sions will he held, one on "Differential Diagnosis in Relation to Therapy" and the other on "Group Aids to Therapy (with Special Reference to Alcoholics Anonymous)." The Wednesday program will be devoted to "Alcoholism and War." Simultaneously the Committee on Alcoholics, Welfare Federation of Cleveland, will present a program of eight papers on various aspects of alcoholism.

AGAR RESOURCES OF THE SOUTH ATLANTIC AND EAST GULF COASTS

By HAROLD J. HUMM

MARINE LABORATORY, DUKE UNIVERSITY

NORTH CAROLINA RESOURCES

COMMERCIAL agar production on the Atlantic coast has become a reality during the past year with the processing by two firms of seaweed found in abundance along the North Carolina coast near Beaufort. Utilization of these newly discovered resources came as the result of a preliminary announcement made in SCIENCE[1] late in 1942 of work carried on in the Duke University Marine Laboratory. If the present abundance of raw material can be maintained, this new industry gives promise of continuing to thrive and expand after the war.

The most abundant red alga of the Beaufort region, *Gracilaria confervoides* (L.) Greville, is now being harvested, dried and sold by fishermen to processing factories. From 1,000 to 1,500 tons, wet weight, are estimated to have been gathered between August 1, 1943, and January 1, 1944. This is approximately 150,000 to 200,000 pounds of dry weed with an agar yield of 60,000 pounds or more, depending upon cleanliness of dry material, yield and thoroughness of extraction. Most of this seaweed was gathered from a single shallow bay of 500 to 600 acres in extent. Many other similar accumulations of Gracilaria were present from which no commercial collections were made.

In the Beaufort area, *Gracilaria confervoides* grows and accumulates in great loose masses in shallow water where salinity is almost that of the open sea. It is collected by simply forking it into small boats. Drying is accomplished by spreading it on racks covered with wire, slats or netting and built several feet above the ground. Dried material that has been carefully cleaned and bleached brings a higher price. Many fishermen are now selling fresh seaweed by the ton as one firm has recently omitted the drying step in processing.

Growth of this valuable seaweed occurs principally from May through November. Loose pieces, which may increase ten times in weight within two weeks, drift about, break apart and continue growth until areas protected from strong currents support masses of seaweed sometimes several feet thick. In late summer and fall, when commercial collecting is best, much of this accumulated material moves out of protected areas into deeper water where tidal currents distribute it throughout the sounds and winds wash it ashore. This drifting seaweed, formerly a net-fouling nuisance, is now collected commercially by shrimp trawlers. That which remains in protected areas continues to grow until about mid-November. Masses of it winter over and serve as "seed" material for the following summer's crop. In December, a slow deterioration begins, characterized by fragmentation of large plants, dying back and a slow decrease in agar yield. In some areas, an encrusting Bryozoan forms a layer of calcium carbonate over the stems. These loose plants apparently do not reproduce sexually, but scattered attached plants do so abundantly. The present abundance of Gracilaria may be coincident with the disappearance of eel grass, *Zostera marina* L. The latter probably occupied the habitats in which Gracilaria now accumulates and may have adversely affected for the alga such a factor as nitrate content of the sea water.

Agar made from *Gracilaria confervoides* of the Beaufort region, though not identical with that from Gelidium, the genus used for this purpose in California and Japan, is sufficiently similar to be referred to as agar. It seems to have somewhat greater gel strength and greater elasticity than Gelidium agar.

Gracilaria agar is more variable in temperature of gelation and usually somewhat higher than Gelidium agar. These variable results are not yet fully understood. Samples of Gracilaria agar produced by a factory located at Beaufort, N. C., have all gelled at about 38° C. Samples from another factory have exhibited a higher gelation temperature, some of these gelling at 55° C. or slightly higher. Raw material from which these agars were prepared came from the same general area at about the same time of year. The two methods of preparation were different. One process involved boiling, the other cooking under steam pressure; one product was purified by freezing, with the other this step was omitted. Variations in salt content and other impurities in agar have an influence

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

upon temperature of gelation and other properties but these factors apparently do not account for the range of gelling temperatures observed in Gracilaria agar from North Carolina. This phenomenon has been attributed to the presence of a fraction of the Gracilaria extract with a high temperature of gelation present in the raw material. It may be a product of the manufacturing process. Because of this variation in gelling temperature and because Gracilaria agar from North Carolina exhibits somewhat greater syneresis as now produced, it is slightly less desirable than Gelidium agar for certain bacteriological uses.

The agar yield, in terms of percentage of the dry weight of the weed, varies from 25 to 45 per cent. Highest yields have been recorded from material collected in August. Some idea of the strength of this gel, as well as yield, can be had from a recent report (private communication) from Dr. John W. Gowen, professor of genetics at Iowa State College. He states that 250 to 300 grams of dry Gracilaria are sufficient to solidify 17 liters of corn-meal medium used for the cultivation of fruit-flies. Assuming a yield of 33 per cent., Gracilaria extract provides a satisfactory gel in this medium in a concentration of less than one per cent.

Gracilaria multipartita (Clemente) J. Agardh., common on shells and jetties along the North Carolina coast, though not of commercial abundance, produces agar of a quality and yield similar to that from *G. confervoides*.

COASTAL SURVEY; FLORIDA RESOURCES

Between October, 1942, and April, 1943, a survey was made, sponsored by the War Production Board, of the Atlantic and Gulf coasts for additional agar-bearing seaweeds of possible commercial value. A search was made of coastal waters from the Eastern Shore of Maryland southward to Key West, Florida, then northward along the Gulf coast and westward to New Orleans. Water transportation, provided by the U. S. Coast Guard wherever requested, proved to be of great value in this work.

Although some agar-bearing seaweed resources were found in addition to those discussed above, the region from Beaufort to Atlantic, N. C., seems to be the most valuable yet discovered of the entire Atlantic coast.

Gracilaria confervoides grows in fair abundance on oyster beds in the general vicinity of Chincoteague Island, Va., and southward to Cape Charles. Here this species apparently grows 100 per cent. attached and is coarser in habit than that of the North Carolina coast. Considerable quantities are collected by oystermen in their dredges, but up to the present, the seaweed is discarded as of no value.

Between Swansboro, N. C., and Jacksonville, Fla., agar-bearing seaweeds were not encountered in commercial abundance. However, Mr. G. Robert Lunz of the Charleston Museum, Charleston, S. C., recalled (private communication) that many tons of Gracilaria were washed in along the James Island shore of Charleston harbor in 1932 and 1934. Possibly transplantation would restore this region to its former productiveness. In the Indian River along the east coast of Florida considerable quantities of Gracilaria were seen but it was not believed at that time that its abundance was sufficient to provide a factory with adequate raw material. Scientists of the Institutum Divi Thomae, working at their Palm Beach laboratory, had discovered Gracilaria in the Indian River previous to the survey reported here. Commercial production from these resources is now in progress.

From Palm Beach southward to Homestead, Fla., agar-bearing seaweeds do not reach an abundance of economic value. *Gracilaria multipartita* is fairly common, however, in Biscayne Bay at Miami.

Along the Overseas highway between Miami and Key West, three species, *Gracilaria cervicornis* (Turner) J. Agardh., *Hypnea musciformis* (Wulfen) Lamouroux and *Eucheuma isiforme* (C. Agardh.) J. Agardh., from which an agar-like substance was obtained, occur in moderate abundance. The extracts from these are here referred to as gelose because they form a weaker gel than agar and one which differs from agar in other properties. They occur mostly mixed with other algae of no economic importance. Commercial utilization may not be profitable, although it is possible that much greater quantities than were seen along the highway may occur among adjacent islands. *G. cervicornis* produces a gelose similar to that from Irish moss (*Chondrus crispus* (L.) Stackhouse) of New England but has a substantially greater gel strength. Gelose from Hypnea sets to a firm gel but its behavior is rather anomalous and unreliable; that from Eucheuma, though softer than agar, is remarkably elastic and tough. With Eucheuma extract, gelation begins at 75° or 80° C. This is probably the gelose referred to by I. A. Field[2] as having been extracted from an unidentified alga collected near Key West.

Florida's seaweed resources of commercial abundance are located along the lower west coast from Cape Sable northward through Tampa Bay. During the winter of 1942–43, and again in 1943–44, thousands of tons of several species of Gracilaria, *Hypnea musciformis,* and *Agardhiella tenera* (J. Agardh.) Schmitz were present in these waters. The more abundant species of Gracilaria were *G. blodgettii* Harvey, *G. armata* (Agardh.) J. Agardh.,[3] and *G.*

[2] I. A. Field, *Chem. Age*, 29: 485–486, 1921.

[3] Because of the inherent taxonomic difficulty of the genus Gracilaria and its need for study and revision, some of these identifications must be considered tentative.

cornea J. Agardh. Less abundant but nevertheless present in large quantity were *G. multipartita,* and *G. caudata* J. Agardh. The more abundant species of Gracilaria of this region yield gelose of lower gel strength than the average sample of commercial agar; the less abundant species yield agar similar in gel strength or only slightly inferior in this respect to commercial agar. *Digenea simplex* (Wulfen) C. Agardh., abundant north of Tampa Bay especially near Tarpon Springs, produces an agar of high gel strength, but apparently the yield is too low to make the species commercially valuable.

Table 1 constitutes a list of agar or gelose-bearing red algae present in abundance along the Florida west coast in winter, together with their dry weights recorded as a fraction of the wet weight.

TABLE 1

DRY WEIGHTS EXPRESSED AS FRACTION OF WET WEIGHT

Gracilaria blodgettii	1/14
Gracilaria armata	1/15
Gracilaria caudata	1/6
Gracilaria multipartita	1/9
Gracilaria cornea	1/10
Hypnea musciformis	1/12
Agardhiella tenera	1/16
Eucheuma isiforme	1/7
Digenea simplex	1/7

Relative to the above table, it should be noted that from 85 to 95 pounds of water are evaporated in drying down 100 pounds of fresh seaweed. Assuming cell sap to be isotonic with sea water, a residue of salt of approximately three pounds would remain. This is largely removed only if the material is washed thoroughly after the first drying. Figures in Table 1 were obtained from seaweed washed well in fresh water soon after collection so that most of the salt content of the cells is included in the dry weight. These figures, although approximations, are of value in making calculations of total agar yield per ton of fresh seaweed and thus in determining value of raw material.

In Table 2 are averages of agar or gelose yield and the highest yield recorded for each species listed.

TABLE 2

YIELD, IN AGAR OR GELOSE, EXPRESSED AS PER CENT. OF DRY WEIGHT

	Average Yield	*Highest Yield*
Gracilaria blodgettii	55	66
Gracilaria armata	56	73
Gracilaria caudata	60	70
Gracilaria multipartita	44	50
Gracilaria cornea	67	72
Hypnea musciformis	53	57
Agardhiella tenera	55	61

In making extractions from which values in Table 2 are taken, usually 20 grams, oven-dry weight at 50° C. were added to 500 cc tap water. This was autoclaved at 15 pounds pressure for one-half hour, the liquid poured off, allowed to gel, then dried down to constant weight at 50° C. From 300 to 500 cc of water were then added to the seaweed residue and autoclaving repeated. Again the solution was poured off and dried. Usually a third such extraction was made, sometimes a fourth. The seaweed residue was saved and dried as a check. A few extractions were made by boiling in an open vessel. Twenty grams of dry *Gracilaria blodgettii,* ground to powder in a laboratory mill, were added to one liter of boiling water. Three-fourths or more of the calculated gelose content went into solution within ten minutes. Studies on yield, rate of extraction and quality of agar or gelose included various extraction methods, lengths of time, volumes of water in proportion to dry seaweed, effect of pH, autoclaving versus boiling, whole versus pulverized and dry versus fresh material. Consideration of these factors is still in progress, the results of which will be presented in a later report.

It may be said at this time that only a superficial study has yet been made of the nature of the gelose derived from these seaweeds. For many of these species, this is apparently the first time they have been considered as possible sources of agar. Each extractive deserves detailed study of physical and chemical properties so that uses to which it is best suited may be found. Tests were made on approximate relative strength of gels from each species, using one or more samples of commercial agar as standards.

Gracilaria multipartita produces agar with a gel strength equal to or exceeding Gelidium agar. *Gracilaria caudata* seems to be from 75 to 100 per cent. that of Gelidium agar. The gels from *G. blodgettii* and *G. armata* seem to have a strength ranging from 50 to 75 per cent. that of the standards. *G. cervicornis* is similar to these. *G. cornea* yields an extract having the lowest gel strength of any member of this genus studied. However, the viscosity of the melted solution is much higher at all temperatures than that of any other species tested. *Agardhiella tenera* yields a gelose that scarcely forms a rigid gel. Even in two per cent. solution the extract is a viscous liquid with only a suggestion of gelation. It is cold-water-soluble.

Some of the seaweed extracts discussed here seem to be composed of two or more fractions that are difficult to separate. Probably the difference lies in the nature of the carbohydrate part of the gelose micelle as has been shown[4] to be the case with the extract of *Chondrus crispus*. Physical and chemical studies may lead to methods of fractionation, greater purification, a greater variety of geloses and an accompanying increase in their uses and value. Furthermore, it may be possible to alter characteristics of a given extract to meet certain food or industrial requirements.

[4] T. Dillon and P. O'Colla, *Nature,* 145: 749, 1940.

Most of the studies on species found along the west coast of Florida were done between January 15 and March 15, 1943, in the new laboratories of Citrus Concentrates, Inc., at Dunedin, Fla. Valuable assistance was given by Mr. Harold Marston, an employee of the company.

OBITUARY

NORTON ADAMS KENT

NORTON ADAMS KENT, for many years professor of physics at Boston University, died on June 5, 1944, at Chocorua, New Hampshire, near the end of his seventy-first year, and just after completing a busy year of academic work.

He was the founder of the physics department at Boston University and for a considerable time he constituted the entire department, a situation which for most men would have ruled out any possible opportunity for research. Yet he continued to publish papers in spectroscopy along with his other duties so that a former head of the physics department of the Masachusetts Institute of Technology about twenty years ago remarked, "There is more scientific spirit in that little physics department at Boston University than there is here at the Institute!"

Professor Kent was born on July 28, 1873, in New York City. His parents were Elmore Albert and Mary Abbie (Holman) Kent. He received his bachelor's degree from Yale in 1895 and spent further time in graduate study there. Then he attended Johns Hopkins University from 1898 to 1901 where he studied under Henry A. Rowland and at the same time associated with some of the foremost men in the American scientific world. These connections he maintained to the end of his life. After obtaining his Ph.D. in 1901 he spent two years as assistant at the Yerkes Observatory in Wisconsin, then he received a professorship at Wabash College, Indiana, where he taught physics until 1906.

In March, 1906, he married Margaret Crowninshield, of Salem, Mass. He is survived by Mrs. Kent and one daughter, Margaret Crowninshield Kent.

In 1906 Dr. Kent undertook to establish a physics department at Boston University which hitherto had sent its students to the Massachusetts Institute of Technology for this part of their training. At that time the university was not over-supplied with funds, so that Dr. Kent found himself raising money not only for the partial equipment of the laboratory but also for his own research projects. He served Boston University for four years as assistant professor and thirty-two years as full professor. He was professor emeritus beginning June, 1942. At this time Dr. Kent also became visiting professor of physics at the Massachusetts Institute of Technology.

He was a member of Phi Beta Kappa, Sigma Xi, the American Association for the Advancement of Science and the American Physical Society. He was a fellow of the American Academy of Arts and Sciences and chairman of its Rumford Committee.

His special field was spectroscopy, and between 1901 and 1939 he published nineteen papers on such subjects as the Zeeman effect, shifts of spark lines due to circuit conditions, fine structure of spectral lines as determined by the echelon, also by Lummer plates, both crossed and in tandem, and determination of wave-lengths. He spent his first sabbatical leave of absence from Boston University in Germany, working in collaboration with Paschen on the Zeeman effect of five lithium lines. His second sabbatical year was spent at the California Institute of Technology with Houston, photographing the hydrogen molecular spectrum and measuring its wave-lengths. One can imagine his emotional reaction when several years later he surveyed Harrison's beautiful recording spectrophotometer which will measure in a few seconds plates such as Dr. Kent had labored over for many months. At the time of his death he was working on the fine structure of $H\alpha$ on which subject he had already published three papers.

While he seized every opportunity for research, he did not neglect his university duties. He was an efficient teacher with a passion for accuracy of statement. He was a wise counselor and a conscientious administrator. Instrumental in obtaining the establishment of the Wadsworth Student Loan Fund, he administered it faithfully until his retirement. He was particularly interested in students of foreign birth, and was very active in a local committee organized to promote friendly relations among such students. He will be long remembered by his students and colleagues alike as a man of tireless energy and thoroughly altruistic nature.

ROYAL M. FRYE
LUCIEN B. TAYLOR

SCIENTIFIC EVENTS

INDUSTRY AND RESEARCH IN GREAT BRITAIN

A STATEMENT in regard to scientific and industrial research has been issued by ninety-two prominent British leaders of industry, science and university teaching. It gives arguments in regard to the importance of scientific research and for the need for a great expansion of research facilities of all kinds. It presents, according to an editorial in *The Times*, London, a well-reasoned discussion of the parts to be played