in 1933. He acted as Vice-Chancellor in 1941 and was elected for his first term of Office in 1942.

The first term of Office recently completed by Sir Lakshmanaswamy is noteworthy for the great interest which the Madras University took in fostering Technological Education in South India. The importance of Technical education so as to train suitable personnel for industrial work has been stressed in our columns from time to time. Chemical and allied industrial development has been particularly backward in South India owing mainly to the absence of suitably equipped training centres. With his characteristic zeal Sir Lakshmanaswamy took up this cause and succeeded in enlisting the support of the Government and a leading Industrialist, Dr. Alagappa Chettiar, with the result that it was possible, with the co-operation of the Government Engineering College at Guindy, to open a College of Technology in 1944. This College began with courses in Chemical Engineering and has already developed further with arrangement for courses in Textile and Leather Technologies, subjects of special interest to industrial development in South India.

Among the other achievements of the Madras University during this period, particular attention should be drawn to the starting of new graduate courses in Commerce and in Nursing, and to the organisation of short-term post-graduate courses for the Medical Profession.

In the various reconstruction programmes for this country, Sir Lakshmanaswamy has already put in much notable work on the Health and Survey Committee of the Government of India, as the Chairman of the Educational Reconstruction Committee of the University of Madras and as Member of many of the Committees constituted by the Government of Madras. Our very best wishes go to him for the success of his future work and the continuation of the sound and energetic policies on Educational and Medical problems that have so characteristically come from him.

ECONOMIC UTILISATION OF SHARKS IN INDIA

BY

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SHARK LIVER OIL industry in India to-day represents one of the war-born industries, whose survival capacity during the post-war period is solely dependent upon the extent of support which the industry would receive from the Central Government. The industry when consolidated and developed would not only afford employment to tens of thousands of fishermen but also provide a supplementary and desperately needed source of nourishing meat and a rich and exclusive source of an indispensable group of vitamins; in addition, other portions of the carcass now discarded could be made to yield a wide variety of valuable products: hides, active principles, biologicals and fine chemicals. As in the case of herds of cattle and flocks of sheep, the sharks need not be raised; they breed naturally in the depths of the coastal waters of this sub-continent; controlled fishing and scientific management of sharks will ensure a steady supply of this raw material. The sharks, if properly utilised, will serve to conserve the cattle wealth of the country, which has got depleted to an alarming extent during the war period. These are circumstances of compelling significance which entitle the industry to every form of Government support and protection.

In consideration of the national importance of the industry, the Central Government may be expected to grant adequate protection against aggressive foreign competition and extend generous financial support for the prosecution of researches on the fundamental and technological aspects of the industry.

At the moment, the shark liver oil industry, which has made some promising headway during the war, is overshadowed by the complacency, the uncertainty and the indecision which constitute a lamentable feature of post-war planning in this country and by the imminent commencement of the whaling operations by Anglo-Norwegian interests as revealed by a recent broadcast. The threatening aspect of this enterprise becomes apparent if attention is called to the recent discovery that the whale liver is the richest source of "Kitol" which on simple distillation gives vitamin A; This is a direct challenge to the shark liver oil whose recognition as one of the richest sources of vitamin A is largely due to the pioneering investigations of Dr. Sunder Raj and his collaborators.

Since 1940, the Departments of Fisheries in the several maritime Provinces and States have intensified their efforts and achieved a substantial measure of progress in the production of shark liver oil; some of them have also investigated the process of filletting and curing the edible portions of the shark by improved methods. We have not been able to secure reliable data ragarding the annual production of shark liver oil in the country; much less have we been able to obtain information with regard to the total number or weight of sharks caught from the coastal waters of India. Setna[1] (1945) is of the opinion that during the past 4 years an output of a million and a half pounds of oil may not be an extravagant claim. Considering the widespread prevalence of night-blindness and general malnutrition in this country, and assuming that an average deficiency (computed on the entire population) works out to about 20 per cent., the country's requirement of shark liver oil of 10,000 I.u/per gm. potency, will amount to about 28 million pounds per annum. Taking 100 lbs. of liver as the average yield per shark, and assuming that 50 per cent. is the average yield of the oil, it can be calculated that 576,000 sharks will have to be caught per year to satisfy the urgent human requirements of vitamin A; we have not taken into account the vitamin A deficiency which is believed to be alarmingly widespread among our cattle.[2] Whether our seas could sustain this rate of depletion of sharks, is a point on which expert opinion will have to be elicited.

The total weight of the catch will amount to 576,000 × 1,500 lbs., *i.e.*, 432,000 short tons. The utilisation of the carcass would thus present a problem of considerable magnitude and economic value. The shark, as indicated before, provides, in addition to the oil, other exploitable products. We could not get at any data pertaining to the relative weights of the various organs and tissues which could be obtained by dressing the carcass of a shark. One of us (I.M.G.) has taken up a study of this question and preliminary studies have revealed that the following percentages (Table I) of the more important organs and tissues could be obtained. We have not been able to obtain data with regard to the ductless glands, which might ultimately prove important sources of hormones. We understand that Dr. B. B. Dey, who has done pioneering work in this field, is already engaged on this problem.

TABLE I

Percentages on the body-weight
(All weighings with fresh material)

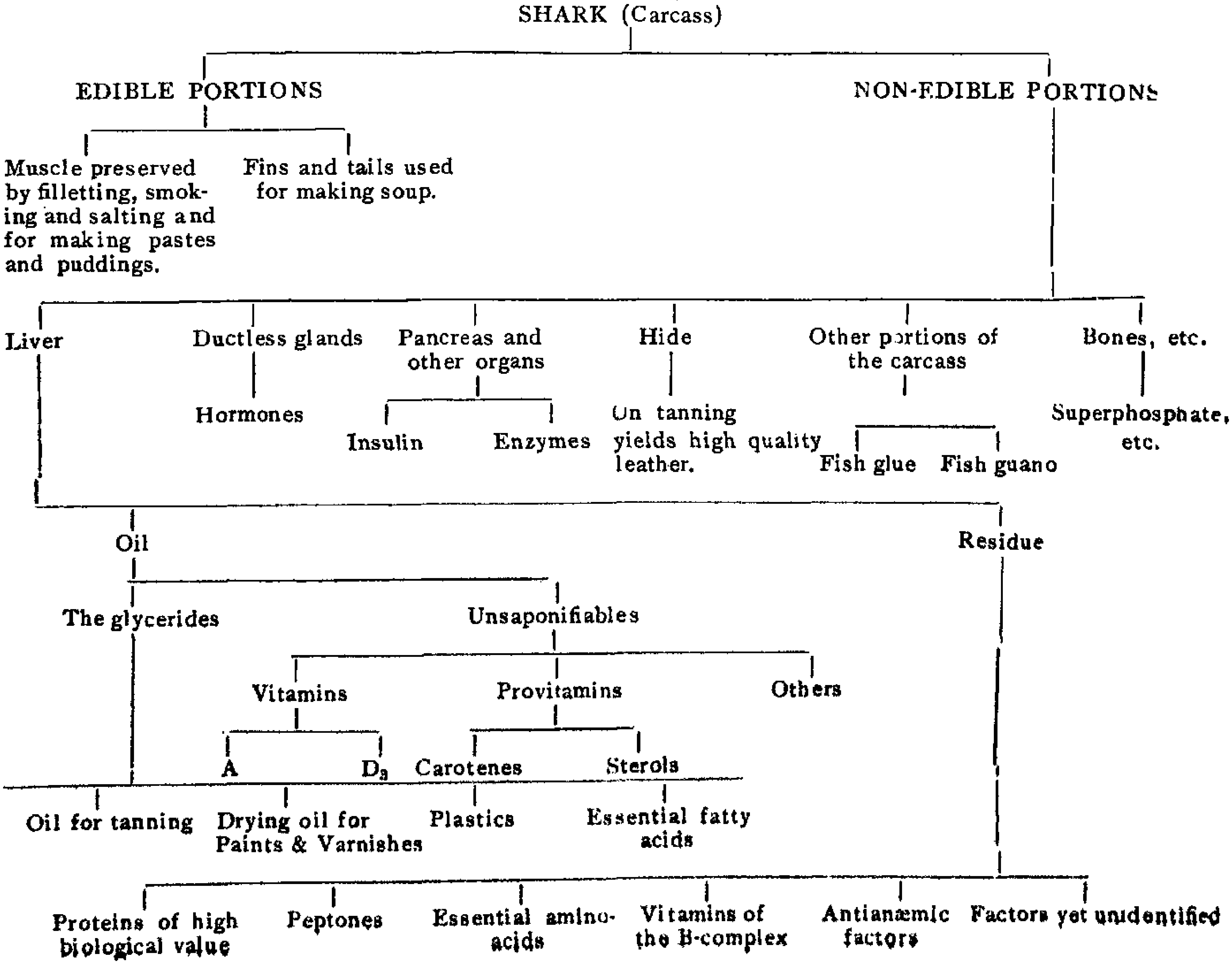
Muscle	45·2	Stomach	2·2
Hide	12·9	Intestines	1·0
Head and Bones	24·2	Blood	0·8*
Fins and tail	6·1	Pancreas	0·32
Liver	3·3	Heart	0·12
		Kidney	0·03

*Obtained by bleeding

It will be seen that the annual catch of sharks amounting to 432,000 short tons would give not only the oil for which they are now fished but also considerable quantities of byeproducts which could be processed into a variety of useful materials. The accompanying chart (Table II) will serve to illustrate the scope of these byeproduct industries. Nutritious meats of high biological value from muscles (shark flesh pastes and puddings), hides of exceptional quality and strength, glues and gelatines from fleshings and sinews, proteins, peptones and amino-acids from nitrogen-rich organs and tissues, hormonal extracts from ductless glands, antidiabetic harmones from the pancreas, and vitamin rich concentrates of high antianæmic value from the liver, represent the more important groups of products which portions of the shark carcass (at the moment mostly discarded) could be made to yield.

The meat consisting principally of the muscle of the sharks and the rays, especially those with black-tipped fins, *Carcharinus limbatus*, *Carcharinus bleekeri*, is now being utilised. Small-sized *Carcharinus melanopterus*,

TABLE II



Sphyrna zygœna and *Carcharinus menisorrach* are consumed fresh and are generally administered to women after child-birth. Setna[1] (1945) has recorded that shark flesh is at present being filletted and salted in the fish-curing yards all along the coasts of Bombay and Madras. The product is said to find a ready market in the interior. Recently smoking of shark fillets has been undertaken and the process has been found to give a satisfactory product. Even the fins and the tails of the larger varieties of sharks are considered edible when made into soup; formerly large quantities of this material were being exported to England, Germany and China.

The skin of the shark can be tanned to an extremely useful leather[3] (1922); at the moment, there does not appear to be any organised attempt in this country to utilise this valuable byeproduct. Cameron[4] (1937) has recorded an exceptionally high content of iodine (1·160 per cent.) for the desiccated thyroid glands of certain fish. The possibility of manufacturing potent preparations of insulin has been suggested; many fish possess pancreatic glands which have been found to contain exploitable quantities of this invaluable hormone. According to Tressler[5] (1923) various species of sharks have been examined to determine their relative value as potential sources of insulin. The shark has been found to contain this active principle in a form which can easily be extracted. In these directions, practically no work has been carried out in this country.

We have completed a piece of investigation directed towards the utilisation of the liver residues of the shark as a source of peptones and amino-acids on the one hand, and on the other, of the vitamins of the B-complex, anti-anæmic factors and other physiologically active principles. With regard to the other organs practically no work has been carried out; it is of utmost urgency that work in this direction should be extended immediately; it will serve to lay the foundation for the establishment of a chain of interdependent industries, which together, would contribute towards the stabilisation of the shark liver oil and allied industries.

1. Setna, *J. Sci. Industrial Research*, 1945, **3**, 303. 2. Fernandes, *Indian Farming*, 1940, **1**, 591. 3. Rogers, *Practical Tanning*, 1922, page 574. 4. Chr. Bomskov. *Methodik der Hormonforschung*, Bd. I, 1937, page 311. 5. Tressler, *Marine Products of Commerce*, 1923, page 693.

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STORAGE OF FOODGRAINS

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In normal times, the supply and demand for foodgrains and their products could be so adjusted as to entail the holding of minimum stocks for a minimum period of storage. Under conditions of war or of threatened famine, the shortage of foodstuffs in general necessitates the maintenance of large stocks and quite often for longer periods. Even in ordinary times, the storage of food-products has presented many problems in countries where climatic conditions favour generally the deterioration of such materials. This deterioration is usually associated with either a high atmospheric humidity or a high moisture content in the stored product. Humidity and moisture are thus primary factors which control insect attack and mould growth in the stored materials. Besides these, the conditions of storage as well as the conditions in which the grains are received are important factors which determine the loss of foodstuffs in a locality. The problem of storing foodgrains and food-products is thus important requiring close scientific approach for its study. In the present review, it is proposed to summarise the available knowledge on this problem and suggest a simple and practical method for adoption, whereby the loss of foodgrains may be reduced to a minimum.

Conditions for Storing Foodgrains

Foodgrains such as cereals and pulses have certain fundamental characteristics. In the first place, their moisture content is not a fixed entity but is conditioned by the humidity of the atmosphere in which it may be stored. Thus depending upon humidity, the grains take up or lose water. According to Snow[1] *et al.*, cereals take up more moisture than pulses (legumes) at a R.H. of 40-80 per cent. Above 80 per cent. R.H., this absorption is reversed. Gane[2] arrived at similar conclusions independently. The former investigators have, however, recommended safe levels of moisture content for storing different feeding-stuffs. Thus, a moisture content of 15·7 per cent. is the safe limit for short storage of wheat (about three months) while it may be 14·6 for longer periods (over one year). In the case of maize, this safe limit has been fixed at 12·5 per cent. for export purposes. In respect of stored grains, the factor of safety varies to some extent with the different types of products, but broadly it may be fixed at 12-14 per cent. moisture for satisfactory storage, although it could be conveniently lower than this. Secondly, grains with a moisture content of 15 per cent. and above, have a tendency to "heat" up, a feature which is not very desirable, as it affects the quality of the grains. Thirdly, with a moisture content of 15 per cent. and more, conditions are favourable for insects to feed and breed on the material. This is then followed by mould infestation. Wheat, with a moisture content of 17 per cent., has been found to be readily infested by insects, particularly weevils. It must be emphasised here that it is not merely the moisture content of the stored grain, but the R.H. of the atmosphere surrounding the grains is equally important. It is not adequately realised that grains reach equilibrium with the atmosphere and absorb or give up