backed up. The reason for the failure was attributed to the fact that it was proposed to try models for different firms, and it was feared that difficulties might arise. Sir William now suggests that what might be called the commercial side of the scheme should be abandoned, and that a tank should be constructed for the sole purpose of research work, and investigation into the general principles underlying the science of naval architecture. This would naturally cut off the income it was proposed should be derived from testing models for firms, and therefore a sufficient sum must be collected, not only to build the tank, but also to endow it. The suggestion is that the tank should be constructed at Bushy, and be incorporated as a part of the National Physical Laboratory. The cost of building would be about 15,000*l.*, and the annual cost of staff, maintenance, &c., would be about 1500*l.* Dr. Glazebrook, who spoke in the discussion, said the management of the National Physical Laboratory welcomed the suggestion most cordially, and it therefore only remains to collect the money. The cooperation of ship owners, as well as of ship builders, was asked for, and the general opinion of the meeting appeared to be that it would argue ill for the enterprise and public spirit of the shipping community if the moderate sum needed were not forthcoming.

The next paper read was doubtless the most valuable presented at the meeting. It was a contribution by Mr. R. E. Froude, and detailed some results on model experiments. It is hardly necessary to remind our readers that Mr. Froude has for many years carried on at Haslar for the Government the work in connection with tank research inaugurated by his brilliant father. The details he now gives are the result of experiments carried through a period of thirty years; in fact, the initial trials were made at Torquay by the late Mr. Froude. The details given were of a purely technical nature, and could not be explained without the advantage of much space and many diagrams of ships' forms, &c. Although the details referred to war vessels, they are applicable to mercantile craft within the limits of form included.

A paper by Prof. Scribanti, of the Royal Italian Navy, on the heeling and rolling of ships of small initial stability, was read in brief abstract, and was not discussed.

A paper by Herr Otto Schlick, on the gyroscopic effect of fly wheels on board ship, was read at the evening sitting of Thursday. The author proposed the installation of an enormous gyroscope for the purpose indicated. The suggestion is not new, but the practical difficulties in the way have generally been considered too great to make the plan acceptable to ship designers. Herr Schlick's paper was, however, acceptable as giving in simple language an admirable exposition of the gyroscopic effect.

Two papers, respectively by Mr. J. E. Thornycroft and Mr. A. F. Evans, gave particulars, chiefly of a historical nature, of the application of oil engines to small vessels. The occasion is perhaps notable from the fact that some members present, connected in a practical manner with marine engineering and ship design, considered the use of gas engines for marine propulsion—with gas producers in place of steam boilers—as a problem that would have to be considered before long.

At the Friday meeting Prof. Plateau, of Paris, gave particulars of vessels fitted with the form of steam turbine he has invented, notably a first-class torpedo boat built by Messrs. Yarrow and Co. This vessel has made a speed of 26·39 knots. The battle of the turbines is likely to be the great feature in the domain of ship propulsion in the immediate future. Whether the impulse type or the reaction type will prove superior is a question that must be settled by experiment, and further information on this subject is anticipated with interest. The adoption of the steam turbine in the two new Cunard liners, after an exhaustive inquiry by a very competent tribunal, has placed the steam turbine on a firm basis as a means of marine propulsion.

A paper by Dr. J. Bruhn, on some points in connection with the transverse strength of ships, dealt with a problem of such complexity that it has often been considered indeterminable; whilst a second paper by Mr. A. W. Johns, on the normal pressure on thin moving plates, is also one that lends itself to abstruse mathematical consideration.

RECENT DISCOVERIES IN BACTERIOLOGY.[1]

THESE are researches towards a fuller knowledge of the morphology and life-history of various orders belonging to Bacteriaceæ. So far the complete life-history of sporogenous forms had only been worked out for a very small number, all belonging to the genus Bacillus. The discovery of spores in the genus Sarcina, and the acquisition of a pure culture of the same by the author, gave him an opportunity of making a complete investigation of this genus. It includes the treatment of spores with various reagents, the germination, the mode of insertion of cilia, the course of development in various media, mode of cell-division, development of spores, and a number of physiological experiments. With appropriate stains the morphology and inner structure of the cell was examined, the cell being differentiated into membrane cytoplasm and nucleus. The results of metabolism fat, glycogen, &c., were not observed, so the products of protoplasm must be dissolved in the cytoplasm, and cannot at present be examined microscopically. The development of the spore is interesting, and requires a very delicate manipulation of stains. It first appears as a vacuole with a central nucleus embedded in it. The vacuole gets denser, until the young spore now dimly outlined stains more deeply than the neighbouring cytoplasm. Then it differentiates a membrane and gradually becomes very strongly refractive, whilst the rest of the cell almost entirely disappears, being only visible when treated with certain stains. This description tallies with Meyer's account of the development of the spore in the genus Bacillus.

Investigation was also carried into the genus Spirillum, the species *Sp. giganteum* being chosen. The variation of size and form, variation, nature, and amount of reserve matter (fat and "Volutans-kugeln"), the ciliation, the course of development in various media, pathogenic structures, &c., were fully examined, so that a complete diagnosis of the species is in our possession. The formation of spores is unfortunately as yet unknown in this species. In this species the most interesting result was the *demonstration* of the origin of the cilia from the inside of the cell. Some investigators had maintained that the cell had no membrane, beng simply naked protoplasm, and that the cilia arose from the periphery, others that there was a membrane, so that the cilia must arise from the inside. The whole question was purely conjectural, but with appropriate staining, which is given in the text, and shown by drawings, the author proves the latter hypothesis to be the true one.

The most important part of the above researches is that dealing with ciliation. Modern classification subdivides according to the possession or non-possession of organs of motion. It is proved that formation of slime in the artificial cultures of the laboratory is the cause of absence of motion. A method is discovered to prevent this formation, with the result that all the supposed non-motile forms were found to be motile, and from everyone the organs of motion were successfully demonstrated. The investigation included 17 forms from the genus Sarcina, 5 forms from the genus Micrococcus, 3 forms from the genus Streptococcus, and 5 from the genus Bacterium, all indiscriminately chosen. Hence the genus Sarcina is absolutely identical with the genus Planosarcina, Micrococcus with Planococcus, and Bacterium with Bacillus (see Migula's "System der Bakterien"). It is therefore obviously necessary that the subdivision of the families Coccacæ and Bacteriaceæ must be remodelled. A new classification is proposed for these two families, the essence of which is as follows:—

Family Coccaceae. Round cells, ciliated.

(1) Genus Streptococcus. Division in one direction of space.

(2) Genus Micrococcus. Division in two directions of space.

(3) Genus Sarcina. Division in three directions of space.

[1] (1) "Untersuchungen über Sarcina Streptoccus und Spirillum," *Centralblatt für Bakteriologie*, Abt. I. Bd. XXXIII. (1903.) (2) "Der Nachweis der Geisseln bei allen Coccaceen," *Ibid.*, Abt. II. Bd. IX. (1902.) (3) "On the Discovery of Cilia in the Genus Bacterium," *Ibid.*, Abt. II. Bd. XI. (1903.) No. 8/9. By David Ellis, Ph.D. (Marburg), B.Sc. (London).

Family Bacteriaceae. Cylindrical forms, ciliated.

(1) Genus Bacillus. Forms with peritrich cilia.
(2) Genus Pseudomonas. Forms with polar cilia.

It cannot but be interesting to medical bacteriologists to learn that the pathogenic Streptococci are motile. At the conclusion of the third paper the exact method by which successful cilia preparations can be obtained is given.

FLUORESCENT BODIES EXCITED BY RADIUM.

SINCE very active preparations of radium have become available, a steady search has been going on in many quarters for agents which will respond to the radiations and convert them into visible light. The most powerful fluorescer towards the α radiations is Sidot's hexagonal blende, a crystallised form of zinc sulphide, which is especially suited for use with the emanation. The most powerful to the β radiation is willemite, a zinc silicate, which gives a magnificent green fluorescence, and is probably quite free from any phosphorescence after the action of the rays ceases. This if left in the radium emanation steadily increases in brightness as the excited activity, and with it the β radiation, is produced, and reaches its maximum some hours after the emanation has been introduced. The same is true of kunzite, a new variety of spodumene discovered by Dr. Kunz, and supplied by Messrs. Griffin and Sons, Ltd. The colour of the light might be variously described by different observers as salmon-pink, warm orange, or orange-yellow, according to individual opinion. Kunzite is a transparent gem-like crystal, and is one of the most beautiful examples of the fluorescent bodies at present available for demonstrating the luminous effects produced by the radium rays. It is, however, not very powerful compared with willemite or the platinocyanides. Being, like the diamond, transparent, it shines especially well when exposed in a tube to the action of the concentrated radium emanation, as the whole mass of the crystal contributes to the light effect. The growth of the luminosity after the emanation is introduced, owing to gradual production of the excited activity, is more marked than in the case of willemite, as kunzite hardly seems to respond at all to the α radiation. This experiment would be instructive as a lecture illustration to prove that the emanation only gives α rays, and that the β rays are produced only when time has been allowed for some of the emanation to change into the matter causing the excited activity.

The most brilliant and exquisite of all fluorescers for demonstration on a large scale are the platinocyanides in the form of large crystals. Those containing lithium give a beautiful pink, not unlike that of kunzite, but more brilliant. The colour of the latter is doubtless due to the lithium contained in it. The calcium and barium salts are characterised by a deep green, especially the former, whereas the sodium compound shines lemon-yellow. Magnesium platinocyanide, which is so beautiful under the X-rays, hardly responds at all to radium. The feeble γ rays are best shown by a large crystal of the barium or lithium salt. Large crystals of the platinocyanides seem extremely difficult to obtain, and any manufacturer who could produce them would probably find a ready market.

A new fluorescent mineral, which, like kunzite, seems to respond only to the β rays of radium, has been recently discovered by Mr. Armbrecht, a member of the firm of Armbrecht, Nelson and Co., chemists, Duke Street, W. The mineral is sparteite, a form of calcite containing a few per cent. of manganese. It occurs associated with willemite and with zincite, the red oxide of zinc, which contains a trace of manganese. It is pure white in colour, and under the action of the β radium rays fluoresces a very deep orange. The light is not at all powerful, but the colour is very remarkable, and would excite comment merely as a fluorescent phenomenon without reference to the way in which it is produced. One authority described it as exactly similar to the colour given by neon in a spectrum tube. It is rather remarkable that the colour seems to depend on the intensity of the rays, and is of a deeper *tint* when the radium is held near than when it is removed a short distance. The same gentleman has discovered among the fluorites some examples of phosphorescence after exposure to radium which persist for several days, and exhibit marked increase of brilliancy on exposure to the warmth of the hand. He finds that kunzite exhibits a similar behaviour, the after phosphorescence (or thermo-luminescence?) being notably increased if the mineral is held in the hand.

The action of kunzite and sparteite under the kathode rays is of interest. In each case the colour is considerably different from that under the action of radium, being much yellower. Sparteite under these conditions is disappointing, but kunzite is a most beautiful sight. Its colour is a pure deep yellow without a trace of the warmth it exhibits under radium.

F. S.

THE PALOLO WORM OF SAMOA.

THE periodical autumnal swarming in the seas around the Samoan Islands of the annelid locally known as the palolo has attracted the attention of residents in those islands and naturalists generally for many years. The swarming takes place in October and November, apparently on the day before the last quarter of the moon, and on this and the following day the sea is absolutely alive with the worms, of which the numbers seem to be greater in the November than in the October swarm. Early dawn is the time for the swarming to commence, and by sunrise the phenomenon is at its height. Not the least curious feature about the swarming is the fact that all the worms are imperfect and headless, and the nature of the complete worm has long been a puzzle to naturalists. Thanks, however, to the investigations of Messrs. Krämer and Friedländer, supplemented by the observations of Mr. W. McM. Woodworth, the solution of the problem has at length been discovered. The results of these investigations have been published in Dr. Krämer's "Die Samoa Inseln" (Stuttgart, 1903), while the original English version of this account, drawn up by Mr. Woodworth, appears in the *American Naturalist* for December last.

Palolo also occur in Fiji and elsewhere. The complete annelid—*Eunice viridis*—burrows into the reef-rock of Samoa, the reef, when prised open with a crowbar, proving shortly before the swarming season to be absolutely alive with palolo. Curiously enough, the Samoan natives, although familiar with the palolo when swarming, are quite unacquainted with it during the period of its rock-boring existence. Owing to the great length of the entire worm, its fragile structure, and its intricate association with the honeycombed reef, the extraction of complete specimens is a matter of considerable difficulty, demanding very delicate manipulation on the part of the operator.

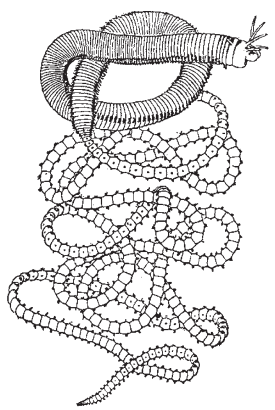

FIG. 1.—*Eunice viridis* (Gray). The narrow posterior epitokal part when detached and free-swimming is known as the "Palolo."

The complete annelid consists of two distinct parts, a broad anterior "atokal" portion, sharply marked off from a slender and much longer "epitokal" portion, which at the swarming season becomes detached and constitutes the free-swimming palolo. The total length averages 40 centimetres, of which about the first fourth is formed by the thick atokal portion. From 250 to 430 is the approximate number of segments in the atokal region, the smaller number occurring in a female and the larger in a male. In the males the colour is reddish brown, and in the females bluish green. These sexual colours are most strongly marked in the epitokal region, where they are due to the sperm and ova, the collapsed integument being quite colourless after the discharge of those elements.

Palolo, as above mentioned, are by no means confined to Samoa. "A similar swarming of marine annelids," writes