the greater care and control required, and the added processing step with its attendant cost have apparently stopped any further work in this direction. The method shows a process energy loss rather than gain because of the fine grinding required and the fact that the products still have to be dehydrated and the fat and protein separated.

The foregoing descriptions do not conclude the list of rendering processes available for the processor of animal fat raw materials, but they cover the basic types. Some of the others are the Laab Pressure System, the Titan Expulsion System developed in Denmark, and the Pavia Heated Roller process, which were patented in March of this year. These others are substantially modifications of the unit operations involved in the processes described or are based on similar principles.

Table III is an attempt to present in abbreviated form the principal features of the processes discussed as they relate to the seven factors described earlier as criteria for rendering process evaluation. Their very briefness makes difference of opinion about their relative evaluation probable. No attempt to determine the best or better of the processes is intended. Such an evaluation must be left up to each individual processor to determine for his own needs. This follows because such a selection must weigh the factors of raw material to be handled, utilities available, specific or special purpose intended, and local economic factors and personal opinion factors on items subject to such judgment. Table III merely is a summation of such information as was available or seemed inherent or apparent to the processes.

Application of the fundamental and natural principles of animal fat recovery which have been outlined should serve to guide the processor in the process selection best suited for his particular conditions. The observance of physico-chemical factors occurring during the operation and intelligent care in the control and use of these variables will chart the way to maximum product value at lowest unit cost. This is the pattern not only for survival but for success.

Marine Oils. Production, General Chemistry, and Utilization 1

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THE fish oils of industrial importance in the United States come from three different varieties of fish, pilchard, herring, and menhaden. All are frequently called sardines.

Pilchard were formerly found in the Pacific Ocean all along the American coast, but in recent years the catch has been decreasing drastically, first in the northern waters, and now in the southern waters as well. The reasons for this are not known, but obviously the effect on the marine oil industry is very serious. The annual catch has dropped from a maximum of 1,500,000,000 lbs. to about 7,770,000 lbs. in 1952.

Pilchard spawn in the open sea as far as 300 miles
off-shore, and the eggs hatch in about three days. The fish feed on minute sea organisms called plankton. When they are 3 to 5 in. long, they gather in schools and migrate toward shore. When full-grown, they are about 7 in. long and leave the shore waters for the open sea again.

Sea herring are somewhat like the pilchard and belong to the same family. They are found along the Pacific coast from California to Alaska and also along the North Atlantic coast, but the most important catches are off the shores of British Columbia. They spawn from winter in the south to late June in the north, laying their eggs on kelp and other marine vegetation. The young are hatched in 10 to 20 days, depending on the temperature, and most of the fish mature in the third, fourth, or fifth year. When mature, they spawn each year.

Menhaden consist of several species of related fish and are found all along the Atlantic and Gulf coasts. Since the decline of the pilchard catch, beginning about 1946, the menhaden have become the most important sources of fish oil for industrial uses. The catch in 1952 was about 1,300,000,000 lbs.

Menhaden are migratory and travel in large schools. During the first year they attain a length of 5 to 6 in. and at full growth, reached in three to four years, they attain a length of 8 to 10 in.

Whale oils are important marine oils also. Whales are not fish; they are mammals which breathe air, suckle their young, and have other animal-like characteristics. Whales are the largest mammals known, some attain a length of 100 ft. and a weight of 100 tons. Some types of whales feed on plankton and other small plants and creatures of the sea, but the

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