ciated the volume of the sarcoglia, whose existence is thereby shown, and which rivals that of the rhabdia, we might have studied this component of muscle in its physiological relations to contractility, as well as in its morphological and genetic relations, which are the only ones yet known.

If now, in many cases, it appears that the nerve comes in contact only with the surface of a thick layer of sarcoglia, while the rhabdia everywhere is covered by very fine layers of the latter, whose absolute absence in the field of innervation can nowhere be demonstrated, we have to conclude that in general the nerve does not act directly upon the rhabdia, but only on the sarcoglia. This at once gives the latter a physiological interest. We have to ask whether the glia is the medium that conducts the stimulus between nerve and rhabdia, or whether it is itself the contractile element, while the rhabdia has a signification other than that formerly attributed to it when we were completely ignorant of the glia.

All contractile substance requires the co-operation of an elastic element. Where is this to be found in the muscle-fibre? The envelope of the sarcolemma, which is certainly elastic, but delicate, and whose mass is almost infinitesimal compared with that of the muscle-fibre, cannot satisfy the requirement; but more solid structures freely distributed in the paste-like sarcoglia could perhaps do so, and such we find in the rhabdia, in the form of prismatic particles, ranged with such constancy and with such regularity longitudinally and transversely, that we may hold them to be the elastic element. Then the sarcoglia would become the contractile element, and the nerve would have an easier task.

I could wish that this view might be accepted as an hypothesis. As far as I can see, it does not contradict experience, for it only puts back the muscle nearer to the protoplasm and to all that is contractile, and so far coincides with experience that we find muscles in the same measure less elastic and more sluggish in protoplasmic movement the richer they are in sarcoglia, as in the case of the red muscles, nucleated and rich in glia, which contract more slowly but with greater power than the white muscles, poorer in glia, which are quick and spring-like, and also the sluggish embryo muscles, in which glia predominates because as yet but little protoplasm has been converted into rhabdia; and further the cells of unstriped muscle-fibre, which are wanting in the regular transverse striation, and contain, as it appears, besides more abundant glia, an elastic material of special form and arrangement.

The hypothesis would be overthrown if contractile fibrils were found in which no sarcoglia was to be detected. But even in the finest fibrils of *Stentor*, the structure of which Bütschli [1] has recently elucidated, we must hold the significance of punctated transversely penetrating indentations to be protoplasmic, and we can therefore scarcely expect ever to find a contractile thread in which nothing whatever should be found of the primitive contractile material such as it everywhere exists.

Of late, this view [2] has been defended from the purely morphological side,[3] on the strength, namely, of the very fine reticular structure of protoplasm to which more attention is being paid, and which is demonstrable on objects of all grades of organization. Protoplasm, in fact, is not so formless as at first appeared, but shows a structure comparable with nothing better than with the appearance presented by a transverse section of muscle with its glia framework stained with gold. We may expect that these reticular structures, whose consistency appears to vary extraordinarily, will some day lead to the establishment of a fruitful hypothesis of the inner mechanism of protoplasmic movement, in place of that held hitherto, which affords no glimpse into the essence of vital mechanical work.

Compared with this larger problem, that of the causation of vital movement appears the more accessible of the two, the latter being considered as a physiological inquiry after the constitution of the normal stimulus by which work is done. Perhaps, indeed, the answer is to be looked for from the most perfected organization of muscle, where the iniatory process is localized by a distinct nerve-ending, rather than from the primitive organization, where the excitation may set in at any place, and lies in the protoplasm itself. We know distinctly that the muscle-wave begins in the field of innervation, for we have long seen the natural contraction in the interior of transparent insect larvæ starting from the nerve-eminences. We know this also from the experiments of Aeby, who followed the muscle-wave myographically from the nerve-line onward, and now we are able to display the beginnings of the contraction as local thickenings at the point of attachment of the nerves caught and fixed by sudden hardening. Since the nerve grasps the muscle in a restricted region, it expends its action upon this exclusively; that which follows on as muscular activity is the nerve's work no longer.

Galvani and his successors for more than a century suspected that nervous forces were electrical, and, in reality, the celebrated champion of electro-physiology in our day has been able with the galvanometer to render the excitation of nerves, unattached to muscles or ganglion-cells, evident as the negative variation of the natural nerve-current, to cause movement of a magnetic needle instead of a muscle, or to put the needle in the place of sensation. After this no consideration of the nature of nervous activity is conceivable which does not take into consideration this discovery of du Bois-Reymond's—least of all where the nerve has to excite something with which it is not fused, like muscle, but which it only touches, and that not directly, while still invested by the axolemma. Only during excitation, as Ludimar Hermann has taught us, are electric currents issuing from the nerve through its conducting surroundings, in which the course of these currents of action is to be estimated from the duration of the negativity of the nerve-tract excited, and from the speed of propagation of the nerve-wave, if we know the conductor and the disposition of the nerve. The motor ending fixes the latter, and so peculiarly that we can only presuppose from it a furthering of the excitor effects of the currents of action.

The currents of action of muscle, whose electromotive behaviour agrees so wonderfully with that of nerve, have long been proved to produce excitor effects, although only powerful enough to act upon nerves; but there are also, under certain conditions discovered by Hering, such effects from nerve to nerve.[1] Is the possibility, we may hence ask, to be excluded, of one muscle exciting another, and is it quite impossible that a nerve only throws a muscle into contraction by means of its currents of action?

The first question we can answer. I will do so by a simple experiment. Two muscles, the nerves of which are disposed of by poisoning with curare, need only to be pressed together transversely over a narrow area to make a single muscle of them of double length, in which the stimulation and contraction are propagated from one end to the other. Since the transference from one muscle to the other is done away with as soon as we bring the finest gutta-percha between the muscles as an insulator, or gold-leaf as a secondary circuit, the first muscle must have excited the second electrically.[2]

¹ "Dr. H. G. Bronn's Classen und Ordnungen des Thierreiches," neu bearbeitet von O. Bütschli, Leipzig und Heidelberg, 1888, vol. i. p. 1298.
² Kühne, "Neue Untersuchungen über motorische Nervenendigung," *Zeitschr. Biol.*, vol. xxiii. pp. 88-95.
³ A. van Gehuchten, "Étude sur la structure intime de la cellule musculaire striée," *La Cellule*, vol. ii. p. 289.

¹ *Sitzber. der k. Akad. zu Wien*, vol. lxxxv. Abth. 3, 1882, p. 237.
² Kühne, "Secundäre Erregung vom Muskel zum Muskel," *Zeitschr. Biol.*, vol. xxiv. p. 383.

THE ASTRONOMICAL OBSERVATORY OF PEKIN.

IN the course of a lecture delivered before the Pekin Literary Society, on the Astronomical Observatory of the Chinese capital, Prof. Russell said that it is the oldest in the world. The oldest in Europe is that of Denmark, founded in 1576 by Frederick III., at which Tycho Brahé made his famous observations. The Royal Observatory at Paris was not opened till 1671, and that of Greenwich three years later. The Pekin Observatory was established in 1279, in the reign of Kublai Khan, the first emperor of the Mongol dynasty, and three of the original instruments yet remain. In 1378, these instruments were probably used in observing Halley's comet, and they will be used twenty-two years hence to witness its next return. If the visitor enters by a door in the south wall of the Observatory, he comes into a court running east and west. In this court are kept the three original instruments. There were four at one time, but the fourth, a celestial globe, has disappeared. Kuo Shouching, a Chinese astronomer, who flourished in the reign of Kublai Khan, was the maker of these. Before their construction, bronze astronomical instruments, which were made about the year 1050, were used, first at K'ai Fêng Fu, the capital of Honan, whence they were removed to Pekin. Kuo Shouching found these worn out by age, and otherwise unsuitable, as the height of the Pole differed by 4°; and so he constructed four instruments, of which three now remain. In the east end of the court is the equatorial armillary, which is made of bronze, and consists of (1) a massive horizontal circle, held up at four corners by four dragons, each of which with one upraised palm supports the bronze circle, while round the other palm a chain is passed and fastened behind to a small bronze pillar,—the dragons are themselves works of art; (2) a double vertical circle firmly connected with the horizontal circle at its north and south points, and supported at its lowest point by a bronze pillar. On the vertical circle, which, like the other, is fixed, at a distance equal to the latitude of Pekin, that is 40°, are two pivots corresponding to the North and South Poles. Revolving round these pivots are two circles, one double, corresponding to the solstitial colure—that is, the great circle passing through the Poles and the solstices; the other single, corresponding to the equinoctial solure—that is, the great circle through the Poles and the equinoxes. Half-way between the Poles is another circle, which corresponds to the equator, the rim of which is let into the two colure circles. There is also another circle, making with the latter an angle of $23\frac{1}{2}$°, and corresponding to the ecliptic. Finally, inside these circles, all of which revolve together round the polar axis, there is another double circle, representing the polar circle or declination, and between the rims of this double circle revolves the hollow tube through which observations were made. It is probable that there were originally threads across the tube to define the line of sight. There are in the circles $365\frac{1}{4}$°—that is, a degree for each day in the year—and each degree is subdivided into divisions of 10′ each. When using this instrument the observer turned round the inner circle till the heavenly body was sighted in the centre of the tube, and then the distance of the star was read from the Pole on the polar circle, and its position on the equator by the equatorial circle. The complex construction was in some particulars of no use whatever: the ecliptic and one of the colures were useless. At the west end of the court are the other two instruments, the equatorial, or astrolabe, and the altitude and azimuth instrument. The former is remarkably simple in its construction. There is a fixed bronze circle placed parallel to the equator, and there is another double circle perpendicular to it, which moves round an axis passing through the centre of and perpendicular to the equatorial circle. Of course there is also the hollow tube for observation. This instrument is free from the clumsiness and complexity of the first-named instrument, and in the form of its mounting much more closely resembles those in use at present in all Observatories than the other instruments. The altitude and azimuth instrument consists of two circles, one horizontal and fixed, the other vertical and movable round an axis passing through the centre of the horizontal circle, and was used to observe the altitudes of the heavenly bodies and their distances from the north and south points. It is curious to observe that all these instruments are exactly similar to those constructed by Tycho Brahé, the great Danish astronomer, who was the first European to make astronomical instruments of metal. And thus we see that the Chinese anticipated European astronomers by at least three centuries, and that the former had at that very early date attained great proficiency both in the science of astronomy and the art of metal-carving. Verbiest, the Jesuit father, says that these instruments had, at the beginning of the present dynasty, fallen into disrepair. The truth was that they were far too clumsy, and were so heavy that it took several men to move them; and in some positions, from the profuseness of ornament, the stars could not be observed at all. Besides they had got out of position, and there were no appliances for righting them. It is more than probable that during the latter part of the Ming dynasty astronomy had been neglected, and so the old instruments fell into disuse. In the year 1670, so bad were the old instruments, that Verbiest was ordered to make six new instruments. It appears that when the high Ministers of State were ordered to go to the Observatory, and make certain observations, the calculations of Verbiest were verified as correct, while those of Wu Ming Hsuen, the Chinese astronomer, were proved to be wrong. And so Verbiest was intrusted with the calculation of the calendar and the construction of these instruments, which were of the same general character as the old instruments, but much more accurate, and more easily adjustable. The circles are divided into 360°, and each degree into six parts of 10′ each. By means of the diagonal scale and a movable divided scale, the observer could, on the new instruments of Verbiest, read to 15″, instead of 10′ as in the old instruments. Since the time of Verbiest two more instruments have been added—namely, an altitude and azimuth instrument, in the fifty-fourth year of Kang Hsi (1715), the other an equatorial armillary in the ninth year of Khien-Lung (1745). The former is said to have been a present from Louis XIV. to the emperor, but by some it is attributed to a German Jesuit, named in Chinese Kilian, and is remarkable for the total absence of ornamentation, and for the degrees being marked in foreign numerals. One of the most curious objects in the Observatory is the Qw'ei Ying T'ang, a three-roomed building lying a few yards to the south of the steps. It is evidently very old. In it is a stone slab 16 feet 2 inches long and 2 feet 7 inches broad, with a groove on both sides, and raised about 3 feet above the ground. At the south end of the slab is a brass pillar, which was formerly 8 feet high, but to which the present dynasty have added 2 feet more, extending to the roof, and at its summit is a small circular hole $\frac{3}{10}$ inch in diameter. Another brass pillar 3 feet 5 inches high stands at the north end of the slab. At noon the sun shines through the little hole in the roof, and throws an elliptical shadow of the sun on the slab, or on the brass pillar at the north end about the winter solstice. By observing the distance of the sun's image from the foot of the south brass pillar the solstices and equinoxes were determined. For instance, at the summer solstice the distance should be 2 feet 9 inches. The instruments of Verbiest are almost perfect of their kind, and will remain a lasting memorial of the industry and genius of the devoted missionary. At the time that he made them they were growing out of date in Europe. The telescope had already begun to be used largely in astronomical observations, and Verbiest must have known of it. The question arises, How does it happen that the Chinese, who in the thirteenth century were far ahead of Europe in the construction of these instruments, seem to have made no head-way since? Many reasons can be given, but the chief one is that with them the main object of making astronomical observations was to regulate the calendar, and to give the time to the people; and for this accurate instruments were not needed, and their want was never felt. The greater problems of the heavens never seriously attracted the attention of the Chinese astronomers. The Astronomical Board consists of eighteen officials, with the fifth prince, an uncle of the emperor, at their head. There are, including students, altogether 196 persons attached to the Board. The privilege of becoming a member of this Board has become hereditary, though it is not of necessity so. The policy, however, pursued by the Board, of keeping secret the book tables of the sun and moon, and everything used in regulating the almanac, tends to encourage the hereditary principle. No one can see them but the relatives of the Board; and so vacancy after vacancy is filled up by members of the same family as the predecessor, and as the office is an honorary, and not a lucrative, one, the people do not grumble at their exclusion. The principal duty of this Board is to prepare the calendar, the most important book published in China. Besides astronomical facts, it gives the lucky and unlucky days, on the latter of which no Chinese will transact the least business. Another duty is to observe eclipses, and this appears to be the only occasion on which the instruments are still used. On every New Year's Eve, at midnight, astronomers from the Board seat themselves in the Observatory, and watch the way in which the wind blows a number of banners which are hung around. As the wind blows, so will the new year be. This year the wind blew from the north-east, the fortunate direction, and therefore it will be a year of long life and plenty.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following were elected Fellows of St. John's College at the annual election on November 5: W. N. Roseveare, B.A. (mathematics), Master at Westminster; E. H. Acton, B.A. (botany and chemistry); F. W. Hill, B.A. (mathematics); T. Darlington, B.A. (philology), University Scholar, London, Head Master of Queen's College, Taunton, author of "The Folk-Speech of South Cheshire"; H. F. Baker, B.A. (mathematics), bracketed Senior Wrangler in 1887.

SOCIETIES AND ACADEMIES.

LONDON.

Mineralogical Society, October 30.—Anniversary Meeting.—Mr. L. Fletcher, President, in the chair.—The Hon. Secretary, Mr. Scott, read the Annual Report, which showed that the