tion and only about two-thirds of the registered patent agents are members.

The recently published work by Prof. A. M. Carr-Saunders and Mr. P. A. Wilson* on the growth and position of the professions, on which the above remarks have been based, is a welcome and valuable attempt to fill a serious gap. The first part gives a survey of the present position of the recognised professions and of other occupations with more or less definite claims to be recognised as professions, and forms an invaluable reference work with regard to qualifications, numbers of practitioners, salaries or positions obtainable in a wide range of professions.

Special interest is attached to the sections dealing

* "The Professions". By A. M. Carr-Saunders and P. A. Wilson. Pp. viii+536. (Oxford: Clarendon Press; London: Oxford University Press, 1933.) 25s. net.

with architects and with teachers, one on account of the recent efforts to obtain a registration which issued in the Architects (Registration) Act of 1931, the other on account of the growth of unity in a profession formerly separated by deep-seated jealousies and also on account of the influence of widespread State employment leading to what is in effect a State register of teachers. So, too, the analysis of the conditions which led to public accord of professional status to the civil service and to local government service, and of those again which prevail in the mercantile marine or among mine managers, are invaluable to all scientific workers who seek to understand the place and functions of professionalism in modern society and to assess the contribution which registration can offer alike to the advance of the professions or of the State they serve.

Taxonomy and Evolution

By DR. W. H. LONGLEY, Marine Biological Laboratory, Tortugas, Florida.

TEN years ago Dr. J. C. Willis developed in his work "Age and Area" his discovery of the existence of an unexpected order in Nature revealed by statistical analysis of selected data of taxonomy. Prof. Bateson expressed keen appreciation of this discovery in a review of the work in NATURE¹. The sign of order represented was, in Bateson's judgment, highly significant and is the central fact to which the present contribution is related.

In the great natural groups of organisms—the larger families and orders—the statistical distribution of genera by size is approximately the same in all cases; or, to put it in other words, the curve of genera plotted against the number of their species is always of the same general form. This suggests at once that the process of evolution occurs according to law. Indeed, only if the naturalist's conception of genera and species is without justification in the order of Nature itself, or if his classification of material given by Nature is grossly inadequate, may the direct inference be avoided. But, letting the necessary inquiry this suggests rest for the moment, is there independent reason for supposing the process of differentiation of genera and species of organisms may occur according to law?

Manifestly such law as is suggested by Dr. Willis's discovery is one of a statistical sort, a description of the outcome of the evolutionary process as a whole and without regard to detail—a law, indeed, of the general order of the gas laws of physics, where the individual is quite lost to sight. If it be urged that such laws do not deal with underlying truths, it may be admitted at once that they are not exhaustive accounts of the events in systems of which they treat: but they are still laws, and laws, too, of a high order of importance.

The laws of gases (with similar statistical laws)

have, in fact, served as the foundation, from one point of view, of our modern industrial civilisation, with all that it entails. If to know how things go, on the whole, with molecules in the gaseous systems they compose, has shown itself so significant a matter, we may believe that the like knowledge of what is involved in the making of genera and species will justify itself. It requires no lively imagination to foresee some of its effects upon our thought, where its important application will chiefly lie.

To consider the gas laws further: these are generalisations empirically established and the basis upon which the kinetic theory of gases rests. It is from them that we derive our idea that the normal gas is a system of ultra-microscopic particles, active and acting at random, incapable of reproduction and variation, capable of exerting an influence upon one another measurable at last as pressure against the weight of a column of supported fluid.

Now clearly there is no theoretical reason why there might not be systems of units differing from molecules in few or many respects, but still active and acting on one another at random, and on that account having among their laws some of the form of the gas laws. Such systems might be composed of macroscopic, as well as of ultra-microscopic units, units capable of exercising some other influence upon one another than that measurable after the precise fashion of gas pressures, units capable of varying or of increasing their number by some sort of reproductive process, or of at once reproducing and varying.

To express such ideas is only to suggest that the kinetic theory of gases is capable of generalisation, and of being applied, *mutatis mutandis*, to a variety of systems, real or imaginary: call them 'kinetic systems', systems the units of which, whatever they may be, are active and act upon others of their kind at random.

Such systems as are proposed do, in fact, exist. 'Glowing gases' are an example. These obey the gas laws but their units are variable. Defective as it may be in detail, Bohr's schematic representation of the structure of the atom and of what is involved in the absorption and release of more or fewer quanta of energy has made this a matter of common knowledge. More still, if the atom's power to vary is exercised, so to speak, under the control of pressure in the glowing gas, the law of distribution of energy in the line spectrum will—when it is made out—prove to be one from which, if it had been first formulated of gas laws, Boyle's, Avogadro's and others might have been derived by inspection. It will be the master-law of the system.

Populations of a single sort of organism, growing under such conditions as are maintained for determining their law of increase, are also kinetic systems in the sense defined. Their law of growth is a master law from which laws of the form of the gas laws may be derived by inspection². They are clearly systems of units, active and acting at random upon one another, but macroscopic; for practical purposes incapable of effective variation within the life of the experiments; capable of reproduction, and exerting an influence upon one another measurable as an effect upon their proportional rate of increase as they grow.

To avoid the inference, it is necessary to disprove the premises from which it is deduced by logical process. In an attempt to invalidate the law of growth of populations, it is as little to the point to refer to unanalysed experience in the field as it would be to cite the wavering course of a mote in the sunbeam in contravention of the laws derived for bodies falling *in vacuo* under the influence of gravity. In each case advanced as exceptional, the fundamental law is undoubtedly momentarily obeyed.

Evolution is the process of differentiation of a compound population, a population composed of more than one sort of thing, one in which the unit is not the individual but a natural group of individuals related by descent. So Dr. Willis's

discovery suggests only that besides the three sorts of kinetic system definitely recognised—and with recognised laws—there is a fourth, the compound population, of which the characteristic process of differentiation also occurs according to law, the master law of this kind of system.

To reach a final decision regarding the soundness of these suggestions, one may first validate the taxonomist's conception of genera and species as groups objectively existing³. The empirical curves of genera plotted by size may then be determined as accurately as possible. In course of this work, it appears that in no great group of organisms are known species a representative sample of the world population⁴. The curves therefore change as knowledge grows respecting the groups to which they individually refer. But as they change, they tend to assume the same limiting form, which is a function of the curve of normal frequency.

Space does not permit the argument to be carried here to its logical conclusion. This requires that it be shown that the curve derived from analysis of the data of taxonomy is what theoretical considerations indicate it should be. But even if it be left for the moment an open question whether the law of evolution is the law of differentiation of a particular sort of kinetic system, the existence of the law as such justifies the confidence expressed in the validity of the species conception one finds so commonly in some sense in the writings of systematists, and nowhere more plainly than in contributions by the scientific staff of the British Museum (Natural History).

The light it throws upon existing order in Nature—specifically in the matter of evolution—establishes taxonomy as a science, its place among the biological sciences being comparable to that of astronomy among the physical sciences. It deals with the products of a process as nearly cosmic, as nearly transcending the resources of the experimental method, as anything biology knows.

¹ NATURE, 111, 39, Jan. 13, 1923.

² Science, 75, 248-250, Feb. 26, 1932.

³ Proc. Linn. Soc. Lond., April 6, 1933.

⁴ Science, 73, 700-702; 72, 141. Proc. Sixth Int. Congress Genetics, 2, 120-123; 1932.

Iraq Petroleum and Pipe-Line

AS M. Victor Forbin so graphically explains in a recent article on "Le Pétrole de Mésopotamie et son Pipe-Line" (*La Nature*, No. 290, pp. 253-262, March 15, 1933), the petroleum industry of Iraq is historically the oldest and commercially the youngest in the world. In spite, however, of sundry biblical and legendary references to natural resources, negotiations for the acquisition of oil land were not opened until the beginning of this century, and no definite concessions were granted until 1928, when the Iraq Petroleum Co. was founded. Even at this stage, further development of the petroleum industry in Iraq was not assured, for it had yet to be discovered whether the seepages were in fact indicative of

untapped resources or merely the dregs of ancient pools.

In 1925, twelve enterprising geologists of various nationalities set out on an expedition to Iraq. Undaunted by extremes of temperature, hostile attacks from nomadic tribes and the numerous problems of structure peculiar to that country, they selected ten sites for testing purposes. The first well drilled in one of these sites, Baba Gurgur, near Kirkuk, was the scene of a great disaster. The boring unexpectedly pierced a dome, of which there had been no surface indication, and liberated a gusher of oil which had finally to be diverted into channels and set on fire in order to prevent further catastrophe. Additional precau-