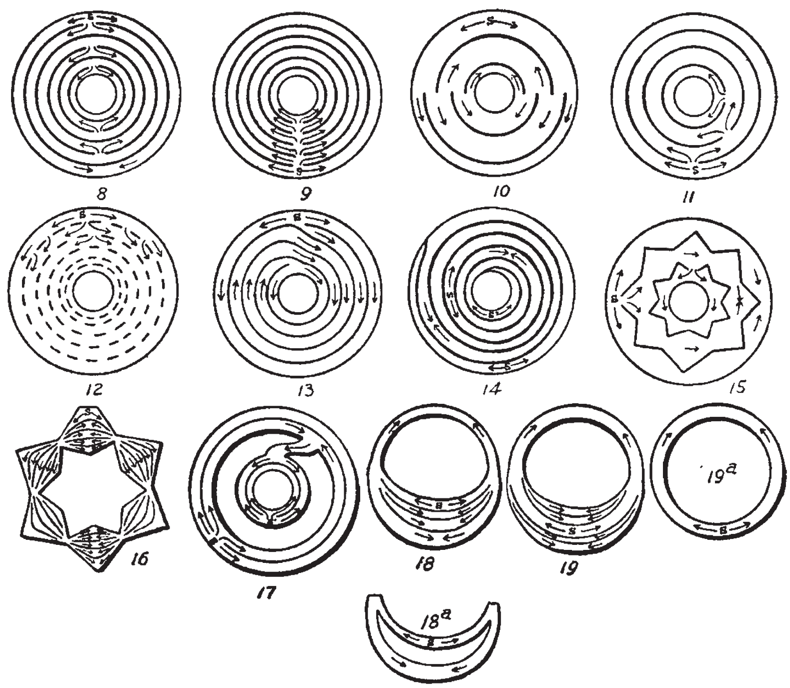
Dr. Gordon has sought for a bacteriological test whereby particles shed from the skins may be detected in the air. He finds that a Staphylococcus (*S. epidermidis albus* of Welch, with certain attributes) is by far the most frequent organism of the skin, and another Staphylococcus of the scalp. Lastly, Dr. Alan Green records further experiments on chloroformed vaccine lymph and on the combined use of chloroform and glycerin in preparing lymph. The volume, therefore, contains much valuable matter, and is illustrated with a number of photographs.

R. T. HEWLETT.

PULSATION IN ANIMALS.[1]

JELLY-FISHES have been the subjects of frequent experimentation—we need only refer to the admirable researches of Romanes—and Mr. Alfred G. Mayer, director of the Department of Marine Biology of the Carnegie Institution of Washington, has been able to draw some new and exceedingly interesting general conclusions from a study of their pulsations. When the marginal sense-organs of the jelly-fish Cassiopea are cut off, the disc is paralysed and does not pulsate in sea-water. If a ring-like cut, or a series of concentric broken-ring-like cuts, be made through the muscular tissue of the sub-umbrella, the mutilated disc (without marginal sense-organs) responds to a momentary stimulus, *e.g.* a mechanical or electrical shock, or a single touch with a crystal of potassium sulphate, and suddenly springs into unusually rapid rhythmical pulsation. This is regular and sustained like clockwork, and continues indefinitely in normal sea-water without further external stimulation. The waves of pulsation all arise from the stimulated point, and the labyrinth of sub-umbrellar tissue around this centre must form a closed circuit—the stimulus being transmitted by the diffuse nervous or epithelial elements of the sub-umbrella. Any cut that breaks the circuit stops the waves of pulsation, and continuous movement cannot again be started. When each wave in a complete circuit returns to the centre it is reinforced and again sent out through the circuit. The centre once established remains a fixed point, while the disc continues to pulsate. The pulsation is fully twice as rapid as that of a normal Medusa, its rate varying with the length of the circuit, and it is self-sustaining (*i.e.* sustained by internal stimuli) once it be started by an external momentary stimulus.



Shapes cut from discs without marginal sense-organs. These will pulsate continuously in sea-water. The arrows indicate the paths of the waves of pulsation.

Mr. Mayer has endeavoured by numerous experiments to discover the *rôle* of the various salts in the sea-water, and he finds that the sodium chloride is the chief stimulant to pulsation in Cassiopea, while magnesium is the chief restrainer of pulsation, and counteracts the influence of the sodium chloride. Similarly, the heart of *Salpa democratica*, the heart of the embryo loggerhead turtle, and the branchial arms of the barnacle pulsate actively in solutions (*e.g.* Ringer's) containing only common salt, potassium and calcium, magnesium being absent. Magnesium inhibits pulsation in all these cases. Thus the general *rôle* of NaCl, K, and Ca in these cases is to combine to form a powerful stimulant producing an abnormally energetic pulsation, which, however, being exhausting, cannot continue indefinitely; and magnesium is necessary to control and reduce this stimulus, so that the pulsating organ is merely upon the threshold of stimulation. More concretely, the NaCl, K, and Ca of the sea-water unite in stimulating the pulsation of the jelly-fish, and in resisting the stupefying effect of the Mg, the general anæsthetic effect of which has been well known since the researches of Tullberg in 1892. All four salts conjointly produce in sea-water an indifferent, or balanced, fluid which neither stimulates nor stupefies the disc (*i.e.* the medusa with marginal sense-organs excised), and permits a recurring internal stimulus to produce rhythmic movement.

Not only has the author shown us a new method of restoring pulsation in paralysed Medusæ, but he has demonstrated that magnesium plays a most important *rôle* in restraining, controlling, and thereby prolonging pulsation in animal organisms. "Rhythmical pulsation can be maintained only when a stimulus and an inhibitor counteract one another, and cause the organism to be upon the threshold of stimulation; thus permitting weak internal stimuli to promote periodic contraction." Thus, once more, marine biology justifies itself in contributing to the progress of general physiology.

J. A. T.

[1] "Rhythmical Pulsation in Scyphomedusæ." By Alfred G. Mayer. Pp. 62; illustrated. (Washington: Carnegie Institution, 1906.)

THE WEATHER AND THE CROPS.

AN interesting paper on the correlation between the weather and the crops, by Mr. R. H. Hooker, head of the statistical branch of the Board of Agriculture, was read before the Royal Statistical Society on January 15.

The subject is very fully discussed by the method of correlation, partial coefficients of correlation being determined between the produce of each crop and (1) the rainfall, (2) the accumulated temperature above 42° F. during successive overlapping periods of eight weeks (first to eighth weeks of the year, fifth to twelfth, and so on). The crops dealt with include wheat, barley, oats, beans, peas, potatoes, turnips and swedes, mangolds, hay from clover and rotation grass, and hay from permanent grass. As climatic conditions differ so materially in England and Scotland, and even in different parts of England, it was thought necessary to deal with a smaller area, and a group of eight of the eastern counties was chosen for the purpose. The group includes the county with the largest acreage under each of the ten crops named, with the single exception of grass.

The results for wheat are of especial interest in connection with Dr. Shaw's conclusion as to the great importance of the autumn rainfall. Mr. Hooker confirms this, and finds, further, that the autumn is more important than any other period. The critical period is, however, probably somewhat shorter, the correlation of the produce with rain exhibiting a marked negative maximum for the thirty-seventh to forty-fourth weeks, the actual coefficient being −0·62; the coefficient with the rainfall of the cereal year as a whole is slightly greater still, viz. −0·69. There are two marked coefficients with the weather of the preceding summer, *i.e.* the summer of the year in which the seed for the crop was grown, viz. −0·49 with rain during the twenty-first to twenty-eighth weeks, and +0·51 with temperature for the twenty-ninth to thirty-sixth weeks, indicating absence of rain during the flowering period and warmth at harvest as necessary for good seed. For barley the chief requirement appears to be a cool summer, and for oats the same thing holds, but the latter crop also demands rain in spring, as indicated by a coefficient of +0·70. In the case of turnips, the highest coefficient, +0·55, is with the rainfall in June–July, *i.e.* the sowing season, this being partly due, in all probability, to the fact that in a dry season the turnip-fly will eat off a young crop almost as soon as it shows above the ground. In spite of prevalent opinion, there does not seem to be any need for rain in late summer. In the case of the hay crops, the great value of the rainfall in spring and early summer is very well brought out, the coefficients attaining sharply marked maximum values of more than 0·7 in the spring.

One conclusion of remarkable generality is reached, viz. the advantage of cool weather during the late spring and summer for all the crops dealt with (except, perhaps, potatoes). Taking the period between the ninth and twenty-eighth weeks of the year, all the four coefficients with temperature are negative in the case of barley, oats, turnips, mangolds, and hay; for wheat and for beans three of the four coefficients are negative. The correlation is with cool weather as such, and not with rain, as the effect of rain is practically eliminated by the method used. The result seems to indicate that grain and roots yield the most bulky crops if developed gradually and equably; neither rains nor heat, in fact, seem to be good for the crop for some time before harvest.

The paper also brings out very clearly another fact, viz. that the condition of the seed sown may be as important as the subsequent weather. As the condition of the seed is itself dependent on the weather of the year during which it was grown, this gives rise to the observed correlations between the crop and the weather of the seed year as well as that of the harvest year. Further, the meteorological conditions necessary for seed quality appear to be, broadly speaking, somewhat opposed to those necessary for a bulky crop. Thus, in the case of wheat, absence of rain during the flowering period and warmth at harvest were found to be necessary for good seed, but for a bulky crop cool weather is desirable. Considering all the coefficients with temperature for the ninth to thirty-sixth weeks, for wheat only one out of six is positive in the harvest year, five in the seed year; for barley none is positive in the harvest year, five in the seed year; for oats none in the harvest year, four in the seed year. This result would, by itself, suffice to account for the tendency observed in the case of cereals to an alternation of good and bad crops.

Although there is considerable uncertainty in some of the less well-marked results owing to the small number of observations available (twenty-one years), the application of the laborious methods used appears to have fully justified itself by the conclusions which have been thereby reached. How great the labour must have been may be judged from the number of correlation coefficients—between six and seven hundred—which have been tabulated by the author. The paper is published, with an abstract of the discussion which took place at the meeting, in the Journal of the Royal Statistical Society for March.

FLAME THE WORKING FLUID IN GAS AND PETROL ENGINES.[1]

FLAME produced by the combustion of inflammable gas or vapour and atmospheric air forms the working fluid of gas or petrol engines.

Mechanical power can be obtained by means of flame in several different methods:—

(1) By filling a vessel or cylinder with a mixture of gas and air, and igniting this mixture, a slight explosion is caused, and the excess pressure blows off through a valve. The temperature of the flame is very high, and so when it cools the pressure in the vessel is reduced below atmosphere. This reduction of pressure may be utilised by means of an engine operating by atmospheric pressure and discharging into a partly vacuous vessel, or by a piston moving into the vacuous vessel. This method may be called the explosion-vacuum method.

A modification of this method exists which may be called the flame-vacuum method. In it the explosion is dispensed with.

(2) By admitting a charge of atmospheric air and inflammable gas or vapour at atmospheric pressure to a cylinder containing a piston, cutting off access to the atmosphere and the gas supply, and igniting the mixed charge, a mild explosion occurs; the pressure rises in the cylinder, and the piston is driven forward to the end of its stroke.

(3) By supplying to a cylinder containing a piston a mixture of inflammable gas and air in a compressed state, and then igniting that mixture, a motive power can be obtained.

These last two methods, (2) and (3), are respectively known as the non-compression method and the compression method of operation in gas and petrol engines. The two methods were illustrated by a specially constructed apparatus. In this apparatus the cylinder of a petrol engine was mounted so that the piston reciprocated vertically, and a guide rod was fixed vertically on the cylinder. A hundred-pound weight was arranged to slide on this guide rod, and arrangements made by which a given charge of gas could be introduced into the cylinder. It was also arranged that the weight could be let down on to the piston, firstly so as to rest without compressing the charge, and secondly allowing compression of about 10 lb. per square inch. The mixture in the cylinder was ignited, and, in the case where the charge was not compressed, the weight was thrown up by the explosion and expansion a distance of about 10 inches. In the case where the charge was compressed, the weight was thrown up about 18 inches, showing clearly the increased effect of the explosion of a given charge when under compression.

It is believed that this is the first time the effect of compression has been shown as a lecture experiment.

(4) A cylinder is supplied with gas and air under pressure, but the mixture is ignited at a grating or shield as it enters the cylinder, and so the pressure in the cylinder never rises above the pressure at which it is supplied. The power here is obtained without any increase in pressure, and is due to the fact that a small volume of cool mixture, when inflamed, becomes a larger volume, so that although a pump may be used to compress mixture the expansion in the motor side is greater, although at the same pressure as the pressure in the pump.

These four modes of action were all illustrated by means of specially constructed apparatus, in which the effect of the working flame could be seen. The four modes of action, and combinations or modifications of them, include all the fundamental methods used in obtaining motive power from flame which have been attempted by mankind for the last hundred years. In the year 1820 the Rev. W. Cecil, of Cambridge, read a paper at the Cambridge Philosophical Society in which he described an engine which he had constructed to operate according to the explosion-vacuum method, and he states that at sixty revolutions per minute the explosions take place with perfect regularity. His engine consumed, he stated, 17·6 cubic feet of hydrogen gas per hour. He also mentions an engine operated in accordance with the second method, the non-compression explosion method, and one

[1] Abstract of a discourse delivered at the Royal Institution on Friday, February 22, by Mr. Dugald Clerk.