same situation holds for the pulsations of a star. As the velocity curve differs more and more from a simple sine curve, so the period may be expected to lengthen relative to the period computed from the elementary theory. Eddington dealt with the subject of an extended pulsation theory in 1918, and showed that theory predicts a faster rise of the velocity to a maximum than the subsequent drop to a minimum, and in 1937 Miss Kluyver extended the investigation to include a dependence of period on amplitude. Prof. Rosseland develops his theory of 'anharmonic pulsations' in an appendix, and finds that the semi-amplitude of oscillation would have to be a quarter of the radius of the star—a value 4–5 times too great for most of the Cepheids. He admits that there is a considerable discrepancy to bridge, and it does not appear that this can be done by varying the model. It can probably be done if the calculations are extended to include more coupling terms in the equations.

In conclusion, Prof. Rosseland points out the incompleteness of the pulsation theory in its present stage, and even the 'anharmonic theory' must still be considered to be in its infancy. As already pointed out earlier in this summary, there is a problem connected with the separation of the Cepheids, long-period variables and the *M*3 group, and no solution has yet been attained. It is suggested that inherent physical differences between the stars of these three groups exist. Regarding the phase retardation of luminosity, the pulsation theory has little to say, though it is admitted that Eddington's suggestion about the hydrogen convection zone may finally lead to a solution of this problem. In this connexion further work on the anharmonic pulsations may be important, and the same applies to the period-luminosity law, an interpretation of which has not yet been afforded. The fact that the pulsation theory has survived for nearly thirty years against hard tests is an indication of the soundness of its basic assumptions, and it will remain a fruitful field of work in the future development of astrophysics.

NATIONAL RESEARCH COUNCIL OF CANADA

THE annual report of the National Research Council of Canada*, 1941–42, includes the report of the president, the financial statement for the fiscal year 1941–42, as well as the reports of the directors of the various divisions, the Gauge Measurement Laboratory, the Radio Board, the Section on Codes and Specifications and the Research Plans and Publications Section. Practically all the activities of the National Research Council in 1941 were directed to the study and solution of problems immediately connected with Canada's growing war effort, and the Council has been officially designated as the Research Station of the Royal Canadian Navy, the Army and the Air Force, and is shown as a civil establishment in the records of the Department of National Defence.

The Divisions of Chemistry and of Applied Biology have been engaged largely in selecting and testing suitable materials for the use of the armed forces and in the Physics, Electrical and Mechanical Engineering Departments, the design and development of new detecting devices to locate aircraft, submarines, mines, and other enemy equipment have been carried forward with much success. Engines, aircraft and other items of equipment used in mechanized warfare have been tested on a large scale, and additional staff and facilities have been provided to meet the new requirements, the staff of the Council working in the Ottawa area numbering 803 on March 31, 1942, as against 308 in July 1939, the greatest increase in numbers being in the Division of Physics and Electrical Engineering. New buildings have been constructed to house the aeronautical and hydraulic laboratories and the work of some of the other divisions. A radio field station has been established near Ottawa, and owing to the large increase in the staff of the radio section, a Radio Board has been established for the general direction of all radio research and development work in connexion with the Council's war activities. An important war service has been rendered by promoting the development in Canada of optical glass manufacture for precise optical parts of military equipment.

The Division of Biology and Agriculture, which has been renamed the Division of Applied Biology, has devised methods for converting large insulated cargo holds into refrigerating space without delaying the vessel to provide an immediate solution for the acute bacon transport problem, and a standard curing practice has been developed in Canadian package plants which yields a more stable product. Other work in progress in this Division relates to the treatment of shell eggs to prevent deterioration during shipment at ordinary temperatures, tests on the quality of dried eggs and the preparation of specifications for shipping, investigations on drying pork, canning poultry, vitamin content of flour and the development of rapid growing, easily propagated forest trees; vegetative propagation has reached the stage when cuttings of Norway spruce, white spruce and white pine can be successfully rooted on a practical scale.

In the Division of Chemistry, the Plastics Laboratory of the Colloidal Section, which was being equipped at the outbreak of war, has carried out a survey and experimental work on the use of laminated wood in aircraft construction in co-operation with the Division of Mechanical Engineering. In the physical chemistry section investigations on the development of de-icing fluids, prevention of frost deposition on aircraft, resolution of aerial photographs, etc., have continued, while the organic chemistry section has continued its general programme of research on alkaloids and has synthesized indicators for war gases and chemicals for other war purposes; in the preparation of some special organic chemicals, production has been advanced to semi-pilot plant scale. In addition to investigating products used by almost every branch of the armed forces, including surgeons' gloves, ground sheets, gas-mask components, etc., the rubber laboratory has given much attention to rubber conservation problems and to the study of processes for synthetic rubbers. The refractories laboratory continued its investigations of high-temperature furnace linings. Experiments on the production of metallic magnesium have been pushed forward until a process worked out in the laboratory has been sponsored in a more detailed study embodying pilot-plant operation by a group of industrialists.

Activities in the textile laboratory were largely devoted to acceptance test work and specifications. An explosives laboratory was established late in 1941 to carry out testing under the Explosives Act and conduct research on explosives and related compounds.

* Twenty-fifth Annual Report of the National Research Council of Canada, 1941–42. (N.R.C. No. 1089.) Pp. 33. (Ottawa.)

Under war-time conditions, the demand for searches of scientific literature in planning laboratory research have increased ; research workers in all fields of science have made increasing demands on the trained personnel of the Council staff who prepare bibliographies and abstracts or digests of the literature. Although ten of the Council's numerous associate committees have been disbanded and others will remain inactive until after the War, many new committees have been established to give advice or organize and direct research on important problems, in addition to the twenty-eight associate committees of the Council in existence at the end of the year. Special reference is made in the report to the associate committees on medical research and on aviation medical research. Subjects selected for investigation by these sub-committees have included problems in fatigue, vision, hearing and related subjects, wound infection studies, including work in chemotherapy, treatment of shock, development and provision of blood substitutes for transfusion purposes, treatment of burns and other war injuries, dietary studies, problems involved in high-altitude flying and the improvement of oxygen breathing-systems, and protective clothing to counteract effects of cold, fatigue and high accelerations.

The Council has also been particularly active in maintaining the most effective liaison possible in the scientific work going on in Great Britain, Canada and the United States.

SEAWEED PRODUCTS IN AUSTRALIA

By E. J. FERGUSON WOOD and VALERIE MAY JONES

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PRIOR to 1940, little had been done in Australia to develop any industries using seaweeds as the raw material. In the last century, a company was formed to make agar from the red alga, *Eucheuma speciosum* (Sond), J.Ag. at Dongarra in Western Australia ; potash was produced from Macrocystis and Ecklonia in Tasmania during the War of 1914–18, and several attempts were made at different times to utilize the fibres of *Posidonia australia* Hook. F., which is prolific in South Australian waters and elsewhere. With the death of each of these schemes, seaweed research for industrial purposes languished, and even taxonomy was so neglected that for some years prior to his death, A. H. S. Lucas was the only person in Australia working with the marine algæ of the Continent.

The need for agar in Australia stimulated seaweed research, and the discovery of a quantity of *Gracilaria confervoides* (L.) Grev. at Bateman's Bay and Botany Bay in New South Wales revived interest in the Rhodophyceæ. Studies on the method of production of agar from Gracilaria, carried out at the laboratory of the Fisheries Division of the Council for Scientific and Industrial Research, have culminated in the undertaking of agar production by a Sydney firm. *Gracilaria confervoides* is known to occur in large beds in shallow water in a number of areas in New South Wales and southern Queensland, and is very easily harvested and dried. It is estimated that there will be sufficient raw material in New South Wales to produce at least 100 tons of agar per year, even allowing for fluctuations in the growth of the seaweed. Gracilaria has been found along the coast from Tuross Lake in New South Wales to Urangan in Queensland, a distance of 850 miles. It occurs on shallow flats, in lagoons, estuaries and bays, where conditions are favourable. There is a seasonal rhythm in its abundance, though it appears that this may vary in some seasons. The spores appear to adhere often to shellfish (usually whelks, sometimes cockles and mussels) or to a polychæte worm cast (Eunice), and occasionally to sticks, rocks, etc. Experiments are being made with a view to the cultivation of Gracilaria.

The seaweed is harvested by special grapnels or, in very shallow water, by hand, then loaded into dinghies and taken ashore and dried on wire-netting racks. When dry, it is pressed into bales, and is ready for the manufacturer.

The cardinal features of manufacture are boiling with live steam in open vats, and keeping the *p*H below 7 and preferably below 6·5, but above 5·0. Owing to the difficulty of procuring the necessary materials, the agar has been made in iron or copper equipment, and this results in discoloration and in a high ash residue. Efforts are being made to overcome this. Gracilaria agar tends to be viscous and to have a high setting point, but these are no detriment in the food industries. For bacteriological purposes, Jensen has shown that although these qualities are a disadvantage for poured plates, slopes made from Gracilaria agar will grow most organisms as well as, if not better than, the slopes made from Japanese agar. Two British bacteriologists have also expressed satisfaction with Gracilaria agar in private communications to one of us.

Agar is also manufactured in Western Australia from *Eucheuma speciosum*, which appears to grow in quantity on reefs in the Dongarra district, and to some extent elsewhere. Detailed surveys of these beds are projected. The agar is more easily extracted from Eucheuma than from Gracilaria, but collection of the seaweed from reefs will prove more difficult. This agar also is used for meat canning, and has the same disadvantages for bacteriological purposes as Gracilaria agar.

Hypnea musciformis (Wulf) Lam. is moderately widespread in occurrence, though not occurring in large quantities in any one part of Australia. It makes a very good bacteriological agar with a low viscosity and setting point. It is not used commercially so far.

At the present time, Australian agar production is far below local requirements, but there appears to be no technical reason why these requirements should not be met within the next twelve months, and there is every indication that the raw material will prove adequate.

The production of alginates, potash and iodine have been studied also, and alginates of excellent quality can be prepared from Ecklonia from New South Wales, or from Macrocystis from Tasmania. Abundant growth of Macrocystis occurs in southern Tasmania, which would be the logical centre of the industry. Unless produced as a sideline from an alginate plant, potash and iodine production could be made payable only in war-time. No commercial production of these substances has yet begun.

The commercial development of agar has stimulated systematic and distributional studies of the Rhodophyceæ, and this work is progressing steadily.