which extends to a smaller lower chamber not yet completely excavated. Where exposed, the cave walls are covered with stalactites and stalagmites. The grey Upper Cave sediments are largely unconsolidated and are in contact only over a few square metres with the hard red beds and stalagmitic floors capping the *Sinanthropus* strata of Locality 1. Elsewhere the Upper Cave appears to be developed as an independent system.

(2) *Fauna of the Upper Cave.* Though not very abundant, the Upper Cave fauna is remarkably rich in types and includes a puzzlingly large number of almost complete skeletons, the bones of which lie in correct association and are but slightly fossilised. The most interesting forms are as follows:—*Hyæna* (an extinct species very different from that found in the *Sinanthropus* beds but similar to that of Sjara-osso-Gol); *Felis tigris* (entire skeleton); *Cynailurus*, which is now restricted to India (an entire skeleton); *Viverra* (no longer found in North China); the wild ass; *Equus hemionus;* and the deer, *Cervus elaphus* (an entire skeleton), having antlers curiously similar to the special form from Sjara-osso-Gol.

(3) *Human and cultural remains.* In association with this fauna there occur both human skeletal remains and traces of industry. The skeletal remains are of modern type (*Homo sapiens*) and so far comprise two almost complete but somewhat crushed skulls, other skull fragments and teeth, fragmentary lower jaws, bones of the upper extremity (including one clavicle displaying a healed fracture), vertebræ, leg and foot bones. Traces of fire (charcoal and ash) are abundant. There are three stone implements in a beautiful black chert, a well-made scratcher in vein quartz and several flakes and nuclei in vein quartz, and also a needle (eye broken), a deer canon bone worked at both ends, some thirty or more fox canine teeth perforated for necklace, an ornamental cylindrical piece made from a long bone of a bird, and a considerable quantity of oolitic hæmatite probably imported from a considerable distance. So far, no trace of pottery, polished stone or microlithic industry has been encountered.

Conclusions. The material recovered will shortly be made the subject of a full report and the conclusions here offered are wholly tentative. (*a*) The Upper Cave deposits appear to be decidedly younger than the *Sinanthropus* layers of Locality 1, from which they are separated by stratigraphic and lithological disconformity and by a faunistic interval (absence of thick-jawed deer, occurrence of a special *Hyæna*, presence of *C. elaphus*, *E. hemionus*, etc.). (*b*) The Upper Cave deposit is, however, probably also Pleistocene in age (collapsed cave, loess-like sediments, presence of Hyæna; cf. *spelæa*, *Cynailurus*, *Viverra*, *E. hemionus*, special deer, etc.). (*c*) In these circumstances, we are inclined provisionally to attribute the associated human remains to a Late Pleistocene, Palæolithic culture. The latter would seem to correspond approximately to the same stage as the Upper Palæolithic of Siberia and Europe. It appears, however, to be somewhat more advanced than the Ordos industries (Shui-tung-ko and Sjara-osso-Gol) in which no typically worked bones have thus far been found in certain association.

Cynocephalus REMAINS

In a cylindrical solution cavity about a metre in diameter in the limestone to the south of Locality 1, Mr. M. N. Pien discovered this season a considerable number of fossil bones imbedded in a peculiar red deposit containing a large proportion of small well-rounded pebbles. These bones are remarkably fossilised and heavy, many of them being water-worn and rounded. A few, however, are well preserved, among the latter being several teeth and limb bones of a large baboon, probably *Cynocephalus wimani*, Schlosser. Strikingly similar deposits containing the same type of heavy rolled bone fossils have already been encountered at the very base of the *Sinanthropus* deposits of Locality 1 (Lower Cave). At the present stage of excavation it remains an open question whether or not these beds represent a pre-Choukoutien stage or merely correspond to an early phase in the last filling of the clefts.

In any case it would seem that one must conclude from this latest discovery that the Choukoutien fissures have been successively inhabited by baboons, by *Sinanthropus* and by a modern type of *Homo*. However, such a coincidence appears less extraordinary when it is recalled that though Ordovician limestone is widely distributed along the Western Hills, at Choukoutien, on account of its low anticlinal structure at the borders of the plain, it is exceptionally well situated for dissection into fissures and caves.

Obituary

PROF. J. JOLY, F.R.S.

JOHN JOLY came of a remarkable lineage. His father's grandfather was a member of a French noble family. His mother, a German countess, whose family had been ennobled by Frederick the Great, was descended from Greek, Italian, and English ancestors. This mixture of blood, perhaps, may explain his ready sympathy with the most diverse personalities, his princely generosity which often gave to others what he denied to himself, and his versatility which enabled him to prosecute research in so many fields of knowledge, and to obtain æsthetic pleasure in the realms of art, literature, music and science.

Joly's earliest papers were mostly occupied with mineralogy. The beauty of the colour and form of minerals had a marvellous attraction for him. In this period he wrote on the ash of Krakatoa, beryl, iolite and harmotome. Investigation on these minerals led him to devise the meldometer and apophorometer, by means of which he determined the melting points of minerals with the greatest accuracy, and was able by volatilisation to reveal their constituents in a much more elegant and delicate way than by the blowpipe. About this time also he devoted some attention to the problem of accurate photometry and devised the well-known diffusion photometer. Next followed the invention of the steam-calorimeter, which not only enabled him to determine with greater accuracy than ever before the specific heats of minerals, but also put into the grasp of his imaginative mind the power of determining directly the specific heats of gases at constant volume. In this way he solved an experimental problem which had the highest importance in molecular theory. In 1892, doubtless in recognition of this achievement, he was elected to the Royal Society.

By a beautiful novel method Joly obtained the volume change of rocks and minerals on fusion, and so contributed accurate and important data to geophysics. His experiments with electrically heated furnaces enabled him at a very early period to isolate aluminium from aluminium silicates, but unfortunately a discouraging word from a senior deterred him from publishing the result, and so others obtained the credit for this method of reducing the element. During this period, photographic work became absorbingly interesting to him, and he investigated the relation of the sensitivity of the photographic film to temperature, and suggested the electronic theory of the latent image. He invented shutters for use in stellar photography and a photographic method for the detection of variable stars. But in this field his most arresting invention was the method of colour photography by which he rendered it possible for the first time to reproduce with accuracy on a single transparent plate the colours of Nature. At about the same time, his attention was directed to Lowell's observations on the canals of Mars. Contrary to the received statements that these markings on the surface of the planet were all portions of great circles, Joly perceived that this was not the case, and he showed that all could be traced by moons rotating near the surface of the primary, and so propounded a rational physical theory. Another essay of astronomical bearing, startling alike in its imagination and literary style, is his "Theory of the Prematerial Condition of the Universe."

Biological speculations frequently kindled Joly's imagination, and in essays on the bright colours of Alpine plants, and on the abundance of life, he made contributions to biological philosophy which are too often neglected. In collaboration with one of the writers of this notice, he formulated the cohesion theory of the ascent of sap, and devised and carried out several novel and beautiful experiments with plants. Here also should be mentioned his speculations on the connexion between cosmic rays and cellular evolution, morbid and normal.

Time and again Joly returned to his first love of mineralogy and geology, and his work on the thermal expansion of the diamond, the action of the ions of sea-water in sedimentation, and the influence of pressure on the order of formation of minerals in igneous rocks, ingeniously made use of physical principles for the solution of long-standing problems. Experiments on solvent denudation led him to formulate his method of determining the geological age of the earth by the sodium content of the ocean. The period yielded by this method in its early stages is now generally considered to be an under-estimate, but it must be remembered that, at the time, it materially and rationally extended the much more crippling estimate of the earlier physicists. In this connexion may be mentioned the attractive spell the sea exercised on his mind, and while he sailed in small boats or in large ships, geological problems were not the only ones which occupied his thoughts. In these surroundings he devised a method of observing the altitude of a celestial object at sea during night-time, or when the horizon is obscured; he devised the collision predictor and synchronous signalling, an explosive sounder, two types of borers for obtaining samples of sediments and rock from the sea bottom, and floating breakwaters whereby the energy of the breaking waves is transformed into turbulent movements round the keel of a floating vessel.

It is, however, in the field of the application of the heat-producing properties of the radioactive elements to geophysical problems that Joly did some of his best-known work. So early as 1903, when Pierre Curie and Laborde first definitely established the continuous heat-production of radium, he pointed out the importance of this fact in geological science and its bearing on Lord Kelvin's view of the age of the earth, which was based on thermal considerations. The first actual detection of the wide distribution of the radioactive elements in terrestrial surface materials was due to the present Lord Rayleigh in 1906, but afterwards Joly and his pupils devoted much attention to this problem, and measurements on materials from most parts of the globe have been made in his laboratory. In 1909 he devised his method for the measurement of thorium in a rock, a problem previously unattacked, and in 1911 his well-known furnace method of determining the radium content of a rock.

Joly's early views on the effect of radioactivity on earth history are contained in his book, "Radioactivity and Geology" (London: Constable and Co., 1909). His theory of the production of pleochroic halos by α-ray disintegration also dates from about this period. In conjunction with Lord Rutherford he devised a new method of deducing the age of the mineral containing the halo, which gave results for geological ages more in accordance with the other radioactive methods than his previous method based on solvent denudation. In subsequent years he expended much time in further investigation of these halos, obtaining many interesting results, among which may be mentioned his discovery of an unknown radioactive element, which he provisionally named hibernium. During the past year, this element has been shown by G. Hevesy and M. Pahl to be samarium.

Joly's general interest in all radioactive problems, and his great sympathy with human suffering, led to the foundation of the Irish Radium Institute by the Royal Dublin Society in 1914. He was both the originator and strong advocate of this Institute, and its present highly satisfactory condition is largely due to him. Among those to whom Joly was personally known, it would, we think, be unanimously agreed that, of all his many activities, this was the one nearest his heart, and for which he would best like to be remembered. The so-called Dublin method of using radon in fine capillary glass tubes, which can be placed inside hollow metal needles, was first developed by him, and his life-long friend, the late Dr. Walter Stevenson. This method of using radon and not the actual radium salt has always been employed at the Irish Institute, and has also been adopted at many other centres. To the end, his interest in radium therapy never failed; some of his most recent papers, read before the Royal Dublin Society, deal with improvements in its technique. These include the use of native radioactive powders and a mechanical means of focusing γ-rays on deep-seated tumours.

During the War, Joly devoted his attention to various technical problems. At its conclusion, he returned to the study of radioactivity, and was among the first to attempt the separation of the lead isotopes by physical methods. Later he became interested in the problem of vision, and developed a theory of colour vision based on the quantum theory of photoelectric emission and the physiological structure of the retina. In 1923 he was asked to determine the radioactive contents of some South African rocks, and this led him to a reconsideration of the effect of radioactivity in geological history. From this sprang his theory of thermal cycles, which he has so brilliantly presented in his book on the surface history of the earth. The publication of this work is a landmark in the advance of geological science, focusing, as it does, the attention of geologists on the enormous importance of radioactivity in earth history, and giving a rational explanation of the succession of revolutions and geological strata. His subsequent work, mostly carried out in conjunction with one of the present writers, was largely devoted to further radioactive measurements, in the course of which the very low radium content of the eclogites was established, a fact of great interest in geological theory.

John Joly was born in Hollywood, King's County, in 1857. His early education was obtained in Rathmines School. In his school-days, which for various reasons were short, apparently he attracted no special attention in the usual educational tests, but won great popularity among his fellows by his powers of narration and the original tales which he contributed to the school magazine. While at Hyères, where he went for his health, he constituted himself 'foreign correspondent' and published many notes on the natural history of the south of France. Owing to these activities, he acquired among his school-fellows the title of 'the Professor', a title by which he was always known among his oldest friends.

In college Joly was omnivorous in his reading, but always refused to be limited by examination courses, and so it happened that while he studied physics, chemistry, mineralogy and modern literature with zeal, his only academic distinction was first honours in English literature. In the engineering school, however, his soundness and originality were recognised and he was placed at the top of the list in all subjects at the B.A.I. examinations. After his degree he held minor posts in the engineering school and in the school of physics, and while still FitzGerald's assistant, he had already attracted attention by his early inventions and researches in mineralogy and calorimetry. In 1897 he became professor of geology at Trinity College, Dublin, and though he received many offers of more lucrative posts, he remained until his death on December 7 last a Trinity man. Throughout his career, he kept in close contact with the students, and formed and accomplished many schemes for increasing undergraduate amenities. He was keenly interested in the scientific development of T.C.D., and was the originator and secretary of the science fund whereby T.C.D. acquired the present schools of physics and botany, with their equipment and most of their endowment. The special research endowment of the school of geology by the late Earl of Iveagh was a recognition of his personality and distinction as an investigator. He acted for many years as secretary to the Academic Council and was a member of the Board of T.C.D. In 1919 he was elected to a fellowship in the College.

Outside his College also Joly had many activities. He was successively member of council, secretary, vice-president and president of the Royal Dublin Society. He contributed many papers to its *Transactions* and *Proceedings*, and interested himself in every way in its welfare, and in forwarding its aims. He was warden of the Alexandra College and was one of the delegates of the Balfour Educational Mission to America in 1918. On the Board of Irish Lights he was one of the most active commissioners, and delighted to put his scientific knowledge and inventive mind at its service. He was also a governor of two Dublin hospitals. In his earlier days he was a keen Alpine climber, and yachtsman, and many of his researches were planned and his philosophical and speculative writings discussed with his companions on these expeditions. His fundamental method of treatment, his extraordinary originality and intellectual fertility, and his æsthetic appreciation of Nature made these conversations unforgettable by those who had the good fortune to be with him.

HENRY H. DIXON.
J. H. J. POOLE.