the stratigraphical horizon of a rock seen in a natural or artificial exposure. From the observations and investigations so made, a geological map can be constructed in the usual way, and the geological structure of the region can thus be determined.

Besides this use in mapping and the location of tectonic lines in an area, the Foraminifera are also useful in connexion with the sinking of wells. In boring to the known oil-bearing stratum, samples of the core are taken at frequent and known depth-intervals, and examined for the Foraminifera, so that a continual check is kept on the depth to which the shaft is to be sunk. Such palæontological observations will also indicate quickly when the productive stratum has been passed (for example, in a fault), or when the well is placed too far from the crest of the oil 'trap' so that it will strike water and not oil (see Fig. 1). The saving in expense by the rapid recognition of the futility of further boring on those sites is obvious.

Further, great wastage of oil has occurred in some fields in the past, because 'gushers' have burst out before it was considered necessary for steps to be taken to prevent this loss. But this has been largely obviated by the sampling of the cores, the Foraminifera giving a sure indication of the horizon reached and therefore of the distance above the oil-bearing stratum. In one field, for example, one species makes its appearance (in the descending series) at a relatively short distance above the reservoir rock, so that its recognition in the core-sample gives the indication that the drill has nearly reached the reservoir rock and that precautions must be taken to prevent loss from the oil 'gushing' on further boring.

It will be seen from the above that the smaller Foraminifera can be used to determine the age of the rocks yielding them, and so, by detailed field collecting and investigation, to unravel the geology of an area. When this has been done, then the knowledge so obtained can be used to determine the best sites for drilling for oil, if oil is present in the area. But there is no causal connexion between the Foraminifera and oil—the presence in an area of a given foraminiferal species, or foraminiferal fauna, or foraminiferal zonal series, is no indication of itself that oil is present, though that, however, is a widely-held misconception.

It is knowledge of the detailed geological structure which is of crucial importance in an area known to be petroliferous. But the Foraminifera, if intensively collected and the results from innumerable rock-samples carefully analysed, often supply the key to the problem of the determination of that structure.

A POSTSCRIPT UPON THE "ORIGIN (AND DEVELOPMENT) OF SPECIES"

By Edward Heron-Allen, F.R.S.

In the foregoing article Dr. Dighton Thomas has efficiently dispelled the somewhat widely-spread illusion that Foraminifera, *per se*, especially certain genera and species, indicate the occurrence of mineral oil at a given depth. There are certain ascertained phenomena which indicate the presence of oil in a district, and it is when the 'show' has been observed and noted, that the importance of the Foraminifera to the 'petroleum geologist' becomes apparent. A word of warning to the young geologist, who has now become a necessary official attached to every petroleum company of any importance, should perhaps be added: Let him firmly ignore what Earland has rightly called "the spate of literature" and I have called "the proliferation of nomenclature". The industrious Dr. Hans E. Thalmann has recorded three hundred and eight papers on the Foraminifera published in the years 1931 and 1932, and to these may be added scores of later papers noted in the "Zoological Record" and in the lists periodically published by Dr. Cushman since that date.

What may be called 'the Commercialisation of Protozoology' has, however, had one beneficial effect—a blessing in a deplorable disguise—and that is that there would have been as many papers again published, were it not that the Foraminiferal fauna of a given district have risen—or fallen—to the rank of a trade-secret, and many oil companies jealously guard their zoological records (and even specimens of material from their bores) from the prying eyes of rivals in the trade.

The shattering fact has already been recorded in these pages*, that of recent years the number of genera forced upon protozoology amounts to five hundred and fifty-eight (not counting sub-genera), whilst as regards species the brain simply reels. It is not humanly possible to keep track of them, but anyone who pays any attention to the literature of Foraminifera gradually realises that professional rivalry has something to do with it. Profs. A, B and C are the recognised authorities of as many rival schools of foraminiferal research, which appear to race one another in the recording of new species (and even genera) and each school is ready to swoop, vulture-like, upon the announced discoveries of its rivals, and to pick them to pieces, fondly imagining that students will collect for themselves a new working nomenclature out of the *disjecta membra* left after their attacks upon one another.

I enjoy being 'howled down' by the spokesmen of the advanced schools of petroleum geologists,

* Heron-Allen, NATURE, 134, 43, July 14, 1934.

and I continue to advise the young men, who recurrently visit our collections at the Natural History Museum, to revert boldly to the bygone nomenclatures (condemned by some) of the great *scientific* Foraminiferists, who died in peaceful ignorance of the pending effects of commerce upon their study—Parker, Jones, Brady, Millett, Williamson in our country ; d'Orbigny, Berthelin, Schlumberger, Terquem in France ; Haeusler, Karrer, Reuss, Schultze in Germany ; Costa, Fornasini, Seguenza in Italy—to mention only the names which spring to the memory at once.

The works of these giants will tell them all they need to know. Let them fix this sound *corpus* of genera in their minds, and distinguish the variations of species by numbers, each for himself, species that they will recognise as their own old friends in every district which they have to examine and report upon.

When their work has been done and borne fruit in the form of adequate remuneration, let them if they like—and are allowed by their board of directors to do so—hand their 'mounts' on to the pupils of Profs. A, B and C, and let them fight it out *They* need not bother about it any more—taking the Omarian advice of the late Aurelius D. Godley :

"The moving Finger writes ; then, having writ,
The Product of your Scholarship and Wit
Deposit in the proper Pigeonhole—
And thank your Stars that there's an End of It."

Obituary

Prof. Hugo de Vries, For.Mem.R.S.

BY the death of Hugo de Vries, on May 20, at the age of eighty-seven years, biology has lost one of its outstanding figures in the history of the last century. He proved himself a master of plant physiology in the period 1870–85 when that science may be said to have had its modern beginnings ; but the problems of evolution held his attention from the time when, as an undergraduate at Leyden, he read a German translation of the "Origin of Species". The transition from experimental physiology to evolutionary theory took place with the publication of his "Intracellular Pangenesis" in 1889, but his earlier work no doubt made it easy for him to introduce experimental methods into the investigation of evolutionary problems.

The range of de Vries's early physiological researches may be indicated by series of papers on such topics as the permeability of protoplasm, the movements of climbing plants, contractile roots, the germination and growth of such crop plants as red clover, potatoes and sugar beets, the reactions of *Spirogyra* and *Drosera*. A series of investigations on food plants were done for the Prussian Ministry of Agriculture while a student with Sachs at Würzburg.

In his classical researches on the mechanical causes of cell stretching in plants (1877), de Vries introduced the plasmolytic method, determining the osmotic pressures of cells and developing the conception of isotonic coefficients. In 1884, by comparing the plasmolytic effects of many isosmotic solutions, he was able to show that the osmotic pressure depends on the number of molecules in solution. He also used these methods to determine the molecular weight of raffinose. This work formed the basis for the laws of dissociation in dilute solutions, with which the names of the physical chemists Van 't Hoff and Arrnenius are connected.

The intracellular pangenesis was an important development of Darwin's earlier theory of pangenesis. In it de Vries related theories of heredity and development to the increasing knowledge of cells, and put forward the view which modern work has proved to be correct, that every nucleus of the organism contains a full representation of the hereditary materials. In that work is clearly stated the conclusion that "hereditary qualities are independent units, from the numerous and various groupings of which specific characters originate", and for these units he adopted the term 'pangen'. This anticipation of the modern theory of the gene in all its essentials was a masterly triumph of clear thinking—especially when we remember its date, 1889.

In the same work de Vries criticised the views of Weismann, especially as regards his theory of the idioplasm and his idea that a sorting out of germinal materials takes place in different types of somatic nuclei. The influence of these erroneous views would have been avoided had contemporary zoologists been able to recognise that Weismann's elaborate architecture of the germplasm held less truth than de Vries's simpler but better founded theory. The two authors agreed, however, in denying the inheritance of acquired characters.

In the same year (1889) the publications with what we would now call a genetical bearing were begun, with papers on sterile maize plants and on the inheritance of twisted stems. This was followed during the next decade by a stream of papers on similar subjects. From now onwards, heredity and variation claimed the whole of de Vries's interest, yet the problems were viewed from the first with an experimental background.