conjunction with, the well-known treatise of Thomson and Tait.

Ernest W. Brown.

DISCUSSION AND CORRESPONDENCE.

ON THE SPELLING OF 'CLON.'

To the Editor of Science: The original orthography of 'clon' should be retained, in the opinion of the present writer, for the following reasons: '*Clone*,' the form preferred by Mr. Pollard (Science, XXII., p. 87), is already in use as a medical term, and is of different origin and significance from *clon*. If the latter word should take final *e* in order to mark an omega sound in the original, so also should eon, pæon, autochthon, halcyon and similar words in common use.

Linguistic usage does not require, however, that loan-words and derivatives from other languages should always preserve the same vowel quantities, and in transliteration from the Greek no distinction is made between the long and short sounds of *o* and *e*. In fact, η and ω were unknown until the introduction of scholastic writing, and remained long afterwards confused with ϵ and o. Final *e* in English derivatives may stand for a distinct syllable in the original, as in the other examples given by Mr. Pollard, or may be added for euphony, but not for the sole purpose of indicating quantity. Sometimes the final vowel is arbitrarily syncopated, whence the resulting variants of metaphor and semaphore, plasm and plasma, hypogyn and hypocrite, rhyme and rhythm, etc.; or we may even write both synonym and synonyme, though the latter form is antiquated.

Scarcely germane to this matter, but suggested by it, is the popular habit of miscalling under a variety of un-English names one of the most famous masterpieces of Greek art. When we say 'Milo,' we are merely following the continental pronunciation of Melos, in which the final *s* is no longer sounded. *Venus de Milo* is the French name of the statue, Aphrodite of Melos the correct English name. The most unpardonable combination of all is 'Venus of Milo,' with the long (English) sound of the *i* in Milo; for in the first place, the Italian goddess is not the precise equivalent of Aphrodite, and in the second place there is no such geographical name as 'Milo,' at least, not in Greece.

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SPECIAL ARTICLES.

THE LAWS OF EVOLUTION.

That account of universal evolution which we owe to Mr. Herbert Spencer may be supplemented by a formulation of certain quantitative laws which Mr. Spencer seems not to have apprehended. Mr. Spencer's own so-called 'Law of Evolution' is in reality only a great generalization, and not in a stricter sense of the word a law at all. It tells us that everywhere the loss and redistribution of the internal motion of a finite aggregate are accompanied by the concentration or 'integration' of mass, a 'differentiation' of arrangements, forms and activities, and a 'segregation' or drawing together of like units. It does not tell us anything about the rate or amount of 'compound evolution' to be expected from any given expenditure of energy under given conditions.

Economists have long been familiar with certain laws of differential cost and gain. They are commonly called laws of increasing and of diminishing return. The usual statement of them in the text-books is inadequate. A more accurate, and possibly a sufficient, statement is, that in any given state of industry and the arts, an increasing outlay of labor and capital in agricultural, manufacturing, or commercial operations conducted upon a given area,[1] will, up to a given limit, yield returns increasing faster than the outlay, and will, beyond that limit, yield returns increasing less rapidly than the outlay.

In the course of my sociological studies I have been led to believe that increasing and diminishing returns, within the realm of economic phenomena, are only special cases of relations that hold good throughout all phenomena, physical, chemical, biological, psychological and social. In a future publication I hope to set forth the grounds of this

[1] Observe, *space* not 'land.'

belief, and to show that the laws of increasing and diminishing return are universal laws; in other words, that they are laws of universal evolution. In the present article I attempt only to offer a tentative formulation of these laws, and to present a few of the more obvious and important explanations that they suggest of certain specific phases of evolution, such as natural selection and survival.

In the evolutionary process 'outlay,' instead of being made in terms of labor and capital, as in industry, is made in expenditures of energy, that is to say, in dissipations of motion. The 'return' for this outlay is the total amount of compound evolution. Under certain conditions an increasing expenditure of the energies—original and subsequently acquired—of an aggregate, results in evolutionary changes that extend or multiply more rapidly than the expenditure of energy increases. Under other conditions, evolutionary changes extend or multiply less rapidly than the expenditure of energy increases.

Chief among the conditions here referred to as determining the rate of evolutionary change, the important ones are, first, the heterogeneity of the elements or materials entering into the aggregate, and, secondly, the kind or quality of the materials.

In homogeneous bodies or aggregates concentration bears a constant ratio to the loss of internal motion, but in heterogeneous bodies there is no such constant ratio. Concentration may proceed more or less rapidly than the loss of energy, according to the composition of the mass.

Different forms of matter differ one from another in their capacity to contain motion with a given concentration of their particles. That is to say, they differ one from another in energy-storing, energy-conveying and energy-transforming capacity per unit of volume and weight, as is seen, for example, in the unequal capacity of woods and metals to convey heat or to transmit electricity.

The general laws which formulate the relation of these facts to the rate of evolution are these:

1. In a heterogeneous aggregate the amount of transformation, *i. e.,* of compound evolution, increases more rapidly than the dissipation of motion if, in the composition of the aggregate, materials of a higher are being substituted for materials of a lower capacity —per unit of weight and of volume—to store, convey and transform energy, and are being maintained in a perfect working correlation.

2. Conversely, the amount of compound evolution increases less rapidly than the dissipation of motion if, in the composition of the aggregate, materials of a lower are being substituted for materials of a higher capacity —per unit of weight and of volume—to store, convey and transform energy, or if they are not maintained in perfect working correlation.

Two or three simple illustrations derived from economics must here suffice as examples of innumerable facts upon which the demonstration of these laws rests.

Increasing the returns of a factory of given floor space by increasing the speed of machinery is possible only if for mechanisms of poorer quality there are substituted boilers, shafting, gearing, etc., of great cohesive strength, and great tensile strength in proportion to weight and volume.

The increasing returns of a department store, in proportion to capital invested, have been made possible by the substitution of such devices as the light and diminutive cash carrier apparatus for the relatively clumsy mechanism of a sufficiently large staff of men and women, or boys and girls, to perform a like function.

The mechanically and commercially possible 'skyscraper' has been made possible by revolutionary changes in building materials and construction, including a substitution of light, but immensely strong, steel frames supporting the outer walls as well as the flooring, for massive outer walls supporting an internal structure.

These laws of evolution are, I think, the basis and explanation of the phenomena of natural selection and survival.

In any finite aggregate of competing things or organisms, those survive in which the total amount of evolutionary transformation in-

creases more rapidly than the net expenditure of energy; those perish in which the total quantity of evolutionary transformation increases less rapidly than the net expenditure of energy.

These laws of evolution and of survival are exemplified in biological evolution both in the constitution of organic matter itself and in the paleontological series.

In all organic matter we find marvelous strength, and marvelous capacity to store and to transform energy, in proportion to weight and volume.

In the paleontological series we see the termination of the line of monster organisms, and the rise and survival of organisms of less weight and bulk, but of higher biological quality.

In psychological evolution the superimposition of reason upon instinct is correlated with an increasing complexity of nerve and brain structure, the marks of which are a finer and finer cell mechanism, of enormously high energy-conveying and converting capacity in proportion to weight and volume.

In the competition of human races one with another, and of population aggregates one with another, those of high energy-storing and converting capacity per individual have occupied the superior environments, and have most vigorously multiplied.

In the evolution of social organization superior corporate forms displace inferior forms only if with a differentiation of departments, a multiplication of officials and a specialization of functions, there is a corresponding improvement in individual efficiency.

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ALTERNATION OF GENERATIONS IN ANIMALS.

In Science of April 28, 1905, Professor Harold L. Lyon attempts to criticize my paper on 'Alternation of Generations in Animals from a Botanical View-point' (*Botanical Gazette* 93: 137–144, 1905). My theory, stated briefly, is this: The egg with the three polar bodies constitutes a generation comparable with the female gametophyte in plants; similarly, the primary spermatocyte with the four spermatozoa constitutes a generation comparable with the male gametophyte in plants. All other cells of the animal constitute a generation comparable with the sporophytic generation in plants, the fertilized egg being the first cell of this series.

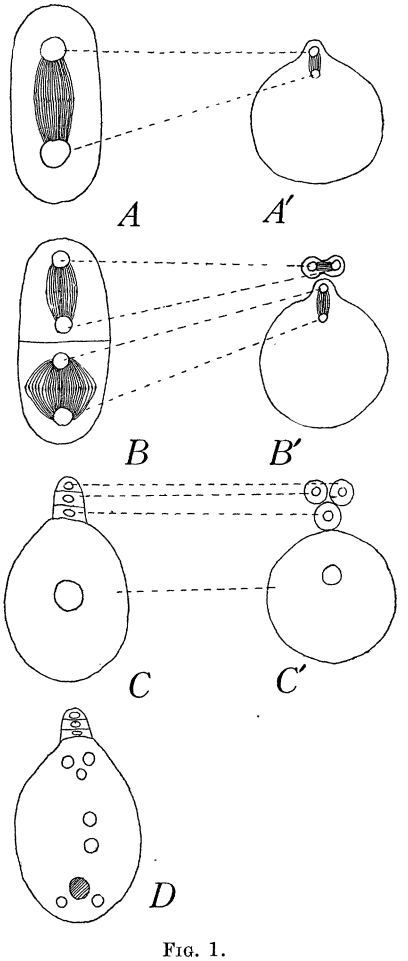

Fig. 1.

According to Professor Lyon, my diagrams indicate "that the animal egg by itself and each spermatozoid is comparable to a plant gametophyte. His statements are not consistent, not in accordance with the facts or even with his figures, and it appears that just where he wishes to draw the homology is not quite clear in his own mind."

Such a positive and dogmatic criticism should be accompanied by some proof, but the