

The Piezo-Electric Loud-Speaker

MODERN broadcasting receivers tend to give an undue response to the lower audio frequencies, and in the majority of cases the range is limited to frequencies below 5,000 cycles per second. This is partly due to the fact that the lower frequencies, which at one time were not reproduced very well, have now become attractive as lending power and tone to the reproduction, but it is also due to the demand for increased range in distant reception, for which purpose a high selectivity is required, a virtue which is most easily attained by reducing or eliminating the higher frequencies. Compensation for this latter deficiency can be obtained to some extent by using tone-correcting arrangements in the audio-frequency stages of the receiver, but the effect of these in the sound reproduction is rather handicapped by the poor response of the moving-coil type of loud-speaker to the higher audio-frequencies.

A solution of this difficulty is now in view in the form of the piezo-electric loud-speaker, an investigation of which has been described in a paper by Stuart Ballantine, of the Boonton Research Corporation, U.S.A., published in the *Proceedings of the Institute of Radio Engineers* of October 1933. The loud-speaker employed in these measurements was of the horn type and was driven by a piezo-electrically active diaphragm built up of crystals of Rochelle salt (sodium potassium tartrate), prepared by the Brush Development Company of Cleveland, Ohio. The diaphragm is formed of four pairs of crystal plates, the plates of each pair being so cut that they move in opposite directions under the influence of an electromotive force. The opposite faces of such a pair of plates are cemented together, and the combination, when clamped along one edge, tends to twist on the application of a potential difference to its foil electrodes. Four such units are cemented together to form a flat square diaphragm, which is clamped around its periphery, so that in use the centre portion or junction of the four units vibrates normally to the plane of the assembly, and in synchronism with the audio frequency electromotive force applied to the metal foil electrodes.

The characteristic of this type of loud-speaker, that is, the relation of output sound pressure to frequency, can be controlled to some extent by the electrical circuit in which it is used and also by the resonant frequency of the crystal diaphragm, which

depends upon its dimensions. In an example illustrated in the above paper, the sound pressure rises fairly uniformly with frequency from about 1,000 cycles per second to the resonant value at 8,000 cycles per second. This characteristic may be partially levelled off by suitably connecting it to an electrical circuit; and in a second case in which the loud-speaker was fed through a transformer in series with an inductance, the sound output, after increasing rapidly between frequencies of 1,000 and 2,000 cycles per second, remained sensibly uniform for higher frequencies up to 10,000 cycles per second. This type of response immediately suggests the possibilities of a combination of a piezo-electric loud-speaker with one of the moving-coil type, in which the output is moderately constant for low frequencies but falls rapidly above the cut-off frequency. Ballantine describes such a combination using a moving-coil loud-speaker which has been designed for uniform reproduction up to 3,000 cycles per second, with a rapidly falling response above that frequency. The combined output is shown to be approximately uniform at all frequencies between 60 and 9,000 cycles per second. Such dual arrangements have the advantage that the response can be limited to that of the low-frequency member of the pair if considerations of noise or transmission interference make this desirable.

The piezo-electric loud-speaker also forms the subject of an article in the *Wireless World* of January 5, in which the development in Great Britain, by the Rothermel Corporation Ltd., is briefly described and illustrated. In this case the crystal unit is built up of four laminations, approximately $2\frac{1}{2}$ in. square, the total thickness being $\frac{1}{4}$ in. Three of the corners of this assembly are clamped between rubber blocks, and the vibration of the fourth corner is used to drive the cone diaphragm. The equivalent capacity of this unit is of the order of 0.03 mfd., and it is suitable for use in conjunction with an ordinary moving-coil output transformer. The efficiency of the unit appears to be very good, particularly in the frequency range 2,000–8,000 cycles per second; while in combination with a standard type of permanent moving-coil loud-speaker the quality of reproduction is claimed to be superior to that hitherto obtained with commercial dual moving-coil units.

Larval Crabs from Japan*

DR. HIROAKI AIKAWA has recently supplemented his first paper on the newly-hatched crab zoeas of Japan (1929) with one on the intermediate (later zoeal) stages between the first zoea and the megalopa. Crab zoeas of all kinds are very common in the Japanese plankton, but few of them have been traced to the adults, and the author has devised a distinctly helpful scheme for placing them in groups characterised by definite features. Recent research by other workers has shown that there are several larval characters by means of which the

various natural divisions can be recognised; the Oxyrhynga can be divided from the Brachyrhynga and many of the families and genera can be identified, whilst by rearing the individuals several species are now known throughout the whole life-history. The Dromiacea always stand apart and should certainly be separated from the Brachyura.

The most important features which can be used in classification are the number of spines on the carapace, the form of the antennæ and the number and position of the spines on the telson. Dr. Aikawa uses the position on the body of the main chromatophores, but these are no good in long-preserved material. Besides elaborating the classification of

* *Records of Oceanographic Works in Japan*, 5, No. 2, June 1933. "On Larval Forms of Some Brachyura". (2): "A Note on Indeterminable Zoeas", by Hiroaki Aikawa.

the antennæ and telson, he now adds the establishment of a hair formula for the endopodite of the two maxillæ and of the second maxillipede and of the joints of the latter, which he finds are constant for the species through all the zoeal stages. He has established nine groups of zoeas based on the form of the antennæ and telson by the aid of which any unknown zoea of any stage may be classified approximately, but the classification is admittedly not a natural one. For example, the group *Inachizoea* is typical for the *Inachidæ*, but also contains *Pilumnus*, *Heteropanope* and *Gonoplax*, whilst the group *Grapsizoea*, although one type is chiefly confined to the grapsoid crabs, contains another type in which are included many of the *Portunidæ*, also *Thia*, *Eriphia*, *Hyas* and *Maia*; nevertheless, with the further and more exact descriptions of the individual zoeas, one can get a very good idea of their probable position in a natural classification and comparing it with those the adults of which are known, many genera can already be identified.

The system of groups here given is to be regarded as a kind of key which is really helpful and a distinct step forward in the elucidation of the difficult brachyuran larvæ. Several zoeas are described and figured, none of which can be actually referred to any known species, but they are classified into these groups. It is possible, however, from the characters given to place them at least in the families if not in the genera to which they belong.

It is hoped that in the near future the author will produce a similar grouping for the megalopæ, which is much wanted.

University and Educational Intelligence

CAMBRIDGE.—Prof. Werner Heisenberg, of the University of Leipzig and Magdalen College, Oxford, has been appointed Rouse Ball lecturer for the year 1933-34.

At Queens' College, Prof. James B. Buxton, professor of animal pathology in the University, has been elected to a professorial fellowship.

LONDON.—The University is making a grant of £100 towards the fund for the purchase of the "Codex Sinaiticus".

A course of six lectures on cytology will be given at University College, Gower Street, London, W.C.1, on Wednesdays commencing on February 7, at 5 p.m. by Dr. R. J. Ludford, Dr. E. S. Horning and Dr. K. C. Richardson. The lectures are open to the public.

OXFORD.—On Tuesday, January 23, Congregation approved an amending Statute for defining more exactly the scope of the Hope professorship of zoology, by adding ("Entomology") to the designation of the professorship, and to the mention of "zoology" wherever it occurs in the statement of the professor's duties.

At the same meeting of Congregation, the Master of Balliol, in moving the preamble of a statute for extending and improving the provisions for the study of forestry in the University, directed attention to the fact that the clauses of the statute, if they were deemed unacceptable, were open to revision by amendment at a later stage. The same point was urged by Dr. N. V. Sidgwick. Prof. F. A. Lindemann, though refraining from opposing the passing of the preamble, thought that the statute in its present

form provided no sufficient guarantee for ensuring the permanence of grants. The preamble was carried without a division.

Prof. W. G. Le Gros Clark, professor of anatomy at St. Thomas's Hospital Medical School, University of London, has been appointed Dr. Lee's professor of anatomy.

On Tuesday, January 30, Congregation approved the preamble of a statute establishing a statutory readership in physical anthropology. The Senior Proctor, Mr. H. G. Hanbury, of Lincoln College, explained that the duties of the post had been voluntarily undertaken by the former Lee's professor of anatomy; and that the present measure was called for in consequence of the recent retirement of Dr. Arthur Thomson from the professorship.

The honorary degree of M.A. was conferred on Miss Ethel Bellamy in recognition of her work at the University Observatory on the photographic chart of the heavens.

Science News a Century Ago

The King's Speech, 1834

February 4, 1834, saw the opening of Parliament, and amongst the items dealt with in the Speech from the Throne (Earl Grey, Prime Minister) was a mention of the Act passed in the previous session abolishing slavery under the British flag. Legislation dealing with the status and power of municipal corporations was forecast (but was not passed until 1835). The Speech lamented the continued distress amongst the proprietors and occupiers of land, and Parliament was recommended to give early consideration to such a final adjustment of the tithes as may extinguish all just causes of complaint. On the subject of Ireland the Speech contained the following passage: "But I have seen with feelings of deep regret and just indignation the continuance of attempts to excite the people of that country to demand a repeal of the legislative union".

Porcupine Men

During January 1834, a middle-aged man, of very athletic and robust form of body, completely covered with a green horny substance in the form of quills, not dissimilar to those which are produced on the porcupine, presented himself at the Westminster Hospital for exhibition. The parts which had escaped the deformity were his face, the palms of his hands and the soles of his feet; every other part of his person was abundantly supplied with this green horny substance. He stated that he shed his horns, or quills, annually, and a fresh crop succeeded.

A description of the case appears in the *London Medical and Surgical Journal* of February 6, 1834. The man was a member of the celebrated Lambert family, in which this remarkable condition, an extraordinarily scarce form of the skin disease named *ichthyosis hystrix*, was present in at least six generations. In every case the condition appeared about two months after birth and affected the males only. The case of the first member of the Lambert family to be affected was reported to the Royal Society on March 16, 1731, by John Machin, the secretary, and Prof. Gresh (*Phil. Trans.*, 38, 299; 1731) at fourteen years of age, and in 1755 at the age of thirty-eight with his son Edward by Baker