dean. Both the War Manpower Commission and Selective Service headquarters have recognized forestry, lumbering and logging as essential activities, and the new program is designed to train men for effective work in those branches of industry in which forestry and forest products are involved. Another objective is to train men so that they may qualify as officer material as quickly as possible after entering the armed forces, especially in forest regiments, engineering units, field artillery and infantry.

DISCUSSION

AGAR-BEARING SEAWEEDS AT LA JOLLA, CALIFORNIA[1]

THE use of red seaweeds as a source of jellies began and developed in the Far East. Nine tenths of the world's agar is produced in Japan by a purely cottage industry, while on the shores of China, Malaya, the East Indies and Ceylon, there is manufactured by native methods a jelly which, if dried, would be the agar of commerce. Of about thirty species of red algae which are recorded as agariferous, only four are used outside of the regions named. It is possible that on the southern and eastern shores of Asia all profitable sources of agar have already been found, but on the other coasts of the world there probably exist considerable resources of this kind which have never been developed. The prospect of competition with cheap Japanese agar has prevented large-scale investment in exploratory and developmental processes. In Russia, with government protection, there is a modern agar industry of less than ten years' standing, utilizing two species of seaweeds, *Ahnfeltia plicata* on the Maritime coast and in the White Sea and *Phyllophora rubens* in the Black Sea. In this country, repeated efforts during the last twenty years have finally established a modern manufacture utilizing *Gelidium cartilagineum* and *Gracilaria confervoides* collected on the coasts of southern California and Lower California.

With Oriental supplies of agar cut off, attention in this country has been turned to agar substitutes and the reclamation of agar, as recent notes in this journal testify. Believing with Humm[2] that, in addition, considerable domestic resources exist, both as unlocated beds of *Gelidium* and *Gracilaria* and as beds of red algae whose agar-producing potentialities have never been recognized, the authors have examined and tested several red algae growing at La Jolla in harvestable quantities. Restrictions on the use of boats at sea have delayed the extensive survey which the situation demands and limited us to collecting at low tide and by swimming and diving in shallow water. About two miles of exposed rocky shoreline have been covered and considerable quantities of agariferous seaweeds located.

The seaweeds were drained and weighed, freed of sand, shells and conspicuous contaminating species while being washed in tap water, dried in the sun and weighed again. Bleaching was not attempted. Fifty gram lots of dried material were weighed out and soaked in tap water for twenty-four hours except where otherwise noted. Each lot was drained and put into one liter of tap water. Sulfuric acid or sodium hydroxide was added to adjust the solution to pH 6.0, 8.0, 10.0 or 12.0, except as otherwise noted and the material cooked for twenty-four hours in a water bath. Distilled water was added periodically to replace evaporation losses. Every two hours a 25 ml sample was removed and cooled to 23°–25°. The strength of the jelly (if a jelly was formed) was measured with a Lipowitz meter as described by Kizevetter[3] in which a segment of a sphere of stated dimensions is driven through the surface of the jelly by weights. The pH was measured and, when necessary, acid or alkali was added to the parent lot to maintain the pH at the value fixed on initially. The cooled sample was stirred back into the parent lot. At the end of the single extraction a 100 gram sample was filtered through two layers of cheesecloth, cooled, frozen, chopped, thawed at room temperature, drained and air dried on a glass plate. The dried agar was weighed, and a 1 per cent. jelly was made from part of it for a strength test.

Six species were readily collected in sufficient quantities to test. *Gelidium cartilagineum* grows below the low tide mark and is collected commercially by divers working as deep as ten fathoms. However, fronds 50–75 cm long can be collected in quantity just below lower low tide. *Pterocladia sp.* grows low in the intertidal zone, the 12–18 cm fronds thickly covering exposed rocks. *Endocladia muricata,* 5–8 cm long, grows higher in the same zone. *Gigartina canaliculata,* with fronds 10–12 cm in length, also occurs in the intertidal zone. *Gigartina serrata* with fronds 20–30 cm. long grows below low tide, very densely in partially shaded places. *Gigartina asperifolia* was the only species collected which so far seems unsuitable as an agar source.

A year-round study will be necessary to establish the amounts of these seaweeds which, on the average, can be collected in a day, week or month and the annual harvest which can be expected from a section of coastline. In summer, with a calm sea, approximately 100 to 300 pounds of wet seaweed of any of the species named can be collected at one tide by our

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 187.

[2] H. J. Humm, SCIENCE, 96: 230–231, 1942.

[3] I. V. Kizevetter, *Bull. Pac. Sci. Inst. Fisheries and Oceanography (Russian)*, 13: 1–135, 1937.

methods. The dry weight varies from 17 to 25 per cent. of the wet weight. The species growing near or below low tide are large and can be collected rapidly but only for a short time each day, while the species of the intertidal zone take more time to collect, but more time is available.

The yield of agar from *G. cartilagineum* was twice as great at pH 6.0 and pH 8.0 as at pH 10.0 and pH 12.0. In the case of one lot no acid or alkali was added and it maintained itself at pH 8.0 during the cooking. At pH 6.0 and pH 8.0 the strength of the jelly increased steadily during the first eighteen hours and afterwards remained unchanged until cooking was stopped after twenty-seven hours. This experience corresponds with the traditional Japanese method which includes the addition of a little vinegar to the cooking water and with the American commercial method in which no attempt is made to control the acidity.

The yield from *Pterocladia* was greatest at pH 6.0, but there was little difference between all lots except the lot at pH 10.0 which showed a very small yield. At pH 6.0 the maximum jelly strength was reached after fourteen hours cooking, after which a 20 per cent. decrease occurred. The greatest yield would probably have been obtained by stopping the extraction at pH 6.0 at the end of fourteen hours.

The yield of agar from *Endocladia muricata* was nearly twice as great at pH 12.0 as in any other lot. The maximum jelly strength was reached after fourteen hours' cooking and remained constant until cooking stopped. The yield of dry matter from *E. muricata* was about twice as great as from *G. cartilagineum* and from *Pterocladia*. However, the firmness of a 1 per cent. jelly was only half as great. Either *Endocladia* agar has a low jellying power or the crude dry extract contains considerable impurities.

None of the three species of *Gigartina* tested yielded a jelly after fourteen hours cooking at pH 6.0, 8.0, 10.0 or 12.0. In a second experiment, the alkalinity of the different lots was maintained by cooking in tenth molar calcium chloride, with excess calcium carbonate, or with excess calcium hydroxide, respectively. Under these conditions *Gig. canaliculata* at pH 12.0 (excess calcium hydroxide) yielded a soft jelly. Following the method described by Kizevetter[3] for the treatment of *Ahnfeltia plicata,* dried seaweed of each of the three species was soaked for three days either (a) in cold saturated calcium hydroxide or (b) in cold 2 per cent. calcium chloride. *Gig. asperifolia* was so badly disintegrated by these treatments that it could not be handled. The other two species yielded firm jellies after two to five hours' cooking either in 2 per cent. calcium chloride or in saturated calcium hydroxide. Under these conditions, the two species of *Gigartina* act like *Gracilaria* in yielding their agar readily.

The most important information obtained is that out of five species of red algae not previously considered agariferous, harvestable in moderate quantity at La Jolla without special equipment, four readily yielded agar, in quantity and quality equal to that obtained from red algae at present commercially exploited.

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EARLY MASTERY OF THE GROUP CONCEPT

ONE of the most interesting facts in the history of group theory is that those who are now commonly regarded as having been the most influential in extending the use of this theory are not also those who first mastered the concept of a group. Among the former Sophus Lie (1842–1899), Felix Klein (1849–1925) and Henri Poincaré (1854–1912) are widely regarded as the most eminent, while the latter are represented by Arthur Cayley (1821–1895), Leopold Kronecker (1823–1892) and Heinrich Weber (1842–1923). None of the former three seems to have ever assumed explicitly all the postulates of the concept of a group which are now commonly regarded as essential. The most fundamental omission is that the associative law must be satisfied when three or more elements of a group are combined. Such a combination has been most commonly called a multiplication, but in the recent literature it is often called an addition.

The interest in the noted omission is partly due to the fact that it exhibits the wide use in mathematics of unannounced restrictions even by some of the most eminent modern writers. It seems, therefore, questionable whether the freshmen in our colleges should be advised to pay close attention to the associative law, which was first thus named by the noted Irish mathematician, W. R. Hamilton (1805–1865), and was effectively introduced by him into the common mathematical literature. It is of great importance in abstract group theory, but the very successful use of group theory by the first three authors noted above implies that in many fields the group concept can be used successfully without restricting it by this law. At any rate, the history of group theory would not be complete without noting the comparatively late emphasis on this law in the development of this subject.

The six names mentioned in the first paragraph of this article exhibit the gradual development of the modern group concept which was practically completed by the last of these writers in the *Mathema-*