can be said of this warped and distorted philosophy is that man is given a more potent if not a higher place than in some other terrestrial philosophies.

The recent revival of mechanical conceptions of society are perhaps a reflexion of the instability and lack of conscious political purpose of a world society in which economic factors and modes of physical contact are establishing a new segregation of population, and in which time-distance has so largely replaced linear distance.

If there is any validity in these reflections on the present condition of geographical study, it becomes evident that some changes in principles and methods are called for. The restoration of man and his mind to their proper sphere as purposive and active elements rather than passive agents, is beginning to appear in some kindred sciences such as physics and

biology. Dr. Isaiah Bowman has written of the "timeless creative experiments" which man is participating in, and geography as one of many forces which are involved in it. Man appears in the world but is not altogether of it. As a tool using animal he gave expression to powers and forces not hitherto known to Nature, and if he remains still part of Nature he carries some evidences of spiritual resources which Nature may utilize, but she cannot endow him with them. Let the argument start from the spiritual ancestry of man rather than from his animal origins, put human will and aspiration and effort first, and the terrestrial domain second—it is after all underneath our feet if we stand up—and the old premises which have clamped us down so long must vanish, and maybe a new birth will be given to a most ancient part of knowledge.

MARINE ANIMAL OILS OF CANADA

BY PROF. T. P. HILDITCH

UNIVERSITY OF LIVERPOOL

THE varied and abundant fauna of the rivers of Canada and especially of the Atlantic and Pacific Oceans on the eastern and western shores of the Dominion form an important section of its natural resources. Canadian salmon, pilchard and cod are well-established edible commodities, but it is perhaps less widely known that in recent years the Canadian production of fatty oils from the flesh, livers, or other specific parts of certain fish and marine mammals has greatly expanded, whilst the quality of the oils is generally of a high standard owing to the increasing use of plant and conditions of extraction in accordance with the results of modern research on the chemical and technical properties of marine animal oils.

Up to the present the fish oils which have been most largely produced in Canada are from pilchards, herring, salmon, cod and halibut. Pilchard and salmon oils are extracted in quantity on the Canadian Pacific coasts, herring oil mainly on the Pacific, but also on the Atlantic shores, whilst halibut is taken from both oceans, and cod mainly but not entirely from the Atlantic side. The total annual fish-oil production of British Columbia varies from 2.5 to 4 million gallons per year, of which pilchard oil usually provides 1.5–2.5 million gallons; the Canadian annual production of cod liver oil of all grades is usually more than 150,000 gallons, although this is only 25–35 per cent of the amount of this oil produced in Newfoundland. There are, however, oils from a large number of other species of fish—coalfish, rockfish, rays, grayfish, ratfish and others as well as the more familiar ling, hake, mackerel or haddock—from which fatty oils could be produced in quantity. Again, more than 500,000 gallons of whale oil are made annually from whales taken off British Columbia; nearly half this output is from sperm or toothed whales, the rest from the baleen whales; seal oil is obtained in less amount (50,000–70,000 gallons per year) on the Atlantic coasts, and porpoise and dolphin oils, although not in much demand, could be obtained in quantity since these members of the Delphinidae are plentiful off all the coasts of Canada.

Marine animal oils differ to quite a large extent in composition, although there are fundamental similarities in the kinds of fatty acids present in the form of glycerides or wax esters. Those of the cod or halibut liver, herring, salmon or baleen whale flesh, and many others are all comparatively similar, especially in containing major proportions of glycerides of highly unsaturated fatty acids with 20 or 22 carbon atoms in the molecule; but even in this group there are well-marked differences in the general proportions of the component fatty acids which seem to be mainly determined by species—perhaps also by dietary and other factors. Some of the other oils which have been mentioned differ more radically in chemical composition. Those of the sperm whales are largely wax esters and not esters of glycerol, the alcohols in combination with the mixture of fatty acids being largely cetyl, $C_{16}H_{33}(OH)$, and oleyl, $C_{18}H_{35}(OH)$. Ratfish liver oil seems to consist to a very large extent, not of glycerides, but of fatty acid esters of complex ethers of glycerol with a higher fatty alcohol. The Delphinidae oils contain large amounts of *iso*-valeric acid in conjunction with the more usual kind of higher fatty acids, in the form of mixed triglycerides. It is natural that such variation in composition should afford scope for a variety of technical uses.

Probably, however, the most interesting of the fish oils at present are those which are found to be exceptionally rich in the fat-soluble vitamins. Halibut liver oil and, still more, the visceral oil, are well known in this connexion, but this is by no means the only instance. The production of exceptionally vitamin-rich fish oils, which serve as a valuable source of vitamin-A concentrates for incorporation in edible fats, is one of the most important fish-oil industries to-day. Although unsuitable *per se* for margarine or soap manufacture (by reason of odour and of proneness to atmospheric oxidation), fish oils and, more particularly, baleen whale oils, are converted by hydrogenation into more stable fats of high quality. But a number of other uses have been found for these oils, some of which may be less familiar. In contrast to their nutritional values, fish oils and their soaps

find considerable use as toxic agents in insecticides, especially in fruit growing; the applications of these oils in the leather and textile industries are probably better known than the growing use of hydrogenated fish oils in the manufacture of tinsplate; they can be transformed into rubber substitutes as well as into varnishes or linoleum.

The wide range of utility of the marine animal oils, potential as well as actual, is extremely thoroughly covered in a recent Bulletin edited by Dr. Brocklesby*; but the work can be commended for other reasons which will appeal to readers of NATURE. Instead of being limited to the purely technical aspects, the discussion of the latter is based entirely upon the fundamental chemical and physical properties of the fats, which are dealt with so adequately that the book forms a remarkably complete guide to the

* The Chemistry and Technology of Marine Animal Oils with particular reference to those of Canada. Bulletin 59 of the Fisheries Research Board of Canada. Edited by Dr. H. N. Brocklesby (Chief Chemist, Pacific Fisheries Experimental Station, B.C.). Pp. 442+74 figures. (Ottawa: Fisheries Research Board of Canada, 1941.) 2.95 dollars (paper), 3.80 (cloth) net.

chemistry of fats as a whole. Moreover, the component acids and glycerides of the marine animal oils are considered in the light of modern research in this field (to which the chemists of the Pacific Fisheries Experimental Station have made their own contributions) and not solely with reference to the technically useful, but otherwise often uninformative, 'analytical characteristics' such as iodine values, specific gravities, etc.

The late Sir William Hardy, first director of Food Investigation of the Department of Scientific and Industrial Research, planned that the work in his research stations should involve equally the technical applications of science and the fundamental principles underlying these applications—a tradition which is still followed by the Food Investigation Board. It is evident that the balance between 'pure' and 'applied' science is similarly maintained by the Canadian Fisheries Research Board; in consequence the monograph now published will be read with as much interest and benefit by other scientific workers as by the technologists for whom it is primarily intended.

ELECTRIC HEATING OF BEEHIVES

THE British Electrical and Allied Industries Research Association has issued a preliminary report, by its director and secretary, Mr. E. B. Wedmore, describing experiments on the heating of beehives*. It also describes the construction and preliminary testing of certain units for keeping beehives at any required temperature. Tests are to be made shortly at the Rothamsted Experimental Station under working conditions on a large scale.

In Nature, the heat required by a colony of bees is produced by the consumption of honey. This is an expensive fuel, and might be helped out and controlled to advantage by the use of electricity. Many observations of temperatures within the hive in relation to the life and requirements of the bee have been made, and the craft has turned in the direction of controlled heating of hives. The aim of the present report is to bring the problem into perspective and to record some preliminary observations on effects within the hive of changing external temperatures and conditions, and of the use of certain heating units.

In obtaining figures of convenient magnitude, and in considering electric heating, it is convenient to measure all energy in electrical terms. The complete combustion of 1 lb. of an average honey with an average water content represents two watts for one month, and honey in the hive may be taken as being worth 6d. per lb. (If removed, extracted, strained, bottled, packed and carted, it may be worth, say, 1s. 4d. wholesale.) Thus the production of heat by the complete combustion of honey costs 3d. per watt per month if the efficiency is 100 per cent. The heat is, in fact, produced by the bees deliberately performing mechanical work, and while the oxygenation is probably fairly complete, there is wear and tear to be made good as well as shortening of the bees'

life, so that the actual cost per watt per month to the beekeeper must be higher, but most probably less than twice 3d.

If sugar is used, the heat of combustion is about doubled, but if reduced to syrup by adding water, this additional water content has to be dealt with. The physiological loss is greater and the syrup has to be prepared. Taking the sugar syrup at 6d. per lb. of sugar including labour and wastage in storing, the cost per watt per month will be between 1½d. and 3d., not allowing for maintenance of and interest on the cost of apparatus.

Electrical energy could be substituted for honey consumption only if the heat be provided at the right time, the right place and in the right quantity. Assuming 100 per cent efficiency in each case, we have then for the cost of 1 watt per month: (a) by consumption of honey in the hive at 6d. per lb., 3d.; (b) by consumption of sugar in the hive at 4d. per lb., 1½d.; (c) by use of electrical energy at 1d. per unit, ¾d. It is clear, therefore, that there must be some definite additional indirect gain if heating by electricity is to be justified, the cost of the equipment must be low and the technique of its use simple and efficient.

With the commencement of frosts in October, breeding is greatly reduced, and it ceases in December or earlier. Bardenbacher's tests suggest that brood raising may be advanced about three weeks by appropriate heating in the spring season, and one such advanced colony may well do the work of two. It is pointed out that in spring there are good hopes of stimulating brood raising by making it easier for the bees to maintain the requisite temperature, especially at night and in cold periods, and at the same time reduce the indirect losses caused by condensation of moisture.

Data as to the thermal properties of a hive and its contents are given. The hives are usually constructed of cedar or firs of varying quality, and some are painted. Probably reduction of forced movement of

* British Electrical and Allied Industries Research Association Technical Report, Reference W/T5: Electric Heating of Beehives—Preliminary Report. By E. B. Wedmore. Pp. 19+5 plates. (London: British Electrical and Allied Industries Research Association, 1941.) 3s. 6d.