

taller, so that while, according to this law, we might expect to find women weaker than men, they should not be weaker than men in proportion to their height. To make this point clearer, let us take an example: The average strength of twelve men, each 70 inches in height, was found to be 5,483 pounds. The average strength of fourteen men, each 65 inches in height, was found to be 4,653 pounds. The calculated strength of the men, compared with that of the average man, is found to be exactly 5,425 pounds—only fifty-eight pounds less than the actual strength observed.

"Applying the same rule in a comparison of men and women, the following result was obtained: The average strength of twenty-five men having an average height of 69 inches was found to be 4,810 pounds; the average strength of thirty-four women, 64 inches in height, was found to be 2,652 pounds. The calculated strength of a woman 64 inches in height, obtained by the same rule, and taking the average strength of twenty-five men 69 inches in height as a basis, is 4,130 pounds. By this we see that, applying the ratio of the square of the height as a means of determining the strength for a person of given height, women fall short of the strength they should possess, the deficiency in the above case being 1,478 pounds. In other words, the strength of woman is only 64 per cent. of what it should be as compared with man. An actual comparison of men and women of the same height brought out the deficiency still more clearly. The average strength of nineteen healthy women between the ages of 18 and 30 years, 65 inches in height, was found to be 2,660 pounds; the average strength of fourteen healthy men of the same age and the same height was found to be 4,653 pounds.

"We find in these observations an interesting confirmation of the correctness of the principle that the strength of two persons of different heights will be in direct ratio to the squares of their heights. It also appears that the actual facts, as observed by the comparison of the average strength of a large number of men and women of equal heights, agree very closely with those shown by calculation, since the nineteen women with an average strength of 2,660 pounds should have had an average strength equal to that of the fourteen men, whereas they fell short 1,993 pounds, or 43 per cent. According to this the strength of the average woman is 57 per cent. that of the average man of the same height.

"4. The strongest single group of muscles in the body in relation to body weight is the foot extensor group, which in men lifts 4.4 times the weight of the body and in women 3.1 times the weight of the body.

"5. The following groups of muscles in the average man, the muscles of both sides being included, are capable of lifting the entire weight of the body or more: Hand flexors, forearm supinators, deltoid, latissimus dorsi, pectoral, shoulder retractors, foot flexors, foot extensors, leg flexors, leg extensors, thigh flexors, thigh extensors, thigh abductors, thigh adductors, trunk anterior, trunk posterior, trunk lateral, inspiration (waist), inspiration (chest).

"6. In women the hand flexors, foot extensors, leg extensors, thigh flexors, thigh extensors, thigh abductors, thigh adductors, trunk posterior, and trunk lateral are each able to sustain the body's weight.

"7. Those muscles which are able to lift a weight equal to that of the body in men but not in women are: Forearm supinators, deltoid, latissimus dorsi, pectorals, shoulder retractors, foot flexors, leg flexors, trunk anterior, inspiration (waist), inspiration (chest).

"8. It is interesting to note that the strength of each division of the body is more than sufficient to lift the entire body. Even the smallest total found—that for the chest in woman—is able to lift $1\frac{1}{4}$ times the weight of the body. The highest total for a division of the body—that for the legs—indicates, in men, a strength sixteen times that required to lift the body weight. The arms in men are able to lift eleven times the weight of the body, while the muscles of the chest and trunk combined are capable of lifting ten times the body weight.

"9. The foot extensors are, in men, a little less than 50 per cent. stronger than in women, when compared with the body weight, although the flexors are but a little more than one-third stronger in men than in women.

"10. The strength of the inspiratory muscles as compared with the body weight in men is nearly twice that of women.

"11. The lateral muscles of the neck have a strength, in relation to the weight of the body, nearly double that of the same muscles in women, a fact which is readily explained by the greater size of the head in men.

"12. The back muscles are stronger in men in proportion to total strength, doubtless in consequence of the heavier arms, shoulders and head which they are required to sustain."

In concluding his paper, Dr. Kellogg says: "The results which have been presented in this paper, it is hoped, will constitute the beginning of a line of study which will prove both interesting and profitable. I do not present these results as being in any sense exhaustive, although they have occupied many months of painstaking work on the part of myself and expert accountants whom I have employed in making the necessary computations. If they shall serve to stimulate further inquiry in the same line, and if they are accounted worthy of recognition by this body of experts, I shall feel amply repaid for my labor. Indeed, I may justly say that I feel already amply compensated by the assistance which I have derived from the information obtained in dealing with the various classes of physically infirm men and women who have come under my professional care. I sincerely hope that some enthusiast in anthropometry who has more leisure for the pursuit of this very fascinating study may take up this line of investigation and carry it still further. I feel sure that the subject may be properly regarded as a mine of unexplored wealth in the aid which it will afford to scientific physical training."

THE TEMPERATURE OF THE SUN.

WE gather from Cosmos the following interesting experiment by Prof. Ceraski, carried out at the Moscow Observatory. He had the use of a large mirror constructed by Messrs. Gettiffe & Simon, of Paris. This mirror was remarkable for the accuracy of its

construction. It was silvered at the back, and had a focal length of about 39 in. The thickness of the glass was varied to correct for spherical aberration, and a high degree of concentration could be obtained with it. The professor tried the old method of measuring the temperature at the focus when the mirror was exposed to direct sunlight, and found it to be about 3,500 deg. C. This experiment only proves that the temperature of the sun is higher than this. The experimenter then tried a similar experiment, using an arc lamp in the place of the sun, and with conditions as alike as possible. The intensity of the luminous source was then known to be very nearly 3,500 deg., but the temperature at the focus was found to be only 100 deg. to 105 deg. C. The professor proceeds to argue that as the temperature of the source in this case was incomparably greater than that at the focus, so the temperature of the sun must be very much higher than 3,500 deg. C. He also thinks that similar experiments may enable a true estimate of the temperature of the sun to be obtained.

MILTONIA SPECTABILIS MORELIANA DULCOTE VAR.

In addition to the type, there are now five or six recognized varieties of *Miltonia spectabilis*, all of them very beautiful orchids when kept free from thrip and otherwise well grown. The most beautiful variety, however, is *M. spectabilis Moreliana*, and here again, with so variable a species, it is little wonder that the variety shows considerable variability. Morel's variety differs from the type in having sepals and petals of a very deep rich purple color, and in its broad, flat labelum veined with rose. A form of *M. s. Moreliana* named *atro-rubens* has very large flowers, and the sepals and petals are of a very dark crimson purple hue. Another form, named *rosea*, has very pretty flowers, the sepals and petals being whitish, with a rosy central band; this blooms during the summer,

shorten their lives. Horses have been allowed to gnaw the bark from many trees, and the injury has resulted fatally in many instances and will do so in the near future in many more. The guards that have been placed around trees have killed many and injured many more. The flagging has been placed too close to trees and many have suffered on that account. Kerosene and various mixtures that have been placed upon the trunks of trees to prevent caterpillars from going up have killed more trees than caterpillars have. Improper pruning has killed many. Some have perished from lack of nourishment, having been planted in subsoil having no fertility, the best soil having been removed in grading for streets. This may apply to both cuts and fills. Gas has killed some trees, but few compared with other agencies. It has been used somewhat as a scapegoat, receiving blame for loss of trees clearly due to other causes. If some care be taken to select long-lived trees for transplanting, and if they receive better care, the next generation will have less dead trees to remove. It is not intended to create unnecessary excitement in regard to dead trees, but rather to call attention to them, for their removal sooner or later will become imperative. There are some dangerous trees that are not dead. It will be well, when the owner is not able to decide, to ask the advice of some one who is competent to judge correctly to examine such trees and report upon their condition. The opinion of one who is seeking the job of their removal is not always unbiased."

It is certainly a matter of congratulation that a man so thoroughly acquainted with trees and their ailments as Mr. Collins assuredly is should be so outspoken in his reference to the subject.

So long ago as 1870 a litigation which grew into considerable magnitude before it was settled arose at Aix-la-Chapelle, in France. The city authorities brought suit against the gas company for recovery of supposed damage to the shade trees of that city resulting from alleged careless pipe laying and subsequent leakage



MILTONIA SPECTABILIS MORELIANA DULCOTE VAR.

whereas other forms of *M. s. Moreliana* bloom about September. The Dulcote variety of *M. s. Moreliana*, figured herewith, has flowers of immense size, quite surpassing the varietal type both in intensity of color and size of flower; it comes nearest to the form known as *atro-rubens*, but is scarcely so deeply colored, though it exceeds it in size, measuring fully four inches from the tip of the dorsal sepal to the front of the lip. When shown by Mr. Cobb, of Tunbridge Wells, in September, 1896, at a meeting of the R. H. S., an award of merit was made to the Dulcote variety.—The Gardeners' Magazine,

THE ACTION OF GAS ON VEGETATION.

In the course of a year gas companies over the country are called upon to put out what must amount in the aggregate to a considerable sum of money to appease citizens along the line of gas supply for the loss of shade trees, the cause for the decay of the foliage being attributed to the action of gas, says the Progressive Age. It may be politic for a gas company to allow itself to be bled in this manner, though in ninety-nine cases in every hundred gas is not properly chargeable with the destruction.

Mr. Lewis Collins, secretary of the Brooklyn Tree Planting and Fountain Society, in a recent communication to the citizens of that community, calls attention to the damages to life and limb from decaying trees, and in the course of his remarks says:

"It may be well to call attention to a few facts in relation to the life of trees. The vegetable kingdom is much like the animal, for the general law of nature, early maturity insures early decay, applies to both. A dog matures at the age of 2 years, a cow at 3, a horse at 4 and a man at 20. A dog is old at 8, a cow at 12, a horse at 16 and a man at 80. Early maturity rather than longevity has been considered in the selection of trees and the death of many of them is in conformity with this law of nature. Trees are like animals in another respect, for accident and mismanagement may

due thereto. As the suit progressed eminent chemists were brought to testify after prolonged investigation of the question. The tests were made with pure hydrogen, light carbureted hydrogen and heavy carbureted hydrogen, as well as purified illuminating gas. A discharge during an entire day of these various gaseous substances into the soil of vessels containing growing plants was found to produce little, if any, hurtful result. We, however, incline to the belief that improperly purified illuminating gas, gases containing a large amount of tarry matter, mingled with carbonic acid, would have an unfavorable action on vegetation if allowed to percolate for any length of time among the roots of young trees or plants.

A German experimenter reported some years ago that in an experiment made by him, covering an entire year, ordinary purified illuminating gas was allowed to discharge for three hours daily at the roots of a well matured plant, and the effect was to produce rapid and fuller development.

BASIC SLAG AS A FERTILIZER.

By F. E. THOMPSON.

THE material commonly known as basic, Thomas, or phosphatic slag has been in the American fertilizer market for about eight years. It is obtained as a by-product in the manufacture of steel from phosphoric pig iron. The slag contains from 15 to 23 per cent. of phosphoric acid and from 40 to 55 per cent. of lime and magnesia. These constitute the fertilizing ingredients, the residue of the slag being made up of silica and oxides of iron, manganese and aluminum, with small quantities of sulphide and carbonate of lime.

The consumption of this material in the United States has been very limited. The agricultural experiment stations have given some attention to the slag as a phosphatic fertilizer, but their very favorable reports have not brought about any greatly increased consumption. Probably the high price heretofore demanded for basic slag, under the patents which con-

trolled the sale in America, has been the most potent influence in restraining sales.—Ohio A. Exp. Station, Bull. No. 71, April, 1896, p. 168.

The slag, at the completion of the process whereby it is formed, is a molten, white hot, homogeneous mass, which is generally poured out so as to cool in a layer from 1 to 3 in. in thickness. When cold, the crude slag is readily broken up. The dried lumps are then ground to a fine powder in a pulverizing mill. In this dried and powdered condition the slag is ready for use as a fertilizer, without further treatment. It keeps unaltered for years, has no odor, and, being a poor absorbent of moisture, does not cake in bags or barrels. There seems to be nothing in the source or preparation of basic slag to warrant a high price being asked for it.

A good sample of slag should show, by chemical analysis, at least 19 per cent. of total phosphoric acid, and should be of such fineness that at least 75 per cent. of it will pass through a sieve of 150 meshes to the inch. This fineness of subdivision is essential. None of the phosphoric acid in basic slag is soluble, so that its availability varies with the fineness of the slag particles.

In common with the natural or raw phosphates, Thomas slag does not yield up all its phosphoric acid in one season. A reserve store of acid remains in the soil as a latent fertilizer, while the changes of weather between crops slowly disintegrate the slag, preparing new available phosphoric acid for succeeding crops. On the other hand, in contrast with the raw phosphates, finely ground basic slag, during the first year of application, yields up its phosphoric acid much more readily than do the phosphatic rocks, guano or ground bone. In this respect it more nearly resembles the soluble phosphates, on some crops equaling or even exceeding dissolved bone black in efficiency.

Some of the State agricultural experiment stations have made tests of basic slag as a fertilizer, and have from time to time published the results. These reports constitute our principal American testimony concerning the slag. Although shipments of slag from the factory seem to show that it is meeting with favor in certain localities, it is very difficult to obtain any reports of value from the consumers. In Europe, the extensive sales of the material, the experiment stations' reports, and the fairly copious literature on the subject, indicate that the use of Thomas slag as a fertilizer has passed the experimental stage and has become a settled fact. In this country the slag is still on trial.

The English and German literature on basic slag is not readily accessible to most American readers. The announced results from its use in Europe are condensed in a paper by Dr. William Frear, in the Agricultural Report of Pennsylvania for 1890, p. 98. Most of the experimental work on slag in the United States has been undertaken since the publication of Dr. Frear's paper, and has never been summarized. The American results confirm the conclusions reached in Europe, which were briefly as follows:

- (1) The more finely ground slag showed a higher availability in both chemical and agricultural tests.
- (2) Two pounds of slag phosphoric acid had, during the first year, an effect equal to one pound of soluble phosphoric acid.
- (3) Thomas slag was most efficient on wet clay soils, least efficient on dry or sandy soils.
- (4) The slag gave the best results when used with other fertilizers.
- (5) The residual effect of slag phosphoric acid was about twice that of soluble phosphoric acid.
- (6) No bad effects from the use of basic slag were ever noticed.

In many European tests the slag proved equal to soluble phosphates.

The experiment stations in this country have generally used basic slag in combination with potash and nitrogen against either an equal money value of some other phosphate or an equal contained weight of phosphoric acid. There follows a summary of the station tests on Thomas slag.

Experiments on Corn (Connecticut State Station Report, 1889, p. 203).—This was a series of one, two and three years' tests of slag and other phosphates on corn. Equal money values of the different phosphates were combined with the same form and quantities of nitrogen and potash. Phosphates were applied during the first year only.

In a three years' test of dissolved bone black, slag, Grand Cayman's phosphate and South Carolina rock, Grand Cayman's phosphate led in yield on the first year's crop, while slag led in yield on the second and third year crops. The residual effect of all insoluble phosphates was seen during the second year and was equally apparent during the third year. Dissolved bone black failed to produce any increase in yield during the third year.

In a two years' test on corn (*ibid.*), dissolved bone black was most effective in increasing the crop during the first year, but was nearly exhausted from the soil in one year. On the second year's crop Bolivian guano ranked first, slag and Grand Cayman's phosphate next, and Carolina rock last.

In a single year experiment on corn (*ibid.*), dissolved bone black again led in crop producing power, while basic slag outranked all insoluble phosphates.

Three other single year experiments in Connecticut were barren of results, unfertilized plots sometimes doing as well as plots receiving dissolved bone black.

Another trial on corn (*ibid.*) showed that dissolved bone black led among phosphatic fertilizers, Mona Island guano being next, with slag and Grand Cayman's phosphate third. South Carolina rock and Bolivian guano produced no gain.

In a six years' test (Hatch, Massachusetts Agricultural Experiment Station Report, 1896, p. 128) of dissolved bone black, Mona Island guano, South Carolina floats, basic slag and Florida phosphate on crops in rotation, the slag produced 15 per cent. more corn than the next most productive phosphate (floats) and 26 per cent. more corn than the least productive phosphate (dissolved bone black).

In a two years' experiment on corn and oats (*ibid.*, p. 142), basic slag being compared with ground bone only, the slag produced during the first year 25 per cent. more corn than did the ground bone, and, during the second year, 20 per cent. more corn.

The general results of three separate single year trials of fertilizers on corn in five crop rotation (Ohio Bulletin, No. 71, p. 119) showed basic slag to be at least

equal to bone black superphosphate, and equal to 8 tons of barn yard manure per acre, while slightly superior to acid phosphate.

In a test of fertilizers on corn grown eight years in succession (*ibid.*, p. 143), linseed oil meal and acid phosphate produced the largest average increase over unfertilized plots, basic slag ranking next. The average increase in yield from basic slag was but a half bushel below the best average yield. The slag in this test proved to be 30 per cent. more effective than dissolved bone black.

Competitive trials (Rhode Island Experiment Station Report, 1893, p. 141) of dissolved South Carolina bone, dissolved bone black, double superphosphate, slag and floats on corn showed nearly equal results from all except floats.

The South Carolina Station (Report 1888, p. 151) finds basic slag as effective on corn as the more expensive fertilizers.

The Vermont Station (Report, 1888, p. 89) concludes that on heavy soils basic slag is equal to soluble phosphates for increasing the corn crop, while on light soils the slag is inferior. In box experiments on corn, basic slag proved as effective, dollar for dollar of cost, as the soluble phosphates.

Experiments on Oats.—In the two years' experiment previously referred to (Massachusetts Report, 1896, p. 142), in which slag and bone meal were used competitively on corn and oats, the slag produced each year 50 per cent. more oats than the bone meal.

In a three years' test on oats (Ohio Station Bulletin No. 3, 1892) with slag in competition with dissolved bone black, acid phosphate, manure and linseed oil meal, dissolved bone black produced the largest average increase over unfertilized plots, while slag ranked second in productiveness.

On oats in five crop rotation, following corn (Ohio Bulletin No. 71, p. 126), slag proved the least effective of any fertilizer except linseed oil meal. On oats seven years successively (*ibid.*, p. 142), slag proved slightly inferior to acid phosphate, slightly superior to dissolved bone black and much superior to linseed oil meal or manure.

Comparative tests of slag and floats on oats at the South Carolina Station (Report, 1888, p. 151) showed the slag to be more effective.

Experiments on Wheat.—In five crop rotation (Ohio Bulletin, No. 71, p. 126) superphosphate, linseed oil meal and wheat bran were ahead of slag when applied to wheat. In three crop rotation (*ibid.*, p. 136) superphosphate (dissolved bone black) produced the greatest gain in the wheat crop, followed by the slag, in competition with manure, wheat bran, linseed oil meal, bone meal and acid phosphate. On wheat in seven years' continuous culture, slag produced a smaller average increase of crop than bone black superphosphate, manure or linseed oil meal, but produced a larger average increase than acid phosphate.

Experiments on Potatoes.—The results on potatoes are at variance with one another. The Connecticut Station (Report, 1889, p. 217) found slag to be more effective than any other fertilizer. The Massachusetts Station (Report, 1896, p. 130) found that dissolved bone black and floats lead slag on potatoes. In Ohio (Bulletin No. 71, p. 133) slag compared very unfavorably on potatoes with every other manure. In Vermont (Report, 1888, p. 89) slag produced more potatoes than did floats, bone black meal or acid phosphate.

Experiments on Other Crops.—On cotton, the Georgia Station (Bulletin No. 2, 1889, p. 37) found slag to be superior to floats but inferior to acid phosphate. The South Carolina Station (Report, 1888, p. 151) found slag to be less effective on cotton than acid phosphate, reduced phosphate or floats.

On stubble cane in Louisiana (Bulletin No. 31, second series), Thomas slag was about equally productive with soluble phosphates, but was much superior to insoluble phosphates.

In the six years' trial of phosphates on crops in rotation at the Massachusetts Station (Report, 1896, p. 128) we find that slag was first on serradella and barley and second on rye.

We have had no conclusive results in America with slag on hay, clover, vegetables or small fruits. In Europe the slag proved very efficient on small fruits and vegetables and also on hay and clover when grown on moist meadows.

In reviewing the experiments on corn, it is seen that basic slag, in competition with numerous soluble and insoluble phosphates, ranked first in six experiments, ranked second in five cases and ranked third in three cases. No phosphate except dissolved bone black was more effective than slag on corn in more than a single instance. As a phosphoric fertilizer on corn, basic slag appears to rank easily with dissolved bone black and to be superior to all other phosphates.

From more meager data we find that on oats Thomas slag proved most effective in three cases and ranked second in two cases. In one case slag was inferior to all phosphates. Acid phosphate and dissolved bone black generally lead basic slag. In six trials the slag was equal or superior to soluble phosphates in five, inferior to all phosphates in one. It seems safe to say that basic slag ranks at least next to soluble phosphates on oats and that it is superior to other insoluble phosphates.

From the Ohio experiments using slag and other phosphates on wheat, we find that slag was always inferior to dissolved bone black, generally inferior to wheat bran and linseed oil meal and always superior to acid phosphate. Neither wheat bran nor linseed oil meal is a true phosphatic fertilizer.

The results of experiments on other crops have been too meager to admit of positive statements regarding the comparative fertilizing value of basic slag.

The Massachusetts Station, after a six years' trial of various phosphates on crops in rotation, has this to say about basic slag (Massachusetts Report, 1896, p. 131): "We find that the plot receiving dissolved bone black leads in yield during the first two years, while for the third, fourth, fifth and sixth years the plots receiving insoluble phosphates are ahead, phosphatic slag being first."

Probably the most valuable and complete series of American experiments using basic slag is that detailed in the Ohio Bulletin, No. 71, covering a period of eight years. In summarizing we find this (p. 185): "Of the various carriers of phosphoric acid, dissolved bone black, acid phosphate and basic slag seem to produce

practically the results, pound for pound, of phosphoric acid contained."

Other conclusions, very favorable to basic slag as a phosphate, may be found in the Connecticut Station Report, 1889, p. 120; Georgia Bulletin, No. 2, January, 1889, p. 37; Massachusetts Station Report, 1896, p. 144; Ohio Bulletin, No. 71, p. 164; Louisiana Bulletin, No. 31, second series, p. 1110.

ORIGIN OF THE VERTEBRATES.*

By STUART JENKINS.

THE metamorphoses exhibited in the development of the frog may be taken as another indication of the compound nature of the vertebrate organism, the tadpole displaying in a modified form the characteristics of the matrix, and the mature animal the final adjustment between the associated organisms. The phenomena can scarcely be claimed as the result of natural selection, because in all essentials the tadpole is just as well fitted to live as the frog, and a further development was not necessitated by the struggle for survival. If it were, the tadpole state must be considered as one highly detrimental to the race of frogs, and so likely either to be eliminated or else bring about the destruction of the race. If the form of the mature frog was evolved by the operation of natural selection on spontaneous variation, the tadpole stage would have been left behind millions of years ago, because the law of survival provides for no dual existence. It leads up to a type which proves its fitness by surviving, but it does not add a supplementary development to this type so as to convert it in one generation into an entirely different one. And yet, if we do not believe this, how are we to account for the existence of the tadpole as an independent, self-supporting organism on any theory of gradual development? Again, if we accept this theory of gradual development, we must believe that at one time the tadpole was the adult animal and able to reproduce its kind, and there is no obvious reason why this power should be lost and transferred to a later stage.

These difficulties disappear in the light of parasitism. In the first individual of the type there existed the future intention of the perfect frog, which is the resultant of definite internal forces. The tadpole stage remains because the imperfect adjustment of the sexual functions, characteristic of fishes, has never been lost. The egg of a frog is in effect a fish egg, capable of producing a fish, or rather a modified form of the matrix, but no more, because it does not contain enough of the special nutrition provided by the parent to carry the development any further. The tadpole, consequently, has to hunt its own living at a much earlier stage in its development than is the case with the embryos of the higher vertebrates. In the case of the Surinam toad, the mother, by a very remarkable arrangement, supplies the nutrition necessary for the whole development, and the young leave her as fully formed toads; but this is an altogether extraordinary and exceptional modification of the normal process. The retardation of the sexual function in the tadpole is due to the development of the cerebro-spinal nerve parasite. This in the first instance made small demands upon its matrix, while in its subsequent development it made increasing calls upon the latter, and by so much retarded its arrival at maturity. Reproduction, with very few exceptions, is the last function to develop, and it is only reached when the necessities of rapid growth have been so far satisfied or the powers of assimilation have so increased that there is a surplus of nutrition over and above the immediate wants of the organism. The growing predominance of the parasite would cause an increasing retardation in the development of its matrix, and with it a retardation of the reproductive function. Where this function is developed during the larva stage it must be due to superior nutrition. In the so-called larva forms, which are, of course, sexually mature, the early development of the reproductive function has resulted in a permanent modification of the parasite.

The evolution of an internal bony skeleton has always seemed to me to present special difficulties. The ganglionic type of animals has from the first traveled in one rut. The lime which is assimilated is passed through their tissues and excreted on the surface, and it is very difficult to conceive why certain cells in the organism should break through this confirmed habit of growth and begin to retain and excrete the lime internally, not in an irregular and haphazard way, but on fixed lines and in a well marked direction. I do not think that spontaneous variation will account for anything so palpably definite. But even granting that it will, we are met by another difficulty, one that seems insuperable. The spontaneous variation was, of course, cumulative, that is to say, it only assumed a definite character through long and gradual development. In the first instance it was confined to a few cells which became differentiated from the surrounding tissue, and put on a new habit of growth. They were in no way connected with the organs of generation, which would of course produce the normal cell growth of the organism. How is it conceivable that a few isolated cells could so influence the product of generation that the new habit of growth which they had put on would be reproduced in the offspring? This objection applies with even greater force to the evolution of the ganglionic nerve system, because this took place in a mass of homogeneous cells without any circulatory system, and where there were no reproductive organs belonging to the organism as a whole, but where each cell reproduced on its own account, some of the new cells being added to the parent tissue, and some being cast loose into the sea to start a new community. Now, if certain cells in the parent mass differentiated into a new kind of cell would constitute what pathologists call a morbid growth, and if they reproduced their kind, part of the offspring would be added to the parent tissue and part would be cast off, as in the case of the normal cells; but

* Continued from SUPPLEMENT, No. 1104, page 17642.

† This explanation is borne out by the fact that when the hermit crab (*Pagurus*) is infested by a parasite belonging to the group of *Rhizocephala*, the development of sexual maturity is wholly arrested, while the growth of the *Pagurus* itself is not in the least hindered. The fact is also illustrated in another way by the worker bee, which is an aborted female, capable in the larval state of being fed up into a queen. I have not attempted to touch in this article the bearing of parasitism on entomology, but it must be obvious that it affords the simplest explanation of the phenomena of metamorphosis.