edible purposes; similarly, there are the black tallows and greases used extensively for soap production.

It has also been suggested recently that it would be more economic to manufacture soapless detergents from petroleum than to embark on very expensive schemes for the clearing of territory for the production of oil-bearing crops, such as the East African Ground-nut Scheme. It is not for me to discuss the economic merits of these alternative projects. I do, however, wish to emphasize, particularly before a society concerned with nutrition, that there is also a great world shortage of protein, and that in growing the ground-nut or similar oil-bearing seeds a great increase in protein production can also be achieved. I should not like to predict the future of the oil-bearing seed. It has been suggested, however, that, whereas up to now the seed has been grown for its oil content and the protein residue has been used for animal feeding-stuffs, the time may come when the protein content may be considered just as important as its oil content.

There is, however, a wider consideration to bear in mind. The standard of living of the peoples inhabiting tropical areas is extremely low, and it is obvious that any improvement in this standard can come only from the development of the territories in which they live. These developments must be agricultural, and can be effective only if broadly conceived. It is our duty to make use of the potentially vast productivity of these tropical areas to improve both the standard of living of their inhabitants and also that of the world beyond them.

Marine Animals as a Source of Fat

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By far the most important marine source of fat is the whaling industry, but the contribution made by fish to the world's fat supply, although much smaller, is by no means negligible. The yearly pre-war whale-oil production was somewhat above 500,000 tons, whereas fish-oil production, excluding that of Japan, was about 160,000 tons, most of it in the United States. Whale-oil production in the 1946–7 Antarctic season was 347,000 tons, and the estimated world production of fish oils in 1947 was 104,000 tons. Before the war whale oil was obtained largely by expeditions from the United Kingdom, Norway, Germany and Japan, although the last named was not a signatory of the International Whaling Agreement. At present, whaling operations are carried out mainly by Norwegian and British fleets, with a very limited, controlled Japanese participation. Fish oil is produced on a large scale in the United States, Canada, Norway and Iceland. Before the war much was produced in Japan; this activity has now recommenced, but so far on a smaller scale.

It is not certain how far production of marine animal oils can be expanded, or even whether it can be maintained at present levels. The whaling industry affords a classic example of the dangers of overfishing. In the early days of whaling the Arctic seas provided the catch. With the development of the harpoon gun and faster and more

efficient whaling ships, the whale population in the Arctic was almost wiped out, and there are now no important operations in that area. In the Antarctic, only international agreement on the limitation of catches has prevented similar destruction of the fishery, and even in the present world fat shortage it has wisely been agreed to maintain a close limitation on the number of whales killed annually. This is at present fixed at 16,000 'blue-whale units', the blue whale being the largest species caught. An average blue whale of 63 tons yields 15–18 tons of oil, whereas an average fin whale of 54 tons yields only 9–11 tons. For purposes of control 1 blue whale is taken as the equivalent of 2 fin whales. The 1946–7 season's catch was quite close to this total, so that no great expansion in whale-oil supplies in the 1947–8 season can be looked for.

Fish oil, as distinct from whale oil, is derived from such species as sardines, herring and menhaden. In many parts of the world such fish are caught deliberately for conversion into oil and meal. In addition, the offal from cannery operations goes to the oil and meal factories. There is little doubt that in some areas considerable development of these fisheries could be achieved, e.g. in South Africa the pilchard fisheries are increasingly being exploited as a source of oil and meal. On the other hand, in some areas the danger of overfishing has been stressed again and again in the light of experience, e.g. in the sardine fisheries of California. In our own fisheries we have, in the herring, the possibility of a very useful development in domestic fat production. Since about 1913 our herring fisheries have been restricted in one way or another, owing primarily to the loss of the former great export markets. Now plans are being pushed ahead, with Government assistance, for the setting up of an oil and meal industry based on the herring catches surplus to the direct outlets as human food. The first full-scale factory under this scheme should be in operation this summer, and others will follow as soon as is practicable.

Most other countries with big herring fisheries have found the production of oil and meal both profitable and essential to the prosperity of the industry. This is true, for instance, in Norway, Iceland and Canada. The Herring Industry Board, which is responsible for the development of such an industry in this country, has planned to convert 175,000 tons of herring into oil and meal in 1951. This should give about 25,000 tons of oil, if 15% is assumed as an average oil content of the fish. In all fatty fish the oil content shows large seasonal variations.

If fishing were to be carried on at the 1913 level, but with the present size of markets for herring as direct human food, the surplus available for reduction to oil and meal would be about 395,000 tons, which would furnish about 60,000 tons of oil. It is most unlikely that fishing will get back to the 1913 level in the immediate future, but these figures give an indication of the amount of oil that could probably be obtained from our domestic fisheries without risk of overfishing. Our herring shoals did not show signs of depletion in the years before 1913, when fishing was very intensive.

It is of interest to compare these figures with the supplies available at present. Since the scheme for the reduction to oil and meal of surplus herring was inaugurated by the Ministry of Food and the Herring Industry Board in 1946, the total production of herring oil in this country has been 500 tons. There are several reasons for the smallness of this amount, chief among them being the absence of sufficient suitable reduction

plant in this country and the suspicious attitude of many of the fishermen. With the present size of the fishing fleet and catching power of a boat, the surplus available for reduction is probably of the order of 70,000 tons, which could furnish about 10,000 tons of oil. Shortage of plant and inevitable delay in building operations will, however, certainly prevent that level being reached immediately. Nevertheless, it is one hopeful feature of our domestic food picture that the herring industry is likely to furnish yearly about 10,000 tons of oil in the very near future and about 25,000 tons of oil by 1951, and that there is a potential yearly supply of up to 60,000 tons if such a development proves economically sound.

As regards suitability for use in edible fats, there is no essential difference between whale oil and fish oils. All differ from the typical land-animal fats, and from the usual seed and fruit-coat fats, in containing large proportions of unsaturated fatty acids of sixteen, twenty and twenty-two carbon atoms, in addition to the more usual unsaturated acids of eighteen carbon atoms. When these marine fats are hydrogenated to give solid fats, their complex chemical make-up is an advantage in such a product as margarine, because it confers plasticity over a considerable temperature range instead of an abrupt melting-point. Similarly, the spreading quality of butter is largely due to the presence of a great assortment of fatty acids with a wide range of lengths of carbon chain. Economically, it is more profitable to hydrogenate whale oil than most fish oils, since the latter are somewhat more highly unsaturated and so require more hydrogen to convert them into fats of a suitable melting range. This point is, of course, of minor importance in the present fat shortage. In a country like Norway, with a large fish-oil production, the margarine is made from about 90% hydrogenated herring oil and 10% hydrogenated whale oil. It is excellent margarine, and affords convincing proof of the suitability of high-grade herring oil for this purpose.

There is another interesting way of using herring oil in human diets, which does not involve hydrogenation. In Norway, herring oil is partially polymerized by heating out of contact with air. The resulting oil has lost its fishy odour and taste, and is much more stable to storage than the original oil. It is used by the Norwegians for frying and baking, as a salad oil, and in the canning of brisling and sild instead of olive oil. More adequate data on the digestibility and physiological utilization of polymerized oil are, however, highly desirable, and until such data are available it may be wiser to concentrate on hydrogenation as a means of converting fish oils into edible fats. Nevertheless, this Norwegian development is a most interesting one, and should not be overlooked.

The traditional methods of recovering oil from whale or fish tissues involve cooking with steam, and the liberated oil either flows away itself, or is pressed out or centrifuged from the cooked mass. In the establishment of a herring-oil industry in this country we have the opportunity of installing the most up-to-date and desirable processes, which may or may not be the traditional ones. This opportunity is not being missed or lost sight of in the urgent need to produce oil as quickly as possible. The Herring Industry Board is charged with the responsibility for developing this new industry here, and is very much alive to this aspect of the matter. In our work at Aberdeen we are giving high priority to research into the best methods of reduction of herrings to oil and meal. I am not free to discuss these experiments at present, but I may say that

we have in mind not only the production of the maximum yield of high-grade oil, but also of protein products suitable for human use, instead of the usual type of fish meal suitable only for use in animal feeding-stuffs.

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The Fat Required for Good Cooking and to make Food Palatable

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As practical cooks we are concerned mainly with serving good food, i.e. food that is nourishing, well flavoured and pleasing to the eye. We maintain that the present weekly fat ration of 3 oz. butter, 4 oz. margarine and 1 oz. cooking fat for one person is inadequate for the presentation of food in an appetizing and attractive manner, if all meals have to be provided at home. Weekly reversal of the butter and margarine allowances does not ease the cook's problem, for there is a tendency to enjoy the extra butter for table use, leaving even less fat for cooking purposes.

The larger the number to be catered for, the easier it is to spread out the fat ration in order to spare a reasonable amount for cooking, and it cannot be too strongly stated that the position of the one- or two-person household, particularly where age, infirmity or expense prevent occasional dining-out, is not enviable. When such households do much cooking there is almost no fat left for table use.

It is true that in many families children, adolescents and adults have at least one meal away from home 5 days in the week in school, canteens, restaurants or hotels. Even so, the extra amount of fat consumed in this way does not bring the present allowance of 8 oz. weekly up to the pre-war suggested amount (Hutchison & Mottram, 1936; Macdonald, 1938; Plimmer, 1941) of 3–4 oz. fat daily (made up of visible and invisible fat), even with the invisible fat obtained from the present ration of meat, bacon, eggs, and the visible fat from suet, oily fish, nuts, peanut butter, oils and soya flour. Most housewives will now make use of the trimmings of fat from the meat ration, fat from bacon, fat from sausages, and skimmings from bone stock, but it takes an expert cook to turn these small amounts to good use. Suet is difficult to get, and olive oil and almond oil, occasionally seen in the shops, are exorbitant in price.

Those concerned with large-scale catering generally maintain that ordinary non-priority canteens in category C also find the fat ration inadequate, but that for industrial canteens in categories A and B the fat allowance is sufficient for the preparation of varied, nourishing and attractive meals. Where a fish fryer is installed matters are much easier. The extra ration of cooking fat then allowed makes it possible for a great variety of dishes to be presented. Not only is the food value of the dishes increased because of the small amounts of fat absorbed from the cooking medium, but the food has a