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

the absence of organic matter, more nearly so than with phosphorus.

In this connection it is of interest that the successful production of bananas is closely associated with available supply of phosphorus. Bennett's suggestion of pH is only correct in as far as the desirable pH is incidental to a high available supply of phosphorus.

The problem of the South and the Tropics of maintaining the fertility of their soils is one of maintaining a high amount of available phosphorus. The incorporation of organic matter is highly important with a judicious application of mineral plant foods. In other words, the partial and sometimes complete failure of fertilizer, particularly superphosphate, is usually due to lack of organic matter in the soil.

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INSECTS AS POLLEN CARRIERS

IS it an instance of inheritance of acquired characters that we descendants of thrifty Yankee ancestors insist on finding "uses" for various objects in the universe? Nature, viewed by man, is the primary waster, in rather sharp contrast to the exactness with which her work is done. Dr. Frank Lutz, in a recent *Science Service* radio talk, "In Defense of Insects," deplores the method, wasteful and inefficient, of the production of vast quantities of pollen which is never used by anemophilous plants, only an occasional pollen grain finding a logical home. Dr. Lutz seeks to show the usefulness of insects in the economy of man, citing, in his argument, various plants, edible and otherwise serviceable, which depend for their genetic continuity upon insects that bring about cross pollination. Dr. Lutz, no doubt, knows his insects but perhaps he gives them somewhat too much credit for their beneficent attitude toward man so far as cross pollination is concerned. All important vegetable garden plants except corn, he tells us, come, directly or indirectly, from seeds resulting from insect pollination. This includes such plants as lettuce, the tomato, pepper, peas and beans, all of which are known to be self-pollinated, cross pollination by insects being the exception. The three textiles, linen, cotton and wool, are claimed by him as due to insects, the latter only indirectly. As a matter of fact, both the cotton and the flax plant are pollinated only occasionally by insects, depending mainly on their own resources and evidently well able to get along without insects at the present time. As for wool, practical sheepmen are *not* seriously concerned about clover in their pastures and no doubt many of the native legumes are self-fertilized. An important clover in New Zealand, *T. subterraneum,* is non-seed-bearing, while common red clover is not one of the important legumes in the lush New Zealand pastures. Tobacco is another plant specifically mentioned by Dr. Lutz as insect-pollinated, but here again this plant, if it ever depended on insects, has learned to "roll its own"; pollen carrying insects are less its concern than are the aphids which carry its mosaic. Coffee, tea and cocoa plants may be insect-pollinated but judging by the above examples, which have really turned out to be "horrible," perhaps the chances are only even. Dr. Lutz scarcely mentions the part insects might have had in the phylogeny of the higher plants, but his statement that there was no extensive growth of land plants before insects became well established means nothing, except to a teleologist, for the primitive plants of the early land floras, which built the coal measures, could not have depended upon insects for progeny. Perhaps pollen-carrying insects have been important to plants mainly from an evolutionary standpoint and only incidentally do they remain important as accessory to seed production. Plant evolution would have proceeded without insects, but quite certainly the plant world is richer and more complex because of insect cooperation.

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AWARDS FOR SCIENTIFIC RESEARCH BY THE CONGRESS

AT the annual meeting of the Illinois State Academy of Science in Peoria, Ill., on May 8, the president made this statement:

I hope that the time will come when our government will establish not merely medal awards but substantial money prizes to be given annually to Americans who have made the most noteworthy and valuable research contributions and that present limitations on the time of ardent research workers will be removed.

I have reason to believe that a bill establishing such awards will be introduced by an Illinois member at the next session of Congress, and I trust that this organization will be the first to approve it, not from any selfish motive but as a grateful recognition of a great service rendered.

Later in the session, the following resolution was reported by the committee:

> Realizing the large value and great importance of research along many lines and the benefits accruing to the people from inventions, explorations and discoveries in science, often the result of patient, persistent and painstaking endeavor,
>
> *Resolved,* that the Illinois State Academy of Science, while fully appreciating the recognition accorded such work, would respectfully recommend that Congress add