

bly, had in the spring of 1648 approved of an agreement with Charles I. by which he was to give a three years' trial to the Presbyterian system of Church Government in England. This agreement was known as the "engagement." A Scots Army entered England on behalf of the King, but was decisively defeated at Preston in September, and the prestige of the Assembly was restored.

Next Session of Parliament passed the Act of Classes whereby all except strict Covenanters were excluded from service in the army or state. This Act was probably largely responsible for the defeat of the Scots Army at Dunbar. It was found necessary to relax the provisions of this Act. The Strict Covenanters protested against resolutions to this effect and the Church was divided into two parties, Protestors and Revolutioners. The Act of Classes was repealed in 1651, and the division between the two parties became very keen. Both parties sought the approval of Cromwell, and deputations went to London with this end in view. But if the parties were represented in the Synod, their minutes do not show any sign of division. The English Parliament in 1657 had made religious toleration a law for the three Kingdoms. The Protestors were the prime movers against toleration and the Synod of Glasgow resolved to send a Petition to the Protector and to Parliament. They invited the Synod of Argyll to join with them. The minute—25th May, 1659—is short and to the point. "To the correspondent from Glasgow desyreing the Synods concurrence in a supplication against tolleration, it is answered that as things now stand the Synod thinks the same not to be needful." But there was then no Protector. Oliver Cromwell was dead. His son Richard had been put out by the officers of the Army who were negotiating for the restoration of the King. In 1661 Parliament passed Act Recessory repealing all Acts passed since 1633, and Episcopacy was re-established by Royal Decree.

THE WORK OF A MARINE STATION.

By SHEINA M. MARSHALL, Marine Station, Millport.

(Read 8th February, 1944.)

In this country there are no very old marine stations. Although some had been built in Europe and even in America before then, the first in Great Britain was founded in 1884, and that was at Granton in the Firth of Forth. It consisted of a lighter, moored in a flooded quarry near Granton, on which a large cabin had been erected. This gave her the appearance of a typical nursery toy, and so she was called the Ark. After some time permanent buildings were put up on the shores of the quarry, and the Ark was brought over to the West Coast and drawn up in a little creek off Kames Bay, Millport. This was the origin of the Millport Marine Station.

There were several events in the second half of last century which turned the thoughts of biologists towards the sea. One was the publication, in 1859, of Darwin's "Origin of Species." This great work called the attention of biologists back from the anatomy of the dead animal in the laboratory to the living animal, to its development, its habits, its adaptation to its environment; and since the most primitive types of animal are found in the sea, it was to the sea particularly that scientists turned. Then from 1873-76 the voyage of the "Challenger" took place, a voyage of exploration into the depths of the oceans, their fauna and flora, their bottom deposits, their physics and chemistry. The treasures which this great expedition brought back and the new knowledge of life in the ocean depths were a stimulus for generations to come. Finally, in 1883, a very

successful fisheries exhibition was held in London, and this encouraged a number of people to get together and to found in 1887 a Marine Station at Plymouth, in Devon, which has become the largest and most important in the British Isles. During the next ten or fifteen years, various small marine stations were built in different parts of the country—at St. Andrew's, near Liverpool, on the Isle of Man, and near Newcastle. Most of these are still in existence. Although most Marine Stations were started as private enterprises, the Government now gives all of them substantial financial help, thus recognising their usefulness. Without this most of them would be unable to carry on.

The spot on which to found a marine station must be carefully selected. Naturally, one wants to choose a place which has a rich and varied fauna, with different types of coast, rocks and rock pools as well as sandy bays, deep water as well as shallow. The further away from a town it is, the more likely is the water to be pure, but, on the other hand, if it is situated in too remote and inaccessible a spot, it won't attract many visitors. When I was in Norway I visited the little marine station on Herdla, an island some distance to the north of Bergen. The director was enthusiastic about the situation. He said it was right in the biological centre of the district, with easy access to three quite different types of ocean water. When in Bergen, however, we heard bitter complaints about the distance and inaccessibility of the island. There was only one boat a day, and it left the island at 4 a.m.

Once the station is founded the first job is to find out what animals and plants there are, the rare as well as the common, and where they are to be found most easily. This means hunting carefully along the shores, digging up the sand in sandy bays, searching under the weed of rocky coasts, turning over the boulders to see what lives underneath, and then bringing back all your

specimens to the laboratory to be identified, often a long and wearisome job. Then there is the sea itself to be investigated with water-bottle and tow-nets, and the bottom to be sampled with dredges, trawls, and mud-buckets.

We in this country are fortunate that most of this work has been already done for us. The nineteenth century was an era of great naturalists whose joy and pride it was to add fresh records to the fauna lists and to describe species and varieties new to science. David Robertson, the Cumbræ naturalist, was responsible for much of the knowledge of our shores here. Although it is rather the fashion to laugh at these old naturalists now, and to look on them as glorified stamp-collectors, yet we must not forget that their work is at the base of all we do. Every marine station must have a good naturalist attached to it, to provide the different animals which visiting scientists may want to work on. Very often there is an old boatman who has been there for years and knows more about where and how to get hold of the animals than all the research workers put together.

Apart from the work done by the resident staff and the visiting scientists, a marine station has several functions, of which one of the most important is the educational facilities it provides. This is partly by way of classes held for university students, for schools, for teachers of biology, sometimes for fishermen, and partly by supplying the needs of schools and universities for specimens of animals, alive or dead, to use in their class work. Most marine stations have, too, an aquarium attached for the amusement and instruction of the public.

In peace-time the marine station is at its busiest during the university vacations, when the classes are held and when lecturers and professors of biology come to spend a few days or a few weeks in working on some problem which interests them. This is a stimulating

time for the resident workers. It takes away that feeling of isolation which one sometimes has, and it is very interesting to find out what other biologists are doing at home and abroad, and to pick up hints for one's own work.

If we look through the annual reports of the Millport station we see that visiting scientists worked on a great variety of subjects. But every year we shall find that some of them, perhaps one or two only, perhaps half a dozen, have been working on the egg of the sea-urchin. From the number of papers which have been published, you would think that there was nothing more to be found out about the development of the sea-urchin egg. But not at all! Every year finds somebody with a fresh idea. The truth is that the sea-urchin egg is large (that is, about one-fifth of a millimetre), it will develop easily in the laboratory, and it shows the process of fertilisation and cell division as clearly as a diagram. Now, fertilisation and the division of the egg are at the very beginning of the formation of any living creature, so these processes are of extreme interest to biologists, and all the changes occurring at that time have been studied—the respiration, the heat production, the change in viscosity of the protoplasm, the production of chemical substances, the change in electrical charge, and so on. The breeding period of the common sea-urchin is in spring, and if biologists want to work on sea-urchin eggs in summer they must use those of the smaller green sea-urchin, which is not so common.

Sea-urchin eggs belong to a class of what is called equi-potential eggs, which means that each part of the egg is capable of developing into a complete larva. It is possible to separate the first two cells formed after the first division of a developing sea-urchin egg, and to keep them separate, either mechanically or by leaving out one of the constituents of sea water essential for this process. Each will then develop into a half-sized,

but complete larva. The same happens if you separate the cells at the 4, 8, or 16-celled stage. Beyond this the cells are so small that though there is an attempt to make a complete larva, there is not enough material for the attempt to be successful.

Many eggs are like this, but many are quite different, and if you divide the egg at the two-celled stage then two full-sized half-larvae develop. The fate of each portion of the egg is apparently fixed from the beginning, and if you cut out one small piece the animal lacks an eye or a limb. Of course, in the first type of egg differentiation must eventually take place, but at a much later stage than in the second type.

An example of the second type of egg is found among the sea-squirts or ascidians, curious sac-like organisms found sticking to rocks, whose early development shows that they are rather closely related to the vertebrates. In the summer of 1939 a Belgian zoologist came to Millport to work on ascidian eggs. He wanted to find out exactly which bit of the egg developed into which bit of the fully grown animal, and for this purpose he used to inject a tiny drop of dye into the bit of the egg he wanted to study—the ascidian egg is about the same size as the sea-urchin egg. He also cut out small pieces of one egg and grafted them on to another, sometimes simply giving one egg's front end another egg's hind end, but sometimes making an egg with two front or two hind ends, or two misplaced quarters. Unfortunately the war broke out before he had finished his experiments.

Other work has been done on the life-histories of various worms, molluscs, and jelly-fish, the breeding of midges in shore-pools, the composition of the body-fluid of marine animals, the pigment in fish eyes, and on many other subjects.

The resident workers at a marine station have almost all their time for research work and can tackle long term problems which may take two or three years to solve. They are there all the time and can study seasonal changes and variations from year to year in a way impossible for the vacation time worker. Very often several marine stations will be working on the same problem, for it is always useful to have comparative data from different places. Thus the seasonal changes taking place in the plankton, and their relation to the physical and chemical changes in the sea water has been a fertile subject of research at almost all marine stations, Millport included.

The Government has set up marine stations of its own, at Aberdeen for Scotland, and at Lowestoft for England, and while the private marine stations usually do work on the more fundamental problems, the Government stations study the life-history and development of the food-fishes, the best means of catching them, the annual variations in the fisheries, and such work of a more directly practical nature. For instance, the problem of over-fishing has occupied them for many years.

At the end of last century there were two opinions current; one set of people believed that there could not be an over-fishing problem, because the number of eggs laid by fish was so enormous that no interference by man could make any difference. The other opinion was that man's interference did make a difference, that there was a real danger of reducing the stock by over-fishing and that something had better be done about it. Events have shown very clearly that the second opinion is the right one. The problem is not a straightforward one, and big advances in solving it came only when methods were developed of telling the age of any fish. Now, samples are taken of all fish caught and their ages determined, so that you know how many 2-year-old, 3-year-old, 4-year-old, and so on, fish are in the catch, and

roughly what the expectation of life is for any year-class of fish.

If you compare the catches from a heavily fished area like the North Sea with an untouched ground such as those which have recently been opened up in the far north you will find the composition of the catch very different. The untouched grounds will have a far larger proportion of old fish, and these will be of poor growth and thin. There has been too much competition for food. Fishing will at first reduce the numbers of large fish, allow more of the small ones to grow up, and on the whole give a better catch. As time goes on, however, and fishing becomes more intense, all the old fish are caught and so large a proportion of the smaller fish each year that the catch consists more and more of small fish. It is this stage which has been reached in the North Sea fisheries. You can see, therefore, that there is an optimum stage of fishing in which enough large fish are taken out each year to let the young fish develop, and yet not so many that future fishing will be endangered. The pause in fishing during the last war brought some relief to the North Sea fisheries, and when fishing began again the catches were larger and the fish in them larger too. But since 1919 affairs have steadily deteriorated; although the total amount of fish landed may have gone up, that is because of the greater number of boats, the increased efficiency of the gear, and the exploitation of fresh ground. The catch per hour's fishing has gone down.

There are two main causes for this: first, the fishing falls too early in the fish's life, and second, there is too much fishing. For some time the Government tried to regulate the first by making a limit of size below which fish could not be sold. This was only partially successful, for the trawl is a very destructive instrument of fishing, and a great many undersized fish were caught, simply to be thrown away dead. The only satisfactory

method is to increase the size of mesh in the trawl until only marketable fish are caught. Eventually the fishing industry itself got anxious about the situation, and in 1933 the Government passed, with their approbation, an Act by which the Government was given power to regulate the size of mesh as well as the size of fish sold. As you can imagine, with half-a-dozen different countries fishing in the North Sea, there would be great jealousy if the fishermen of one country were allowed to catch and sell undersized fish while the fishermen of another country, fishing in just the same place, were forbidden to do so, and it was not long before the International Council took the matter up. The International Council for the Exploration of the Sea, to give it its full title, is a body composed of the members of the fisheries scientific services from all the maritime countries in Europe. It met once a year to discuss common problems of fishery research. After several meetings on this subject, a Convention was signed in 1937 which follows the lines laid down in the British Act of 1933. Ten nations signed it, though they had not all ratified it before the war broke out. I hope that when the war is over we can begin again where we left off, for it is certainly possible to get international co-operation, even in controversial matters when it is so clearly seen that the object is for the good of all.

The other cause of overfishing—too much fishing—remains to be dealt with, although the war is doing that just at present. That it is possible to limit a fishing is shown by the North Pacific halibut fishery, shared by Canada and America, which had reached the same stage of overfishing and dwindling returns. A close season of three months was instituted, but this had little effect, since as much fishing then took place in nine months as there had previously been in the whole year. Therefore a limit was fixed to the amount of fish which could be landed in one season, and with the reduced intensity of fishing the stock began to build itself up again. Indeed,

the fishermen can now catch the permitted total in five months instead of nine. This is a startling proof of the recuperative power of a fishery and shows how foolish it is to be greedy and try to get the biggest possible catches out of a fishery.

There are altogether in Europe fifty or sixty research stations, not all marine stations, since some are situated on lakes or ponds to study conditions in fresh water. Some of them are founded to study particular problems, such as oyster culture.

The first to be founded, and perhaps the most famous of all, is that at Naples. Its founder, Anton Dohrn, was a German biologist, whose ambition it was to provide a kind of marine university, a place where any research worker could go and find the animals he wanted, as well as a staff of scientists competent to help him in his work. The building began in 1872 on a beautiful site in the Bay of Naples, and was finished in 1874, after many delays and difficulties. In it Dr. Dohrn sank all his fortune, but this did not meet the entire cost, the balance being raised by outside contributions. Eventually the station became self-supporting. One method of raising the necessary income has been adopted by many other marine stations, that of renting "tables." A "table" really means the provision of facilities for a research worker for one year. Tables cannot be rented for less than one year, and the cost is high, £100 per annum. This means that they are rented mainly by state or educational authorities, such as universities, and are a more or less permanent source of income. The Naples marine station was the Mecca of all marine biologists, and I hope that when peace comes it will re-open as before.

Norway is a country which is populated mainly in a narrow strip between the mountains and the sea. The people are naturally seafarers, and perhaps this is why they are so go-ahead in fishery matters. I should like

to tell you of one scientific discovery which, taken up at once by the fishermen, led to a whole new industry.

Professor Johan Hjort teaches in Oslo University and is well known for his marine research work. In his early years he came to work in Scotland under Sir John Murray on the collections made by the Challenger Expedition, and he has taken an active part in marine work ever since. In 1897 he was engaged in experimental fishing with fine-meshed trawls, and he found that, scattered about in the depths of the fjords, there were patches of very soft muddy bottom inhabited by a large population of prawns. These prawns are edible, and Professor Hjort suggested to the fishermen that they might try to fish them commercially. After a good many experiments he evolved a suitable net, a kind of trawl, and the fishermen soon began to find it a paying proposition. They themselves explored the fjords all round the coasts of South Norway and found that this particular type of bottom was very widespread, although it occurred in only small patches. On all these patches prawns were found and the fishery expanded rapidly from 405 tons in 1908 (returns were not made earlier than this) to 3387 tons in 1935. This was in Norway alone, but Sweden and Denmark had soon copied Norway and now have rapidly expanding prawn fisheries of their own. A large proportion of the prawns is exported, many to this country.

But in the last few years before the war signs of over-fishing were apparent. In spite of improved gear the individual catches were falling off, particularly on the older grounds, although the increasing number of prawn fishermen and the discovery of fresh grounds allowed the total catch to go on increasing. This, as we have seen, is a dangerous stage to reach in any fishery, and the marine biologists who had all along kept in close touch with the fishermen were able to suggest a remedy, namely, that the size of mesh of the trawl

should be increased, so that the smaller prawns should escape capture. There is a very curious feature in the life of the prawn which was discovered only after prawn fishing started. It was early noticed that the male prawns were all small and the female prawns all large, and it was then supposed that the wastage of the large number of small prawns which were caught in the nets did not matter since they were only males and would not grow any bigger anyhow. But on studying the life history it was found that all prawns in their first season, or sometimes in their first two seasons, were males, but that after that they turned into females and functioned as females for the rest of their lives. The wastage of the small prawns, therefore, did matter very much, for this was the stock on which the fishery depended, which was going to become valuable in subsequent years when they had turned into large females. A number of experiments were carried out by Professor Hjort and his collaborators on the best size of mesh to use. It was found that with a net of 36 meshes to the ell, the number of prawns caught was smaller than with a net of 40 meshes to the ell, but that the value of the catch remained much the same, because there was a greater proportion of large prawns. With a still larger mesh, 32 to the ell, the proportion of large prawns was still greater, but there were fewer of them, so that the value of the catch had decreased. It was therefore recommended that 36 meshes to the ell should be fixed as the lower limit of mesh size, but that was in 1938, and we do not know what has happened since.

This is a case where fishermen and scientists worked together from the beginning. In 1936 Professor Hjort was invited by the director of the big marine station at Woods Hole, in the Gulf of Maine, to go for a cruise there on the American research vessel. Now, Professor Hjort had been thinking that the same type of bottom in different parts of the world might be inhabited by similar types of animals, so he took with him, not

only the prawn trawling gear, but also an experienced prawn fisherman, Skipper Hagbert Hoiium, with the happy result that several suitable areas were located, prawns were found, and a prawn fishery was begun in the Gulf of Maine.

When my colleagues and I were in Norway in 1939 Professor Hjort invited us to go prawn fishing in the Oslo fjord with himself and Skipper Hoiium and we had a most interesting day. We had done a little fishing ourselves in the Clyde area, where there are large patches of soft muddy bottom, and had found prawns, although we had not the proper gear and did not know if they were present in numbers large enough to make fishing worth while. Professor Hjort was much interested and even offered to bring his boat and Mr Hoiium over to Scotland the next summer for an exploratory cruise in the West Coast lochs. But then war broke out and made all such projects impossible.

When war came we all had an idea that we should be taken away from our ordinary work and put on to something of more immediate importance. This did happen in some cases, and of course many of the younger members of the staffs of marine stations are now serving in H.M. Forces, but many of us were left undisturbed to get on with our ordinary work, and we began to look round for something more directly useful to do.

About two years ago I told you of an experiment we were starting, financed by Imperial Chemical Industries and in collaboration with two zoologists from Edinburgh University, on the effect of adding fertilisers to a small dammed-off loch on the west coast, Loch Craiglin. Although our hopes of adding to the nation's food supply during this war have faded, yet the experiment itself has been fairly successful, and we have shown that flounders will grow at a greatly increased rate in fertilised water.

Our original intention was to grow plaice and oysters, and you may remember that we intended to mark a large number of young plaice and release them in Loch Craiglin. We met straight away with two difficulties, first, that it was very difficult to get small plaice of the size we wanted, and secondly, that, having put the fish in, it was very difficult to get them out again. Loch Craiglin proved to be rather unsuitable for plaice, having a very soft muddy bottom, and also, although small plaice were very difficult to get in large numbers, small flounders were comparatively easy, so we changed over and made our main fish species the flounder. The process of marking them was also found to be rather injurious and to retard their growth, so we have mostly given that up and simply try to catch enough fish at frequent intervals to give a fair sample for growth measurements. When we compare the growth of the young flounders in Loch Craiglin with the growth rate in the Baltic, where flounders have been carefully studied, we find that at the end of two years in the fertilised waters of Loch Craiglin they have reached a size attained by Baltic flounders only in five or six years.

Owing to special conditions in Loch Craiglin oysters did not grow well there, although they did grow very well in other places close by in Loch Sween.

The effect of the fertilisers on the plant and animal plankton was also studied. The reaction of the very smallest plant organisms, the mu-flagellates (so-called because each is only a few thousandths of a millimetre in size) is the most rapid, that of the larger plankton plant is rather slower. No relation can be made out between the fertilisations and the animal plankton, but the animals flourish only when the plants on which they feed are abundant. In early summer fertilisation has no effect on the plankton at all, and this is because at that time there is a great growth of green seaweeds round the edge of the loch and these use up the fertiliser so quickly that nothing else can benefit.

The experiment is still going on, and has been extended by our colleagues to take in another arm of Loch Sween, Kyle Scotnish. This is not dammed off, but it has been found that the fertilisers added, nitrate of soda and superphosphate, are so rapidly taken up from the water that damming is probably unnecessary.

In 1941 Dr. J. E. Harris, of Cambridge University, came to settle at the Millport laboratory to work for the Iron and Steel Institute on anti-fouling paints. Those of you who have had anything to do with boats will know how quickly organisms settle on the hull of a boat once it is in the sea, seaweed, barnacles, worms, mussels, and still worse, boring shellfish. These creatures grow rapidly, and after a while the speed of the boat through the water is much reduced by the resistance of these myriads of small projections. The boat then has to be taken out of the water, scraped and re-painted. Animals grow even more quickly in tropical waters, and altogether it becomes a serious problem in war-time, not only for naval vessels, all of which are needed all the time, but also for cargo ships, for which a quick turn round in port is essential.

There are ways of preventing or lessening this growth. Copper is very poisonous to plants and animals, and many small wooden boats, such as yachts, have their hulls sheathed in copper below the waterline. But you cannot sheath a steel or iron hull in copper because there is an electrolytic action between the two metals which sets up corrosion. In any case it would be impossibly expensive. So, immediately after being scraped and cleaned, the hull is painted, first with an anti-corrosive paint as groundwork, and then with a special anti-fouling paint. There are a great many of these paints on the market, but very little is really known about their action and efficiency. Most of them contain either copper or mercury as a poison, both metals now scarce and difficult to get.

Dr. Harris set to work to study the subject from the foundation, to find out what organisms settle first, what conditions are most suitable for the settling of the different creatures, how quickly the poison washes out of the paint, and how long it takes before it disappears altogether, making the paint valueless, and if any organic poisons could replace the two metals—copper and mercury.

There is a large raft anchored close beside Keppel Pier, and from it are suspended not only a number of steel plates to represent the plates of a ship's hull, but also innumerable glass microscope slides painted with different paints in different ways. The work has grown, and there is now a team of biologists, chemists, and laboratory assistants working. They have recently developed a very delicate and accurate way of measuring copper and mercury in solution, and have carried out many hundreds of estimations to find the rate at which these poisons wash out into the sea.

In 1940 it struck Dr. A. P. Orr that agar-agar, being almost entirely a Japanese monopoly, might soon become scarce or even impossible to get owing to the shipping situation. He therefore began to look for a substitute among our own seaweeds. Japanese agar, at least the best variety, is made from the red seaweed *Gelidium*; varieties not quite so good are made from *Gracilaria*, and in Russia some is made from *Ahnfeltia*. All these are red seaweeds, that is, they belong to the order *Rhodophyceae*, and contain a red pigment in their cells, although this is often masked by other pigments so that to look at them growing on the shore you would call them brown, or brownish-red, or even yellow, rather than red.

Dr. Orr soon found that the same seaweeds growing on our own shores, *Gelidium*, *Gracilaria*, and *Ahnfeltia*, gave a good agar, but unfortunately these seaweeds were very scarce round the Cumbraes, and on

enquiry from other botanists and marine stations it appeared that they were very scarce all round Great Britain. There was one red seaweed common on the shore which would give a jelly, though an inferior one, and Dr. Orr was wondering whether it was worth while going further with this when I finished the bit of work I was at and offered to join him. Since then we have worked together on producing a suitable jelly from this *Gigartina*, and have met with some success.

Japanese agar is obtained simply by boiling up the seaweed with water, when a thick jelly comes out, and the remains of the seaweed are strained off. The jelly is allowed to set, cut up in strips and exposed on a frosty night. It freezes solid, and then, when it thaws next day, most of the impurities run away with the thaw-water. This method of manufacture explains why the Japanese word for agar means cold sky, and why the price used to vary with the weather, being high in a mild winter and low in a hard winter.

The strips are then dried and sold as strips, or else ground and sold as powder. In a good agar a stiff jelly is formed in 1½-2% solution, and this jelly, when allowed to set in a sloping test-tube and then stood upright, will maintain its slope at blood-heat. There is a big gap between melting and setting points. To melt the agar, it must be heated up to about 85°C, but it does not set again till cooled down to about 35°C. It is essential in medical work, for bacteriologists use it to grow bacteria on. They combine it with various nutrient fluids and it forms a solid substratum on which the bacteria can multiply to form distinctive colonies, each type of bacterium being recognisable by the type of colony it makes. Bacteriologists use agar, not only in medicine but for testing the purity of various food stuffs, such as shellfish or milk. Besides this, agar is widely used in industry—in bread, in ice-cream, in meat pies, in cosmetics, in textiles, in photography, and a dozen other ways.

Needless to say, the use of agar just now is restricted to bacteriological work.

The jelly which is produced on boiling *Gigartina* is a much softer and stickier jelly than true agar, but after various simple treatments it can be made much stiffer and less sticky, nearly as stiff as Japanese. One difficulty is that it melts at a much lower temperature so that there is less of a gap between melting and setting point. This, however, is not an insuperable objection to bacteriologists, and some of them have reported quite favourably on British agar.

The next thing was to get it produced on a commercial scale, and the Ministry of Health found an enterprising firm near London who were willing to do so. Making agar in a small way, from half a pound of seaweed in beakers and pails in the laboratory was, we found, a very different matter from making it in a full-size factory with vats and sterilisers holding hundreds of gallons, and yards and yards of steel piping liable to be completely blocked if the agar jellied in the wrong place. Various troubles developed, the plant was at first not quite suitable, and the firm in addition was busy making another war-time product, Rose Hip Syrup, so that, as yet, there has been only limited production, although we hope it will begin in 1945.

One of the first things to worry the manufacturers was the question of supplies. They, and we too, of course, were anxious to know if there was enough *Gigartina* round the shore to supply Britain's need of agar. In the summers of both 1942 and 1943 teams of people surveyed the coasts of England, Scotland and Wales to estimate how much *Gigartina* is available. In 1942 Dr. Conway, Dr. Orr and I, with various other helpers were working mainly inside the Clyde, in 1943 we finished off the Clyde by doing Arran and the Mull of Kintyre, and then worked north to Oban, taking in on the way the islands of Islay, Jura, Colonsay, Seil and Luing. Other teams have surveyed Mull, Skye and South Uist. I don't

think it is revealing any secrets to tell you that our own islands, Bute and the Cumbraes, and some other bits in the Clyde estuary, are among the very richest we have struck. Here harvesting began in 1943, an attractive price was offered, and as you probably know, the collecting of this seaweed went on actively from June till September. Even so, there are several rich areas which have not been touched because they are difficult to get at, but we hope that in future all the shores may be properly harvested.

One curious thing we found was that here inside the Clyde, where it is so abundant, nobody was in the habit of using it, whereas on the west coast and on the outer islands, where it is comparatively scarce, many housewives kept a store of dried and bleached weed to use in making puddings. Because of the lime salts in it, milk will set to a firm sort of blancmange when boiled with some Girgantina, and this is a popular dish with children.

In war-time the country always seems to turn to its seaweeds in search of raw material. It was so during the last war, especially in America, and it is so in this war. There is another substance produced from seaweed, this time from the brown weeds, the tangles, the knot-wracks and the bladder-wracks, a substance which is called alginic acid. Before the war the beginnings of an industry were just appearing. Several research workers had been engaged for some years on products made from alginic acid, and they were making silk, and cellophane, and custard powder. Now the business has increased enormously, but the substances they make are shrouded in deep mystery. There is still a lot of research work going on, and I hope that when the war ends seaweed will still have a place among the raw materials of industry.

At anyrate, I hope I have persuaded you that the research work undertaken at marine stations is not a luxury, even in war-time.

BIRDS OF THE SCAR ROCKS.

THE WIGTOWNSHIRE GANNETRY.

By JOHN MORELL McWILLIAM.

(Read 14th March, 1944.)

The Scar Rocks are situated in Luce Bay, almost due east of the Mull of Galloway, and about five miles from land on either side of the bay. They consist of the Big Scar, a precipitous rock about a hundred yards long and about fifty feet high, and several smaller rocks about half a mile away. At the west end of the Big Scar there is a semi-isolated stack which I have heard called the "Castle Rock." As compared with the great bird-rocks everything here is on a miniature scale. My photographs, showing the fine outline, perhaps make the rock appear larger than it really is. The true scale can be seen from the row of Kittiwakes nesting on a ledge of the Stack.

It appears that no one claims private ownership of the Scars. I wrote to Mr Kenneth McDouall of Logan on this point and he kindly replied—"I cannot give you any definite answer on who owns the Scar Rocks. My father used to say that they belonged to Logan, but I have no paper or charter to show that they do. Neither do they seem to belong to any parish. Therefore, I conclude that they are Crown Property." The Marquess of Bute and others have searched on my behalf for references to them in the usual historical sources, but without success. The larger bird-rocks, like the Bass and Ailsa, figure frequently in old documents, but the Scars are much too small for human habitation, and