which the Ordnance map gives no hint. On the "Palæozoic schist" range, south of Suanetia, there are glaciers not very inferior to those of the Grand Paradis group, near Aosta. Dismiss for ever, Mr. Freshfield says, that preposterous fiction about the 120 square kilometres of ice in the Caucasus. It is too soon to say how many square kilometres there really are. One estimate, Von Thielmann's, would make the extent covered by ice close upon 2000 square kilometres, or equal to that in Switzerland—political Switzerland, not the Alps. Mr. Freshfield dwelt on many other points in connection with this interesting range, his notes on the inhabitants of the Caucasus being specially valuable, correcting as they do many prevalent errors.

OUR ELECTRICAL COLUMN.

CONSIDERABLE attention has been drawn to the peculiarities of manganese steel by a paper read before the Institution of Civil Engineers, by Mr. Hadfield. Not only is such steel entirely non-magnetic, but its electric resistance is extremely high. Prof. Fleming (*Electrician*, March 9) gives the following figures:—

German silver	20·9	·044
Platinoid	32·8	·021
Manganese steel	68	·122

The first column gives the resistance in microhms per cubic centimetre at 0° C., and the second column the average percentage variation of resistance per 1° C. between 0° and 100° C. These figures agree very well with those given by Prof. Barrett at the British Association meeting at Manchester.

HEIM has been investigating the electro-positive character of magnesium, with the view of replacing zinc in primary batteries. He finds that in a Daniell cell its E.M.F. is 2 volts, in a Grove cell it gives 2·9 volts, and in a Leclanche cell 2·2 volts. In a bichromate cell it gives as much as 3 volts.

MAGNESIUM can now be produced for about 8*s*. per lb., but local action is considerable, and its constancy uncertain. Hence, except for exceptional circumstances, its practical use is still questionable.

PROF. OLIVER LODGE has been giving some admirable lectures on lightning-protectors at the Society of Arts, and has pronounced the use of copper for such purposes as doomed. He argued that the supposed area of protection was mythical, and that the true way to protect a building was Maxwell's cage. He advocated iron, and showed copper to possess "inertia" to such an extent as to render its use dangerous. He also found that under certain circumstances, such as sudden violent discharges, untempered by time, points were of no use, but he suggested the use of barbed wire along the ridges and eaves of roofs.

THAT careful and accurate worker, Prof. Roberts-Austen submitted a paper to the Royal Society on the 15th inst., in which he narrated his recent inquiries into the mechanical properties of certain alloys that will have an important bearing on the metallic conductors employed in electrical enterprises. He has found that the tenacity of pure gold is very much diminished by the smallest admixture of impurities, and that this follows the order of the atomic volumes of the elements. Those elements the atomic volumes of which are higher than gold greatly diminish its tenacity. Doubtless the same principle is applicable to copper and other metals. The abnormal price of copper has raised a great demand for some better conductor than iron, or some improvement of iron in this respect.

DERHAM'S HYDROMETER.

THE Revenue system of estimating the duty on spirits consists of hydrometer, and tables of strengths for each degree of temperature from 30° to 80° F. When constructing the present Revenue tables of strengths, Sikes ignored the expansion and contraction of spirits due to variations of temperature from the standard temperature of 51° F., and assumed that the strength of any given sample of spirits remained the same at all degrees of temperature. From this false assumption it follows in practice, for example, that 100 gallons 40 overproof at 51° are estimated at 98·9 gallons at 30°, and 101·6 gallons at 80°, of the same strength as at 51°; reducing these quantities to the standard of proof strength, we have—

At 30°	...	$98{\cdot}9 \times 1{\cdot}40 = 138{\cdot}5$	gallons of proof,
51°	...	$100{\cdot}0 \times 1{\cdot}40 = 140{\cdot}0$	,, ,,
80°	...	$101{\cdot}6 \times 1{\cdot}40 = 142{\cdot}2$	,, ,,

showing a discrepancy of over 3½ gallons, although the same actual quantity of spirit is present in each case.

In its original construction, Sikes's hydrometer was not intended to furnish specific gravities, but simply so many indications, respectively corresponding to the strengths in his tables. But it has since been found necessary to supply a table of specific gravities corresponding to the indications of the instrument. It is well known that scientific precision cannot be attained in experiments with the hydrometer, consequently the specific gravities in this table are far from accurate: for example, the specific gravity at the proof point, to the accurate definition of which the Inland Revenue attaches so much importance, is given as ·9233, instead of ·9236. The whole specific gravity table is in fact incorrect, the error sometimes amounting to two subdivisions of the stem. The errors, however, arising from this source are trifling compared with those inherent in the tables of strengths. For the purpose of constructing correct tables of strengths, the best data and those susceptible of the most accurate determination are the specific gravities of the spirits and the percentage by weight of alcohol they contain. The specific gravity of proof spirit, as defined by the Spirit Act is ·9236; therefore the weight of one gallon is 9·236 pounds. Proof spirit contains 49·3 per cent. by weight of alcohol, of specific gravity ·79385 at 60°; therefore one gallon of proof spirit contains—

$$\frac{9{\cdot}236 \times 49{\cdot}3}{100} = 4{\cdot}553 \text{ pounds of alcohol.}$$

To determine the true ratio of any spirit to proof spirit nothing more is required than to ascertain the weight of alcohol in one gallon of the spirit, and to divide that weight by the pounds of alcohol in a gallon of proof spirit; for example, spirit having a specific gravity of ·825 at 60° weighs 8·25 pounds per gallon; its percentage by weight of alcohol is 89·13; therefore one gallon contains—

$$\frac{8{\cdot}25 \times 89{\cdot}13}{100} = 7{\cdot}353 \text{ pounds of alcohol,}$$

equivalent to

$$\frac{7{\cdot}353}{4{\cdot}553} = 1{\cdot}615 \text{ gallons of proof spirit.}$$

Or 100 gallons are equivalent to 161·5 gallons of proof spirit, and the spirit is said to be 61·5 overproof. It is obvious that although the bulk and specific gravity of a spirit vary with the temperature, the percentage by weight of alcohol it contains does not vary from that cause. The specific gravity of the spirit in the preceding example is ·839 at 30°; the weight of one gallon therefore is 8·39 pounds; its percentage by weight of alcohol is 89·13 as before; therefore one gallon contains—

$$\frac{8{\cdot}39 \times 89{\cdot}13}{100} = 7{\cdot}478 \text{ pounds of alcohol,}$$

equivalent to

$$\frac{7{\cdot}478}{4{\cdot}553} = 1{\cdot}642 \text{ gallons of proof spirit.}$$

The strength of the spirit, therefore, at 30° is 64·2 overproof.

It should be here pointed out that the diminished bulk of the spirit at 30°, as compared with its bulk at 60°, is exactly compensated, in estimating the equivalent value in proof gallons, by the increased strength at the former temperature; for 100 gallons of spirit 61·5 overproof at 60° contract to 98·33 gallons at 30°; and, reducing to proof strength—

$$100 \times 1{\cdot}615 = 161{\cdot}5 \text{ gallons of proof spirit,}$$
$$98{\cdot}33 \times 1{\cdot}642 = 161{\cdot}5 \text{ do. do.}$$

whence it is evident that, by the employment of correct tables of strengths, the estimate of the equivalent value of a given quantity of spirit in gallons of proof spirit would be identical at all degrees of temperature. The spirit tables published by Dr. Derham, to which Sir Henry Roscoe lately called the attention of the Chancellor of the Exchequer, are calculated on this principle.

Dr. Derham also supplies what has long been wanted, a scientific hydrometer having a succession of poises to continue the series the indications of which are also specific gravities. It is well known that, in order to effect this, the increment to the total bulk of the instrument with each successive poise should be the bulk of the graduated stem. Bates's saccharometer is a more or less successful mechanical adaptation of this requirement. But it had escaped previous inventors that, in order to perfectly satisfy the conditions of the problem, the specific gravities of the successive poises should bear an exactly defined relation to the specific gravities to be indicated by the instrument. The principle upon which the calculation of the hydrometer is based is that—

$$\frac{\text{weight}}{\text{bulk}} = \text{specific gravity.}$$

Let W = weight of hydrometer; B = bulk of hydrometer; G = initial specific gravity of the instrument; g = specific gravity of any poise; a = the number of degrees of gravity indicated in the length of the stem; and unity = bulk of graduated stem; then, since the bulks of the poises must be multiples of the bulk of the graduated stem, according to their position in the series,

$$n = \text{bulk of } n\text{th poise.}$$
$$ng = \text{weight of ,,}$$

By the definition of specific gravity,

$$\frac{W}{B} = G \text{ ; and } \frac{W}{B - 1} = G + a,$$

whence

$$W = BG, \text{ and } \frac{BG}{B - 1} = G + a,$$

and

$$Ba = G + a.$$

Again, generally, with nth poise attached,

$$\frac{BG + ng}{B + n} = G + na,$$

whence

$$g = 2G + (n + 1)a.$$

And if the hydrometer were intended to indicate gravities from ·780 to 1·000, the value of the stem being ·020, and the initial specific gravity accordingly of each range ·800, ·820, ·840, &c., the successive specific gravities of the poises would be 1·60, 1·62, 1·64, &c.

THE CŒLOM AND THE VASCULAR SYSTEM OF MOLLUSCA AND ARTHROPODA.[1]

THE object of the author was to establish the fact that the system of blood-containing spaces pervading the body in Mollusca and in Arthropoda was not, as sometimes (and indeed usually) supposed, equivalent to the cœlom or perivisceral space of such animals as the Chætopoda and the Vertebrata, but was in reality a distended and irregularly swollen vascular system—the equivalent of the blood-vascular system of Chætopoda and Vertebrata. Hence he proposed to call the body-spaces of Mollusca and Arthropoda "hæmocœl," in contradistinction to "cœlom." It had been held by previous investigators that in Mollusca and Arthropoda the cœlom and the vascular system were united into one set of spaces—whether by a process of gradual fusion, or owing to the fact that the two systems had never been differentiated from a common original space representing them both in the ancestors of these two great phyla. The author stated that he had been led to the view which he now formulated by his discovery of distinct spaces in both Mollusca and Arthropoda, which appear to be the true cœlom, and are separate from the swollen vascular system.

In Mollusca the pericardial space is the chief representative of cœlom. It is usually taught that the pericardium of Mollusks contains blood, and is in free communication with veins; but the author had succeeded in showing by observations on the red-blooded *Solen legumen* (already published, *Zoolog. Anzeiger*, No. 170, 1884), and by more recent careful investigation of *Anodonta cygnea*, *Patella vulgata*, and *Helix aspersa*, that the pericardium has no communication with the vascular system, and does not contain blood. The perigonadial spaces (so-called generative glands) and the pericardial space (which has arborescent tubular outgrowths in some Lamellibranchs forming Keber's organ) are, then, the cœlom of the Mollusca. It is quite distinct from the hæmocœl. In Cephalopods, and in the archaic Gastropod Neomenia, the pericardial and perigonadial cœlomic remnants are continuous, and form one cavity. There is strong reason to believe that in ancestral Mollusks the hæmocœl was more completely tubular and truly vasiform than it is in living Mollusks. In the later Mollusks the walls of the vessels have swollen out in many regions (especially the veins), and have *obliterated* the cœlom, which has shrunk to the small dimensions of pericardium and perigonadium. There are, however, many Mollusks with complete capillaries, arteries, and veins, in certain regions of the body. These had been recently studied by the author by means of injections, and by silver impregnation, and drawings illustrative of them were exhibited to the Section.

With regard to the Arthropoda, Prof. Lankester formulated the same view, viz. that the ancestral blood-vessels have swollen and enlarged, especially the veins, so as to form large irregular spaces, which have blocked up and so obliterated the previously existing cœlom. Nevertheless the cœlom still persists in some parts of the Arthropod body quite separate from the swollen blood-vascular system. It persists as the tubular generative glands (perigonadium), and also as a system of small spaces (lymph-system) in the connective-tissue of Astacus and of Limulus, and as the internal terminal vesicle of the green glands and other nephridia present in various Arthropoda. Prof. Lankester stated that he had been led to this view with regard to the vascular system and cœlom of the Arthropoda by the results of his histological investigations on the vascular system and connective-tissues of Astacus and Limulus, and by the results obtained in his laboratory by Mr. Gulland in studying the development of the nephridial "coxal gland" of Limulus (already published, with note by Prof. Lankester, in the *Quart. Journ. Micr. Sci.*, 1885, vol. xxv. p. 515). He had also been led to this view by the attempt to explain theoretically the origin of the peculiar structure of the Arthropod's heart and blood-holding pericardium.

The Arthropod's heart and pericardium are absolutely peculiar to the group, and characteristic of all its members—even of Peripatus. The author had asked himself how the existence of a tubular heart with paired valvular apertures in each segment of the body—lying within a blood-holding sac—could be explained. He conceived that it might best be explained by that tendency of the veins to dilate and to form irregular large blood-sinuses, which on other grounds we have reason to consider as a structural tendency of Arthropods. Each pair of valvular apertures in the Arthropod's heart represents a pair of distinct tubular veins which in the ancestors of the Arthropoda brought blood to the heart from the gills. These veins have dilated, and their adjacent walls have been absorbed, so that we now have, instead of a series of veins, a great continuous blood-sinus on each side of the heart or dorsal vessel.

Capillaries of the finest dimensions were shown by Prof. Lankester to exist in certain parts of Astacus and of Limulus. In studying these he had come across the remnants of cœlom. Between the capillaries and unconnected with them—in the connective-tissue of both Astacus and Limulus—is a system of spaces containing a coagulable fluid. (These spaces were described and figured in Limulus in 1884 by Prof. Lankester in the *Quart. Journ. Micr. Sci.*) It is into this system of spaces that the tubular nephridium which becomes the coxal gland of Limulus opens. Hence these spaces are remnants of the cœlom, elsewhere blocked up and obliterated by the swollen veins which form the hæmocœl. The tubular generative glands of Arthropods are to be explained as perigonadial cœlom communicating with the exterior through modified nephridia. Beddard's discovery of such a condition of the ovary and oviduct in the earthworm Eudrilus is confirmatory of this explanation.

The views which had been thus arrived at by Prof. Lankester and very briefly indicated in the note in the *Quart. Journ. Micr. Sci.*, 1885, p. 515, have received a startling and demonstrative confirmation in Sedgwick's brilliant results as to the development of cœlom and hæmocœl in Peripatus, published in the *Quart. Journ. Micr. Sci.*, February 1888, and announced early in 1887 to the Cambridge Philosophical Society.

[1] Abstract of a Paper read in Section D, at the Manchester meeting of the British Association, by Prof. Ray Lankester, F.R.S.