the International Union of Radio Sciences, observations of radio noise are to be made at a network of stations, mostly outside the belt of totality but on both sides of it. A study of the behaviour of the E, F_1 and F_2 layers during the eclipse will be made. The Department of Scientific and Industrial Research is sending Mr. W. R. Piggott to Ibadan, Nigeria, and Mr. C. M. Minnis to Khartoum.

The eclipse will be visible as a partial eclipse in the British Isles about 0900 h. on February 25. The magnitude of the partial eclipse will be about 0·11.

ORIGIN OF THE EARTH

GEOPHYSICS has hitherto relied mainly on the principles of mechanics of solids and fluids, assisted by geology and atomic physics, especially in relation to the outer parts of the earth. Prof. Harold C. Urey has now produced[1] a new synthesis largely based on physical chemistry. Long as the paper is, it is very condensed and could have been made into about ten papers. The central principles are as follows:

(*a*) Kuiper's theory of the origin of the solar system is adopted. This requires the planets to have been derived from much more massive protoplanets, which lost the greater part of their mass in the process.

(*b*) The planets grew by accretion of solid planetesimals, up to some hundreds of kilometres in diameter. The surface features of the moon are regarded as produced by impact of such planetesimals in orbital motion about the earth.

(*c*) A discussion of the stability of various chemical compounds under different temperatures and pressures reveals some difficulties about the retention of certain elements, notably nitrogen and carbon. This indicates a high temperature at some stage, but not general fusion.

(*d*) The planets in consequence are supposed to have started as cold bodies, but to have become hot mainly on account of heat developed in accretion.

(*e*) The earth's central core is identified with iron and the inner core with nickel, and it is held that there is still considerable admixture of iron in the rocky shell to within a few hundred kilometres of the surface.

Whether the conclusions are accepted or not, the arguments are novel and important, especially the chemical ones. In what follows I shall mention some outstanding difficulties.

I am not satisfied by any existing theory of the origin of the solar system. Kuiper's appears to fail on account of the Nölke difficulty, that mass lost by the planets would not have enough angular momentum to leave the system. It must either remain spread through the system, where it would probably be visible and would certainly produce secular perturbations of the planets' orbits that are not observed; or it would be absorbed into the sun and make its rotation too rapid. While, again, accretion may be important, it is not clear that the large planetesimals are possible in sufficient numbers. My original argument against the planetesimal hypothesis was that the planetesimals, if they contributed a large fraction of the planets' masses, must have had a much larger total surface than the planets. Consequently, they would collide with and volatilize one another before the planets could grow appreciably. The argument was answered by A. L. Parson, who showed that the density of the resulting gas would be greater than the saturation density, so that the gas would at once re-condense into dust. But it is difficult to understand why growth occurs by picking up large planetesimals.

Urey, like Hoyle, regards the lunar maria and craters as produced in the early stages, in this respect differing from Baldwin, the chief protagonist of the meteoric theory. I myself still think a volcanic theory tenable. On an accretion theory Urey, again like Hoyle, shows that the earth would become fluid if the material took less than 10^5 years to collect, but would remain solid if it took longer. Urey prefers the latter alternative, Hoyle the former. For myself, I do not see how the strong concentration of radioactive elements near the surface could have occurred except as a result of general fusion and recrystallization; and I know of no satisfactory alternative to the subsequent thermal contraction as an explanation of mountain formation.

W. H. Ramsey's hypothesis that the earth's core is a high-pressure modification of olivine is rejected by Urey on the ground that if it was correct the mean density of the earth, reduced to zero pressure, would be about 3·3, whereas Urey gets about 4·4. But the latter result is got by extrapolating Bullen's pressure-density relation for the core down to zero pressure. It is no argument against Ramsey, because if he is right there is an intervening discontinuity in the relation, and the extrapolation is illegitimate.

Bernal's explanation of the 20° discontinuity in seismology as due to a transition from rhombic to cubic olivine is also rejected, because Urey's co-workers have not succeeded in preparing the cubic form of Mg_2GeO_4 reported by Goldschmidt, from which Bernal inferred the possibility of cubic Mg_2SiO_4 at high pressure. This is an awkward fact; but it is hard to see how Goldschmidt could have been mistaken. Urey proposes instead that the discontinuity is due to admixture of metallic iron. This, however, would not explain the facts. The fundamental fact is that the times of seismic waves at distances from about 15° to 25° indicate a rapid increase of velocity with depth, starting at a depth that might be 150–500 km. on various interpretations. The increase of density inferred by Bullen is a secondary result. The elastic moduli of iron are not very different from those of olivine, and admixture of iron would reduce the velocities of elastic waves on account of the high density. Consequently if Urey's interpretation was right, the velocities would decrease with depth instead of increasing.

The variation of velocity of seismic waves with depth is smooth from a depth of 800 km. or so until a little outside the core; but just outside the core the variation becomes much less rapid. Bullen pointed out that this could be explained b admixture of denser material. Urey's notion of admixture of iron would agree here. Urey suggests further that settling of iron into the core is still going on (he considers that on the whole the planets acquired their silicates first and that iron planetesimals were added later). This would decrease the moment of inertia and produce a secular acceleration of the rotation. This would tend to explain the fact that the observed secular accelerations of the sun and moon are not in the ratio predicted by the theory of tidal friction.

The densities of the inner planets had appeared to be consistent with either the iron-core theory or with

Ramsey's. In either case the densities would require the relative size of the core to increase with the mass of the body, and a theory to account for this on the iron-core hypothesis had been proposed by Lyttleton. Ramsey and Bullen found that the data are approximately reconciled on Ramsey's theory, attributing a uniform composition to all the bodies with discontinuities of density at certain pressures. Mercury, however, has contributed little to the comparison on account of the uncertainty of its mass. But E. Rabe's recent work, based on the perturbations of Eros, combined with the old diameter, makes the density nearly as great as the earth's. Rabe's determination looks thoroughly reliable, and Urey thinks that the old diameter is more likely to be too large than too small. If this is so, Mercury affords strong evidence against similarity of composition, and it would have to be mainly iron.

Other evidence is given from Mars. Harrison Brown finds the ellipticity almost in agreement with uniformity of density. On this ground, Urey regards Mars as a mixture of iron with silicates, like certain meteorites; there has been little separation of materials, as in the earth. However, the argument from the ellipticity appears to be based on a hydrostatic theory, and in a discussion of the same problem I found that the departure of the ellipticity from the hydrostatic value, with a considerable central condensation, is not too great to be explained by a strength in the neighbourhood of that of much of the earth's shell. Accordingly, I do not find the evidence for the homogeneity of Mars convincing.

The theory, therefore, appears to need considerable modifications; but it is certainly stimulating.

HAROLD JEFFREYS

[1] Urey, H. C., "The Origin and Development of the Earth and other Terrestrial Planets", *Geochimica et Cosmochimica Acta*, 1, 209 (1951).

LIPOID CHANGES IN THE GONADS OF WILD BIRDS

THEIR POSSIBLE BEARING ON HORMONE PRODUCTION, SEXUAL DISPLAY AND THE BREEDING SEASON

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Comparison between Male and Female Cycles

IN the males of several widely unrelated birds there is, at the conclusion of spermatogenesis, exhaustion and breakdown of the interstitial cholesterol-containing lipoid Leydig cells and a massive metamorphosis, involving the production of lipoids and cholesterol, of the remaining contents of the seminiferous tubules[1,2]. When a testis metamorphoses and collapses after the breeding season it does so completely, and it is therefore impossible to agree that the differential sexual cycles of migratory and 'stationary' starlings (*Sturnus vulgaris*) are the result of the testes of "one type . . . not regressing so far as the other"[3]. The new generation of Leydig cells remains minute and meagrely lipoidal for a time and is presumably unable to produce sex hormone, while the tubules, clotted with fatty debris, cannot produce spermatozoa: the refractory period begins and the organ will not respond to artificial photostimulation. Meanwhile, a new testis tunic arises, the new Leydig cells manufacture cytoplasmic lipoids which are cholesterol-positive, and the tubule lipoids and their cholesterol begin slowly to disappear. The tubule-clearance rate varies from species to species.

It appears inconceivable that the reservoir of slowly disappearing cholesterol is functionless. We believe that it may be a source of androgens during the post-nuptial summer period while the new interstitium remains comparatively immature. Androgens cannot be stored in the animal body, and so during the period of interstitial inactivity the production of sex hormone should have value in preserving aggressive behaviour in food gathering, the retention of the former place in the peck-order (in colonial species) and so on. Towards the end of the above-described period of reorganization and rehabilitation—the old term 'regression' no longer covers the known facts—the interstitium can once more respond to neurohormonal influences initiated by changes in the environment. As the next breeding season progresses and the tubules ripen, the Leydig cells gradually give up their lipoids and cholesterol, and so spermatogenesis and interstitial exhaustion occur once more.

An investigation of the ovarian changes of a non-migratory wild bird (the rook, *Corvus frugilegus*, L.) has not revealed a corresponding post-nuptial period when the ovary lacks what appears to be the essential apparatus of ovulation, that is, non-atretic follicles and large numbers of cholesterol-positive lipoidal 'interstitial' cells scattered through the stroma. The cycle appears to be as follows. Ovulation occurred in March (in Cornwall) and the successive empty follicles were quickly invaded by blood cells and fibroblasts which built up bands of connective tissue across them. These sometimes converted a single discharged follicle into several scars, making it impossible to determine the age by a scar count as in mammals. At the time of ovulation both interstitial and thecal cells were largely depleted of their cytoplasmic lipoids and cholesterol. While the female was incubating or attending the young, follicles continued to develop and to undergo lipoidal atresia. As the atretic follicles became sudanophil they produced cholesterol and in them appeared numbers of lipoid cells that enlarged and became distributed as interstitial cells through the neighbouring stroma as each old follicle lost its identity. Small patches of hyaline tissue incorporating old and distorted nuclei remained for a time as the only trace of the larger atresias.

Early in May, when the young were about to leave the nest and the male testis tubules were packed with post-nuptial lipoids (Fig. 1), follicle growth to a diameter of about 800 μ continued and each follicle involuted and produced its quota of interstitial cells (Fig. 2). Moulting began in June, and from then until towards its termination (late in September and early in October) the ovary continued active but to a lesser degree. At this autumn period, at a time of resurgent male display and occasional spermatogenesis, the majority of females showed increased activity involving the loss of interstitial lipoids and oocyte growth to a diameter of 1 mm. externally