borne, often in pairs, on stalks; they are about 5-6 mm. long by 3 mm. broad, and are described as cupulate. They appear to be perfectly clear seeds, so far as impressions can show. Male organs, rather large terminal discs, with apparent impressions of sporangia on the lower surface, have also been observed. This, then, is the oldest seed-plant known, for the age is undoubtedly no later than Upper Devonian.

We may now briefly review the results of our rapid survey. Recent research has revealed, in the Early Devonian, vascular plants far simpler in structure than any known before. We can no longer regard these simpler types as reduced, for there are too many of them. With these primitive

forms, however, much more advanced types are associated, possibly, as Dr. Bidder suggests, the survivors of an earlier land-flora.

Lignier's theory of the double origin of the leaf, from emergences forming 'phylloids,' on one hand, and from thallus branches forming true leaves, on the other, seems to find strong confirmation from the early flora, as, for example, in *Asteroxylon*. In many cases the circinate tips of thalloid branches clearly indicate incipient fronds.

On the whole, the data now available favour the rise of the land-flora from a well-developed thalloid stock of marine origin, which branched out into the two main Archegoniate lines, the mosses and the ferns.

The Progress of Marine Propulsion.

By Engineer Captain EDGAR C. SMITH, O.B.E., R.N.

NEVER since Fulton launched the *Clermont* or Bell built the *Comet* has there at any time been a fixed or standard type of machinery for all ships. Inventions, improvements, innovations have followed in rapid succession, and the history of marine engineering presents an endless and bewildering variety of engines and boilers which have been adopted one day, only to be superseded by better ones the next. With all this change and development, however, designers have never before been faced with the problem of choosing between so many rival methods of driving ships as they have to-day, each method of propulsion making by its performance or promise some claim to consideration. Modern marine engineering embraces its scope not only steam boilers and steam engines, but also steam turbines, oil engines of various types, and also the use of electricity on an extensive scale.

One of the most notable steps in the progress of the marine engine was the adoption of compound working associated with the name of John Elder; another the introduction of the triple expansion engine by Alexander Kirk; another stage in marine propulsion was marked by the application of the Parsons steam turbine; while to-day there is an ever-increasing fleet of ships driven by Diesel oil engines. The advance made during the last sixty years will be realised by comparing the Cunard ships of 1869 with modern liners. Then, no Cunard ship used more than 30 lb. pressure in her boilers; the greatest horse-power in any ship was 4200, found in the *Scotia*; while the coal consumption was 3-3½ lb. per h.p. per hour. To-day, ships are running with 350-400 lb. pressure; the total horse-power of a big Atlantic liner is 70,000-80,000; while in the most modern steam machinery less than ¾ lb. of oil per h.p. per hour is used. At one time, Great Britain built 80 per cent of the steamships of the world. Owing to various causes, one of which is the rise of great shipbuilding yards abroad, this proportion has fallen considerably; yet the volume of construction and marine engineering remains very large, and there is no slackening of the effort to maintain our position. For a long period marine engineering was largely a matter of experience and

rule-of-thumb, but to-day it is not only influenced at every stage by scientific research, but sometimes very costly large-scale experiments are made and the industry is ready to try out any new system which offers reasonable expectation of success. Very great popular interest was taken formerly in the records of the ships of the 'Atlantic ferry,' the blue riband of which has now been held for twenty-two years by the famous *Mauretania*. During the coming summer, the new German turbine-driven liners *Europa* and *Bremen* are due for completion, and it may be that for a time the Atlantic record will pass to Germany as it did some thirty years ago.

Apart from the new machinery for very large and fast ships, however, there are many developments taking place, and a few particulars of recent marine practice may be of value to those who, though not directly associated with marine engineering, may nevertheless be engaged in the study of some of the numerous problems which are connected with it. Marine engineering to-day owes very much to the mathematician, the chemist, the physicist, and the metallurgist.

Confining this article to recent steam practice, it is proposed to give a few notes on up-to-date boiler work and then refer to some recent improvements in reciprocating engines, steam turbines, and electric transmission gear. At first simply great square or oblong boxes with internal flues, or with banks of tubes in place of flues, sixty years ago the box boilers gave way to the cylindrical or Scotch boilers, and these have been used until recently almost without exception in merchant ships. Such boilers are suitable for steam pressures up to 200 lb. or even 250 lb. pressure, but with still higher pressures, marine engineers have had to follow naval engineering practice and use one or other of the many types of water-tube boilers, of which the Babcock and Wilcox and the Yarrow are favourite examples.

In the successful working of water-tube boilers, a supply of pure water free from grease or scale-forming substances is an absolute necessity. In high pressure steam vessels the condenser is

still the Achilles heel of the machinery, and any leakage of the condenser tubes is a source of great anxiety. Some of the most interesting boiler installations of recent times are seen in the new vessels of the Canadian Pacific Railway Company, such as the *Duchess of Bedford*, *Duchess of Atholl*, and *Duchess of York*. These vessels are driven by steam turbines with single reduction gear. Each of them has six Yarrow boilers working at 350-370 lb. per sq. in. with 250° of superheat; and also two Scotch boilers working at 200 lb. pressure. All the steam from the Yarrow boilers and a part of the steam from the Scotch boilers passes to the turbines, but it is the latter which supply steam to the auxiliary engines. Separate condensing and separate feed systems are used, and by this means oil which happens to pass over from the auxiliary engines is prevented from entering the Yarrow boilers. Salt and grease in high pressure boilers are things to be avoided at all costs. By the use of high pressure superheated steam in these Canadian Pacific vessels, it is expected to be able to reduce the running costs by 20-30 per cent.

While the turning of the water into steam, and the condensation of the steam and its return to the boiler as feed water, present the marine engineer with one set of problems involving questions such as the conduction and transmission of heat, the flow of cooling water through tubes and the prevention of deposits and corrosion in condensers and boilers, the burning of the fuel affords ample scope for ingenuity and experiment in another direction. Important mercantile steam vessels, like warships, have abandoned coal for oil, but now the possibilities of burning coal in the pulverised state are being explored. Reference was made to this by Sir Eustace D'Eyncourt in his paper on "Fuel for Ships," read to the Royal Society of Arts on Dec. 5 of last year.

Pulverised coal has been used in large boilers in some important power stations ashore for some time, and now in the American ships *Mercer* and *Lingan* and the British ships *Stuartstar* and *Horotata*, various pulverised coal systems are on trial. The *Mercer* was the first ship with pulverised coal to cross the Atlantic, the *Stuartstar* is the first British ship to be fitted with a pulverising plant, and the *Horotata* is the largest ship so fitted. Many firms have carried out experiments, and it is apparently only a question of time before the main problems of crushing, pulverising, distribution and burning will have been solved. There may possibly be a great future for pulverised coal for ships.

In the propelling machinery itself, many changes are being made, all with the object of improving economy and reducing running costs. The first essential for marine machinery is trustworthiness, but with present-day manufacture and design, few serious breakdowns occur in any of the various types. Triple expansion and quadruple expansion engines have been fitted for many years and, in spite of the progress of the steam turbine and the oil engine, the reciprocating engine is found in more ships than is any other engine. In triple expansion engines new valve gears are being

tried, while a very promising development is the fitting of an exhaust steam turbine in series with the reciprocating engine and coupled to the same shaft through reduction gearing. Suggested by Sir Charles Parsons, but introduced first in Germany, this plan is known as the Bauer-Wach exhaust turbine system. The Anchor liner *Britannia*, a vessel of 8464 tons, built two years ago, has just had such a turbine fitted to her quadruple expansion engines, resulting in an increase of power with a reduction in oil consumption per horse-power, and other vessels are being similarly altered, among them being five P. and O. ships running to Australia via the Cape. In view of the large number of ships with reciprocating engines, it may be expected that exhaust turbines will be adopted on a wide scale.

Marine engineering has always been influenced by contemporary land practice, but up to the coming of the steam turbine no power station contained machinery comparable in size to that of an Atlantic liner. The steam turbine to some extent has reversed that position, but while the largest single unit turbines are found in the super-power houses, practice ashore and afloat tends to progress on parallel lines; higher pressures and higher temperatures being used in both cases. Then, too, marine steam turbines to-day drive the propeller shaft through reduction gearing, instead of directly, or alternatively use hydraulic or electric transmission. The introduction of reduction gearing with pinions and wheels with helical teeth cut with extreme accuracy led to a great increase in both turbine and propeller efficiency. In a presidential address delivered about two years ago, Engineer Admiral Sir Robert Dixon stated that in torpedo boat destroyers the use of gearing had led to an increase in the distance steamed per ton of oil of 14 per cent at full speed and 70 per cent at cruising speed. With the use of gearing came the introduction of the single collar thrust block invented by Michell of Australia, a solution of a difficult problem as complete as it was unexpected. In the development of the turbine, the gearing and the thrust block are seen many striking results of the successful application of theoretical investigations to urgent practical problems of ship propulsion.

For the transmission of the power of the turbine to the propeller shaft, electricity has been used extensively in the United States Navy, which tried out the system first in the collier *Neptune*, now the aircraft carrier *Langley*. This system is also found in about thirty ships with a collective horse-power of 500,000 plying on the Great Lakes. Much interest was created last year by the performances of the American Panama-Pacific Liner *California*, with turbo-electric machinery, and in view of the recent completion of the P. and O. *Viceroy of India* with turbo-electric machinery, comparative figures may be of interest. Though tried in an experimental launch, the *Electric Arc*, in 1911, and in the s.s. *Tynemount* in 1912, the electric drive has not previously been fitted in any large British ship, and the running of *Viceroy of India* will be

watched by every superintendent engineer. The *California* is 601 feet long and has a gross tonnage of more than 20,000 tons. Steam is supplied by oil-fired Babcock and Wilcox boilers at 275 lb. pressure and 120° F. superheat to two turbo-alternators, each of 8500 s.h.p. running at 2880 revolutions per minute, which supply current to the twin-screw propelling motors running at 120 r.p.m. At full power the vessel has a speed of 18 knots, and the consumption of oil on the first voyage for all purposes was 0.8 lb. per h.p. The *Viceroy of India* is 612 feet long, with a gross tonnage of 19,000 and a displacement of 25,000 tons. In her, six Yarrow boilers supply steam at 350 lb. pressure to two 9000 k.w. turbo alternators running at 2700 r.p.m. supplying current to twin screw motors running at 109 r.p.m. The speed of the ship at full speed will be 18½ knots, while with only one alternator in use a speed of 16½ knots will be obtained. It is stated that the guaranteed consumption for propelling purposes only is 0.6 lb. per s.h.p. per hour. Besides the main generators, the *Viceroy of India* has four 500 k.w. auxiliary turbo generator sets and two 165 k.w. oil-driven sets, while for the pumps, fans, steering motors, etc.,

which are electrically driven, there are no fewer than forty-three circuits. This notable vessel is advertised to sail on her maiden voyage on Mar. 28. It has been announced that the new 'Super-Olympic' liner building at Belfast for the White Star Line will also have electric drive, but particulars of her machinery have not yet been published.

Progress in steam marine machinery has unquestionably been stimulated by the growing popularity of the motor-driven ship with its surprising economy in fuel. For fast ships and warships, however, the steam turbine is at present the only suitable engine, while in other classes of vessels no doubt various types will continue to be used according to circumstances. In Lloyd's Register Book the tonnage of ships above 100 tons included amounts to 65,159,413 tons gross, of which 5,432,302 tons are driven by oil engines, 9,682,063 tons by steam turbines, and 50,045,048 tons by steam reciprocating engines, while of the total tonnage 62.4 per cent burn coal and 37.6 per cent use oil either under the boilers or in the engines. Some of the steamers fitted for burning oil can if necessary use coal.

Obituary.

SIR BERTRAM WINDLE, F.R.S.

IT is with deep regret that we record the death of Sir Bertram Windle, professor of anthropology in St. Michael's College, University of Toronto, which took place in Toronto on Feb. 14. Bertram Coghill Alan Windle was born on May 8, 1858, the son of the Rev. S. A. Windle, vicar of Market Rasen, Lincolnshire. He was educated at Kingstown and Repton schools, and had a distinguished career at the University of Dublin, where he graduated M.D. and D.Sc. He was for a time Dean of the Medical Faculty and professor of anatomy and anthropology at the University of Birmingham. He afterwards became professor of archaeology in University College, Cork, of which he was appointed president in 1904, holding this office from 1904 until 1919, when he went to Toronto. During his residence in Ireland he was extremely active in educational and other affairs, with results that were not always conducive to his tranquillity of mind.

In his more strictly professional studies, Windle attained considerable eminence. His contributions to anthropological literature were marked by originality and freshness of view. Besides papers in scientific journals, he was the author of a manual of surface anatomy, now in its third edition, and of "The Proportions of the Human Body," published in 1892. He was, however, almost as widely known as an archaeologist as an anatomist. He published several books on prehistoric archaeology, of which the best known are "Life in Early Britain" and "The Prehistoric Age." His "Romans in Britain" was of a more popular character and was based on lectures delivered in Toronto. He was elected a fellow of the Royal Society in 1899. The breadth of his interests was also shown in a series

of literary guide-books, of which "Shakespeare's Country" is most likely to be of enduring value.

Windle's main preoccupation, however, outside his professional studies, was in religious questions, and especially the relations of religion and science. At the age of twenty-five he joined the Roman Catholic Church, and by far the greater part of his not inconsiderable literary output was concerned with religion. "The Church and Science" was awarded the Gunning Prize in 1917, and Windle was honoured for his writings by two popes; Pius X. made him a knight of the order of St. Gregory, and Pius XI. made him an honorary Ph.D.

NEWS has just reached us of the death on Jan. 17 at Moscow of Dr. G. S. Zaitzev, director of the Turkestan Plant Breeding Station. Beginning in 1914, Dr. G. S. Zaitzev devoted himself to serious and large-scale genetic, botanical and breeding work in cotton, occupying the position of the chief of the Division of Plant Breeding of the Golodnostepskay Agricultural Experiment Station until 1919. In 1919 Dr. Zaitzev was appointed director of the Turkestan Plant Breeding Station, where he remained until his death, which has interrupted a life full of scientific achievements in our knowledge of the cotton plant. In addition to his work at the Turkestan Plant Breeding Station, Dr. Zaitzev was engaged in the U.S.S.R. Institute of Applied Botany (Leningrad) as cotton specialist, and in the Central Asia State University (Tashkent) as professor of cotton growing at the Agricultural College. By the death of Dr. Zaitzev, the Soviet Union and the whole world have lost a distinguished scientific worker in the field of genetics and plant breeding, whose memory will be long preserved and honoured.