mechanism that I have hypothesized for the charged drops from bubbles that burst at the surface of the sea[13]. There I have put forth the idea that charge can be separated by a shearing of the electrical double layer that is assumed to exist at the surface of the bubble just prior to breaking. Whether such a process could operate in the present case will remain questionable until one understands the details of the mechanism by which the drops are produced. From this point of view it would be well worth while to carry out investigations of the mechanism with the aid of high-speed motion pictures.

The potential geophysical significance of this charge lies in the fact that under certain conditions it might play a significant part in the electrification of the atmosphere, at least on the local scale. When a 4·2-mm diameter drop of sea-water is dropped on to a molten lava surface it produces a cloud above the surface that has a volume of about 2,000 c.c. Since the charge carried by the cloud is about 15 E.S.U. the mean charge density is $7 \cdot 5 \times 10^{-2}$ E.S.U. $c.c.^{-1}$; this is about two million times as great as the positive space charge that is normally found in the atmosphere[11]. If we assume that this charge density holds for the sea-salt particle and water clouds that are observed to form (see the photographs in the paper by Woodcock and Spencer[12]) above the regions where volcanic lava flows into the sea, we can predict the existence of extremely high potential gradients. At the surface of such a cloud of a radius of 100 m the gradient would be about 10^6 V cm^{-1}, and, on the assumption that the gradient decreases with the inverse square of the distance, it would still be 10^4 V cm^{-1} at a distance of 1 km. These gradients are far in excess of the Earth's positive, fair-weather potential gradient of about 1 V cm^{-1}. Such high lava cloud potential gradients could not exist, for spark discharge and lightning to the ground would tend to neutralize the charge on the cloud. But even if the charge separation were 10^4 times less than that assumed here, the space charge and gradients would still be sufficiently above the background values to be easily measurable. It would be of interest to obtain the potential gradient in the vicinity of these clouds.

Woodcock and Spencer[12] have suggested that extensive volcanic activity in past geological epochs may have, by lava flowing into the sea, significantly increased the aerosol content of the air to the point of influencing long-term weather changes. Under these conditions there is also the possibility that the positive charge carried by these particles may have significantly increased the normal positive space charge of the atmosphere on other than a local scale. But data are needed on the electrical and other parameters of actual lava steam clouds before any reasonable estimates of such space charge can be made.

I plan to continue with this work and hope that others will be stimulated to pursue this interesting problem on charge separation. It does not appear to have any answer in the theories at present accepted of charge separation, and the solution may have some relevance to the problem of charge production by bursting air bubbles at the surface of the sea[13].

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THE CURIOUS EYE OF *COPILIA*

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EXNER[1] described the visual apparatus of the copepod *Copilia*, which he examined at Naples in the 1880's. Exner's account is discussed by Wilkie[2], which directed our attention to this eye.

According to Exner, each of the lateral eyes of *Copilia* has a pair of lenses. The anterior lenses are large, and exceptionally widely separated. The posterior lens of each eye lies a great distance behind the anterior lens—half-way along the extraordinarily transparent body of the animal—so that it is not at first obvious that it has any connexion with the eye. The most striking feature reported by Exner is that this second posterior lens was "in continuous and lively movement", apparently moving across the image plane of the anterior lens. From his description, it appears that there is no retina but rather a single functional receptor unit, transmitting its information to the central brain down a single pathway.

With what we now know about transmitting spatial information by conversion into a time-series by scanning, as in television, it seemed possible that Exner was describing an organism the eye of which works on a principle now very familiar to the engineer. We decided to try to find and examine this animal. This was made possible through the kindness and enthusiasm of Prof. J. Z. Young, and the generous co-operation of the Director and Staff of the Stazione Zoologica di Napoli.

The animals were collected from hauls made at a depth of about 200 m in the Bay of Naples. We succeeded in finding 9 living specimens of *Copilia*, in the course of examining some 14 plankton hauls. Of the nine, eight were female and one male.

Exner's description we found to be accurate with regard to the female specimens, the males being very different. Using high-quality optical microscopes (bright-ground, dark-ground and phase contrast Leitz equipment) we found that the internal structure, muscles, ligaments and the nervous system could easily be observed in the living unstained specimen. In particular, the oscillatory movement of the posterior lens and receptor, as reported by Exner, was readily observable.

The following remarks apply only to the female.

Copilia quadrata is about 3 mm in total length including the long tail; about 1 mm in width, and about 1 mm in depth through the maximum thickness of the body. The diameter of the anterior lens is about 0·15 mm. The posterior lens is situated about 0·65 mm behind the first, the two being joined by a delicate cone-shaped membrane. The posterior lens, lying deep in the animal, is clearly seen in Fig. 1, which shows the whole of the body but not the tail. The lens is attached to a heavily pigmented bow-shaped, orange-coloured structure which contains the photosensitive elements. The optic nerve is clearly seen in the living animal leaving the medial side of this bow-shaped structure, passing thence to the supra-œsophageal ganglion. It seems that the whole structure is essentially the same as a single ommatidium of a conventional compound eye, except that the distance between the corneal lens and the crystalline cone is vastly increased. The detailed structure of the 'rhabdom' of this 'ommatidium' has been described by Vaissière[3], whose observations both with optical and electron microscopy show the micro-structure to be very similar to the conventional compound eye. There seem to be the usual cluster of receptor cells, generally believed to function as a single unit.

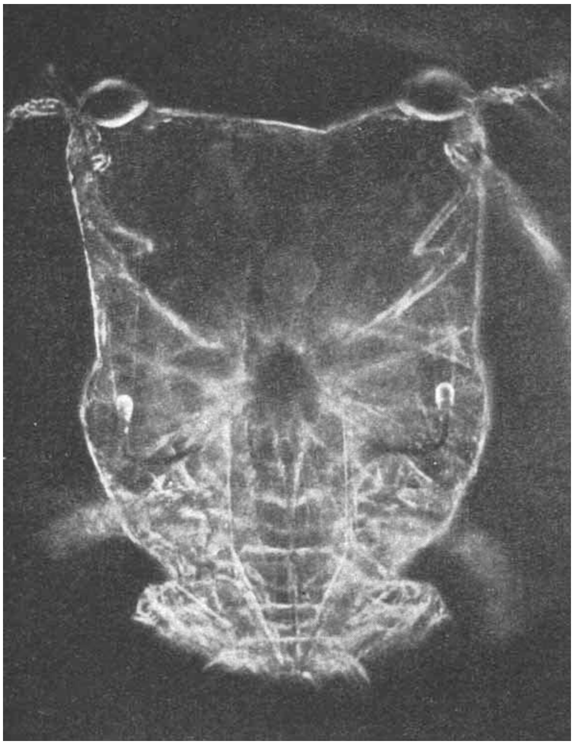

Fig. 1. Photomicrograph of *Copilia quadrata* showing the whole of the body, from above, but not the tail. The anterior lenses are seen somewhat out of focus; the posterior lenses and the opaque pigment (orange) of the photoreceptors are seen in sharp focus. These 'scan', apparently across the image planes of the anterior lenses. The specimen is living and unstained

The anterior ('corneal') lens is rigidly fixed in the strong transparent carapace of the animal. The posterior lens ('the crystalline cone') is suspended in a dynamic system of ligaments and muscles which produce movements of the crystalline cone and its attached photoreceptor across what we assume to be the image plane of the corneal lens, but we were unable to get direct optical evidence for this. The oscillatory movement is 'sawtooth' in form, the receptors moving rapidly towards each other, separating comparatively slowly. The resting state (particularly noticeable in dying animals) is with the receptors farthest apart, when the optical axes of the two eyes are parallel. The axes never converge, and so the 'scanning' (as we are inclined to regard it) can scarcely be associated with range-finder distance vision. The maximum amplitude of the scan is about four times the diameter of the crystalline cone. The scan appeared unrelated to movements of other body structures, which were easy to observe simultaneously. We were able to confirm the independence of the movement of the eye parts by examination of cinematograph film of living specimens. This autonomy seems strong evidence for regarding the movement as scanning. We found the frequency to be very variable (though Exner reports it as constant), but the variability may have been related to the condition of the specimens, which we were unable to keep alive for more than about

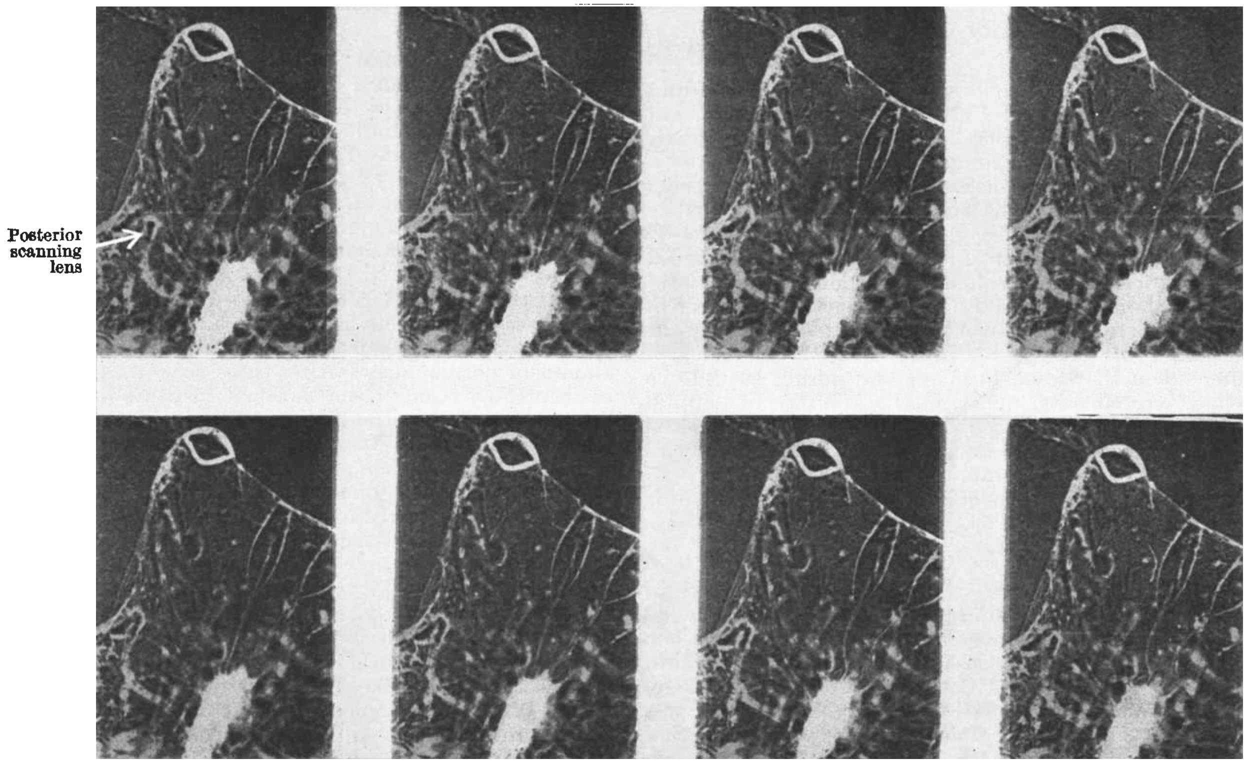

Fig. 2. A series of eight consecutive ciné-frames of the living animal, during one scan. Photographed at 16 ft./sec.

12 h. The maximum observed frequency was about 5 scans per sec in *Copilia quadrata*, though there appear to be species differences, which will be described in a subsequent report. A single scan is shown in the series of consecutive ciné frames in Fig. 2. We were unable to produce systematic variations in the scan by subjecting the animals to visual stimuli, although there were frequent spontaneous variations in amplitude and in frequency. Even violent changes in illumination (occluding the microscope lamp) produced no related changes in scanning, though the animals would try to avoid too bright a light. We regret that we did not use a red filter while examining them, as the animals are probably insensitive to red light. The maximum intensity they would encounter at the depth we found them is about that of moonlight, but we examined them with many times this intensity.

At this stage we can only speculate as to the place of this eye in the evolutionary sequence. Is it an unsuccessful 'experiment' ? Is it a precursor of the compound eye—multiple ommatidia developing to overcome the limited information channel capacity of a neural path ? This most curious of eyes seems an ideal target for a microelectrode.

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NEWS and VIEWS

Royal Society Leverhulme Visiting Professor to Poland

In 1962 the Royal Society and the Leverhulme Trust announced the establishment of a scheme for the appointment of two Visiting Professors to India each year. The Society and the Trust have now announced the establishment of a somewhat similar scheme by which a Royal Society Leverhulme Visiting Professor will visit Poland each year for the next seven years to lecture and carry out research, preferably for an academic year, at a university in Poland in a subject field suggested by the higher education authorities in Poland. Dr. J. W. Boag, who is on the staff of the British Empire Cancer Campaign Research Unit in Radiobiology at the Mount Vernon Hospital and the Radium Institute, Northwood, Middlesex, has been appointed to be the first Royal Society Leverhulme Visiting Professor to Poland in the field of biophysics. Dr. Boag will visit Poland from October until December 1964 and will lecture at the University of Warsaw.

Mathematics at University College, London : Prof. W. R. Dean

Prof. W. R. Dean, who was elected to the Goldsmid chair of mathematics in University College, London, in 1952, retires in October 1964. He was educated at Christ's Hospital and entered Trinity College, Cambridge, as a scholar in 1919; he was elected to a fellowship four years later. Afterwards he was an instructor in mathematics at the Royal Naval College, Greenwich, during 1922–33 and an assistant professor of mathematics at the Imperial College of Science and Technology, London, during 1924–29. Then he returned to Trinity College as a lecturer in mathematics from 1929 until he was elected to his present position. Prof. Dean served in the First World War as a lieutenant in the Royal Fusiliers, and during 1940–45 as a senior experimental officer in the Ministry of Supply. He has published many papers on elasticity and on the motion of viscous fluids; he was awarded an Adams Prize by the University of Cambridge in 1951. He helped to found the journal *Mathematika* and has served as editor since its foundation in 1954.

Prof. K. Stewartson

Prof. K. Stewartson, who has been appointed to succeed Prof. W. R. Dean, has been professor of applied mathematics at the University of Durham since 1958. He was born in 1925 at Barnsley and educated at Stockton Secondary School and at St. Catharine's College, Cambridge. He was a Wrangler in 1944 and, after National Service, passed Part 3 of the Mathematical Tripos with distinction and was awarded the Mayhew Prize. This he followed up in 1949 by gaining a Rayleigh Prize after his first year's research. In the same year he was appointed lecturer at the University of Bristol, where he was, in 1954, promoted to reader, a post which he held until his appointment to the chair at Durham. Prof. Stewartson has held visiting appointments at the California Institute of Technology and the University of Wisconsin. He has a wide range of research interests within the field of fluid dynamics; boundary layer theory (including the intricacies of separation and the interaction between a boundary layer and the external flow), compressible flow, rotating fluids and magneto-hydrodynamics are the general headings under which these interests may be grouped and to all of which he has made significant contributions. In addition to a review article on unsteady boundary layers in *Advances in Applied Mechanics* (1960), he is the author of a stimulating book recently published by the Oxford University Press on the *Theory of Laminar Boundary Layers in Compressible Fluids*.

Applied Physics at the National Physical Laboratory: Dr. B. W. Robinson

Dr. B. W. Robinson retires from his post as superintendent of the Applied Physics Division at the National Physical Laboratory at the end of October. Dr. Robinson was educated at Oundle School and at Trinity College, Cambridge. As Coutts–Trotter student, he worked in the Cavendish Laboratory; and then at the Davy–Faraday Laboratory, assisting Sir William Bragg, particularly in the field of intensity measurements in X-ray crystal analysis. He was for four years senior lecturer in physics at the Royal Military College of Science, Shrivenham. During the Second World War he worked at the Royal Aircraft Establishment, Farnborough, and the Ministry of Aircraft Production, latterly as assistant director in armament development. After three years as head of the Instrument Section at the National Institute for Medical Research, he joined the National Physical Laboratory as superintendent of the then Physics Division in the autumn of 1947. Dr. Robinson was appointed superintendent of the newly formed Applied Physics Division in 1958, and since then has greatly expanded the scope of the work carried out in his Division on acoustics and radiology.

Dr. P. J. Campion

Dr. P. J. Campion has been appointed to succeed Dr. B. W. Robinson as superintendent of the Applied Physics Division at the National Physical Laboratory. After serving with the Royal Navy during the Second World War, Dr. Campion returned to the University of Oxford to graduate and then to complete his D.Phil. Afterwards he was appointed a Nuffield Research Fellow but shortly resigned his position to take up a National