The Experiment Station Record reports that an Agricultural Research Institute of Rumania was established under a law enacted in 1927 and formally organized in 1929. It now contains sections of phytotechny and phytogenetics, chemistry, phytopathology and rural economics, and it is expected that these will be supplemented with sections on animal production and rural engineering. It has also taken under its direction the Central Agronomic Station at Bucharest; the agricultural chemistry, agricultural technology, seed control, and medicinal plants stations at Cluj; the phytopathology station at Chisinău; the newly established machinery testing station at Bucharest; the agricultural plant improvement and experiment stations at Jassy and Cluj, and agricultural experiment stations at Mărculesti and Tighina.

VISITORS from twenty-one foreign countries registered at the Petrified Forest National Monument in Arizona during the month of April, according to an announcement made by the Director of the National Park Service of the Department of the Interior. The countries represented were: Australia, Austria, Canada, Czecho-Slovakia, Denmark, England, France, Germany, India, Indo-China, Ireland, Italy, Japan, New Zealand, Norway, Poland, Singapore, Spain, Sweden, Switzerland and Venezuela. Visitors from every state in the union and from the District of Columbia also registered at the monument. The Petrified Forest National Monument is an eroded deposit of petrified logs said by scientists to be nearly two hundred million years old. Many of the petrified tree trunks found in the area are more than 100 feet in length. The indications are that some of these trees must originally have attained a height of more than 200 feet. Many interesting features of this ancient deposit of great tree trunks, cross sections of which reveal every color in the rainbow, have been uncovered by the work of erosion. One petrified log, originally embedded in sandstone, forms a natural bridge, erosion having scooped out a small arroyo under the log. One of the three divisions of the area is called "Rainbow Forest," and chips of agate, onyx, carnelian and jasper are scattered over the ground in every direction.

THE Bird Sanctuary Committee of the Selborne Society, England, has made an urgent appeal for help in safeguarding the Brent Valley Bird Sanctuary, according to a report in the London *Times*. The founding of this reserve, the first of its kind, by the Selborne Society in 1902 set an example which has been widely followed, as the numerous nature reserves now in being attest, and many bird lovers wishing to make small sanctuaries of their gardens have been supplied by the society with boxes like those designed for the Brent Valley Sanctuary. In 1920, the bicentenary year of Gilbert White, of Selborne, the sanctuary was bought as a memorial to the father of British field natural history. The amenities of the Brent Valley Sanctuary will be safeguarded on the north and east by the welcome decision of the Middlesex County Council to keep adjoining fields as an open space. On the west, however, a factory has recently been built. Two fields on the south and south-east are now scheduled as factory sites, and unless the Selborne Society can buy them by June 1 the land will be sold. It is for the purchase of these fields on the south and south-east of the reserve that the Bird Sanctuary Committee is appealing. Most of the land in question, it is stated, could be used for playing fields if some benefactor would come forward in time to save it. For some time past the society has been trying to raise the necessary sum, but it still needs nearly £1,400 to secure the smaller field or £5,000 to secure both. The address of the honorary secretary is The Hermitage, Hanwell, W. 7.

DISCUSSION

EVOLUTION A DETAIL IN THE DYNAMICS OF POPULATIONS

As has already been pointed out,[1] known sorts of organisms are not a representative sample of the world population of species in their respective families and orders. The statement rests upon analysis of the taxonomic record of living Chiroptera, Ophiuroidea, Crinoidea, Decapoda and Cactaceae. The relative constancy of form of the curve of genera plotted by size in such groups permits the extension of the conclusion to the living world in general.

Two facts explain why matters stand as they do. First, the ranges of species of great genera are larger upon the average than those the species of lesser genera occupy. Second, collectors are impressed by the novelty of species of the smallest genera and, when working in the field, spare no effort to secure specimens.

As a result, in groups where the prevailing method of collection is mechanical, as it is when tow-net, dredge or trawl is employed, the greater genera are over-represented in the haul. But, in groups where the collector's psychology determines in part what shall be turned in for study and naming, genera least and greatest in size are both over-represented; and

[1] SCIENCE, lxxii, 1858, 141, August 8, 1930; *Anat. Rec.*, xlvii, 3, 350, December, 1930.

others too large to permit their species to enjoy the one, and too small to allow them to enjoy the other advantage extremes profit by, are under-represented.

When this fact is recognized it becomes plain that the distribution of no peculiarity in the known sample certainly corresponds with its statistical distribution in the grand total of species. But, as the sample moves inevitably toward the total as its limit, all calculated distributions of attributes in it move toward actual distributions in the whole as their respective limits.

Now upon investigation it appears that the limiting form of the curve of genera plotted by the number of their species is a function of the normal curve. Pursuing this clue one finds that in all large natural groups of organisms, with whatever ability to maintain itself in the world the family or ordinal ancestor may have been endowed, the living species sprung from it have normal frequency distribution of the like ability. It is determinable also that though the species of small genera have on the average, when world population is considered, less ability than those of greater, in all local faunas and floras groups of species assorted by world size, or by local size of the genera to which they belong, have the same average ability to spread.

In the relations existing within systems of species one thus discovers the equivalents of dynamic relations holding within systems of molecules free to move. Both sorts of system show a tendency to attain a "normal state," to which they are bound to return after whatever disturbance. In each, for a given energy content, there is a single normal state attainable. In molecular systems in the normal state there is normal frequency distribution of component velocities along each of the three axes with respect to which actual velocities are conventionally resolved. Finally, in the inorganic system and the systems of species compared with it there is equipartition of energy among the different capacities to receive it.

This means that all that interplay of action and reaction which occurs between species and species, and between species and environment, and passes as a whole under the name of "struggle for existence," proceeds with an order as definitely predictable in its outcome as that manifested in a gaseous system under the terms of kinetic theory.

A kinetic theory of species is, indeed, as completely justified as a kinetic theory of gases, but before proceeding further we must for a moment consider a related matter, the mode of growth of populations.

As Pearl and Reed,[2] and Pearl and others have shown, the process, whether in cultures of yeast and bacteria or in human populations, follows one law. This may be stated as follows:

In an environment of which the limited resources are constantly renewed every population tends momentarily to be augmented by a fraction which diminishes as the attained fraction of the limiting population increases.

But populations may not increase so, unless they are in fact as sensitive to fractional increases in population pressure as the formula requires. It is astounding, but a fact, nevertheless, that the measure of difficulty the generation of 1790 had in rearing its children in America should have gauged accurately the ultimate and largely unutilized resources of so great a country. Each later generation, however, so far confirms the ancestral experience.

The only factor of known power to modify the curve of a population's growth effectively is the exhaustion of resources, as Pearl has shown in experimental cultures of Drosophila, or the utilization of new resources, as when a population turns rather abruptly from agriculture to industry for its support. In either case a new maximum is set for the limiting population against which fractional increases are measured. That is all.

It is a fact of profound significance that the curve of population growth in the United States is unaffected permanently by the varying rate of immigration. From census to census the effect is *nil*. When a nation's resources permit a definite increase in the number of its people in a prospective unit of time, that increase and no more tends to be attained, whether or not the resident population be augmented in any degree by immigration.

In a mixed population the pressure equals the sum of the partial pressures, and the increase in pressure in the total population as it grows is equal to the sum of the increases in the partial pressures of its several components.

To say that the slope of the curve of population growth is a function of the limiting population, and has nothing to do with immigration, is simply to put the same fact in other terms. The steeply rising curves of population of the United States and of Russia, as contrasted with other less favored regions, merely reflect the richness of those countries' resources.

The effect of the law of partial pressures is evidenced again in the negative correlation between death-rate and birth-rate.[3]

Now grant molecules of any gas at zero pressure the power of producing others like themselves at a

[2] See Raymond Pearl, "Biology of Population Growth," Knopf, 1925.

[3] G. Udny Yule, *J. Roy. Statistical Soc.*, lxxxviii, January, 1925.

rate determined by their inherent energy only. Let the power of increase fail by the attained fraction of a limiting pressure fixed in the beginning. Then the increasing number of molecules plotted against time will follow the logistic curve. And the addition of molecules from without, or arbitrary changes in the limiting pressure, will induce just such changes in the form of the curve as are registered by actual populations comparably treated. So we see why the growth of populations, human populations included, is subject to laws as little varying and in kind scarcely differing from the gas laws. Populations are simply more complex kinetic systems than physics usually deals with.

Large groups of species related by descent are kinetic systems even more complex than simple populations. They are populations of populations. Species are their elements. These elements are endowed with inherent energy and react with one another at haphazard in an ever-changing environment. The dependence of their mutual adjustments upon the law of chance is revealed in every detail of the equilibrium they momentarily maintain.

In gases, then—simple populations of organisms and populations of the second order—we have a series or hierarchy of kinetic systems of increasing complexity. The gas laws are the characteristic laws of the simplest of the three. The law of population growth expressed by the logistic curve is the new and distinctive law of the intermediate system. But the analogues of the laws of the lower system are inherent in this distinctive law of the higher. We may read them off by inspection:

The population pressure within a group of fixed size varies inversely with the volume it occupies in a uniform medium capable of affording support to a limiting population of definite size per unit volume.

In a uniform medium in which the diffusion of a particular sort of organism is rapid in comparison with its rate of reproduction, while the limiting population remains the same, equal volumes under the same population pressure include the same number of individuals.

The analogy between these and the gas laws they respectively suggest is due to the fact that the simplest gaseous systems and simple populations are each composed of elements of one sort, inherently energetic and attaining a stable state through the play of energy upon energy under the law of chance. That the higher system possesses its distinctive law is due to the fact that its units have one property or capacity significantly different from those of units of the lower. This is their capacity for multiplication at a rate dependent upon the attained fraction of the limiting population.

As the analogues of the gas laws are inherent in the law of the logistic curve, it remains to say that the law of the logistic is itself inherent in the law of evolution expressed graphically by the function of the normal curve so often mentioned. It is the power the new unit, the species, possesses—of variation for better or worse—which makes the new system with its new law possible. But with the new law of the highest system the laws, or analogues of the laws, of the lower prevail too. So in a very real sense evolution, stupendous phenomenon as it is, is a detail in the dynamics of second-order populations.

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NECESSITY OF ORGANIC MATTER FOR THE MAINTENANCE OF AN AVAILABLE SUPPLY OF PHOSPHORUS IN THE SOIL

LABORATORY and field tests of the Louisiana Experiment Station indicate that the greatest problem of the upland soils of the South is of keeping the soil phosphates sufficiently available for the growing of cotton, even with the application of soluble phosphate fertilizers to the soil. It has been found that organic matter is more important from the point of keeping soil phosphates sufficiently soluble for plant growth than from any other point or points. With the depletion of organic matter, the soil phosphates as well as those added become less and less effective. The benefits ascribed to organic matter in the literature are indeed very important, but the rôle of the organic matter in keeping the soil phosphates sufficiently soluble for plant growth overshadows them all.

The problem of keeping the soils of the South in a high state of fertility is one that requires a program of farming that embodies the practice of green manuring in combination with the applications of the required plant foods. In soils depleted of organic matter even heavy applications of soluble phosphates do not have the desired effect. It is only with very heavy applications that a sufficiently high level of available phosphorus is maintained. In soils low in organic matter and high in the sesqui-oxides, the solubility of the phosphates is too low for the maximum growth of plants. It has been suggested that the soluble phosphates be applied in narrow bands to avoid immediate complete reversion, and this practice has given promising results. However, there are still some undesirable features to be worked out in such a practice. The less soluble phosphates, as precipitated tricalcium phosphates, have been suggested, owing to their slower rate of reversion. From a theoretical consideration they should give some promise.

It appears that the full fertilizer value of mineral nitrogen and potassium fertilizers can be obtained in