The composition of the Youndegin iron was found to be as follows:—

Iron	92·67
Nickel	6·46
Cobalt	0·55
Copper	trace
Magnesium	0·42
Phosphorus	0·24
Sulphur	none
Insoluble cubes	0·04
	100·38

JAMES R. GREGORY.

THE CROSS-STRIPING OF MUSCLE.

PROF. RICHARD EWALD of Strassburg, has just communicated a paper to the fifty-second volume of the *Archiv. f. d. ges. Physiol.*, in which he confirms Prof. Haycraft's views concerning the structure of striped muscle. The latter observer has held for many years that muscle fibrils are varicose threads, and that the cross-striping is but an optical appearance due to this varicosity. The varicosity is often difficult to demonstrate in the ordinary way, and most histologists were not prepared to admit that the stripings are all and entirely due to it. Prof. Haycraft, however, recently brought forward to the Royal Society of London, and to the Berlin International Medical Congress, fresh and striking proof of the strength of his position, by demonstrating films of moist collodion, on which pieces of muscle had been pressed and then withdrawn. As a result of this pressure the collodion films were stamped as with a seal, and the impressions revealed in striking detail every stripe of the original fibre. Prof. Ewald confirms these experiments in the fullest manner, but suggests that the collodion impressions might be produced on the assumption that there are layers of hard and soft material alternating with each other in the course of the fibrils. In this case the hard material would press into the collodion and make a series of furrows, which would appear as a series of stripes when examined with the microscope. Prof. Haycraft had previously demonstrated the varicosity of the fibrils, seen by transmitted light, and had published photographs of his preparations, but Prof. Ewald was still sceptical upon this particular point, and sought to assure himself still more conclusively. With this end in view he examined muscle, which had been rendered quite opaque, by means of reflected light, for under these circumstances the influence of the internal structure would be entirely set on one side, and the surface of the fibrils would alone receive and reflect the illuminating rays. For purposes of illumination Prof. Ewald used the apparatus of W. and H. Seibert, of Wetzler, by means of which vertical rays can be projected upon an opaque object; and he rendered his preparations, both of fresh and of hardened muscle, quite opaque by a method of over-silvering. Under these conditions Prof. Ewald found that the cross-striping is most distinct, and he was able, with his admirable method of illumination, to examine the surface of a muscle just as one may observe the surface of the country at night by means of a search-light from an observatory. With the light perfectly vertical the tops of the ridges of the muscle are bright, and the valleys on either side in half-light. By shifting the light to one side or to another the slopes of the ridges can be thrown alternately into shadow or bright light. Prof. Ewald concludes by admitting that his experiments fully prove that the striping is due to the shape of the fibrils alone, and that the internal structure of the muscle plays no part in its production.

IRIDESCENT COLOURS.[1]

ON taking a general survey of coloured objects, whether natural or artificial, we become aware of the fact that whilst the colours of some remain unchanged as regards tint, whatever their position in relation to the incident light, the tint of others varies with every alteration in their relationship to such light source. We thus see that so far as their colours are concerned all bodies may be arranged in two groups according as their colours change or do not change in tint as their angular relationship to the light varies. Nor is this classification entirely an artificial one, since, as will shortly be seen, though this change in tint with variation in the light source is an essential difference, it is not the only difference, even in the colour manifestations of the two groups, for it is also characteristic of the nature of the colour-producing structure. It is to the above-mentioned varying colours that we apply the term iridescent, from the resemblance they have in the sequence or play of colours to the tints of the rainbow. The unvarying group of colours, having no equivalent term to "iridescence" to express the nature of their colour production, are spoken of as "pigmentary," or absorption colours. In naming examples of objects, natural and artificial, grouped as above in accordance with the nature of their colours, it is difficult to make a selection where all are so varied and characteristic. I have preferred therefore to cite only such instances as I myself possess, and am therefore able to show you. As examples of pigmentary colours, I need only name one or two for the sake of comparison, since the colours of most objects ordinarily met with are pigmentary. Leaves, flowers, dyes, birds, fish, insects, minerals, &c., exhibit these colours, some almost entirely, and all, excepting fish, in far the majority of instances. Of objects displaying iridescent colours we have also examples in the various divisions of the animal, vegetable, and mineral kingdoms. Amongst birds the most striking examples are found amongst the humming birds, sun birds, birds of paradise, &c. Insects, again, furnish numerous examples, more especially amongst tropical species, though not, perhaps proportionally in greater numbers than amongst those belonging to our own more temperate regions. The colours of fish are almost entirely iridescent, since their very whiteness, or silvery sheen, is due to the admixture of the iridescent colours of innumerable minute thin lamellæ, too small to be seen individually with the naked eye, but plainly perceptible under the microscope. In the vegetable kingdom iridescent colours are far more numerous than is ordinarily recognized, since the surfaces of the cell walls produce interference colours which are more or less obscured by the pigmentary colours of leaves and coloured flowers, but may be readily seen in the case of white flowers by the aid of a lens and sunlight. Under these conditions each cell may be seen to sparkle with its own iridescent colour, forming, by admixture of the interference tints of neighbouring cells, the varying shades of white seen in numerous flowers which are devoid of pigmentary colour. Mineral bodies displaying iridescent colours are also numerous; opals, sunstone, fire-marble, felspar, mica films, tarnish on various metallic crystals, certain crystals of chlorate of potash, &c., are examples.

In describing the various natural objects for purposes of identification, or mere description, no account can be considered complete which omits all reference to their colours, and more especially is this the case where the colours constitute such a striking feature, as in the case of iridescent bodies. In innumerable instances, more especially amongst birds and insects, their specific names are taken from some conspicuous colour they possess. It thus becomes evident that a correct description of the colours of bodies is of importance, and where these colours are of the pigmentary, or unchanging kind, this is a matter of no difficulty. How different, however, in the case of objects, the colours of which not only vary with every change of position, but disappear altogether, unless viewed with special relation to the light source. Nor can it be wondered at that descriptions of these objects, even by observers of undoubted repute, vary according to the different angles from which they have been viewed; or are vague and profuse, owing to fruitless attempts to describe their changing tints produced by every movement. The fact is, no words can convey an adequate impression of the gorgeous effects produced by most of such objects, whether birds, insects, or fish, when in motion in brilliant sunshine. Some notion of the difficulties to contend with in describing the colours of humming birds, for example, may be gathered from the remarks of Wallace in his work on "Tropical Nature," when speaking of humming birds:—"In some species they must be looked at from above, in others from below; in some from the front, in others from behind, in order to catch the full glow of the metallic lustre; hence, when the birds are seen in their native haunts, the colours come and go and change with their motion, so as to produce a startling and

[1] By Alex. Hodgkinson, M.B., B.Sc. Reprinted from the fifth volume of the fourth series of "Memoirs and Proceedings of the Manchester Literary and Philosophical Society." Session 1891-92.

beautiful effect." Most observers, in describing the colours of iridescent bodies, do so by attempting to depict the varied effects produced by casually changing the position of the object in relation to the light, omitting to mention the exact *sequence* of the play of colours, or the relation of these colours to the direction of the iridescent light, *i.e.*, whether produced by perpendicular or oblique illumination. Here is a description of the tufted neck humming bird, *Trochilus ornatus*, taken haphazard from a well-known work :—"The throat is of a fine green colour, variable in different lights to a golden hue with a yellow or brown metallic lustre, and below that the whole of the belly is a rich brown, glossed with green, and golden." Such descriptions as the above, which happen to be the first I met with in seeking for an instance, are vague, and fail to give a definite idea of the appearance of the object. But vagueness in the description of these objects is not the only result of the changing character of their colours. As might be expected, where such variation in appearance exists, the descriptions of different authors are almost as variable as the colours. Few attempt descriptions without acknowledging the hopelessness of the task. Thus Jardine, after describing this humming bird, *Chryslampis mosquitus*, remarks :—"It is impossible to convey by words the idea of these tints, and having mentioned those substances to which they approach nearest, imagination must be left to conceive the rest." And I adduce this quotation as fairly expressing the feeling of naturalists in reference to the description of iridescent objects generally. Recognizing the admitted inability of observers to convey by description an idea of the appearance of these iridescent objects, and havtng myself, for many years, constantly experienced the same difficulty, I have been led to adopt a method for the examination of such objects, which, whilst extremely simple and available in its application, yields unvarying results with different observers, results, moreover, which admit of the simplest description.

Before describing this method, I may say that long experience in the examination of iridescent objects has proved to me that, almost without exception, the colours of natural iridescent objects are due to interference produced by thin plates. In order, therefore, to render clear the principles on which the method I propose is founded, I will briefly refer to certain fundamental facts in connection with colour production by thin plates, and for this purpose will select a thin film of mica, which with light at perpendicular incidence, appears red, iridescent red. If, now, this plate be inclined so that the light falls on it at a more oblique angle, it is, of course, reflected at the same angle, and now appears orange, and if the plate be still further inclined, the reflected light appears yellow, then yellowish green, green, and bluish green, and if the light were not too copiously reflected from the first surface to allow of perceptible interference by further inclination of the plate, all the colours of the spectrum in their proper sequence might be observed. The same results, but much more vividly, may be seen in these crystals of chlorate of potash. Thus, we see that by rendering the incident light more and more oblique, the reflected light changes from a lower to a higher tint, that is, from the red towards the violet end of the spectrum. And this is what occurs in the case of all iridescent bodies, as the incident light becomes more oblique the colour changes to the tint above it in the spectral order, so that, if we know what colour any such object appears when seen at a certain angle, we can infer what colour it will change to on varying the incidence. This beetle (*Sagra purpurea*), for instance, is red at perpendicular incidence, it will, therefore, appear orange yellow and green when examined by successively increased obliquity of light. And the same is true of all other iridescent red objects. If the object at perpendicular incidence be green, as in the case of this beetle (*Bupristis*), it will become blue and then violet as the incidence is increased. We thus see that an iridescent object varies in colour, simply because it is examined by light incident, and therefore reflected, at different angles. Thus, different observers see the same iridescent object of a different colour, when they view it illuminated by light at a different angle of incidence. If, however, the object is seen by all at the same angle of the incident light it will present the same colour, and this is, in fact, what the method I propose ensures, *i.e.*, that iridescent objects shall always be seen by light at one and the same angle of incidence. The angle I select is one of 90, so that the incidence and reflection are normal or perpendicular to the reflecting surface. By selecting this angle all trouble of measuring angles is avoided, since we know that the incidence is perpendicular when it coincides with reflection. Now, the reflected light may be made to coincide with the incident light by reflecting it on to the object by means of a mirror, and so adjusting the object that the light reflected from it passes to the eye through a perforation in the mirror. When examined in this way iridescent objects are marvellously altered in appearance, their changing colours are replaced by one fixed tint, visible only in one position, a fact which serves at once to distinguish them from bodies coloured by absorption, which remain coloured whatever the relation to the incident light. Such methods of examining bodies scarcely takes more time than by the eye alone. The mirror may be attached to a spectacle frame so as to leave both hands free, such as the one I show, or may be a simple hand mirror. For objects too small to be seen by the unaided eye, I have so arranged the microscope that light is made to pass down the tube of the instrument, through the object glass on to the objects, and by a special arrangement, so adjusted the position of the object that the light is reflected back again through the instrument to the eye. The method is thus available for macroscopic as well as microscopic objects.

To illustrate the practical value of this plan of examination, I have here a few objects exhibiting iridescent colours, which, by trial, will be found to give the following results :—

The crest of this humming bird, *Chrysolampis mosquitus*, which, to the unaided eye, appears resplendent with all shades of red, orange, yellow, or green, according to the angle of the incident light, appears, when examined by the mirror, of one unvarying red tint, disappearing when the object is moved but absolutely unchanging in tint. Such an object, therefore, I should describe as "iridescent red"; all else regarding its colour may be inferred. Again, the breast, or gorget, of the same bird reflects all shades of orange, yellow, or green to the eye alone ; with the mirror it is seen of a deep orange, which, as before, is unchanged in tints by any variation in position. Such an object I would describe as "iridescent orange." The gorget of another humming bird, *Calliphlox amethystina*, to the eye alone appears crimson, orange, yellow, or green : with the mirror it is iridescent crimson only, spectroscopically a red of the 2nd order. Amongst insects, instances of iridescent species are numberless, the results of examination are just the same as in other iridescent bodies. This butterfly, *Morpho*, to the eye alone appears either greenish-blue, blue, or violet, as its inclination to the light varies ; examined with the mirror it appears green, and should be described as iridescent green, or iridescent bluish-green. This beetle, *Poropleura bacca*, appears any shade of red, yellow, or green to the eye alone ; with the mirror only iridescent red. In this extraordinary beetle, *Chrysochroa fulminans*, we have all the colours of the spectrum in their natural sequence, beginning with red at the tip of the wing case, and ending with violet higher up the elytron. These colours vary in an indescribable manner when attentively examined at different angles of incident light with the eye alone ; with the mirror the wing cases are seen to be coloured successively from base to tip iridescent green, yellow, orange, and red, and these tints remain unaltered by change of position of the object. This piece of *Haliotis* shell exhibits indescribable changes of colour with every movement, but the difficulty of description, though by no means removed, is immeasurably lessened by the use of the mirror. And the same with this specimen of iridescent iron ore, its colours, which vary to the unaided eye, remain unchanged when examined by the mirror. To simplify the description of iridescent objects, therefore, I would advocate the above method, and would describe the result of such examination by recording the colour observed by aid of the mirror, and prefixing the term "iridescent" to express the changing properties of the colour. Bearing in mind the unvarying nature of these changes, a far clearer idea may be formed of the appearance of these objects than from any attempted description of what is admittedly indescribable. Time and space are also economized by the omission of lengthy descriptions. The accuracy, and, therefore, the value of any description of colour, is always enhanced by mapping its spectrum ; more especially is this true in the case of iridescent colours. This is easily done, and by applying such map to a spectral chart, the order of the colour, and therefore its tint, is apparent. In examining many objects, chiefly birds or insects, by means of the mirror as above described, apparent exceptions are repeatedly met with to the fact stated above, that the colour is invariable in tint and disappears by inclination of the body. Such instances are no real exceptions, but are due to the reflecting plates being curved, or having pigmentary matter beneath them, or an opalescent medium above them. In this way some of the most extraordinary and beautiful colour effects it seems possible to conceive are produced.

In examining objects with the perforated mirror a single light is necessary. The sun is of course the best, and the electric light probably almost as good. I frequently employ the lime-light, but a good paraffin lamp may be used as a substitute. Ordinary gas is unsuitable. The light should be placed in front of the observer, its direct rays being prevented from falling on the objects by means of a book or partition of some kind resting on the table, and of such a height that the light can be seen above it. On placing the mirror to the eye the light may be reflected from the mirror on to the object, and the latter manipulated so as to reflect the ray back through the perforation in the mirror to the eye. The incidence is thus known to be normal, and the colour observed is the one to be recorded.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following letter has been addressed by the University of Cambridge to that of Padua, which is about to celebrate the tercentenary of Galileo's professorship :—

Universitas Cantabrigiensis Universitati Patavinae S.P.D.

Litteras vestras, viri doctissimi, GALILAEI GALILAEI Professoris vestri celeberrimi in laudem conscriptas vixdum nuper perlegeramus, cum statim in mentes nostras rediit non una Italiae regio viri tanti cum memoria in perpetuum consociata. Etenim nostro quoque e numero nonnulli urbem eius natalem plus quam semel invisimus, ubi Pisano in templo lucernam pensilem temporis intervallis aequis ultro citroque moveri adhuc iuvenis animadvertit; etiam Vallombrosae nemora pererravimus, ubi antea scholarum in umbra litteris antiquis animum puerilem imbuerat; ipsa in Roma ecclesiam illam Florentinam intravimus, ubi doctrinae suae de telluris motu veritatem fato iniquo abiurare est coactus; Florentiae denique clivos suburbanos praeterivimus, ubi provecta aetate caeli nocturni sidera solus contemplabatur, ubi extrema in senectute diei lumine orbatus cum MILTONO nostro collocutus est, ubi eodem demum in anno mortalitatem explevit, quo NEWTONUS noster lucem diei primum suspexit.

Hodie vero ante omnia non sine singulari voluptate sedem quandam doctrinae insignem, intra colles Euganeos urbemque olim maris dominam positam recordamur, ubi trecentos abhinc annos saeculi sui ARCHIMEDES discipulorum ex omni Europae parte confluentium numero ingenti erudiendo vitam suam maturam maxima cum laude dedicavit; ubi, ut LIVII vestri verbis paulum mutatis utamur, ultra colles camposque et flumen et assuetam oculis vestris regionem late prospiciens, caelo in eodem, sub quo vosmet ipsi nati estis et educati, instrumento novo adhibito inter rerum naturae miracula primus omnium Lunae faciem accuratius exploravit, Iovis satellites quattuor primus detexit, Saturni speciem tergeminam primus observavit, ultraque mundi orbem ingentem a Saturno lustratum fore suspicatus est ut etiam alii planetae aliquando invenirentur.

Ergo vatis tam veracis, auguris tam providi in honorem, nos certe, qui Professorum nostrorum in ordine planetae etiam Saturno magis remoti ex inventoribus alterum non sine superbia nuper numerabamus, hodie alterum ex Astronomiae Professoribus nostris, Georgium DARWIN, nominis magni heredem, nostrum omnium legatum, quasi Nuntium nostrum Sidereum, ad vosmet ipsos libenter mittimus. Vobis autem omnibus idcirco gratulamur quod tum Italiae totius, tum vestrae praesertim tutelae tradita est viri tanti gloria, qui divino quodam ingenio praeditus rerum naturae in provincia non una ultra terminos prius notos scientiae humanae imperium propagavit quique caeli altitudines immensas perscrutatus mundi spatia ampliora gentibus patefecit. Valete.

Datum Cantabrigiae
a. d. viii *Kal. Decembres*
A. S. MDCCCXCII.

Mr. F. Darwin has been appointed Deputy Professor of Botany for the current academical year, Prof. Babington being unable to lecture on account of the state of his health.

SCIENTIFIC SERIALS.

American Journal of Science, November.—Unity of the glacial epoch, by G. Frederick Wright. An examination of the evidence in favour of two successive glacial epochs separated by an inter-glacial epoch, during which the glaciated area was as free from ice as it is at the present time. This evidence is shown to be inconclusive, at least as far as American observations go.—A photographic method of mapping the magnetic field, by Charles B. Thwing. Iron filings are strewn upon the film side of a dry plate laid horizontally in a magnetic field, and the plate is exposed to light from above. The filings are then brushed off, and the plate developed. From the negatives excellent lantern slides may be obtained.—Contributions to mineralogy, No. 54, by F. A. Genth, with crystallographic notes by S. L. Penfield. Description and analysis of aguilarite, metacinnabarrite, döllingite, rutile, danalite, yttrium-calcium fluoride, cyrtolite, lepidolite, and fuchsite.—The effects of self-induction and distributed static capacity in a conductor, by Frederick Bedell, Ph.D., and Albert C. Crehore, Ph.D.—The quantitative determination of rubidium by the spectroscope, by F. A. Gooch and J. I. Phinney. The method is that of comparing photometrically the intensity of a certain line in the spectrum of the metal under investigation with the intensity of that given by a standard solution containing a known amount of the metal. A definite amount of the salt solution—usually the chloride—is taken up by a hollow coil of platinum wire, which may be made to take up constant quantities of liquid by taking care to plunge the coil while hot into the liquid, and removing it with its axis inclined obliquely to the surface. The coils were made of platinum wire 0·32 mm. in diameter, wound in about thirty turns to a spiral 1 cm. long by 2 mm. across, and twisted together at the ends to form a long handle. Each coil held 0·02 gr. of water. With such a coil, the blue rubidium lines were produced in a Muencke burner from 0·0002 mgr. of the chloride. Some test experiments showed that in the case of pure solutions of rubidium chloride the percentage could be found spectroscopically up to 1 part in 30,000 with an error as low as 1·25 per cent. In presence of potassium or sodium, however, the error may be as great as 20 per cent.—Notes on the meteorite of Farmington, Washington County, Kansas, by H. L. Preston.—A note on the cretaceous of North-western Montana, by H. Wood.—A deep artesian boring at Galveston, Texas, by R. T. Hill.—Notice of a new Oriskany fauna in Columbia County, New York, by C. E. Beecher, with an annotated list of fossils, by J. M Clarke.—Description of the Mount Joy meteorite, by E. E. Howell.—Influence of the concentration of the ions on the intensity of colour of solutions of salts in water, by C. E. Linebarger.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 17.—"Stability and Instability of Viscous Liquids," by A. B. Basset, F.R.S. (Abstract.)—The principal object of this paper is to endeavour to obtain a theoretical explanation of the instability of viscous liquids, which was experimentally studied by Professor Osborne Reynolds.[1]

The experiment, which perhaps most strikingly illustrates this branch of hydrodynamics, consisted in causing water to flow from a cistern through a long circular tube, and by means of suitable appliances a fine stream of coloured liquid was made to flow down the centre of the tube along with the water. When the velocity was sufficiently small, the coloured stream showed no tendency to mix with the water; but when the velocity was increased, it was found that as soon as it had attained a certain critical value, the coloured stream broke off at a certain point of the tube and began to mix with the water, thus showing that the motion was unstable. It was also found that as the velocity was still further increased the point at which instability commenced gradually moved up the tube towards the end at which the water was flowing in.

Professor Reynolds concluded that the critical velocity W was determined by the equation

$$Wa\rho/\mu < n,$$

where a is the radius of the tube, ρ the density, and μ the viscosity of the liquid, and n a number; but the results of this

[1] *Phil. Trans.* 1883, p. 935.