum *m.*
Obelia nigra *v.f.*
Willsia stellata *v.f.*
Octorchis Gegenbauri *v.f.*
Tomopteris helgolandicus *f.*
Sagitta bipunctata *v.f.*
Larval Polychaeta *v.c.*
Copepoda *v.c.*
Larval cirripedes *v.c.*
Mysidacea *f.*
Larval Gastropoda *v.c.*
Oikopleura *m.*

ELLY BAY, BLACKSOD, 13TH SEPTEMBER, 1909.

Odontosyllis gibba *f.*
Polydora ciliata, *larv. m.*
Nereis Dumerilii, *larv. v.f.*
Macrochaeta clavicornis *v.f.*
Spadella cephaloptera *m.*
Pseudocalanus elongatus *f.*
Centropages typicus *v.f.*
Centropages hamatus *v.f.*
Temora longicornis *v.f.*
Isias clavipes *c.*
Acartia clausi *c.*
Oithona similis *f.*
Idya angusta *v.f.*
Porcellidium fimbriatum *v.f.*
Alteutha interrupta *f.*
Thalestris mysis *f.*
Thalestris hibernica *v.f.*
Dactylopusia tisboides *m.*
Diosaccus tenuicornis *f.*
Amphiascus varicolor *f.*
Evadne nordmanni *v.f.*
Guernea coalita *v.f.*
Microprotopus maculatus *v.f.*
Urothoe elegans *v.f.*
Eurydice pulchra *v.f.*
Mysidacea *f.*
Larval Caridea *c.*
Porcellana larva *m.*
Larval anomura cetera *f.*
Larval Gastropods *m.*
Lamellaria larva *v.f.*

Among the Coelenterata in this region *Phialidium temporarium* and *P. cymbaloideum* are the most abundant, and *Obelia nigra, Octorchis Gegenbauri, Laodoce calcarata, Willsia stellata, Margellium octopunctatum, Sarsia prolifera,* and *S. tubulosa* are common. The Polychaeta are represented by several species which may be taken in tow-nettings, especially by night, such as *Odontosyllis gibba, Polyophthalmus pictus, Chaetozone setosa,* juv., *Scalibregma inflatum,* juv., *Nereis Dumerilii* and *N. longissima,* adult males, *Sphaerosyllis hystrix,* mature, and the breeding buds, male and female, of *Autolytus* and other Syllids. *Tomopteris helgolandicus* is occasionally taken, but is probably drifted in from outside. *Spadella cephaloptera* is a permanent inhabitant, and *Sagitta bipunctata* also occurs at times. Larval Echinoderms, Ophioplutei, Echinoplutei, and Bipinnariae are found, but not in great numbers. Most important in point of numbers are the Copepods, fifteen or twenty species being not an unusual number in a single gathering, especially at night when many of the Harpacticidae leave the weeds and swim to the surface. Among the Cladocera are *Evadne nordmanni,* which is more plentiful than in the open sea, and *Podon Leuckarti,* which is characteristic of water of low salinity as *P. intermedius* is of high, while *P. polyphemoides* only thrives where there is a considerable admixture of fresh water; in fact, these three species might be used as an index of salinity. The Euphausians, which are so noticeable in open-sea gatherings, are absent from the inshore waters except as occasional

immigrants, but the Mysidacea supply their place though they do not occur in such large shoals. *Siriella armata*, *S. Clausi*, *S. Jaltensis*, and *Macromysis flexuosa* are all nocturnal swimmers, occurring plentifully throughout the area, and *Macropsis slabberi* indicates the presence of a large admixture of fresh water.

The Isopods do not furnish many species. *Eurydice truncata* and *E. spinigera* are frequently planctonic, as in *Gnathia oxyurea* in its larval stages. The Amphipods which became planctonic at night are too many to enumerate, but amongst the most abundant are *Perioculodes longimanus*, *Apherusa bispinosa*, *Dexamine spinosa*, *Corophium Bonelli*, *Proto ventricosa*, and the young stages of *Caprella acanthifera*. The Cumacea by day remain buried in the sand, but at night come to the surface, in shallow water, in large numbers. The three most abundant species in the district are *Pseudocuma longicornis*, *Iphinoe trispinosa*, and *Bodotria scorpioides*.

The larvae of Decapods, Anomura, Brachyura and Macrura, form a large percentage of the catches in the summer months, the zoeae and megalopae of Porcellana being, perhaps, the most numerous. Molluscan veligers and, in small numbers, tailed larvae of Ascidians also contribute to the bulk, and a species of Oikopleura, probably *O. dioica*, is fairly numerous at times.