change of colour and whether it is connected with any special state of the weather I have not yet determined.

Note.—Since the above was written, I have made a rough attempt to measure definitely the rate of growth of these crystals. A cylindrical stoneware bottle 3·6 inches high and 2·25 inches diameter was stuck upside down on a post 40 inches high for three hours at a time, the crystals formed on it melted down and the volume of the water measured. Assuming that the cylinder acted like a flat surface placed perpendicularly to the wind whose height and breadth are equal to its height and diameter—an assumption that appears to be very nearly true, at least for small surfaces—I find that with dense fog and strong wind (force 6 to 8 of Beaufort's scale) the rate of growth, as measured above, is about 0·125 inch per hour. That is to say, if the density of the snow be one-tenth that of the water, the crystals were growing at the rate of one and a quarter inch per hour. The crystals were quite loose and feathery, and contained practically no fallen or drifted snow; all had been formed directly out of the fog.

R. T. OMOND

BIRD ARCHITECTURE

THE way in which a bird builds its nest, seemingly without instruction, thought, or experience, has been repeatedly brought forward as a convincing proof of blind infallible instinct governing it in its task. No more popular proof has been brought forward by the supporters of the blind instinct theory than that of bird-architecture. It is thought a wonderful thing for a bird to build a nest without any instruction, or without ever seeing a nest typical of its species. That birds are capable of such marvellous powers has long ago been denied by Mr. Wallace, and we have not a particle of evidence that such is really the case ("Nat. Selection," and Seebohm's "Brit. B.," ii. Introd.). Indeed the evidence, such as we can glean, goes far to disprove the presence of any such instinctive power. Birds brought up in confinement have been found not to make a nest typical of their species, but generally content themselves with forming a rudimentary structure—heaping a lot of material together without any design, or even laying their eggs on the bare ground with no provision at all! In my opinion, however, the conditions of life are so changed when a bird is kept in confinement that too much weight should not be attached to its actions in captivity, and the experiment has never to my knowledge fairly been tried with wild birds or birds living under normal conditions.

A remarkable instance, however, of a changed mode of nest-building has just been brought to my notice by Mr. W. Burton, the well-known naturalist of Wardour Street. Some time ago his brother (now employed at the museum at Wellington, N.Z.) took out to New Zealand a number of young birds of our common native species, with the object of introducing them to the Antipodes. Amongst them were some young chaffinches (*Fringilla cœlebs*). These were turned out and have thriven well in a wild state, bidding fair to permanently establish this charming little bird in our distant colonies. Some of the birds have built a nest; and to Mr. Burton I am indebted for a photograph of the wonderful structure they have woven. It is evidently built in the fork of a branch, and shows very little of that neatness of fabrication for which this bird is noted in England. The materials with which it is made seem very different, too. The cup of the nest is small, loosely put together, apparently lined with feathers, and the walls of the structure are prolonged for about eighteen inches, and hang loosely down the side of the supporting branch. The whole structure bears some resemblance to the nests of the Hangnests (Icteridæ), with the exception that the cavity containing the eggs is situated on the top. Clearly these New Zealand chaffinches were at a loss for a design when fabricating their nest. They had no standard to work by, no nests of their own kind to copy, no older birds to give them any instruction, and the result is the abnormal structure I have just described. Perhaps these chaffinches imitated in some degree the nest of some New Zealand species; or it may be that the few resemblances this extraordinary structure presents to the typical nest of the Palæarctic chaffinch are the results of memory—the dim remembrance of the nest in which they had been reared, but which had almost been effaced by novel surroundings and changed conditions of life. Any way we have here, at last, a most interesting and convincing proof that birds do not make their nests by blind instinct, but by imitating the nest in which they were reared, aided largely by rudimentary reason and by memory. I have not the least doubt that, had these young chaffinches been *hatched* in an alien nest in this country, and never allowed to see a nest typical of their species, or have any connection with old and experienced birds, the results would have been still more startling and strange. Man has to *learn* the particular art of house-building practised by his own peculiar race—birds have to do the same!

CHARLES DIXON

THE INSTITUTION OF NAVAL ARCHITECTS

THE Annual Meetings of the Institution of Naval Architects were held during the week preceding Easter at the rooms of the Society of Arts. There were five sittings, at which the necessary routine business was transacted, the presidential address of Lord Ravensworth was delivered, and seventeen papers were read and discussed. On the whole the meetings were successful and the papers of good quality, but far too much work was attempted in the time available. It is to be hoped that the growing importance of the proceedings and the improving financial position of the Institution may lead the Executive to arrange for holding regular autumnal sessions at the principal outports, in addition to the spring sessions in London.

The papers read were chiefly "papers of information," having a strictly practical or descriptive character, only two or three having scientific pretensions. Marine engineering also occupied a far more prominent place than has been usual hitherto, nearly one-half of the papers having relation to the propelling apparatus of steamships. The fact is significant, indicating the remarkable progress which has recently been made in marine engineering, and suggesting the progress which may yet be made. Of the papers coming into this group, that by Mr. Macfarlane Gray, of the Board of Trade, was the only one of a scientific nature. Mr. Gray has on more than one occasion brought his "ether-pressure" theory before the Physical Society, where it has not been well received. His recent paper "On the Theoretical Duty of Heat in the Steam-Engine" was probably understood by only a few of his hearers; and Prof. Cotterill, whose authority on the subject is undoubted, was the only speaker who really contributed any useful criticism. While complimenting Mr. Gray on some of his graphic processes, and expressing admiration for his courage and perseverance, Prof. Cotterill took exception to the generalisations attempted in the paper and to the assumption that the results so far obtained were any real confirmation of the soundness of the theory advanced.

All the other engineering papers were of a practical character. The actual performances of "triple-expansion" engines as compared with the "double-expansion" or ordinary compound marine engines, were discussed at length. Experience appears to be conclusive on the point that, by using steam of 120 to 150 pounds' pressure, and having three successive expansions in separate cylinders, an economy of from 15 to 20 per cent. in coal consumption is to be realised. This economy is of the highest importance, both in mercantile and war ships and on long ocean voyages its effects are felt, not merely in the lessened expenditure of coal, but in the gain in cargo-carrying capacity. Twenty-five years ago an expenditure of from 4 to 6 pounds of coal per indicated horse-power per hour was considered good engineering practice. By the introduction of surface-condensers the expenditure was reduced to about 3 to 4 pounds; by the use of the compound engine with higher steam pressures the expenditure fell to about 2 to $2\frac{3}{4}$ pounds; and now with triple expansion it has been brought nearly to $1\frac{1}{2}$ pounds, or less than one-third of the rate common a quarter of a century ago. These are results of which marine engineers may be proud, and which make the extended use of steamships certain. Nor is further progress to be doubted. Much remains to be done in improving the marine border, and Mr. Milton's thoughtful paper on the subject will do good. Attention has been so fixed on the economical use of steam in the engines, that the possible gains by improvements on the generators of the steam have been overlooked to some extend. The employment o "forced draught" in the stokeholes is becoming so common, that it was to be expected that a discussion would arise upon it. Mr. Robinson read a paper describing a method by which steam yachts might have the combustion quickened by driving air under pressure into the furnaces, but not closing in the stoke-holes as is done in torpedo boats. This paper was not merely interesting in itself, but served the useful purpose of calling forth some valuable statements of experience gained on larger ships. Forced draughts with closed stoke-holes is now becoming a recognised feature in war-ship design. By these arrangements, involving very moderate additions of weight and cost, the indicated horse-power can be increased by from 50 to 60 per cent. above that obtained with natural draught, and the "forcing" of the combustion can be carried on for four or five hours. A very considerable gain of speed is thus possible for a moderate time, and under ordinary working conditions with low speed, the economical expenditure of fuel is possible. In special types of merchant ships forced draught would also prove of great value; and even in sea-going steamers something of the kind is likely to be done. Trials are already in progress which promise a great economy in the weight and space required for the steam boilers, while preserving economy in coal consumption. A paper by Mr. Linington, of the Admiralty, on the propelling machinery of high-speed ships, gave a considerable amount of information as to recent Admiralty practice; and another paper by Mr. Joy, described a special arrangement of valve gear adapted for quick-running engines. Upon the efficient working of such gear, and the proper distribution of the steam, very much depends when high piston speeds are accepted, and the weight of machinery reduced.

Mr. Thornycroft's name will always be associated with the introduction of the modern torpedo boat, in which quick running engines of remarkable lightness in proportion to their power are fitted. His paper on a special form of screw propeller suitable for vessels of very shallow draught and relatively high speed naturally attracted great attention. The fundamental principle of this propeller is not a novelty: but Mr. Thornycroft has brought to a practically successful form what has been little more than an experiment in the hands of others. The propeller is one which works with a large amount of "slip," but it is associated with a system of fixed "guide-blades" and casings, by means of which the momentum of the water in the propeller race, which would otherwise be wasted, is made to contribute effectively to the forward thrust of the propeller. The net result of the arrangement is that for a given total weight of propelling apparatus a higher speed can be obtained than is possible with any other propeller yet tried in shallow draught vessels.

Mr. Parker, of Lloyd's, read a paper on the use of thick steel plates for boilers carrying high pressures of steam, with special reference to a case of recent occurrence where a plate fractured badly and in a most unexpected manner. This paper gave rise to one of the most lengthy and interesting discussions at the meetings. Steel makers and users of steel mutually benefit by the joint examination of such problems, which will probably become much rarer than they now are as the manufacture advances. The general opinion expressed in the discussion was distinctly in favour of the generally good behaviour of the new material, whose superior strength, ductility and homogeneity make it so formidable a rival to the best classes of iron.

Two papers on riveted joints were well received: the first giving a *résumé* of recent Admiralty experiments on riveted specimens of steel shipwork; and the other dealing with certain points of importance in the riveting of boiler shells.

Amongst the remaining papers, one, dealing with the stowage of steamships, contained a mass of valuable facts. Another paper dealt with the possibility of making such a disposition of the coal bunkers in steamships that the consumption of the coal might not prejudice the stability or render large quantities of ballast necessary. A third was a scientific attempt to lay down rules for competitive yacht-rocking—a hopeless task we fear.

There still remain to be noticed three of the most important papers in which a distinctly scientific method was followed. Undoubtedly the best of these, from the scientific point of view, was that contributed by Mr. Watts, in which he examined into the remarkable effects which free water may produce in checking the rolling motion of even the largest ships. Mr. R. E. Froude assisted greatly in the investigation, and exhibited a model in which the behaviour and influence of the free water were admirably illustrated. It seems obvious that by this means much greater steadiness at sea may be insured than is possible with bilge keels or other appliances of that kind. But there is a need for scientific treatment in order to secure the best steadying effects in a safe and practicable form.

Another excellent paper was that on "A Mechanical Method of Measuring a Vessel's Stability," by Mr. Heek. Here also a model was used, and by a very ingenious device the movements of the centre of buoyancy of the ship represented by the model were accurately and simply determined for all angles of inclination. It is a method which can be used by comparatively unskilled assistants in a drawing office, although its invention is a proof of thorough knowledge of the principles of stability on the part of the inventor. The plan ought to be widely used, and doubtless will be.

Finally, reference must be made to the only paper contributed by a naval officer, Capt. Noel, in which he attempted to lay down rules of general application for measuring the "fighting efficiencies" of war-ships of all classes and sizes, differentiating their values according to the nature of their speeds, manœuvring powers, armaments, protection, seaworthiness, and other qualities. The task is seemingly a hopeless one, and no general rules can apply. At the same time the paper sets out clearly and succinctly the leading characteristics on which fighting efficiency depends, and in that sense will be of service to the Institution.

W. H. W.

THE EGGS OF FISHES[1]

CONSIDERABLE advances within comparatively recent times having been made in regard to our knowledge of the spawning of fishes, and the treatment of

[1] Introductory Lecture delivered to the Class of Natural History in the University of St. Andrews, on November 10, by Prof. McIntosh, LL.D., F.R.S.