decim has several very distinct and variable notes. He has probably been misled by the abnormal condition of things the present year in the District of Columbia, where the English sparrow has so prevented the full maturity of the males, and so decimated their ranks, that the more characteristic noises, and those most apt to be recollected, have scarcely been heard. This has been a common remark among entomologists, who recollected former visitations in other parts of the country.

Finally, Professor Ward will convince no one that I was ever guilty of speaking of the note of Cicada pruinosa as 'precisely like' that of C. septendecim, though the mature and louder note of the latter much more nearly resembles that of the former than he seems to imagine. C. V. RILEY.

Washington, D.C., June 17.

Periodical cicada in Massachusetts.

Among the localities given by the earlier writers for the present septendecim brood of the periodical cicada, are Fall River and the south-eastern portion of Massachusetts. These need confirmation; as, so far, no reports have been received from Massachusetts the present year. There is a brood which appears at Fall River one year later. I shall be glad to get confirmation either of the absence or presence of the insect the present year from the readers of *Science* in south-eastern Massachusetts. C. V. RILEY.

Washington, D.C.

Height of land in Connecticut.

The ninth and last edition of the 'Encyclopaedia Britannica' has the statement that there is no land in Connecticut 'above a thousand feet in elevation.' Statements equivalent to this will be found also in 'Appletons' American cyclopaedia' and in 'Johnson's cyclopaedia.' A survey by an engineer, Mr. G. M. Bradford, in 1873, which was based on the survey of the Connecticut western railroad, gives the heights of several points in the north-western part of this state, and these results cannot be much in error. I am indebted to Mr. Henry Norton of Goshen, Conn., for the communication of these heights. It will be remembered that Salisbury is the north-western town of the state, and that east of it, joining Massachusetts, are Canaan and Norfolk: Goshen joins Norfolk on the south. The following are some of the heights above sea-level: —

	Feet.
Ivy Mount (Goshen)	1,642
Haystack Mount (Norfolk)	1,672
Bald Mount (Norfolk)	1,770
Bradford Mount (Canaan)	1,910
Bear Mount (Salisbury)	2,100
Brace Mount (Salisbury)	2,300

It may be thought hardly worth while to dispute any statement made in a cyclopaedia; but, having been born and reared among the beautiful hills of Connecticut, I dislike to see them diminished to one-half their height, even by such a ponderous authority as the 'Encyclopaedia Britannica.'

ASAPH HALL.

June 27.

The ginkgo-tree.

In *Science*, No. 124, Mr. L. F. Ward states that the Frankfort, Ky., ginkgo-trees are the only ones known to him in the United States that have borne fruit. Permit me to say that a group of these trees in Central Park, New-York City, have borne fruit to my knowledge for the past six years, and that in great abundance. R. P. WHITFIELD.

Amer. mus. nat. hist.,
June 24.

THE FORMATIVE FORCE OF ORGANISMS.

THE assertion is safe, that the majority of biologists incline at present to explain the forming of an organism out of its germ upon mechanical principles. The prevalent conception is, that the forces of the ovum are so disposed that the evolution of the adult organism is the mechanical result of the predetermined interplay of those forces. The object of the present article is to point out that this conception is inadequate, and must be at least supplemented, if not replaced, by another view; namely, that the formative force is a generally diffused tendency, so that all parts inherently tend to complete, by their own growth and modification, the whole organism, — a fact which finds a legitimate hypothetical expression in Darwin's doctrine of pangenesis. The nature of the view here advanced will become clearer upon consideration of the evidence upon which it is based, and which is adduced below. The evidence that the formative force is diffused through all parts falls under three heads: 1. The process of regeneration in unicellular and multicellular bionts; 2. The phenomena of the duplication of parts; 3. All forms of organic reproduction. Let us briefly consider these categories.

1. *Regeneration.* All living organisms have to a greater or less degree the ability to repair injuries: indeed, we must regard the power of regeneration as coextensive with life, but the capacity varies enormously in the different species. In man the power is very small, though more extensive than is generally realized. Among annelids are species the individuals of which may be divided in two, and each piece can regenerate all that is needed to render it a complete worm. We sometimes see a small fragment of a plant, a single switch of a willow for instance, regenerate an entire tree, — roots, trunk, branches, leaves, flowers, and all. In the last instance a few cells possess a latent formative force, which we recognize by its effects, but cannot explain. We perceive, therefore, that each individual has, as it were, a scheme or plan of its organization to which it strives to conform. As long as it actually does so, the cells perform their routine functions; but when an injury destroys or removes some portion, then the remaining cells strive to conform again to the complete scheme, and to add the missing fragment. The act of regeneration of lost parts strikes the imagination almost as an intelligent pursuit by the tissues of an ideal purpose.

Our knowledge of the regenerating power

has recently received important extensions through the noteworthy experiments of Nussbaum [1] and of Gruber,[2] who have demonstrated independently the possibility of dividing unicellular animals so that each piece will regenerate the missing parts. In this manner the number of individuals can be artificially multiplied. For example: Nussbaum divided a well-isolated Oxytricha into two equal parts, either transversely or longitudinally, and found that the edges of the cut became soon surrounded with new cilia. Although some of the substance of the body, or even a nucleus, was lost through the operation, yet, by the following day, the two parts converted themselves into complete animals with four nuclei and nucleoli (*nebenkerne*) and the characteristic ciliary apparatus. "The head-piece has formed a new hind end; the right half, a new left half." The new-formed duplicate Infusoria multiplied subsequently by spontaneous division. From one Oxytricha cut in two, Nussbaum succeeded in raising ten normal animalcules, which subsequently all encysted. After an unequal division, the parts are both still capable of regeneration, but parts without a nucleus did not survive; which suggests that the formative energy is in some way bound up with the nucleus. But nucleate pieces may break down. Thus all attempts at artificial multiplication of the multinucleate Opalina failed, although the division of Actinosphaerium had been successfully made by Eichhorn as long ago as in the last century. Pelomyxa palustris has been successfully divided by Greef, and Myxastrum radians by Haeckel.

Gruber (*l. c.*, p. 718) describes his experiments with Stentor: "If one divides a Stentor transversely through the middle, and isolates the two parts, one finds on the cut surface of the hind part, after about twelve hours, a complete peristomial field with the large cilia and buccal spiral newly formed. On the other hand, the piece on which the old mouth is situated has elongated itself backwards, and attached itself in the manner peculiar to these Infusoria. If one has made a longitudinal section, so that the peristom is cut in two, then the peristoms both complete themselves, and the lateral wounds heal over. I have repeatedly separated by trans-section pieces considerably less than half of the original Stentor, and these have also regenerated themselves to complete animals." Gruber, too, observed that artificially divided Infusoria were capable of subsequent spontaneous multiplication. If the section is not very deep, there may arise double monsters; but here, just as in spontaneous divisions, as long as there remains an organic connecting-band, the two parts act as one individual, showing that the nervous actions are not restricted to determined paths. Gruber also adds, that two divided pieces may be reunited, if they are brought together again quickly enough. The observation thus briefly announced is of such extreme interest and importance, that the publication of the full details of the experiment will be eagerly awaited. Gruber adds, that at present we cannot go much beyond the proof of the existence, to a high degree, of the regenerative capacity in unicellular organisms. He also makes the significant observation, that, in the Protozoa, we have to do foremost with changes of function; in the Metazoa, with growth also.

2. *Duplication of parts.* In these anomalies we find an organ which, although an extra member, yet still conforms to the type of the species. For example: a frog is found with three posterior limbs; dissection proves the third leg to agree anatomically with the typical organization of the frog's hind leg. In determining the importance to be attributed to this evidence, it should be remembered, on the one hand, that these instances are by no means unusual; on the other, that the agreement with the normal structure is not uniform.

3. *Asexual reproduction.* When a species multiplies by fission of any kind, we must assume that each part, after division, possesses the formative tendency, since we see it build up what is necessary to complete the typical organization of the individual. Again: a bud of a hydroid or polyzoon, although comprising only a small part of the body, is equally endowed with this uncomprehended faculty. In pseudova we reach the extreme limit: in Aphis, for example, the parent gives off a single cell, the capacity of which to produce a perfect and complicated individual, fully equals the like capacity of a hydroid bud or of half a worm.

The evidence forces us to the conclusion that the formative force or cause is not merely the original disposition of the forces and substances of the ovum, but that *to each portion of the organism is given*, 1. *The pattern of the whole organism;* 2. *The partial or complete power to reproduce the pattern.* The italicised formula is, of course, a very crude scientific statement, but it is the best which has occurred to me.

[1] M. NUSSBAUM. *Ueber spontane und künstliche zelltheilung.* Sitzungsb. Niederrhein. ges. nat. u. heilkunde. Bonn, Dec. 15, 1884. [I regret very much that I know this paper only by Gruber's abstract.]

[2] A. GRUBER. *Ueber künstliche teilung bei Infusorien.* Biolog. centralbl., iv. (No. 23) 717–722.

The formative force, then, is a diffused tendency. The very vagueness of the expression serves to emphasize our ignorance concerning the real nature of the force. In this connection, I venture to insist upon the fact that we know little or nothing concerning any of the fundamental properties of life, because I think the lesson of our ignorance has not been learned by biologists. We encounter not infrequently the assertion that life is nothing but a series of physical phenomena; or, on the other hand, what is less fashionable science just now, that life is due to a special vital force. Such assertions are thoroughly unscientific; most of them are entirely, the remainder nearly worthless. Of what seem to me the prerequisites to be fulfilled before a general theory of life is advanced, I have written elsewhere.[1] CHARLES S. MINOT.

UNDERGROUND WIRES.

DURING the last few years the number of electric wires in all of our large cities has rapidly increased, especially since the introduction of the telephone and the electric light; and the probability is that the next few years will show a further large increase. If these wires run on poles, they not only disfigure the streets, but seriously interfere with the operations of firemen, as we have repeatedly seen during the last few years. A cobweb of wires supported on housetops requires the line-men to continually tramp through the houses and over the roofs, causing annoyance to the tenants, and damage to the buildings. Moreover, wires fixed to housetops are subject to removal at the whim of the owner, and they have to be continually removed from building to building as the good will of each owner is exhausted. Again: overhead wires, whether placed on poles or housetops, are continually coming in contact with each other, causing annoyance and danger; and an extra heavy rain or sleet storm so entangles and breaks them as to entirely interrupt communication. The annual cost of repairs of overhead wires in cities is not less than thirty per cent of the first cost of construction.

In almost all of the large cities the question is being asked, Why cannot these wires be gathered into cables and buried, along with the gas and water pipes, under the streets? In answer, it is proposed to review briefly the technical difficulties that arise, and to show how they may be and are overcome. It is proposed, further, to compare the cost of construction and maintenance of overhead wires with the cost of construction and maintenance of underground cables, and thus to see which is desirable from economical considerations.

There are two reasons, apart from the difficulty of securing good insulation, why underground lines are comparatively inefficient: —

1. If an electric conductor be brought near to a large mass of conducting-matter, as is a wire when it is taken down from a pole and buried in the earth, there appears in the current the phenomenon of retardation, by which each signal, instead of being sharp and distinct, is partly kept back, so that it overlaps and mingles with the next. The result is to limit the speed of working of the apparatus, or, if, like the telephone, it be an apparatus in which the currents are necessarily extremely frequent, to confuse and destroy the signals altogether.

2. The second difficulty is called induction, and is noticed when two or more wires are run side by side and near together, as they necessarily are in an underground cable. If the signals on one wire of such a cable be sharp and quick, they cause facsimile signals on all of the neighboring wires; and this, too, though the insulation may be absolutely perfect. The result of this phenomenon is, that messages sent over one wire are liable to be received on all of the other wires; and in telephony each person can easily overhear all that the others are saying.

Fortunately, however, both of these difficulties vary with the electrical qualities of the cable; and while I have seen cables of a thousand feet, over which it was difficult to talk, and in which the cross-talk was nearly as loud as the direct conversation, on the other hand, I have conversed easily over an underground cable extending from Paris to Orleans, eighty-five miles; and this, too, while other parties similarly separated were talking over other conductors of the same cable. There was absolute secrecy.

Last summer I visited France and Germany, and made, together with Mr. Berthon (chief engineer of the French telephone company), Mr. Cäel (chief engineer of the French government telegraph), and Herr Guillaume (constructor of the underground lines of the German empire), a series of telephone experiments on underground lines, varying from 5 to 100 miles in length, from 2.87 to 48 ohms resistance, and from 0.06 to 0.35 microfarads capacity per mile.

These experiments furnish us with ample

[1] C. S. MINOT. *On the conditions to be filled by a theory of life.* Proc. Amer. assoc. adv. sc., xxviii. 411.