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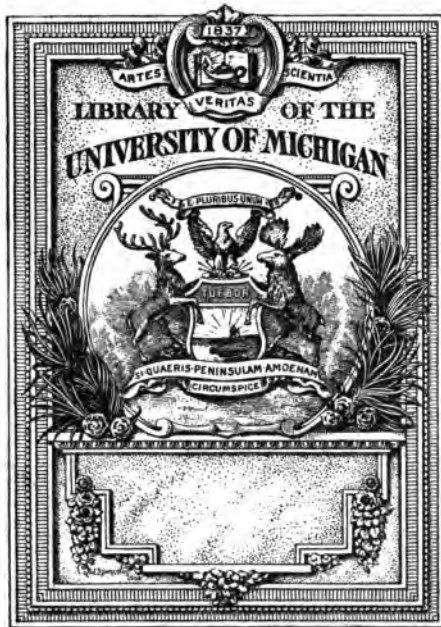
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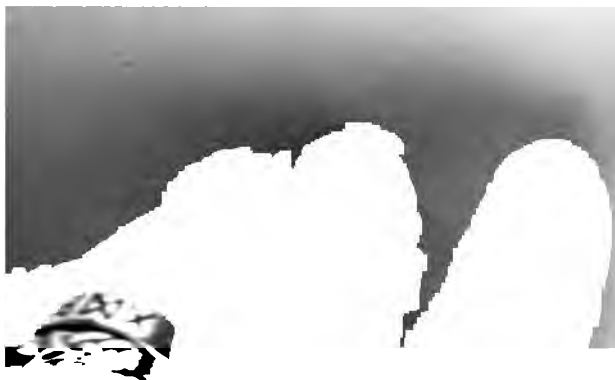
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I. Plumbism in Pottery Workers.

BY WILLIAM BURTON, F.C.S.

Received November 10th. Read October 2nd, 1900.

It is a truism to say that plumbism occurs among pottery workers because lead compounds are used in the manufacture of pottery. It becomes necessary, therefore, to explain, how and why lead compounds are so used, and to enquire as to the possibility of dispensing with their use entirely, or, in the alternative, reducing by every known means the risks run by the workers in handling them.

Lead compounds are used, and have long been used, in the manufacture of pottery, for three distinct purposes.

First: As a very important constituent of the glaze or glass with which most pottery is coated.

Second: As an important constituent of the flux, or binding material, by which on-the-glaze colours are attached to the surface of the previously fused glaze.

Third: As actual colouring matters in the form of pigments such as Naples Yellow, which is a crude antimoniate of lead.

The third group covers such a small number of substances that it will only be necessary now to direct attention to the use of lead compounds in glazes and in the fluxes of on-the-glaze (enamel) colours.

In dealing with the use of lead compounds in glazes, it would be well to mention the different kinds of glazed pottery that are largely made. All glazed pottery is

March 11th, 1901.

composed of a body or clay substance, which may be a natural clay, of no matter what kind, mixed with varying proportions of fusible substances such as felspar, or with hardening and infusible substances such as ground sand or flint. The exact composition of this body or paste, together with the nature of the actual ingredients used to arrive at the required chemical composition, determines the nature of all the manufacturing processes through which the material passes in becoming finished pottery. For instance, in the most highly developed form of pottery known, *i.e.*, Hard-paste porcelain, familiar to everyone in the form of Chinese vases and Berlin porcelain basins and crucibles, the body or paste is a mixture, principally, of china clay and felspar, while the glaze is, practically, pure felspar. It is evident that the temperature required to melt a felspar so that it will uniformly glaze a piece of pottery must be exceedingly high, indeed it is generally estimated at about 1500°C. In other forms of pottery, where the firing temperature can be carried to the point of incipient fusion of the clay-substance without bending the pieces, a glaze is obtained by flooding the kiln, at that high temperature, with vapours of common salt. A reaction takes place between the vapours of common salt, the water vapour always present in the kiln gases, and the free silica in the body of the ware, resulting in the formation of a thin glassy coating on the ware, known as salt-glaze, and the liberation of hydrochloric acid. Here again the firing temperature must be very high, though inferior to that at which hard-paste porcelain is produced. With wares such as these, whether hard porcelain, such as is largely made on the Continent, or salt-glazed stonewares (made as largely in our own country as in any continental one), it is perfectly possible to use glazes free from lead, so that,

so far as the glaze itself is concerned, no cases of plumbism can arise in their manufacture.

A very different set of conditions regulates the manufacture of the greater portion of the pottery produced in England. English earthenware is made from clay mixtures possessing great plasticity. A working mass is made containing 50 to 60 per cent. of various native clays, with variable proportions of ground siliceous and felspathic minerals. In English china, the materials used for hard-paste porcelain are mixed with a large proportion of bone-ash, so that the mixture will vitrify at a much lower temperature. With a vessel made of either earthenware or bone china, the highest temperature at which it can be fired up, and yet retain its shape, is far below either the melting point of felspar or the temperature of the salt-glazing kiln, and in effect English potters are limited to the use of glazes which will melt perfectly, and flow easily and evenly over the surface of the pottery, at temperatures ranging from 1000° to 1100°C. In order to obtain glazes suitable for this lower range of temperatures it is necessary to combine the felspar, which still forms the basis of the glaze, with silicates of the alkalies and alkaline earths, or with their borates. Glazes can be made in this way, perfectly free from lead, and melting at the required temperature, but in actual work on the commercial scale, they are very partially successful, as they are subject to serious defects, which render their extended use, in the present state of our knowledge, impossible. It will be readily understood that one of the conditions governing the employment of any substance or process commercially, is the certainty of its results. The making of pottery is in any case attended with great risk from many causes, of which the chief is the impossibility of controlling the temperature of every part of the kiln to

within 50° to 100°C. Leadless glazes of the kind under discussion are unduly sensitive in this respect, and appear to have a very limited range of temperatures within which they can be depended on to come clear, bright and glossy.* Again, leadless glazes do not flow very easily, but manifest a great tendency to draw back from sharp edges or surfaces, and in extreme cases they often "ruckle" all over or draw up into beads. They frequently exhibit a tendency to become "opaline," especially when they contain a considerable proportion of lime or barium. These defects, and many others which are of too technical a nature to be discussed here, have always stood in the way of their general adoption.

The common experience of potters for centuries has proved that, of all glazes fired at comparatively low temperatures, those containing lead compounds are by far the simplest in use, and the most reliable in practice. Many instances might be given, some of them dating from remote centuries, to prove that leadless glazes have been often abandoned for those containing lead; so that when, in the last century, England became a great pottery-producing country, the use of glazes containing lead was already firmly established in Europe. The use of lead glazes is therefore not a question of the ignorance or obstinacy of English manufacturers, as we are sometimes given to understand; nor is it because we lack technical knowledge possessed by our German or French rivals. English domestic pottery is admittedly the best in the world. The varieties of earthenware and china made in this country were invented and have been perfected here, and differ fundamentally from the indigenous products of other countries. In fact, in discovering English earthenware and English china, the English potter produced species of pottery more easy to

* Samples of tiles and pottery were shewn to illustrate this point.

manipulate and more perfectly fulfilling ordinary requirements than anything known before. The present tendency in all foreign countries is more and more to make wares on English lines and by English methods. In France and Germany the manufacture of earthenware and bone china is spreading, and in the United States no hard-paste porcelain is manufactured at all, but plenty of earthenware on English lines.

Assuming, then, that lead compounds must be used in the preparation of English pottery glazes, what steps can be taken to diminish the risks attending their use at present? In order to arrive at sound conclusions on this point we must first consider, exactly, what the risks are that a pottery worker runs in dealing with glazes and colours, seeing that these are the only substances he has to handle which contain lead at all. There has long been an idea current among pottery workers that the lead compounds used, which are either carbonate, oxide, or boro-silicate, were absorbed by the skin, so that a worker engaged, say, in dipping the articles of pottery into the glaze mixture must inevitably contract plumbism, because his hands were continually being immersed in glaze. Unfortunately this idea was reiterated in the famous report of Professors Thorpe and Oliver, issued by the Home Office. Unfortunately! for two reasons; first, because it is held by the leading medical authorities to be *quite erroneous*, and also because, so long as this notion was prevalent, it was difficult to persuade a man to avoid the dust of lead glazes when he supposed he was inevitably absorbing the poison through the skin of his hands.

The real source of danger has been proved conclusively to lie in the taking in of lead-containing dust at the mouth or nostrils. Once in contact with the mucus membranes, white lead, or any similarly soluble compound,

is readily converted into soluble and assimilable compounds which can be absorbed by the living tissues of the body, and so set up a dangerous disturbance of the system. The one point to guard against, therefore, is the creation of dust, or, if that be impossible, the breathing or swallowing of this dust by the workers. It will be readily understood that the various processes in use for applying glaze or colour to pottery will differ greatly in their liability to create dust. In some of them, as in the dusting of colour, for instance, the use of dust is a necessary part of the process; in others, the only dust created is due to the slovenly or careless habits of the workpeople themselves. It is possible to deal with the dust, however created, by careful arrangements, involving, in extreme cases, the use of fans where dust is created in some quantity. Safeguards such as these, which may be called mechanical safeguards, together with the provision of adequate and convenient washing appliances, and the careful and systematic washing of the floors, benches, and walls of workshops, will undoubtedly do much for the prevention of plumbism.

An additional protection, which may be called "the medical safeguard," is also of considerable value. It has long been known to medical men that plumbism is generally a somewhat slow form of poisoning, and that persons of certain idiosyncrasy are more than normally susceptible to its influence. Cleanliness, and care of the person, of the general health, of food, &c., are also factors of importance. It has therefore been considered advisable that all persons whose occupation in pottery works brings them in contact with lead, shall be examined once a month by the certifying surgeon for the district, who has power to suspend them from work, on the appearance of signs of plumbism, until, after a further examination, he

finds the symptoms have disappeared. Further, if the certifying surgeon is of opinion that any of these workers are constitutionally unfit to follow such employment without running grave risks, he can interdict their further employment in the lead processes.

These two sets of safeguards, the mechanical and the medical, have been now pretty generally adopted in all pottery works in this country, under special rules from the Home Office. The question of credit for the adoption of these rules does not concern us here, though there is a great deal more due to the manufacturers than is generally supposed. That they have been of very great service is shewn by the fact that although they have not been in operation yet for quite two years, the number of plumbic cases, due to the pottery industry, during the year 1900, will be fewer by nearly one-half than they were in 1898.

Quite recently a third and most important precaution has been proposed by Dr. Thorpe, as an outcome of the investigations he has conducted on behalf of the Home Office during the last two years. Dr. Thorpe points out that it has been found possible by certain manufacturers, especially on the Continent, to reduce the lead used in their glazes to a form in which it is far less readily attacked by dilute hydrochloric acid (and presumably also by the gastric juice), than the white lead or red lead in general use in this country. This result is attained by first of all fusing the lead oxide necessary, along with some siliceous and aluminous substances, so as to make a lead glass, known technically as "fritted lead."* Much depends on the chemical composition of the fritt, and on its perfect preparation, but it is possible, with care, to make fritted lead compounds which yield up to dilute

* Samples were shewn of a number of these substances.

hydrochloric acid (of about the strength normally found in gastric juice) only a small percentage of the lead they contain. Dr. Thorpe argues, and I believe rightly argues, that if these compounds are used as a means of introducing the lead into glazes, then whatever glaze is accidentally taken into the system, must have its poisonous effects greatly minimised, as only a small percentage of the lead present could pass into solution in the body, whereas at present practically the whole of the lead would be dissolved and absorbed, under similar conditions. The preparation and the general use of fritts of low solubility such as those described are attended with many practical difficulties which seem to me to have been insufficiently considered by Dr. Thorpe and the Home Office. Speaking from practical experience of a number of such fritts, it seems impossible to prepare them under such constant conditions as will ensure the same degree of insolubility. Moreover, the fritts of lowest solubility that we have been able to prepare on the commercial scale are more infusible, and cover the ware less readily, than fritts of somewhat higher solubility. It seems very doubtful if the use of fritts possessing as low a solubility as 2 per cent., which is the standard now proposed by the Home Office, can ever come into practical operation; nor am I convinced that such a low standard is even necessary, when it is to be combined with the safeguards previously mentioned which are now in operation. Neither has it been shown that such a stringent standard is necessary, or that it obtains, in those continental works where plumbism has practically disappeared. That a low standard of solubility should be set up certainly appears advisable, and it is sincerely to be hoped that, by mutual agreement between manufacturers and the Home Office, a standard which

manufacturers can work under, and which shall be low enough to be effective, may be adopted with as little delay as possible. To sum up, I have claimed that, for the manufacture of English pottery, lead is an essential ingredient of the glaze. To dispense with the use of lead would cause such an alteration of the manufacturing conditions that English pottery, as we know it, would cease to exist. I contend, further, that, retaining the use of lead, it is still possible to diminish the plumbism to the vanishing point by due attention to the safeguards I have mentioned. While the partial operation of the mechanical and medical safeguards has done a great deal, we must adopt, in addition, and make imperative, the general use of lead compounds of lower solubility than those in general use at present ; and then we may hope to turn the last page in this painful and troublesome chapter of industrial disease.

**II. The Solubility of certain Lead Glasses or Fritts
used in the Preparation of Pottery Glazes.**

By WILLIAM JACKSON, A.R.C.S.,

AND

EDMUND MILTON RICH, B.Sc.

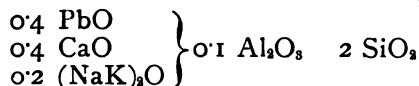
[*Communicated by William Burton, F.C.S.*]

Received and read October 30th, 1900.

By the term "Lead Fritt" is usually meant the glassy compound produced by fusing together a mixture of various silicates, silica and bases, of which last lead oxide is one. The following recipe is typical :—

Red lead	227	parts by weight.
Whiting	100	" "
China clay	65	" "
Soda ash	53	" "
Flint	270	" "

This may be expressed in chemical language thus :—



the coefficients referring to strict molecular weights.

In manufacturing a fritt, the constituents are carefully weighed, thoroughly mixed, and then fused completely in a reverberatory furnace. The glassy substance thus produced is mixed with the other constituents of the glaze, and ground with water on a mill. When it is reduced to a smooth cream it is ready for use.

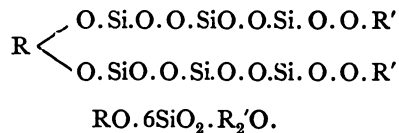
During the past few years, as is well known, the question of the solubility of such lead glazes in dilute acid, of a strength approximating to that of the gastric juice,

March 11th, 1901.

2 JACKSON AND RICH, *Solubility of Lead Glasses.*

has received a great amount of attention; and much experimental work has been carried out, with the view to reduce the solubility to such a degree that the glazes should be innocuous to the workers coming in contact with them.

According to Zulkowski a glass which shall be capable of resisting chemical agents must approach a trisilicate; and the insolubility appears to be developed by the presence of dibasic oxides, and may be due to the coupling of two polysilicates by a dyad metal as



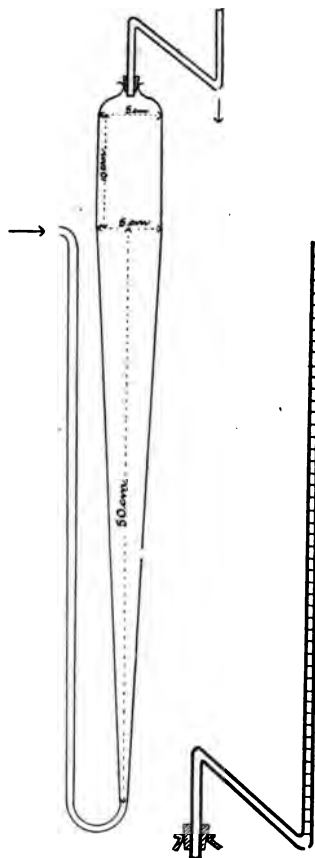
The use of a trisilicate for Pottery purposes is, for practical reasons, impossible; hence it appeared important to determine the solubility of certain compound disilicates, which it is proposed to employ.

It appeared to us necessary to determine whether there exist factors, other than the chemical composition, which may influence the solubility of lead fritts in dilute acid, and also to examine the extent of the action of any such factors. The following is an account of experimental work carried out with these ends in view.

I. *The Effect of Fineness on the Solubility of Lead Fritts.*

In the first place, solution being possible only from the surfaces of non-porous particles, it seemed that the solubility might be affected by the extent of surface exposed to the solvent, or in other words, by the degree of fineness; for it can be readily shown that the surface of unit mass of spherical particles varies inversely as their mean diameter, and we may consider that the glaze particles are, or approximate to, spheres.

In no published work have we been able to discover any mention of the part which fineness plays in connection with the solubility of fritts.



Schöns' Elutriation Apparatus.

Fig. 1.

At the outset of the work our attention was called to the possible influence of surface by the following circumstance. A fritt was ground in an agate mortar

and was then found to give up an amount of lead oxide equal to 0.75 per cent. of its dry weight when shaken for one hour with 1000 times its weight of a 0.25 per cent. solution of HCl; on the other hand, when ground in a mill, as before described, the solubility was found to be 7.02 per cent., that is the solubility was increased nearly ten times.

Another fritt, when exceedingly finely ground by hand, showed a solubility of 3 per cent. ; while when mill-ground this was increased to 4.4 per cent.

We then proceeded to a systematic examination of the question, using Schöne's elutriation apparatus (see *Fig. 1*). The method adopted was the following:—The former of the two fritts before mentioned was well ground in an agate mortar and the lighter particles washed out with water into the apparatus. This operation was continually repeated on the coarse residue in the mortar until all was removed. When water flows steadily through the apparatus, as the water rises in the conical part, its velocity diminishes regularly until the cylindrical portion is reached, when it is a minimum. All particles which have been carried into the cylindrical region will, by the same current of water, be eventually carried out of the apparatus. Hence, by means of definite successive increases in the velocity of the water in this part of the apparatus, it is possible to separate a powdered material into a number of fractions of constantly increasing coarseness. The velocity of the water current is determined by the height of the water in the piezometer, each instrument having been calibrated.

The material was thus separated into various fractions by subjecting it to the action of currents of water of definite velocities, these being regulated by the height of the water column in the piezometer. The whole of the

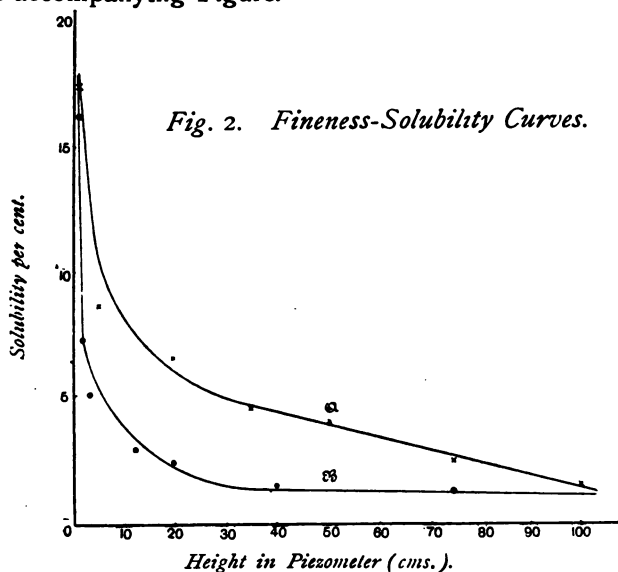
material which it was possible to bring over at any particular velocity was collected in a large cylinder. On standing, the solid matter was allowed to settle, the accompanying water was then decanted and the residue dried at 100°C.

0.2 gram of each fraction was weighed, shaken for one hour with 200 cc. of a 0.25 per cent. solution of hydrochloric acid, allowed to settle for one hour and then filtered. Sulphuretted hydrogen was passed through 100 cc. of the filtrate, and the lead sulphide which separated was filtered off, ignited with a drop of nitric and sulphuric acids, and weighed as lead sulphate.

The results obtained with this fritt are indicated under the heading A in the table, and are accompanied by a second series of results obtained in the same manner from another fritt B, supplied to us, already ground, by Mr. W. Burton, and the solubility of which, as determined by the Home Office, was 5.06 per cent.

Height in Piezometer.		Weight of PbSO ₄ from .1 gram. Fritt.		% of PbO dissolved, calculated on weight of Fritt used.	
A.	B.	A.	B.	A.	B.
1 cm.	.7 cm.	23.4 mgms.	20.4 mgms.	17.5	15.2
5 "	1.5 "	11.7 "	9.8 "	8.7	7.3
" "	3 "	8.8 "	6.8 "	6.6	5.1
35 "	12 "	6.2 "	4.0 "	4.6	3.0
50 "	20 "	5.4 "	3.2 "	4.0	2.4
75 "	40 "	3.2 "	2.2 "	2.4	1.6
100 "	75 "	2.0 "	1.6 "	1.5	1.2

These numbers when plotted as curves appear as in the accompanying Figure.



Now since the finest material is carried over by the slowest current of water, or when the water is at the least height in the piezometer, it is clear from the above results that there exists an undoubted connection between the amount of surface exposed to the solvent, and the solubility. At first sight it might appear that the solubility should vary directly as the original surface of the particles; but our numbers do not support this conjecture. This we consider can be explained by the hypothesis that the action is more complex than a mere surface action of the acid on the fritt, *i.e.*, that by the friction of the particles, during the hour's shaking, fresh surfaces are to some extent exposed to action and so more material is dissolved than is demanded by the simpler supposition of surface action only.

Having found that solubility in dilute acid is greatly

influenced by the degree of fineness to which the particles have been ground, we next enquired if there exists any recognised standard of fineness for the grinding of glazes. It is a matter of common knowledge that the fineness of a glaze is intentionally varied according to the purpose for which the glaze is required; but even in the case where it is desired to obtain the same degree of fineness, when we considered the means adopted by the mill-man to test the fineness, it seemed to us that great variations must be expected. We therefore collected seven representative finished glazes, and subjected them to elutriation, by which means the fineness of each was determined.

The results obtained are set out in the following table :

Velocity of water-current.	Percentage proportions of Glaze carried over.						
mm. per sec.	I.	II.	III.	IV.	V.	VI.	VII.
0·18	42·6	42·4	44·6	80·0	35·4	41·4	26·8
0·70	29·0	32·0	35·6	13·4	58·0	42·0	7·6
1·50	18·0	17·6	9·4	3·4	4·0	5·6	7·2
residue	10·4	8·0	10·4	3·2	2·6	11·0	58·4
Surface* Factor }	1811	1836	1901	2814	1773	1836	1066

Highest, 2842 }
 Lowest, 1066 } Mean 1866.

These figures for surface give the relative areas of equal masses of the different glazes.

It is therefore clear that great differences exist in the degrees of fineness to which glazes are reduced by various manufacturers.

* In computing the relative surface of glaze-particles, it has been assumed that the surface-area of unit mass varies inversely as the mean diameter of the particles (*cf. Pottery Gazette, Oct., 1900.*).

Since we have shown that solubility in weak acid and fineness are intimately connected, it is essential that details of the solubility of a glaze or fritt should be accompanied by particulars enabling a judgment to be formed as to its fineness.

II. *The Formation of an insoluble Coating on Particles of a Lead Fritt during the action of dilute Hydrochloric Acid.*

That an apparently maximum solubility is always reached after shaking a lead fritt with acid a short time, points to the existence of a factor, other than fineness of the particles, affecting the action; and this may be the formation of an insoluble layer of silica or other compounds on the surface of the particles.

Dr. Thorpe states that a fritt by treatment for one hour with dilute hydrochloric acid yields to the solvent the whole of its soluble lead oxide, with the exception of the merest trace, approximately 0.1 per cent. [*Blue Book*, "Lead Compounds in Pottery," 1899, page 32]. Again in the lecture entitled "Pottery and Plumbism," delivered at the Royal Institution, on May 4th, 1900, Dr. Thorpe gave other instances to the same effect, which are incorporated in the accompanying table:—

No. of Fritt.	Sol. of Fritt on 1st Extraction.	Sol. of Fritt on 2nd Extraction.
2	2	0.4
3	1.5	0.2
101	0.6	0.2
102	0.8	0.2
103	0.7	0.2

Dr. Thorpe, both in the *Blue Book* and in the Lecture, surmises that this circumstance is due to the existence of at least two different lead compounds, one of which is easily soluble in dilute acid and is easily extracted in one hour, and the other practically insoluble.

If the latter surmise is correct it would appear that the statement of Zulkowski,* to the effect that insolubility only occurs in trisilicates, is incorrect.

We are of opinion that Dr. Thorpe has in his surmise overlooked a very important fact, namely, that on the surfaces of the solid non-porous particles an insoluble coating of oxides or salts is left, which at once puts a stop to further action by the solvent. Hence it is at once evident that until this coating is removed no further solution is possible, that is, maximum solubility has been attained, notwithstanding that the interior portions of the particles have never been brought under the influence of the solvent. The existence of this coating and its nature may be deduced from figures to be found on page 32 of the *Blue Book*. Three grams of a fritt lost 3.02 per cent. of its weight in dilute acid and the remainder on further treatment with acid was found to be insoluble. The table on the following page shows the nature of the material dissolved.

From this it is seen that all the bases and the boracic acid are dissolved in practically the same proportion, but the quantity of silica dissolved is remarkably small, namely, about $\frac{1}{8}$ of the proportion in which the bases and boracic acid are dissolved. We must, therefore, conclude that nearly all the silica separated from combination remains undissolved and will be found deposited, in a great measure, at the place of its liberation, that is, on the particles themselves; *unless*, indeed, the bases exist in

* Chem. Ind., 1899, 22,280; 1900, 23,108; Chem. Ztg. Repert, 1900, 24,98.



the free condition, or a glassy compound possessing the composition of the dissolved material is present. The formula for such a compound would contain 3 molecules of basic oxides to 1 of acid oxides, whereas, according to Benrath, a normal glass is taken to possess exactly the reverse proportion between bases and acids.

Then again, in the case of a compound showing so high a solubility as 8.24 per cent. (the solubility of di-silicate of lead as mentioned later) one would expect that, if the soluble matter is extracted from the whole mass of the

	Composition of Fritt.	% amount dissolved.	Fraction of each constituent dissolved.
SiO ₂	52.94	0.15	$\frac{1}{336}$
PbO	22.44	1.27	$\frac{1}{17}$
Al ₂ O ₃	7.62	0.41	$\frac{1}{18}$
CaO	8.82	0.54	$\frac{1}{16}$
MgO	0.12	trace	—
(NaK) ₂ O	3.99	0.30	$\frac{1}{13}$
B ₂ O ₃	4.07	0.35	$\frac{1}{11}$

compound, and not from its surface only, there would occur some change in its physical condition. The particles would either become porous or they would be disintegrated. Neither of these effects was apparent after the action of the acid on the compound, which remained, in these respects, unaltered.

We therefore submitted the idea of the existence of this insoluble siliceous coating to the test of experiment. Two lines of attack suggested themselves to us

(a) a chemical method in which the layer would be removed by solution.

(b) a mechanical method in which it would be removed by friction.

In each case the removal of the layer would be followed by treatment with hydrochloric acid.

(A) *CHEMICAL METHOD.*

Since dilute caustic soda solution readily dissolves amorphous silica, we prepared a 5 per cent. solution with which we treated a fritt after extraction with hydrochloric acid. We found that an amount of silica passed into solution and the fritt became again soluble in hydrochloric acid. We found, however, that even the fresh fritt yielded silica to the soda—though less in amount than after acid extraction—and the solubility of the lead oxide in the fritt was at the same time increased. It appeared that the soda had a decomposing action on the fritt, and hence a 10 per cent. solution was adopted. This we found did not take up silica from the fresh fritt, though an amount was extracted from the fritt after treatment with hydrochloric acid. But even in this case, with 1 per cent. solution, there was a slight increase of the solubility of the fresh fritt after treatment with the soda.

The results are tabulated below.

Action of 5 per cent. NaOH Solution.

a. 1 gram fritt + HCl	- 1.8 mg. PbO extrd.
b. Residue from a + 5% NaOH soln.	10.3 mg. SiO ₂ „
c. „ „ b + HCl	4.8 mg. PbO „
<hr style="width: 20%; margin: 0 auto;"/>	
1 gr. fresh fritt + 5% NaOH soln.	8.1 mg. SiO ₂ „
∴ Layer of Silica = 10.3 - 8.1	= 2.2 mg.

Action of 1 per cent. NaOH Solution.

<i>a.</i> 1 gr. fritt + HCl	2.2 mg. PbO extrd.
<i>b.</i> Residue from <i>a</i> + 1% NaOH solut'n.	1.3 mg. SiO ₂ „
<i>c.</i> „ „ <i>b</i> + HCl	2.1 mg. PbO „
—————	
<i>d.</i> 1 gram fresh fritt + 1% NaOH sol'n.	No SiO ₂ „
	∴ layer of silica = 1.3 mg.
—————	
<i>e.</i> Residue from <i>d</i> + HCl	3.3 mg. PbO „

Seeing that even 1 per cent. solution caustic soda caused an increase in the solubility of the lead oxide in a fresh fritt, we considered the method to be unsatisfactory and it was abandoned in favour of

(B) MECHANICAL METHOD.

A fritt which had been shaken with hydrochloric acid until no more lead oxide was dissolved, the amount obtained being 7 per cent., was lightly rubbed in an agate mortar and once more shaken with acid. Lead oxide was found to have passed into solution. This led us to examine the matter systematically.

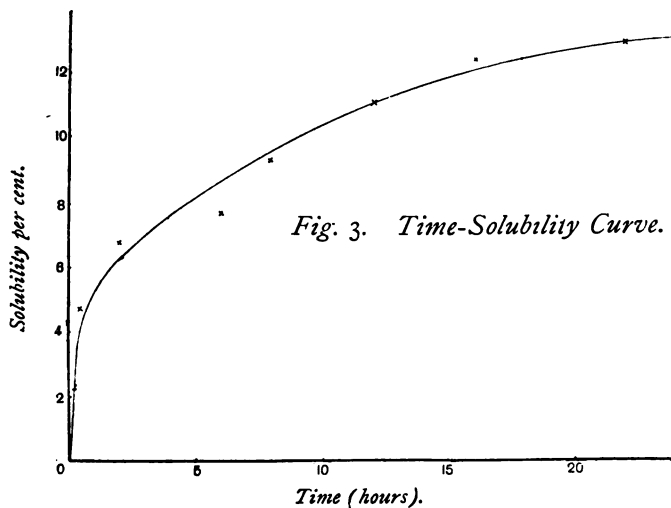
Five grams of a glaze containing about 18 per cent. lead oxide were placed in an Alsing cylinder with 2,000 cc. dilute (0.25 per cent.) hydrochloric acid and a quantity of clean flint pebbles. The cylinder was rotated for various lengths of time, after the expiration of which the dissolved lead oxide in 50 c.c. was determined.

It was thought that, by the friction of the contents of the cylinder, the insoluble siliceous layer would be rubbed off continuously as it was produced, and so the action of the acid would not be interfered with, and the amount of lead oxide dissolved should be found to continually

increase. This was found to be the case, as is seen in the following table :—

Hours action.	PbSO ₄ from 0.125 gm. glaze m.g.	% PbO dissolved (calculated on material taken).
$\frac{1}{4}$	3.8	2.28
$\frac{1}{2}$	7.8	4.68
2	11.3	6.78
6	12.8	7.68
8	15.5	9.30
12	18.6	11.16
16	21.0	12.60
22	22.2	13.32

These numbers give the accompanying curve.



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In the foregoing experiments we have dealt with a compound di-silicate. It appeared to us the action of HCl must be simpler in the case of di-silicate of lead, $\text{PbO} \cdot 2\text{SiO}_2$, in which the supposed insoluble pellicle *must be* composed of silica. A piece of such a fritt was placed in dilute HCl, and after a short time a white layer was distinctly visible which was insoluble in the acid. We also submitted a sample of commercial di-silicate to examination, by treating it with pebbles, in the manner already described. The results are put out in the table below.

Solubility before action.	8.24 % on material taken.
„ after $\frac{1}{4}$ hour's action.	8.58 „ „
„ „ $\frac{1}{2}$ „	9.36 „ „
„ „ 1 „	12.96 „ „
„ „ 3 „	15.90 „ „
„ „ 6 „	22.56 „ „
„ „ 12 „	28.8 „ „
„ „ 17 „	31.68 „ „

These are quite in accordance with our previous results.

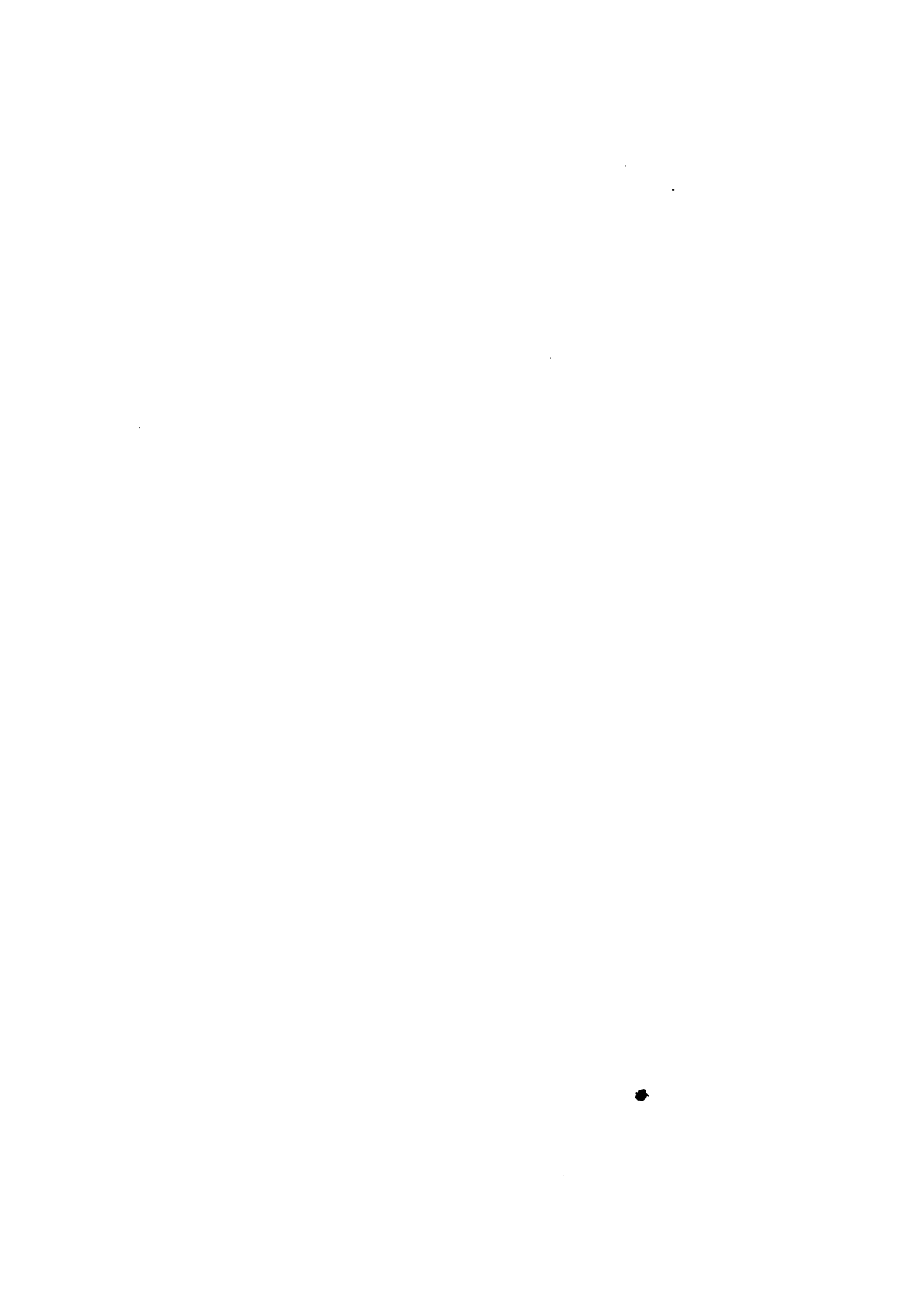
It had, however, repeatedly occurred to us that the increase in solubility in all the before-mentioned experiments *might be entirely* due to the increased fineness caused by the grinding, as we have shewn in Part I. of this paper that increase in fineness and of solubility go hand in hand.

With the apparatus at our disposal it was impossible to directly test this, but it seemed most unlikely, considering

that we were dealing with 5 grms. only of solid in 2,000 of liquid, that any great grinding efficiency could be obtained, and hence the very large increase in solubility observed could not be due entirely to increased fineness. On the other hand any insoluble pellicle formed would be soft and easily removed even in a suspension of such small solid contents. We intend to pursue this point further, but the results of our experiments tend to show that the apparent insolubility of a fritt after extraction with hydrochloric acid is not due to its actual insolubility as a whole, but rather to the formation of a protective insoluble layer of silica on the surface of the particles.

Our thanks are due to the Technical Instruction Committee of the Staffordshire County Council in whose Pottery Laboratory the work has been conducted.

Victoria Institute, Tunstall, Staffs.



III. The Thermodynamical Properties of Superheated Steam, and the Dryness of Saturated Steam.

By J. H. GRINDLEY, M.Sc.

Received January 8th, 1901. Read December 11th, 1900.

I. *The total heat of formation of Superheated Steam.*

In a previous paper* by the author on the subject of superheated steam, a description is given of some experiments on the cooling effects produced by the free expansion of steam obtained by the evaporation of water in an ordinary Lancashire or locomotive boiler. As regards its dryness, the condition of the steam used in the experiments was, as far as could be arranged, the same as that on which Regnault made his experiments on the latent and total heats of evaporation of saturated steam, as it was intended to use his results in the deduction of the properties of superheated steam.

Since writing this paper, the author has been considering his experimental results, and, in the light of further evidence by other experimenters, he has been led to calculations the results of which may be of use and interest.

In the first place, the author's own experimental results enable a table, of the total heats of formation of superheated steam at various temperatures and pressures, to be made, which will be of use. This table is compiled by calculations of a nature described in the above paper, and it contains values of the total heat of formation of superheated steam from water at 32°F. in B.T.U.'s, for every 5lbs. pressure per square inch, and every 5°F., over

**Phil. Trans.*, Vol. 194 (1900), pp. 1—36.

March 11th, 1901.

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the same range of pressure and temperature as that covered in the actual experiments.

It must, however, be understood that this table is to be considered as a useful auxiliary to the usual tables of the properties of saturated steam compiled from Regnault's experimental data, as the figures in it are deduced by a previous knowledge of the properties of saturated steam, and are therefore subject to the same errors, though it is not likely these will be very appreciable.

In the following section I propose to shew the kind of results to which we are led when we rigidly adhere to the data given by Regnault and the laws deduced by him for the saturated condition of steam.

II. *On the specific heat at constant pressure (K_p) in Superheated Steam.*

The most popular method, up to the present, of deducing the value of K_p for superheated steam is that of wiredrawing by free expansion saturated steam in a known initial condition, the total heat of formation of the steam in that condition being assumed to be that given by steam tables founded on Regnault's experiments.

What is really required, however, for the purpose of determining the value of K_p by this method, is a knowledge, not of the actual total heat of the steam in any dry saturated condition, but of the rate of variation of this quantity with temperature.

The law of variation given by Regnault, for the total heat of formation of dry saturated steam, is the linear one

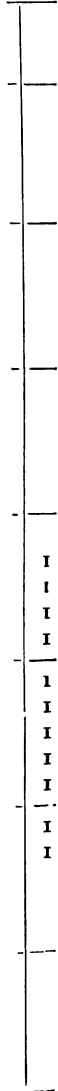
$$H = 1091.7 + .305(\theta - 32) \text{ B.T.U's.}$$

the variation being assumed to be linear and to have the constant value .305. Now, from the data obtained by the author in his paper already mentioned, determinations of

formation of Su

30	35	
—		
—		
—	—	
1161'5	—	
1163'9	1162'5	
1166'4	1165'0	
1169'0	1167'6	I
1171'6	1170'2	I
1174'4	1173'0	I
1177'3	1175'9	I
1180'2	1178'8	I
1183'2	1181'8	I
1186'3	1184'9	I
1189'3	1187'9	I
1192'5	1191'1	I
1195'7	1194'3	I
1199'0	1197'6	I
1202'3	1200'9	I
	1204'3	I

ated



the value of K_p were made for superheated steam at various pressures and temperatures, and it was essayed to express the results in a formula which would represent the variation of K_p with the temperature, there being no variation of K_p with pressure shewn. The formula best representing the results of the calculations was the follow-simple one,

$$K_p = A - \frac{B}{\tau^4} \dots \dots \dots (1)$$

where $A = 1.069$, $B = 151 \times 10^9$ and τ is absolute temperature Fahrenheit, the range of temperature represented by the expression being from 220° to 320°F . This formula is very interesting, as it would appear that at the temperature 152°F ., which occurs when

$$\tau = \sqrt[4]{\frac{B}{A}},$$

the specific heat K_p vanishes. It may be that the formula does not actually represent what would be the results given by wiredrawing experiments below the range of temperature mentioned, but the rate of variation of K_p actually shewn between the experimental limits of temperature leads to the conclusion that, if Regnault's linear law is true, then K_p will vanish at a temperature not far removed from 152°F .

That K_p does actually vanish for any temperature so high as 152°F . is very improbable, and the only conclusion which can be arrived at is that the value .305 of the variation $\frac{dH}{d\theta}$ is not sufficiently accurate to enable the value of K_p to be deduced from it, and it may be pointed out that Griffiths' value for the variation $\frac{dH}{d\theta}$ below atmospheric pressure is nearly 30 per cent. higher than the value .305.

It does not appear probable, however, that the value

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·305 is far removed from the mean value of $\frac{dH}{d\theta}$ between the range of temperatures given in Table I., and a small alteration in its value would make no appreciable difference to the figures in the table.

For further evidence on the value of K_p , the author has taken the results of Ramsey and Young's experiments* on the densities of superheated steam, and from them has obtained values of $\left(\frac{dv}{dt}\right)_p$ in superheated steam at various pressures. This, however, was only possible when dealing with steam not near the saturated condition, as near that condition the results were interfered with by surface condensation.

Assuming that the values of $\left(\frac{dv}{dt}\right)_p$, obtained for superheated steam, could be taken with very little variation to hold near the saturated condition, various values of $\left(\frac{dv}{dt}\right)_p$ were obtained and used in the formula†

$$K_p = 1 - \frac{1438}{\tau} + \tau \left(\frac{dv}{dr}\right)_p \left(\frac{dp}{dr}\right)_{\text{sat}} \dots (2)$$

to determine the values of K_p in superheated steam near the saturated condition. The number 1438 in the formula presumes an accurate knowledge of $\frac{dH}{d\theta}$, and is obtained by assuming Regnault's linear law; it is therefore liable to the same source of error as in the previous determinations of K_p .

The values so obtained are given in the following table, along with values obtained from the equation (1).

* On the properties of Water and Steam. *Phil. Trans.* (1892), p. 117.

† For proof, see Perry's "Steam Engine," p. 580.

TABLE II.
Table of Specific Heats K_p in Superheated Steam.

Temp. Fahrenheit.	K_p		Temp. Fahrenheit.	K_p	
	from eq. (2)	from eq. (1)		from eq. (2)	from eq. (1)
290·3°	·560	·595	386·8°	·694	·777
309·5	·573	·641	394·3	·694	·787
325·1	·531	·674	401·4	·706	·796
338·5	·594	·699	407·9	·711	·804
350·1	·641	·720	414·2	·700	·812
360·6	·734	·737	420·4	·686	·819
370·1	·744	·753	426·5	·756	·826
378·8	·710	·766			

It will be noticed that the variation of K_p given by equation (2) is of the same nature as, but slightly less in amount than, that given by equation (1). This difference would have been reduced if a slight variation had been allowed in the value of $\left(\frac{dv}{dt}\right)_p$ as we approach saturation.

Recently, however, determinations have been made of the value of K_p by an absolute method,* and, from the few figures published, it appears that the results confirm the statement made above, viz., that Regnault's linear law of variation of total heat with temperature is incorrect.

III. On the equation of adiabatic expansion in Superheated Steam.

From the knowledge of the total heats of formation of superheated steam, given in the first part of this paper, it is possible to utilise the results of Ramsey and Young's experiments on the densities of superheated steam to determine whether the adiabatic law of expansion in superheated steam could be expressed in the form

$$pv^n = \text{constant},$$

the data in the superheated condition being given by the

* Callendar, *Proc. Roy. Soc.*, Vol. 67 (1900), p. 279.

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entropy determined from the author's experiments, the density being given by Ramsey and Young's results, and that for the saturated condition by Regnault's results solely.

The calculations already made shew that, from 1 to 5 atmospheres pressure and between temperatures 210°F. and 330°F., which is as far as they have been carried, the mean value of the index n was 1.286, a value not far removed from the theoretical ratio of the specific heats in a gas composed of triatomic molecules.

IV. On the value of the product CK_p .

In the remarks on the specific heat K_p , it was stated that the values of K_p thus deduced from Regnault's results did not vary with the pressure, and from this circumstance the author was led to make further calculations on the values of the product CK_p , where C is the cooling effect, $\frac{d\theta}{dp}$, produced, by free expansion, in superheated steam. Thus it was found* that a particular relation existed between the variations of K_p , C , and $\left(\frac{dv}{dt}\right)_p$, namely

$$\frac{\delta}{\delta p}(K_p) = -\tau \left(\frac{\delta^2 v}{\delta t^2}\right) = -\frac{\delta}{\delta \tau}(CK_p) \quad \dots \quad (3)$$

and, assuming Regnault's law, the first and last of these three expressions was found to be zero.

For independent evidence as to the value of $\frac{d^2 v}{dt^2}$ the author examined the results of Ramsey and Young's experiments on the densities of superheated steam. The results have been rather surprising, as Messrs. Ramsey and Young had already announced as one of the results of their researches that $\left(\frac{\delta^2 p}{\delta t^2}\right)_v$ vanishes. Carl Barus†, however, found that this relation did not

* *Phil. Trans.*, 1900, Vol. 194, p. 31.

† *Phil. Mag.*, Vol. 30, 1890, p. 358.

hold for steam, and an examination of Ramsey and Young's results showed that the relation was only an approximate one.

When, however, various values of the specific volume v are taken, at different temperatures but under constant pressure, from the curves obtained by Ramsey and Young, and plotted on a volume-temperature diagram as curves of constant pressure, these curves are found to be almost exactly straight lines when considering superheated steam not near the saturated condition. It is impossible from the diagram to distinguish any marked deviation of the results from the linear relation $v = b\tau - a$ at constant pressure.

The values of $\left(\frac{\delta v}{\delta \tau}\right)_p$ obtained from this diagram have already been used on p. 4 to obtain the values of the specific heat K_p .

In the author's experiments the product CK_p at a pressure of 20lbs. per square inch was found to be 1.525 and within a short range of pressure practically uniform (the units being lbs., feet and degrees Fah.). As Ramsey and Young's results related to a wide range of pressures, they were examined to see if any great variation of CK_p existed, with results given in Table III., the units of CK_p being as above.

It will be seen that the values of CK_p above three metres pressure are practically continuous with those obtained by the author at 1.014 metres or 20lbs. per square inch pressure, and, on plotting these results, the variation of CK_p with pressure is expressed by a formula of type

$$CK_p = \frac{D}{a^p} \dots \dots \dots (4)$$

where D and a are constants. If p is in lbs. per square foot $D = 1.625$ and $\log a = .0000101$.

TABLE III.
Values of the product CK_p .

Pressures in metres of Hg.	CK_p		Pressures in metres of Hg.	CK_p	
	From Ramsey and Young's experiments.	From formula (4).		From Ramsey and Young's experiments.	From formula (4).
(1'014)	(1'525)	1'523	10	0'806	0'857
3	1'426	1'341	11	0'769	0'805
4	1'186	1'258	12	0'718	0'754
5	1'161	1'180	13	0'697	0'707
6	0'864	1'107	14	0'622	0'663
7	0'908	1'038	15	0'614	0'622
8	1'088	0'974	16	0'559	0'582
9	1'011	0'913	17	0'654	0'546

Formula (4) is really a very important one, as it represents the value of the product of the cooling effect and the specific heat in superheated steam not near saturation point, and cannot, from the mode of its deduction, be much in error, the only equation required in the process being the thermodynamically correct one

$$\frac{v + CK_p}{\tau} = \left(\frac{dv}{d\tau}\right)_p \dots \dots \dots (5)$$

and hence equation (4) will undoubtedly prove useful in checking any values of the cooling effects C and specific heats K_p found for superheated steam not near saturation.

V. *On the densities of Saturated Steam.*

It appears, from the data already existing on the density of dry saturated steam at any pressure, that we must either rely for the determination of these densities on Regnault's latent heats, to which the densities are inversely proportional, or obtain them by deduction from the properties of superheated steam.

The first method is the one usually adopted, and, if it can be shewn that the latent heats determined by Reg-

nault are not in appreciable error, no objection can be taken to its continued use. Now, for that condition of saturated steam obtained by the evaporation of water in a closed boiler, the steam being relieved of suspended moisture as far as possible by gravitational methods only, if we accept the values of the latent heat given by Regnault as correct, the author's own experiments shew that such steam requires very slight heating to become superheated, an addition of 0.05 per cent. of the latent heat of steam at atmospheric pressure being sufficient to superheat it.

Suppose, however, that, instead of using Regnault's latent heats, we take Ramsey and Young's experimental results on the densities of superheated steam, and, taking the law of expansion in the steam under constant pressure given by these results, and assuming this law to hold to the saturation temperature, make use of equation (5) to determine the specific volume of steam at the saturation temperature. As $\left(\frac{dv}{dr}\right)_p$ is practically constant and has been already found for various pressures,

$$v = r \left(\frac{dv}{dr}\right)_p - CK_p$$

will give the specific volume v at saturation.

Now the value of the specific volume at saturation so obtained is in every case greater than that obtained from Regnault's latent heats, the percentage difference increasing as the pressure rises, and the only feasible explanation of the difference, if we do not admit serious error in Regnault's latent heats, appears to be that, near the saturated condition, the law of expansion in the superheated steam differs considerably from that in highly superheated steam, the alteration being probably due to a change in the ultimate homogeneity in the superheated steam as saturation is approached.

The results recently published by Callendar, and briefly referred to previously, appear to be of similar character to those obtained by the above process from Ramsey and Young's experiments, and in his paper it appears that his results on the specific volumes of saturated steam have been obtained by a deduction from some of the properties of superheated steam, and, therefore, by a process similar to that just adopted with the results of Ramsey and Young's experiments. The main difference is that in Callendar's paper the deduction was made from a knowledge of the cooling effects and specific heats K_p in superheated steam, while in the other case the deduction was made from a knowledge of the densities of superheated steam.

To see whether there was any agreement between the results so obtained by these two processes a few values found for the specific volumes of saturated steam deduced from Ramsey and Young's results, have been placed in the following table with a few of Callendar's results, and with the specific volumes determined from Regnault's latent heats.

TABLE IV.

Specific volumes of dry saturated steam.

Pressure lbs. per sq. inch.	Sp. volumes in c.c.			Percentage excess of (1) or (2) over (3).
	Deduced from R. & Y.'s experiments. (1)	Given by Callendar. (2)	Deduced from Regnault's L. Hs. (3)	
14·7	—	1672·5	1650·5	1·33
28·83	—	890·6	876·3	1·61
52·52	—	508·4	499·4	1·80
58·03	461·13	—	454·0	1·60
77·37	354·48	—	346·0	2·30
88·35	—	307·1	300·7	2·10
225·9	—	129·6	126·8	2·10
290·13	103·67	—	100·4	3·30
309·47	97·29	—	94·2	3·20

An examination of this table shews that both Callendar's results and those deduced from Ramsey and Young's experiments, give practically identical differences with the results of calculations from Regnault's latent heats, the percentage difference of either from Regnault being given in the last column. Now we have seen that the kind of steam used by Regnault requires but little addition of heat in order to superheat it, and hence we are forced to the conclusion that, if we accept the deductions from the superheated conditions as correct, Regnault's latent heats must be *too small* by amounts varying from 1·33 to 3·4 per cent. It should be observed, however, that the difference, between the specific volumes of saturated steam given by Callendar, or those obtained by deduction from Ramsey and Young's experiments, and those given by Regnault's latent heats, may be due entirely to the method of deduction adopted in the determination of these volumes in the first two instances, viz., by assuming the data in the superheated condition to hold down to the saturated condition.

IV. Note on d'Orbigny's figure of *Onychoteuthis dussumieri*.

By WM. E. HOYLE.

Received and read January 8th, 1901.

In the year 1895 Professor Joubin (95, p. 1172) described a remarkable cephalopod taken from the stomach of a sperm-whale, taken in the neighbourhood of the Azores by His Serene Highness the Prince of Monaco, the most striking characteristic of which was that it appeared to be covered with scales of a subquadrangular form and arranged with great regularity. Such an arrangement was, of course, quite novel in the order, and excited no little interest, but as the specimen was unique and only consisted of the partially digested trunk, without head, arms or suckers, no opinion as to its systematic position could be offered. A few years later Dr. Einar Lönnberg (98, p. 55) noticed a similar appearance in a specimen of *Onychoteuthis ingens* obtained by the Swedish Expedition to Magellans Straits. This he found to be due not to the presence of scales, but to the raising of the skin by numerous subcutaneous papillæ in consequence of the maceration it had undergone.

During a visit to Hamburg last summer, my friend, Dr. Pfeffer, of the Natural History Museum in that city, showed me a squid, which had similarly been obtained from the stomach of a cetacean, and was covered over the greater part of the mantle with small shining convex bodies, about half a millimetre across, and presenting an appearance like fine-grained shagreen.

March 11th, 1901.

2 HOYLE, *d'Orbigny's figure of Onychoteuthis dussumieri.*

Dr. Pfeffer had been struck with the idea that this specimen might probably throw light on the true nature of *Lepidoteuthis*, and I pointed out to him the similarity of his conclusion to that reached by Lönnberg. In fact, as Dr. Pfeffer observed—it seemed as though it might be possible by partial digestion to convert genera of various families into *Lepidoteuthis*.

Not long afterwards, on looking over the atlas to Férussac and d'Orbigny's great work (35), I was struck by the figure of *Onychoteuthis dussumieri* (Pl. 13), the mantle of which is studded over with small tubercles, to all appearance of a precisely similar character. In fact, it would be difficult to describe Dr. Pfeffer's squid more appropriately than in the words used by the French writers regarding their species—"corps finement chagriné par de très-petits tubercules égaux, très-rapprochés les uns des autres."

Gray (49, p. 56) placed this species in his genus *Ancistroteuthis*, on account of the form of the pen, but it does not appear that he had any specimen for examination, basing his conclusion merely on the published figures. No example other than this type has ever, to my knowledge, been recorded.

D'Orbigny's statement (35, p. 335) that the drawing is "d'après nature sur un individu décoloré," and his description of the tentacular clubs as "paraissant avoir été couverts d'au moins trente crochets sur deux lignes alternes" show that post-mortem changes had taken place in his specimen. Hence it seems to me extremely likely that the tubercular appearance is an artificial, not a natural character, and if this be the case it adds a little to the presumption in favour of the accuracy of Dr. Lönnberg's explanation of the constitution of *Lepidoteuthis*.

POSTSCRIPT.—Since the above paper was in type I have received a letter from Dr. Pfeffer, in which he tells me that since my visit to Hamburg he has dissected out and examined the gladius of the squid in question. He finds it to agree exactly with the figure given by d'Orbigny, and has, therefore, no doubt that its resemblance to *O. dussumieri* is to be explained by its being a second example of the same species! The type specimen of the *Onychoteuthis ingens* in the British Museum unfortunately has no body, so that I have been unable to see how far it agreed with Lönnerberg's description. The exact nature of *Lepidoteuthis* is still a matter of uncertainty, and we look with interest to Professor Joubin's further account of it in the memoir on the cephalopods collected by the Prince of Monaco.

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- 35.** FÉRUSAC & D'ORBIGNY. "Histoire naturelle générale et particulière des céphalopodes acétabulifères, vivants et fossiles." Paris, 1835-48.
- 49.** GRAY, J. E. "Catalogue of the Mollusca in the British Museum.—I. Cephalopoda Antepedia." London, 1849.
- 95.** JOUBIN, L. "Céphalopodes recueillis dans l'estomac d'un Cachalot, capturé aux îles Açores." *Comptes rendus*, vol. 121, p. 1172-1174, 1895.
- 98.** LÖNNERBERG, E. "On the Cephalopods collected by the Swedish Expedition to Tierra del Fuego, 1895-96. *Wiss. Beobachtungen d. schwedischen Exped. Magellansländern*, 1895-97. Stockholm, 1898.
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Manchester Memoirs, Vol. xlv. (1901), No. 5.

THE WILDE LECTURE.

Sur la Flore du Corps Humain.

Par M. ÉLIE METCHNIKOFF, For. Mem. R.S.

Delivered April 22nd, 1901.

En m'annonçant que vous m'aviez décerné la médaille de Wilde, votre Président a exprimé le désir que je fasse une conférence devant vous. Je me suis empressé de saisir cette occasion de vous dire de vive voix toute ma reconnaissance pour le grand honneur que vous m'avez fait.

Je voudrais bien vous prouver que je mérite une si haute distinction, en vous apportant quelque chose de nouveau, mais en science le neuf est très rare et je n'ai pas d'autre prétention que de vous montrer toute la sincérité de ma gratitude. La lettre de votre estimé Président m'a trouvé absorbé par des études entreprises dans le but de dresser une sorte de programme de recherches nouvelles. Les savants, comme vous le savez bien, sont hantés par des idées fixes et il leur est impossible de parler d'autre chose que du sujet qui les préoccupe pour le moment.

Je me suis donc décidé, au lieu de vous exposer des résultats définitifs, à vous présenter un simple programme de recherches déjà commencées dans mon laboratoire de l'Institut Pasteur de Paris. Je désire vous entretenir des microbes qui vivent dans le corps humain, dans le but de vous démontrer que les deux grandes théories biologiques du XIX^{me} siècle, celle de l'évolution des espèces de votre illustre compatriote Darwin, et la théorie microbienne des fermentations et des maladies, formulée par Pasteur, sont

May 28th, 1901.

2 METCHNIKOFF, *Sur la Flore du Corps Humain.*

comme des phares lumineux dans la recherche des problèmes compliqués et difficiles dont la solution incombe au siècle qui vient de commencer.

Il y a déjà plus de 200 ans, aussitôt après l'invention du microscope, qu'on a trouvé de petits êtres pullulant en grande quantité dans le corps humain. Leeuwenhoek exprime son étonnement en constatant que la bouche et l'intestin de l'homme sont peuplés d'une quantité d'organismes microscopiques, dont beaucoup manifestent des mouvements très actifs et se présentent comme de tout petits animalcules.

Cette découverte a été confirmée à maintes reprises dans les deux derniers siècles, mais vous serez étonnés de constater le peu de précision de nos connaissances sur la flore de notre corps.

Les animalcules de Leeuwenhoek, les microbes, comme on dit aujourd'hui, qui pour la plupart sont des plantes inférieures et microscopiques, existent en très grand nombre sur la surface et dans l'intérieur du corps humain.

L'homme naît sans microbes. Il n'a aucune flore microbienne ni à la surface ni à l'intérieur de son corps. Quelquefois, en sortant du sein de la mère, alors même que celle-ci et l'enfant sont tous deux bien portants, la conjonctive du nouveau-né est contaminée par un petit bacille, très semblable à celui de la diphtérie. Cependant, comme il est à peu près inoffensif pour l'homme, on l'a rangé dans le groupe des bacilles pseudodiphtériques. Ce microbe est le premier qui s'installe pour végéter sur le corps humain.¹

Aussitôt après la naissance, la surface de la peau et

¹ v. Hallé. *Recherches sur la bactériologie du canal génital de la femme*, Paris, 1898, p. 22, Note 3. Le développement précoce du bacille pseudo-diphtérique sur la conjonctive du nouveau-né a été observé par M. Morax, dont je tiens le fait.

des muqueuses se peuple de microbes ; au bout de quelques jours, ils sont nombreux et variés. La semence de ces microbes provient de l'air ou de l'eau qui sert à laver l'enfant. En été, la flore se développe plus vite qu'en hiver et quelquefois, déjà 4 heures après la naissance, on trouve dans le contenu de l'intestin, le méconium, plusieurs espèces de bactéries. Le plus souvent l'apparition de la flore dans ce milieu a été observée entre la dixième et la dix-septième heure après la naissance.¹

Il n'entre pas dans mon plan de vous ennuyer par la description minutieuse et détaillée de tous les microbes qui s'établissent ainsi dans le corps de l'homme sain. Du reste il serait impossible de bien différencier ces espèces microbiennes, car les caractères spécifiques des bactéries sont extrêmement variables et difficiles à préciser. On peut dire que la bactériologie a presque toujours affaire à des "mauvaises espèces," d'après la langage des taxonomistes.

La flore microbienne du corps humain à l'état normal est constituée en grande partie par des bactéries ; les champignons inférieurs, comme les levures, ou blastomycètes, n'y figurent qu'en très faible minorité. Parmi les bactéries, ce sont surtout des formes rondes, des microcoques, qui peuplent notre peau. On en distingue plusieurs espèces, ou variétés, parmi lesquelles une est surtout remarquable par une coloration orange qu'elle prend dans les cultures sur les différents milieux. Ce microbe, connu sous le nom de staphylocoque doré, est moins répandu sur la peau de l'homme sain que deux variétés incolores ; et cependant il est encore assez fréquent et se retrouve, de même que ses congénères, dans beaucoup d'autres régions du corps humain. Les microcoques

¹ v. Schild. Das Auftreten von Bakterien im Darminhalte Neugeborener. *Zeitschrift für Hygiene*, Bd. 19, 1895, p. 113.

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en forme de chapelets de grains sont plus rares que les staphylocoques.

Les formes bacillaires sont moins nombreuses sur la peau normale que les cocci. On en trouve une toute petite, décrite sous le nom de microbacille de la séborrhée et une bactérie très bizarre, désignée par Unna, un dermatologiste allemand bien connu, sous le nom de Bacille-bouteille (*Flaschenbacillus*). Ce microbe si particulier se rencontre constamment dans les pellicules qui se détachent si facilement du cuir chevelu. Mais le lieu de prédilection de nos microbes cutanés est incontestablement le follicule pileux. Il constitue une sorte d'étui profond qui s'enfonce dans la peau et sert à la formation du poil. Son canal présente des conditions très favorables pour le développement des êtres microscopiques et aussi, le plus souvent, il est envahi par les staphylocoques qui y forment des amas solidement et profondément établis.¹

Les muqueuses, avec leurs surfaces toujours humides et recouvertes de substances qui alimentent facilement les microbes, accusent une flore généralement plus riche que celle de la peau. Cependant, la conjonctive de l'œil, grâce au lavage continuel par les larmes, se débarrasse de la plupart des microbes qui y pénètrent soit avec les fines poussières de l'air, soit par le contact avec les doigts ou les autres parties du corps.

La flore de la conjonctive, comme celle de la peau, est plus riche en cocci qu'en bacilles. Quelques auteurs ont signalé la présence de staphylocoques, dorés et incolores, pareils à ceux de la peau. Les bacilles pseudo-diptériques ont été trouvés par plusieurs observateurs.²

La muqueuse du nez est également peuplée de mi-

¹ Sabouraud, *La pratique dermatologique*. T. I., p. 701.

² Axenfeld, *Berliner klinische Wochenschrift*, 1898. Bach, *Archiv für Ophthalmologie*, Bd. 40, p. 130.

crobes, parmi lesquels on a souvent reconnu les staphylocoques, les streptocoques et quelques bacilles.

Il est incontestable que les microbes pénètrent dans les voies respiratoires de l'homme, même les plus profondes. Seulement il est très difficile de se rendre compte d'une façon précise de la flore microbienne de la trachée, des bronches et du poumon de l'homme à l'état normal. La constatation des bactéries dans ces organes sur le cadavre ne peut être considérée comme une preuve suffisante de leur présence chez le vivant, et pourrait s'expliquer par la pénétration *post-mortem* des microbes des organes voisins. Dans tous les cas, la flore des voies respiratoires profondes ne doit jamais être riche chez l'homme sain.

Ce sont les organes de la digestion qui présentent la plus grande richesse en fait de flore microbienne. Le Docteur Miller de Berlin¹ a réuni en un volume une grande quantité d'observations et décrit plus de trente espèces qui habitent la cavité buccale de l'homme. Parmi ces microbes, il y en a qui se trouvent également sur la peau humaine ; mais en outre il existe autour des dents plusieurs formes bactériennes bien distinctes qui sont caractéristiques de la flore buccale et ne se rencontrent nulle part ailleurs, comme les leptothrix et les spirochaetæ de la bouche. La flore de la cavité buccale est au moins aussi riche en bacilles qu'en microcoques, parmi lesquels se trouvent très fréquemment les staphylocoques, dorés et incolores, les streptocoques et les pneumocoques.

Plusieurs représentants de la flore de la bouche descendent dans les voies digestives profondes et se retrouvent dans l'estomac et les intestins. Le premier de ces organes, caractérisé par l'acidité de son contenu, présente des conditions tout-à-fait particulières pour le développement des plantes microscopiques. Beaucoup de bactéries

¹ *Die Mikroorganismen der Mundhöhle. 2^e Auflage. 1892.*

en effet ne supportent pas un milieu acide, tandis que quelques levures et leurs congénères de la classe des champignons tolèrent beaucoup mieux l'acidité du suc gastrique. Eh bien, malgré ces conditions défavorables, la flore bactérienne stomacale de l'homme est encore assez riche. M. Coyon,¹ qui n'a étudié que les microbes de l'estomac qui croissent en cultures aërobies, mentionne 30 espèces différentes, parmi lesquelles la plupart ne se rencontrent pas dans les autres parties du tube digestif.

Depuis longtemps, on a trouvé des microbes tout-à-fait caractéristiques dans le contenu stomacal de l'homme. Ce sont des cocci, réunis en gros paquets et décrits sous le nom de *sarcines*. Ils sont aussi typiques pour la flore stomacale que le spirochaete pour la flore de la bouche. Mais en dehors de ces sarcines, il n'y a que peu de cocci dans l'estomac humain, et ce sont surtout les bacilles et aussi les levures qui constituent la majorité des microbes gastriques.

Cette prédominance des bacilles est encore plus marquée dans la flore de l'intestin grêle. La principale source de nos connaissances sur cette flore est un mémoire de MM. Macfadyen, Nencki, et Madame Sieber² qui ont eu la chance d'étudier pendant plusieurs mois le contenu intestinal qui s'écoulait d'une fistule, consécutive à une opération d'hernie étranglée. Ils ont isolé de ce liquide, provenant de l'intestin grêle, quatorze formes microbiennes, parmi lesquelles les levures et les moisissures étaient rares ; les bactéries rondes, entre autres deux formes de streptocoques, étaient plus fréquentes. Mais la grande majorité de la flore de l'intestin grêle était représentée par les différents bacilles, parmi lesquels les plus constants étaient le colibacille, hôte commun du tube digestif de

¹ *Flore microbienne de l'estomac.* Paris, 1900.

² *Archiv für experimentelle Pathologie.* Bd. 28, 1890, p. 311

l'homme et d'une quantité d'animaux, et le bacille du lait aigri.

Les auteurs que je viens de citer ont constaté que la flore de l'intestin grêle changeait avec la nourriture que prenait leur malade. Le régime carné et l'alimentation végétarienne provoquaient le développement de formes bactériennes particulières. Même avec un régime constant, ils ont pu observer des variations notables dans la population microbienne.

De l'intestin grêle, les microbes passent dans le gros intestin, où s'associent à eux un grand nombre de formes nouvelles. De toutes les parties du corps humain, c'est sans doute le gros intestin qui renferme la végétation microbienne la plus riche. Cette flore a déjà toute une littérature. Celle-ci nous apprend que le contenu du gros intestin de l'homme est peuplé d'environ 45 espèces microbiennes. Les levures y sont plus rares que dans l'estomac et même dans l'intestin grêle. La flore du gros intestin renferme principalement des bactéries, parmi lesquelles les bacilles sont de beaucoup les plus nombreux. Nous retrouvons dans le contenu de cette partie du tube digestif beaucoup de microbes qui ont été mentionnés comme habitant la cavité buccale, l'estomac et l'intestin grêle. Parmi les formes propres au gros intestin, un grand nombre n'ont jamais pu être cultivées en dehors de l'organisme, ce qui explique la grande imperfection de nos connaissances sur ce chapitre.

Le gros intestin commence à se peupler presque aussitôt après la naissance. Déjà dans la première journée, c'est à dire avant que l'enfant ait pris une nourriture quelconque, dans le méconium, ou contenu du gros intestin, on trouve une flore microbienne assez variée. A côté de plusieurs bactéries sphériques, ou microcoques, apparaissent des formes allongées, parmi lesquelles on reconnaît surtout le

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colibacille, déjà mentionné comme hôte de l'intestin grêle.

L'alimentation par le lait maternel change bientôt la flore du gros intestin. Elle devient plus uniforme et renferme surtout, quelquefois presque exclusivement, un petit bacille mince qui ne se développe en dehors de l'organisme que difficilement et seulement à l'abri de l'air. M. Tissier,¹ qui a découvert cette espèce, l'a désignée sous le nom de *Bacillus bifidus*.

Chez les enfants, nourris au biberon avec du lait de vache, ce même bacille se retrouve aussi, mais en moindre quantité. La flore du gros intestin de ces enfants est beaucoup plus riche en formes microbiennes, parmi lesquelles on retrouve les colibacilles, les streptocoques, les staphylocoques, les bacilles du lait aigri, les sarcines et encore une série d'autres bactéries. Les bacilles sont prédominants, mais les formes rondes et les spirilles sont aussi largement représentés.

Les enfants, soumis au régime lacté, nourris avec du lait de vache cru ou stérilisé, renferment, comme vous voyez, déjà une flore du gros intestin assez riche. Mais, à partir du moment où la nourriture est plus variée, après le sevrage, cette flore devient encore beaucoup plus abondante. Ce caractère persiste chez l'adulte. D'après les données réunies par Vignal et Suckdorf² on peut évaluer qu'un homme rejette de 30 à 50 milliards de microbes par jour. Beaucoup d'entre eux n'ont jamais pu être cultivés en dehors de l'organisme et sont encore fort peu connus.

Dans l'état actuel de la science, il est impossible d'évaluer le nombre d'espèces microbiennes qui constituent la flore de l'homme sain. Ce n'est qu'à titre provisoire et purement approximatif que nous pouvons l'estimer

¹ *Recherches sur la flore intestinale des nourrissons*, Paris, 1900.

² *Archiv für Hygiene*, Bd. 4, 1886.

comme se trouvant entre 60 et 70. Ces microbes, comme vous l'avez déjà vu, sont répartis d'une façon très inégale. La peau en renferme le moins, le gros intestin en contient le plus.

Que peut-on dire du rôle de cette flore si variée? L'homme n'est pas le seul être qui soit contaminé par une multitude de plantes inférieures. La peau et les cavités de beaucoup d'animaux renferment aussi des flores plus ou moins riches. Parmi les Invertébrés, il y en a qui sont recouverts d'une végétation beaucoup plus abondante que celle qui se trouve sur la peau humaine. Parmi les crabes, il y a une espèce, très abondante sur les côtes méridionales et occidentales de l'Angleterre, connue sous le nom d'araignée de mer, ou la *Maya (Maia squinado)*. Sa carapace épineuse est le plus souvent recouverte d'une quantité d'algues qui s'élèvent à une hauteur considérable et poussent de tous côtés. L'utilité de cette flore est incontestable et évidente. Les algues dissimulent le crabe sur les fonds herbeux et le cachent aux regards de ses ennemis et des animaux qu'il poursuit pour en faire sa nourriture. La flore de la peau humaine n'a aucun but semblable à remplir et son utilité ne peut être aucunement démontrée.

Par contre, la flore de la cavité buccale peut rendre des services à l'homme. Tout le monde a remarqué que les plaies de la bouche guérissent beaucoup plus vite que celles de la peau. Humectées par la salive, les plaies restent au contact des microbes et de leurs produits solubles qui stimulent notablement la réaction de l'organisme. Les sécrétions microbiennes attirent une grande quantité de globules blancs, ou leucocytes, et ces cellules nettoient la plaie, la débarrassent des microbes et des parties mortifiées, favorisant ainsi la réparation définitive.

Dans les parties plus profondes du tube digestif, ce rôle des microbes est moins important, car les lésions de la muqueuse y sont beaucoup plus rares. Mais il est très probable que les acides, que beaucoup de bactéries sécrètent dans l'intestin grêle, rendent un service réel en empêchant le développement de certains autres microbes qui pourraient gêner la digestion normale. Cette action empêchante se manifeste même dans la lutte de l'organisme contre des microbes très dangereux. On a observé souvent que des hommes peuvent impunément ingérer une grande quantité de vibrions qui, chez d'autres individus, occasionnent le vrai choléra asiatique. On est en droit de supposer que cette immunité est due à la présence des microbes intestinaux qui gênent le vibron cholérique dans son action pathogène. Un argument en faveur de cette hypothèse nous est fourni par les expériences sur les très-jeunes lapins. Tant que ces animaux se nourrissent exclusivement de lait maternel, lorsque leur flore intestinale est encore peu variée, l'ingestion du vibron cholérique leur donne le choléra mortel. Mais à partir du moment où ils commencent à se nourrir de végétaux et où leur flore intestinale devient beaucoup plus riche, même de grandes quantités de vibrions cholériques ingérés ne provoquent plus aucun trouble.

M. Bienstock¹ suppose que certains microbes de notre flore intestinale normale, notamment le colibacille et le bacille du lait aigri, empêchent l'invasion du tube digestif par des microbes de la putréfaction, s'appuyant sur ce fait que le lait cru, qui renferme les deux espèces mentionnées, n'entre pas en putréfaction.

Bien que ce rôle empêchant des microbes intestinaux n'ait jamais pu être bien prouvé, il est néanmoins très probable. Mais on a supposé encore une autre action

¹*Archiv für Hygiene*, Bd. 39, 1901, .

utile de notre flore intestinale. A propos d'une communication de M. Duclaux à l'Académie des Sciences de Paris, Pasteur a énoncé cette hypothèse que les microbes du tube digestif jouent un rôle important dans la digestion des aliments et que, sans leur concours, l'utilisation de la nourriture par l'organisme animal serait impossible. En raison des grandes difficultés pratiques pour la réalisation des expériences, tendant à résoudre ce problème, ce n'est que dans ces dernières années que l'on s'est mis à les exécuter d'une façon précise. Nuttall et Thierfelder¹ ont essayé d'élever de jeunes cobayes à l'abri des microbes et Schottelius² a tenté de faire vivre de jeunes poussins dans des conditions d'asepsie complète.

Les deux premiers observateurs ont réussi à élever des cobayes, extraits par opération césarienne, jusqu'à 13 jours. Ils les ont, pendant tout ce temps, gardés dans un espace rigoureusement privé de microbes et les ont nourris avec du lait de vache et des *cakes* stérilisés. Les cobayes ont bien supporté ce régime, ont augmenté de poids pendant leur captivité (quoique à un degré moindre que les cobayes témoins, élevés dans des conditions normales) et, à l'autopsie, se sont montrés totalement dépourvus de microbes. Nuttall et Thierfelder concluent donc à la possibilité pour un jeune mammifère de vivre et d'utiliser les matières alimentaires sans aucun concours de microbes, uniquement grâce à ses propres sucs digestifs.

Schottelius est arrivé à un résultat diamétralement opposé. Les petits poussins qu'il faisait éclore dans un espace privé de germes et spécialement approprié pour l'élevage de ces oiseaux, nourris avec des aliments stériles, ont vécu pendant 17 jours. Seulement, au lieu d'augmenter de poids, comme leurs témoins, gardés en liberté, ils ont

¹*Zeitschrift für physiologische Chemie*, Bd. 21, 1895, p. 109.

²*Archiv für Hygiene*, Bd. 34, 1899, p. 210.

tellement maigri et leur faiblesse est devenue si grande que Schottelius a dû interrompre ses expériences. Les poussins sacrifiés se sont montrés complètement privés de microbes et c'est justement à leur absence dans le tube digestif qu'il attribue l'état lamentable dans lequel se sont trouvés les jeunes oiseaux, abandonnés uniquement à leurs propres ressources digestives.

Comme vous voyez, malheureusement, les deux séries d'expériences ont donné des résultats si contradictoires qu'il devient impossible d'en tirer une conclusion définitive. Il est donc indispensable de continuer les recherches dans le but d'aplanir ces contradictions. Du reste, Schottelius lui même ne considère ses tentatives que comme un premier pas vers la solution du problème. On peut lui reprocher que, dans son appareil pour l'élevage des poussins, il a introduit trop de matières antiseptiques qui pouvaient nuire au développement normal des jeunes oiseaux. Il commençait par laver les œufs pondus avec une solution de sublimé assez forte (5 pour 1000) et ceci à deux reprises. Ce traitement, sans être mortel pour les embryons, pouvait diminuer leur résistance vitale.

En dehors des faits observés, Schottelius invoque en faveur de la nécessité absolue du concours microbien pour la digestion chez les animaux, des considérations générales, basées sur la grande théorie Darwinienne. Comme, d'après lui, "il n'existe pas d'animal sans qu'il renferme constamment dans son canal intestinal des quantités énormes de bactéries," il lui semble impossible que la sélection naturelle n'eût pas éliminé depuis longtemps cette flore si elle ne remplissait quelque rôle utile. D'abord cette thèse que tous les animaux renferment une flore intestinale à l'état normal ne peut pas être soutenue. Il existe un nombre considérable d'espèces animales, chez lesquelles le tube digestif ne contient pas du tout ou

presque pas de microbes. Comme exemple, je peux citer le scorpion, dont l'intestin se montre toujours complètement stérile. Mais, m'objectera-t-on, il s'agit ici d'un être qui se nourrit du sang des petits animaux. Or le sang est un aliment qui se digère très facilement et qui dans la plupart des cas ne renferme pas de microbes. Le scorpion pourrait être considéré comme une sorte de "parasite libre." Eh bien, les exemples ne manquent pas où les animaux, destinés à se nourrir avec des aliments très difficiles à digérer, sont cependant complètement dépourvus de flore intestinale. On en trouve beaucoup parmi les larves d'insectes. A côté du ver à soie ou des vers blancs qui renferment beaucoup de bactéries dans leurs intestins, nous pouvons citer les larves de diverses mites. Ces insectes vivent dans des tissus poussiéreux, dans des amas de graines, où la poussière et les microbes ne manquent pas, et cependant leur tube intestinal, examiné à maintes reprises, s'est montré le plus souvent complètement privé de microbes. Quelquefois on trouve de rares bactéries, disséminées dans l'intestin de ces larves, qui évidemment ne peuvent jouer aucun rôle important. Dans ces exemples, que je pourrais multiplier à volonté, les sucs digestifs des insectes suffisent non seulement à eux seuls pour digérer des aliments aussi difficiles à solubiliser que la laine et les graines, mais peuvent même tuer et digérer les microbes. La larve de la mite de la cire qui vit en parasite dans les ruches des abeilles, possède une force digestive tellement puissante qu'elle est capable d'attaquer avec ses ferments intestinaux les bactéries les plus résistantes, comme le bacille de la tuberculose. On essaie même d'utiliser cette propriété remarquable dans la lutte contre ce bacille.

Parmi les vers intestinaux, on en rencontre quelques uns, comme les ascarides, qui vivent dans un milieu rempli

de microbes. Lorsqu'on compare la richesse en bactéries du tube digestif de l'ascaris du cheval et de l'intestin grêle du cheval même, habité par ce parasite, on est surpris de la grande différence. Tandis que le premier ne renferme que quelques rares microbes, le second en contient une véritable purée.

Il n'y a pas de doute. L'organisme animal peut se passer du concours des microbes pour digérer la nourriture qui est nécessaire à son entretien. Seulement, les animaux présentent une si grande différence sous tous les rapports, qu'il est impossible d'appliquer les résultats, obtenus avec les scorpions, les insectes, ou les vers intestinaux, à l'homme, l'espèce qui nous intéresse surtout. En nous plaçant sur ce terrain, il faut bien dire que le cobaye qui, d'après les recherches de Nuttall et Thierfelder peut se suffire avec ses sucs digestifs, même aussitôt après sa naissance, est plus rapproché de l'homme que le poussin nouveau-né ou âgé de quelques jours. Si l'on accepte sans critique les résultats de Schottelius, on ne peut que formuler cette conclusion que des oiseaux en bas âge ne peuvent pas se passer, pour digérer leurs aliments, de l'aide des infiniment petits, comme le peuvent certains mammifères.

L'examen du pouvoir digestif des ferments intestinaux de l'homme et des mammifères démontre qu'il est très puissant et capable de digérer la plupart des substances alimentaires. Autrefois, on ne tenait pas compte de l'intervention microbienne dans les expériences sur la digestion par des sucs digestifs, extraits à des animaux. Mais, depuis que le rôle des microbes dans les fermentations a été bien établi, on a eu soin d'ajouter des antiseptiques aux ballons, dans lesquels on mettait des substances alimentaires en contact avec les sucs digestifs. Eh bien, malgré l'élimination des microbes, la digestion se

faisait très bien par l'action seule des ferments contenus dans ces sucs. Les substances albuminoïdes, beaucoup de substances hydrocarbonées et de graisses, sont facilement digérées par les ferments du tube digestif des animaux. Il n'y a que la cellulose pour laquelle on n'ait pas trouvé de ferment animal correspondant. M. Duclaux en conclut que si l'intervention des microbes pour la digestion est réellement nécessaire, cette collaboration serait utile surtout pour les espèces herbivores. Pour l'homme, elle ne doit pas jouer un rôle tant soit peu considérable.

Depuis longtemps déjà, Nencki soutient cette thèse, que les microbes intestinaux chez l'homme sont loin d'être nécessaires pour la digestion normale. Dans son travail, fait en collaboration avec Macfadyen et M^{me} Sieber, il a étudié la flore intestinale de la femme, opérée d'une hernie étranglée, et a cherché à déterminer par des recherches précises le rôle des microbes. Ces observateurs ont pu constater que les substances albuminoïdes étaient digérées, chez la malade opérée, par ses propres ferments, sans aucun concours appréciable de la part des bactéries assez nombreuses qu'ils avaient isolées. Ces microbes ont été incapables de décomposer les substances albuminoïdes, mais agissaient énergiquement sur les matières hydrocarbonées. Seulement, les produits de leur activité, notamment l'alcool et les acides lactique et acétique, se sont montrés inutiles pour la nutrition de l'homme.

Beaucoup de données conduisent donc à ce résultat général que la flore intestinale de l'homme n'est nullement nécessaire pour sa digestion normale.

Essayons maintenant d'établir si les microbes du corps humain peuvent être nuisibles à sa santé. Nous avons vu que la peau de l'homme et surtout les canaux des follicules pileux renferment une flore bactérienne assez

abondante, parmi laquelle figurent surtout des formes rondes, comme des staphylocoques et des streptocoques. Il est incontestable que ces microbes saisissent chaque condition favorable pour se reproduire en grande quantité. Lorsque les forces défensives de l'organisme fléchissent pour une raison quelconque, les microbes de la peau commencent à pulluler et à déverser dans les tissus et le sang leurs produits nuisibles.

Les chirurgiens et les accoucheurs qui se lavent les mains avec des antiseptiques voient souvent se développer des éruptions dans lesquelles on trouve des quantités de microbes. Ceux-ci n'ont pas certainement pénétré du dehors, justement à cause de l'antisepsie, mais ils sont venus de la peau même, dont les cellules défensives ont été beaucoup plus touchées que les microbes par les substances antiseptiques.

Chez des diabétiques ou d'autres personnes atteintes de maladies générales, se développent souvent des furoncles et des anthrax, quelquefois très graves. Mais leur cause ne réside pas, comme dans l'anthrax charbonneux, dans l'importation du dehors du germe morbide. Ce sont les staphylocoques de la peau normale de l'homme qui, profitant de l'affaiblissement des cellules défensives, se multiplient abondamment et provoquent les anthrax et les furoncles. Très souvent ceux-ci se succèdent pendant un temps très long, ce qui amène un affaiblissement encore plus considérable des malades.

Non seulement les staphylocoques, jaunes et incolores, de la peau normale peuvent devenir très nuisibles, mais encore d'autres microbes de la flore cutanée peuvent également provoquer des maladies plus ou moins sérieuses.

Les antiseptiques avalés ou employés pour gargariser la bouche peuvent réveiller aussi l'activité des microbes de la flore buccale et provoquer des ulcères.

Mais ce sont surtout les microbes de l'estomac et des intestins dont le rôle nuisible est très considérable. Depuis très longtemps, on avait la conviction que beaucoup de maladies humaines viennent du tube digestif, mais on n'avait à ce sujet que des notions très peu précises. On savait bien que la perforation de l'intestin amenait des conséquences très graves qui le plus souvent aboutissaient à la mort. Plus tard, on a reconnu que ce sont les microbes de la flore intestinale qui, après leur passage dans le péritoine, y provoquent une inflammation très dangereuse. On a souvent retrouvé dans ces péritonites des quantités de colibacilles, ou bien des staphylocoques dorés ; dans d'autres cas, on a reconnu plusieurs bactéries de la flore intestinale (aérobie et anaérobie), associées dans leur œuvre néfaste. Même sans perforation préalable, les microbes peuvent pénétrer de l'intestin dans la cavité péritonéale, comme dans les cas de hernies étranglées ou dans l'occlusion intestinale.

Chez certains animaux (chien, cheval) on a constaté même la pénétration des microbes de la flore normale des organes digestifs dans le sang d'une façon assez régulière (Porchet et Desoubry¹). Il est probable que l'homme est également sujet à cette pénétration. Seulement les conditions précises de son accomplissement ne sont pas encore suffisamment connues.

L'effet nuisible des microbes de la flore humaine ne se borne pas seulement au cas où ces organismes pénètrent directement dans les organes et le sang de l'homme. Les microbes produisent des substances solubles qui peuvent être résorbées par la paroi intestinale et pénétrer dans la circulation. Or, parmi ces excréments, il en existe de très nuisibles pour la santé.

¹ Porchet et Desoubry. *Comptes rendus de la Société de Biologie*, 1895.

Le fait que les produits microbiens sont réellement absorbés dans le sang ne peut être mis en doute. Depuis assez longtemps on a trouvé dans l'urine de l'homme et des animaux toute une série de substances, comme les dérivés du phénol, crésol, indol, skatol, pyrrohocatechine, etc. dont on soupçonnait l'origine microbienne. Baumann, qui s'est beaucoup occupé de la question, a fourni un grand nombre d'arguments, appuyés sur des expériences qui plaident en faveur de cette hypothèse. Ewald l'a confirmée par des faits d'un autre genre et très démonstratifs. Il a trouvé occasion d'étudier une personne chez laquelle, à la suite d'une hernie étranglée, on a dû établir une fistule intestinale. Pendant tout le temps où le gros intestin ne fonctionna plus, le liquide intestinal et l'urine ne renfermaient ni phénol, ni indol. Mais aussitôt que la fistule fut fermée et la communication avec le gros intestin rétablie, le phénol et l'indican apparurent dans les excréta. Ewald en conclut que ces deux substances ont leur source dans le gros intestin. Nencki a également soutenu cette thèse, et le cas de la fistule de l'iléon, dont nous avons déjà parlé, lui en a fourni une nouvelle preuve. Il a en outre démontré que l'hydrogène sulfuré et le mercaptan sont également des produits des microbes de la flore du gros intestin.

Les expériences si intéressantes de Nuttall et Thierfelder, que nous avons relatées, renferment aussi des données importantes sur ce sujet. Leurs cobayes, élevés sans l'intervention des microbes, ne produisaient ni de l'indol, ni du skatol, ni aucun des autres corps analogues (phénol, crésol, pyrrohocatechine), de sorte que leur origine microbienne peut être considérée comme définitivement prouvée.

Les microbes de notre flore intestinale sécrètent donc réellement toute une série de substances qui sont résorbées

dans le sang et de là éliminées par les émonctoires. Plusieurs de ces substances ont une action plus ou moins toxique, comme les acides gras, le phénol, les combinaisons ammoniacales, etc. On a même trouvé quelquefois des ptomaines, dont l'action nuisible ne peut être mise en doute. Il est très probable que beaucoup de ces produits toxiques de notre flore intestinale sont encore inconnus et parmi eux la plupart des toxines proprement dites.

Malgré cet état imparfait de nos connaissances, on a le droit d'affirmer avec la plus grande conviction que les poisons des microbes intestinaux jouent un rôle considérable comme cause de maladies nombreuses et variées. M. Bouchard¹ a depuis plus de quinze ans développé sa théorie des auto-intoxications, dans laquelle l'empoisonnement par les produits de la flore intestinale occupe une place prépondérante. Avec plusieurs de ses élèves, il a cherché à réunir à l'appui de sa manière de voir des arguments probants. Dans ces dernières années, cette question des auto-intoxications a passé à l'ordre du jour et on s'en occupe beaucoup dans les réunions des cliniciens. En 1898 notamment, elle a fait le sujet de discussions très intéressantes au Congrès de Médecine Interne, tenu à Wiesbaden,² auquel ont pris part les savants allemands les plus compétents. Malgré une critique très sévère, à laquelle on avait soumis les auto-intoxications intestinales, tout le monde a dû reconnaître leur réalité et leur grande importance. Un des rapporteurs, Müller, qui avait manifesté le plus de réserve et de scepticisme à ce sujet, est cependant arrivé à cette conclusion " que dans une série de maladies le lien causal avec les phénomènes de décomposition anormale dans les intestins pourrait difficilement être nié." Il cite les maux de

¹ *Leçons sur les auto-intoxications.* Paris, 1886.

² *Verhandlungen des XVI. Congresses für innere Medicin, 1898.*

tête, la fatigue, l'état neurasthénique et autres. Même dans certaines formes d'épilepsie, il attribue un rôle considérable aux produits toxiques, venant du tube digestif. Le second rapporteur, Brieger, y ajoute encore l'asthme dyspepsique et plusieurs maladies de la peau, comme le prurit, l'érythème toxique, l'acné, etc. Les dermatologistes ont reconnu depuis longtemps que, dans certaines maladies de la peau, le traitement doit être dirigé plutôt vers le tube intestinal que contre l'affection locale même. La recherche des poisons élaborés par les microbes intestinaux leur fournit des renseignements précieux,¹ et lorsqu'un malade, atteint de séborrhée ou d'acné, excrète une quantité exagérée d'indican, on le soumet à un régime approprié et on tâche de débarrasser ses intestins autant que possible de leur flore. Il est de toute évidence que dans l'acné ce sont les staphylocoques de la flore normale de la peau qui commencent à pulluler et à produire leur effet nuisible sous l'influence des poisons sécrétés par les microbes intestinaux. Ces sécrétions empoisonnent les cellules défensives de l'organisme et renforcent ainsi les représentants de la flore cutanée. Nous voyons ici un exemple, où les microbes, éloignés entre eux et dont les uns habitent la peau et les autres les intestins, unissent leurs actions pour nuire à l'organisme humain.

Le rôle des poisons de la flore intestinale dans la neurasthénie, cette maladie si importante et si répandue, devient de plus en plus évident et tout récemment encore, dans la discussion qui a été soulevée à la Société de Thérapeutique de Paris, MM. Robin et Huchard ont avec beaucoup de succès soutenu cette thèse. Même dans les maladies mentales, l'importance de l'auto-intoxication intestinale ne peut plus être niée, quoiqu'on soit encore

¹ Saalfeld, Allgemeine Therapie der Hautkrankheiten, *Berliner klinische Wochenschrift*, Nn. 1, 2, 1901.

loin d'être d'accord sur son rôle, fondamental ou secondaire, dans ces affections. Dans les maladies atrophiques des organes nobles, comme le cerveau, le cœur, les reins, le foie, les poisons de la flore intestinale occupent une place notable. Chez les animaux, on a pu produire une véritable cirrhose du foie à l'aide des acides butyrique et acétique, ces produits constants de nos microbes intestinaux.

Même dans la sclérose des artères, qui joue un rôle si considérable pour abrégéer notre existence, on a le droit d'incriminer la flore intestinale. On sait d'une façon précise que des maladies infectieuses d'origine microbienne avérée, comme l'influenza, le paludisme, la diphtérie, la fièvre typhoïde et autres peuvent amener l'artériosclérose. Parmi les maladies infectieuses chroniques, il y en a une (syphilis) qui est la cause la plus fréquente de cette altération des artères. Et cependant il est encore un grand nombre de cas où cette affection vasculaire ne peut être expliquée par aucune des causes que je viens de citer. Les poisons des microbes intestinaux qui provoquent la sclérose du foie ou des reins doivent être capables de produire la sclérose dans d'autres organes et aussi dans les artères. Il est difficile d'appuyer pour le moment cette thèse par des arguments directs. Mais il y a des faits bien établis qui plaident en sa faveur. Il existe dans la République Argentine une maladie des veaux qui est accompagnée d'une inflammation aiguë des intestins. Lignières, qui a étudié cette épizootie avec beaucoup de soin et de science, en a établi comme cause un tout petit microbe, un coccobacille qu'il désigne sous le nom de Pasteurelle bovine.¹ Cette bactérie se développe surtout dans l'intestin et provoque une entérite des veaux, assez souvent mortelle. La grande majorité (4/5) de ces

¹ *Contribution à l'étude de la diarrhée des jeunes bovidés*, Buenos Aires, 1898.

animaux guérissent cependant. Seulement, au bout d'un temps plus ou moins long, après des mois et même des années, les bœufs tombent dans un état de faiblesse extraordinaire et meurent d'une maladie bizarre, connue dans le pays sous le nom d' "enteke." A l'autopsie, on constate une artériosclérose très intense des grosses artères et une calcification du parenchyme pulmonaire. Ces lésions définitives sont précédées d'inflammation chronique des artères qui a pu être reproduite artificiellement à l'aide d'injections du microbe du choléra des veaux. Nocard,¹ vétérinaire et bactériologiste, dont la grande compétence est reconnue universellement, confirme de tous points cette importante découverte de Lignières.

Dans l'exemple de cette artériosclérose infectieuse, il s'agit d'un microbe pathogène qui n'est pas connu jusqu' à présent comme habitant normalement l'intestin des veaux. Il ne peut donc pas être cité comme argument en faveur de ce que l'artériosclérose chronique humaine soit due à la flore normale du tube digestif de l'homme. Cet exemple a pour nous une grande importance seulement comme le premier cas d'artériosclérose chronique d'origine microbienne, démontré par la méthode expérimentale.

Quant à la question de la flore microbienne normale et pathologique, elle est beaucoup plus compliquée qu'elle ne paraît de prime abord. Nous avons déjà cité plusieurs exemples de bactéries qui vivent normalement à la surface ou dans l'intérieur du corps humain et qui, sous l'influence de certaines circonstances, peuvent devenir pathogènes. Nous avons également mentionné comme très probable que certains microbes peuvent pénétrer et vivre dans l'intestin de l'homme, sans produire de maladie, parce qu'ils sont gênés dans leur action pathogène par leurs voisins de la flore

¹ *Les maladies infectieuses du bétail argentin.* Paris, 1899.

normale. Pendant les épidémies de choléra, on a à maintes reprises retrouvé le vibriion cholérique dans le contenu intestinal normal de personnes bien portantes. Ces exemples nous ont fourni même une indication de l'action utile de certains représentants de notre flore. Seulement, à côté de ces microbes bienfaisants et avec une probabilité encore plus grande, il faut admettre l'existence d'autres microbes du tube digestif qui, sans être nuisibles par eux mêmes, peuvent faciliter le rôle néfaste des bactéries pathogènes. Ainsi ce même vibriion cholérique qui est empêché dans certains cas, est favorisé dans d'autres par le voisinage des blastomycètes ou des sarcines qui appartiennent à la flore normale de notre canal gastro-intestinal. Cette action favorisante des microbes a pu même être démontrée par voie expérimentale sur des petits lapins. Ainsi des vibrions cholériques, trop faibles pour provoquer seuls la maladie chez ces animaux, leur donnent le choléra intestinal mortel, si on les associe avec des torulas et des sarcines, provenant de l'estomac humain.

Malgré toute l'imperfection de nos connaissances, il faut bien reconnaître que la flore de notre corps renferme des représentants qui, à chaque moment, peuvent devenir infectieux ou bien qui sont nuisibles en favorisant l'action pathogène de microbes accidentels et en sécrétant des poisons plus ou moins dangereux.

Lors de la discussion au Congrès de Wiesbaden, que nous avons mentionnée, Müller a énoncé cette idée que notre corps doit être déjà suffisamment immunisé contre les microbes de notre flore, ainsi que contre leurs poisons. C'est pour cela, pense-t-il, que leur effet est si souvent sans gravité pour notre santé. L'examen plus détaillé de cette question doit conduire à un résultat tout opposé. L'organisme humain reste tout le temps très sensible au staphylocoque pyogène qui cependant constitue une espèce

des plus banales de notre flore. Sous l'influence de facteurs favorisants, ces bactéries produisent des acnés, des furoncles, des anthrax et des suppurations encore plus graves. La furunculose peut récidiver pendant une période de temps très longue, et la pyémie devient facilement chronique. L'homme n'est donc pas immunisé contre son staphylocoque et cependant la vaccination artificielle des animaux vis-à-vis du même microbe est chose réalisable. La pratique des vaccinations préventives, établie par Pasteur et ses collaborateurs Chamberland et Roux, nous montre suffisamment que, pour aboutir à un résultat efficace, il faut suivre une méthode délicate et compliquée. On prépare des virus atténués à des degrés déterminés, on les adapte à des espèces ou à des races animales et on les introduit dans des conditions particulières. Tout ceci ne peut être facilement atteint par les moyens naturels seuls. Voilà pourquoi notre organisme n'est immunisé ni contre les staphylocoques, ni contre beaucoup d'autres microbes de notre flore (streptocoques, colibacilles, etc.).

Sans compter sur cette vaccination spontanée et naturelle, l'art médical a mis beaucoup de soins pour éviter l'action nuisible des microbes de notre flore. Dans ce but, il a largement appliqué la désinfection de la peau pour empêcher leur pénétration dans l'organisme. En chirurgie, on cherche à désinfecter la peau du malade et celle de l'opérateur. Les ophtalmologistes essaient de désinfecter la conjonctive. On tente la désinfection de la cavité buccale et même celle de l'estomac et des intestins. Au début de cette période d'antisepsie, on avait les plus grandes espérances dans son efficacité ; mais plus on étudiait et approfondissait la question, plus il devenait clair que la destruction des microbes si nombreux de notre flore est chose très difficile, sinon impossible. Même pour désinfecter la peau de nos mains qui est si

accessible à l'influence des antiseptiques, on a rencontré des difficultés extraordinaires. Les microbes adhérents à la surface peuvent être éliminés sans difficulté ; mais ceux qui se sont accrochés aux canaux des follicules pileux ne se laissent pas facilement atteindre. Les chirurgiens ont beaucoup discuté dans ces dernières années la question de la désinfection de notre peau et sont pour la plupart arrivés à la conclusion que ce but ne peut être atteint que d'une façon imparfaite.¹

Bien plus difficile encore est la destruction des microbes sur les muqueuses qui sont elles mêmes beaucoup plus sensibles à l'action nuisible des antiseptiques que la peau et les microbes. Beaucoup de médecins ont reconnu toute l'inutilité de l'emploi des antiseptiques intestinaux et y ont renoncé plus ou moins complètement. Müller résume une opinion sur l'antisepsie intestinale, partagée par un grand nombre de ses confrères, lorsqu'il dit que " les antiseptiques ont souvent été non seulement d'utilité nulle, mais ont même été nuisibles, en diminuant par leurs propriétés toxiques la réaction salutaire des cellules vivantes." Stern², à Breslau, a beaucoup étudié cette question, en se servant des méthodes bactériologiques. Il a trouvé, entre autres faits négatifs, que de fortes doses de β -Naphтол, considéré comme le meilleur antiseptique intestinal, administrées pendant 12 jours, n'ont pas été en état de diminuer la quantité des microbes du tube digestif. Il exprime à la fin de son rapport l'espérance que peut-être plus tard on trouvera quelque moyen meilleur pour arriver au but.

Renonçant plus ou moins complètement à l'emploi des antiseptiques, on recourt de plus en plus aux procédés

¹ Quénu, *Bulletin et Mémoires de la Société de Chirurgie de Paris*, 1900.

² *Verhandlungen d. XVI. Congresses für innere Medicin*, 1898, p. 198.

mécaniques pour éloigner les microbes de notre corps. Le lavage prolongé des mains par les liquides qui n'abîment pas les cellules vivantes de notre peau, les irrigations de la conjonctive des yeux et d'autres muqueuses avec des liquides indifférents, comme la solution physiologique du sel marin ou l'eau bouillie, sont entrés généralement dans la pratique. Le meilleur moyen d'antisepsie intestinale, quoique relative, est reconnu dans l'emploi des médicaments qui produisent une évacuation fréquente et abondante de l'intestin. On obtient encore un certain résultat en modifiant l'alimentation et en prescrivant le régime lacté qui, d'après les recherches de MM. Gilbert et Dominici,¹ diminue le nombre des microbes intestinaux.

Les tentatives si nombreuses, dirigées contre la flore de notre corps, indiquent bien le danger dont nous menacent beaucoup de microbes qui la constituent. S'il est possible d'accepter quelque action utile de certains de ses représentants, il est encore plus certain qu'un grand nombre de microbes de cette flore ont une influence nuisible sur la santé. Mais comment concilier ce résultat avec l'opinion, citée plus haut, que si notre flore est réellement dangereuse, elle devrait depuis longtemps déjà être éliminée par le fonctionnement unique de la sélection naturelle? Cette sélection, qui n'est autre chose que la survivance des organismes adaptés aux conditions de leur existence et la disparition de ceux qui ne leur sont pas adaptés, doit se manifester chez l'homme et chez les êtres supérieurs tout aussi bien que chez n'importe quel animal ou plante. Or, nous observons constamment que, non seulement les propriétés nuisibles pour la vie, mais même les organes, devenus simplement inutiles, disparaissent plus ou moins totalement. Sous la terre, dans les cavernes

¹ *Comptes rendus de la Société de Biologie de Paris, 1894.*

et les souterrains, où la lumière ne pénètre pas, les yeux ne peuvent servir à rien et nous les voyons régulièrement s'atrophier chez des animaux très divers, comme la taupe, les poissons, les crustacés, vers et autres.

Pour faire ressortir encore davantage ce côté paradoxal de la conservation de notre flore, dont la majorité des représentants est, non seulement inutile, mais incontestablement nuisible, je vous signalerai ce fait que même les organes du corps humain qui nourrissent cette flore, sont pour la plupart, eux aussi, inutiles ou nuisibles pour notre santé et notre existence.

Vous vous rappelez que les canaux des follicules pileux sont le siège d'une végétation microbienne, dans laquelle se trouvent quantité de staphylocoques capables de produire beaucoup de maladies, plus ou moins graves. Eh bien, ces follicules pileux sont des organes inutiles et ne représentent que des restes des poils qui recouvraient la peau des animaux—nos ancêtres. Autrefois ils étaient très utiles pour protéger la peau de ces anthropoïdes contre le froid ; pour l'homme, ils ne sont rien moins que nécessaires.

Dans le tube digestif de l'homme qui renferme la flore la plus riche, nous rencontrons aussi des parties au moins inutiles. Les conditions de l'alimentation de l'homme, surtout de l'homme civilisé, sont tout autres que celles des animaux. Mais, même avant d'être arrivé à ce degré de perfection, l'homme a accusé déjà une tendance vers la disparition de certaines parties de son intestin. Ainsi l'appendice vermiforme du cæcum constitue le reste d'un organe qui était plus développé chez ses ancêtres-animaux. Chez les singes anthropoïdes, on trouve déjà cette même réduction du cæcum sous forme d'appendice, très semblable à celui de l'homme.

Mais même l'estomac, cet organe qui peut paraître si indispensable pour la digestion et la vie normale de

l'homme, n'est en réalité qu'un grand réservoir d'aliments, dont on peut se passer sans grands inconvénients. On a commencé par l'enlever à des chiens et comme ces animaux supportèrent bien l'opération, on s'est décidé à la pratiquer chez l'homme, atteint de tumeurs cancéreuses. Le premier cas de résection totale de l'estomac a été exécuté en 1897 par Schlatter à Zurich. Le résultat favorable de cette opération a encouragé d'autres chirurgiens à suivre cette voie et actuellement il y a déjà 4 personnes qui vivent sans estomac¹ et fournissent ainsi un argument important en faveur de l'inutilité de cet organe. Avec l'estomac, a été éloignée aussi sa flore, dont l'absence n'a été nullement ressentie par les opérés.

De toutes les parties de notre tube digestif, c'est certainement l'intestin grêle qui est le seul organe indispensable à la vie. Et encore chez l'homme qui peut se nourrir avec des aliments facilement digestibles, l'intestin grêle est démesurément développé. Au lieu d'avoir d'une longueur de 5½ à 6½ mètres, l'homme pourrait se contenter d'un tiers. Roux, le chirurgien suisse bien connu, a déclaré, lors de la discussion de la chirurgie intestinale au dernier Congrès international à Paris, que l'homme peut très bien vivre avec un mètre et demi de jéjunum.² Aussi Kukula³ rapporte un cas, où il a supprimé à peu près deux tiers d'intestin grêle avec le plus grand profit pour son malade. Ce chirurgien ajoute à sa communication cette réflexion que le gros intestin peut être supprimé même dans toute sa longueur. Et en effet, depuis que la chirurgie intestinale s'est si largement développée pendant ces dernières années, on a obtenu des résultats remarquables sur l'élimination du gros intestin. Ainsi dans un cas,

¹ *Bulletin de l'Académie de Médecine de Paris*, 1901, N° 1, p. 17.

² *Berliner klinische Wochenschrift*, 1900, N° 38, p. 855.

³ *Archiv für klinische Chirurgie*, Bd. 60, 1900, N° 4.

Körte¹ a enlevé, avec une partie de l'intestin grêle, la plus grande portion du gros intestin, dont il n'est resté que le segment terminal. Le malade qui a subi huit opérations intestinales consécutives, a fini par guérir complètement. Chez un autre malade, opéré par Wiesinger,² il a été éliminé à peu près deux tiers du gros intestin ulcéré. Le cæcum et le colon ascendant ont été soudés avec le rectum, tandis que les colons transverse et descendant ont été séparés et ouverts du côté droit du ventre.

Je pourrais citer d'autres exemples d'opérations chirurgicales, couronnées de succès, pour prouver l'inutilité du gros intestin pour l'homme. Mais, sans vouloir abuser de votre patience, je ne peux me dispenser de vous mentionner un fait qui confirme mieux que n'importe quelle opération chirurgicale la thèse que je défends. Il s'agit³ d'une vieille femme qui, depuis 37 ans, a une fistule intestinale, par laquelle s'évacuent les déchets de sa digestion. La fistule s'est ouverte spontanément à la suite d'un abcès au côté droit du ventre. Cette infirmité ne l'a pas empêchée cependant de se marier, d'avoir trois enfants et de gagner sa vie par un travail pénible. 35 ans après la formation de la fistule la personne en question fut examinée par un chirurgien qui lui proposa de lui faire une opération, afin de la remettre à l'état normal. La femme consentit. Mais, après l'ouverture du ventre, on constata que le gros intestin était atrophié dans toute sa longueur, depuis le cæcum jusqu'à son bout terminal; l'ouverture de la fistule se trouvait au dessus du cæcum et conduisait directement dans l'intestin grêle. Dans ces conditions, il était impossible de fermer la fistule, de sorte que le chirurgien, M. Ciechowski, a dû renfermer le ventre et abandonner la patiente à son

¹ *Archiv für klinische Chirurgie*, Bd. 48, 1894, p. 715.

² *Münchener medicinische Wochenschrift*, 1898.

³ *Archiv für klinische Chirurgie*, Bd. 48, 1894, p. 136.

sort. Celle-ci guérit promptement et continua à vivre comme avant l'opération. Voilà donc un cas où l'absence complète de tout le gros intestin a pu être très bien supportée par une personne qui vivait dans des conditions assez difficiles.

Il résulte de tout ceci que nous possédons un organe volumineux et très développé, le gros intestin, qui, ne remplissant aucune fonction utile, héberge une flore très abondante et variée, toute une masse de microbes, capables de nous nuire par leurs poisons.

En présence de ce fait il y a lieu de se demander ce que c'est que le gros intestin, quelle est son origine et sa raison d'être? Les follicules pileux qui servent de refuge aux microbes de la peau sont également des organes inutiles; mais leur histoire est plus simple, car ce sont des restes de poils qui protégeaient les mammifères, dont descend l'homme, contre le froid. Le gros intestin au contraire, loin de se présenter comme un simple reste, est un organe largement développé.

Eh bien, malgré cela il faut le considérer aussi comme un héritage inutile de nos ancêtres zoologiques qui, il n'y a pas à en douter, tiraient quelque bénéfice de sa possession. L'anatomie comparée nous enseigne que, de tous les vertébrés, il n'y a que les mammifères qui soient munis d'un gros intestin proprement dit. Les oiseaux, les reptiles et les autres vertébrés inférieurs n'en possèdent point. Il y a bien des appendices chez certains poissons et des cæcums chez beaucoup d'oiseaux, mais ces organes ne correspondent pas au colon de l'homme et des mammifères. Ces derniers sont des animaux, pour la plupart terrestres, qui trouvent leur nourriture, animale ou végétale, à la surface du sol. Il est possible que quelques mammifères herbivores aient besoin du cæcum et du gros intestin pour l'utilisation de leur nourriture

peu digestible. Dans ces cas, la présence d'une quantité de microbes pourrait aussi leur être utile, notamment pour la digestion de la cellulose. D'un autre côté, il est probable que le développement du gros intestin servait comme réservoir pour les déchets de la digestion. Les mammifères qui devaient courir très vite, soit pour échapper à leurs ennemis, soit pour attraper leur proie, étaient gênés pour vider leurs intestins. Un gros intestin devait dans ces conditions être d'une grande utilité. Aussi nous voyons que les mammifères qui courent le plus rapidement, comme le cheval et le lièvre, ont le gros intestin et le cæcum le plus développés. Il est remarquable que, parmi les oiseaux, les coureurs, comme les autruches et les casoars, ont acquis également un gros intestin assez long et que leurs cæcums sont les plus développés de toute la série des êtres à plumes. Ce sont donc les exigences de la lutte pour la vie qui ont amené la formation du gros intestin chez les vertébrés. Le développement de cet organe, qui servait comme réservoir pour les résidus de la nourriture, a déterminé à son tour le développement d'une flore microbienne très riche. Pour la plupart des mammifères, les avantages de cette acquisition devaient compenser les inconvénients qu'elle entraînait. Les mammifères ont une vie plus courte que les oiseaux et les vertébrés inférieurs en général. Les amateurs de bêtes savent bien que, des animaux que l'on peut garder dans les appartements, comme souris, petits oiseaux, tortues et poissons dorés, ce sont les souris qui meurent les premières. Elles ne vivent qu'un petit nombre d'années, 3, 4 tout au plus. Les petits oiseaux, comme les canaris, vivent en moyenne 16 ans et peuvent dans de bonnes conditions atteindre 20 ans et même davantage. Les poissons dorés ont à peu près la même longévité que les petits oiseaux, tandis que les tortues ont une vie encore plus longue. Eh

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bien, dans cette petite collection de bêtes vivantes, il n'y a que la souris qui possède un gros intestin véritable. La même règle se confirme d'une façon générale. Il y a bien quelques mammifères qui vivent longtemps, comme l'éléphant qui peut atteindre l'âge de 120 ans. Mais ce cas est plutôt exceptionnel. Les grands mammifères, le cheval par exemple, vivent difficilement plus de vingt ans. Des chevaux, âgés de plus de 30 ans, sont très rares, et des exemples, comme le poney de Shetland qui a vécu 42 ans ou un poney du pays de Galles qui a atteint soixante ans, sont tout-à-fait exceptionnels. Les mammifères de taille moyenne ou petite vivent encore moins longtemps, tandis que, dans le monde des oiseaux, les cas de longévité sont fréquents. Il y a même des oiseaux de taille moyenne ou petite, comme les perroquets, les grands-ducs (*Bubo maximus*), les corbeaux, qui peuvent vivre 60 à 100 ans. Chez les reptiles, la longévité est quelquefois encore plus grande et on cite des tortues ayant vécu plus de 250 ans.

On peut dire en général que la vie des vertébrés qui n'ont pas de gros intestin et qui ne possèdent qu'une flore intestinale pauvre est plus longue que celle des mammifères avec leur gros intestin fortement développé et leur flore intestinale très abondante. On est presque tenté d'ériger en loi que plus le gros intestin est long, plus la vie est courte. Il y a certainement quelques exceptions à cette règle. Mais aussi il y a beaucoup de cas qui la confirment. Parmi les oiseaux, ce ne sont pas du tout les plus grands, comme les autruches ou les casoars, qui vivent le plus longtemps. M. Rivière qui s'occupe de l'élevage des autruches en Algérie, estime la vie de cet oiseau à 35 ans, ainsi qu'il résulte d'une lettre qu'il a bien voulu m'envoyer. On a signalé un casoar Emu d'Australie

qui a vécu au Jardin des Plantes de Paris pendant 23 ans,¹ mais on ne connaît pas chez ces oiseaux de longévité aussi grande que chez les perroquets, les oies, les cygnes et autres de taille beaucoup plus petite. Eh bien, les autruches et les casoars se distinguent par un grand développement de leur gros intestin et des cæcums, tandis que les oiseaux à longue vie n'ont le plus souvent aucun de ces organes ou bien n'ont que des cæcums peu développés.

Lorsqu'on compare la flore microbienne de l'intestin terminal chez des oiseaux, chez des mammifères et chez l'homme, on est frappé de la faible quantité de microbes chez les premiers. Les oiseaux, ne possédant pas de gros intestin, ne peuvent pas accumuler de grandes quantités de déchets qui se peuplent de myriades de bactéries. Ils doivent pour cette raison évacuer très souvent leur tube digestif, ce qui est, comme vous vous rappelez, le meilleur procédé d'antisepsie intestinale. D'une façon naturelle et inconsciente, les oiseaux sont arrivés sous ce rapport au même résultat que celui qui avait été si nettement formulé au Congrès de Médecine Interne à Wiesbaden.

N'ayant besoin du gros intestin et de sa flore ni pour digérer la cellulose, ni pour garder pendant longtemps les résidus de la digestion, l'homme ne tire aucun profit de cet organe. Par contre, il en éprouve tous les inconvénients. Il est soumis à l'influence des sécrétions continues des nombreux microbes abrités par le gros intestin. A côté des poisons, qui favorisent l'action nuisible de la flore cutanée, il en existe bien d'autres qui empoisonnent à la longue les éléments les plus précieux et les plus nobles de notre organisme, amenant ainsi un vieillissement précoce de nos organes et tissus. Il faut ajouter encore les maladies nombreuses du gros intestin et

¹ Oustalet, *La Nature*, Paris, 1900.

de ses annexes, comme les appendicites, les colites, la dysenterie et surtout le cancer, dont le gros intestin est un des sièges favoris.¹

On conçoit comment un organe, devenu inutile, contribue à abrégier notre existence. Et cependant, l'instinct de l'homme lui dit d'une façon éloquente que sa vie n'est pas assez longue, qu'elle s'arrête avant d'aboutir à son terme normal. Depuis longtemps, les poètes et les philosophes ont eu le sentiment de quelque chose de contradictoire dans notre nature, ce qui les a amenés à voir notre existence d'une façon très pessimiste. Votre grand poète, Lord Byron, a exprimé déjà cette pensée.

Ah ! Ce monde visible, en lui même et ses lois,
Comme il est beau ! mais nous, qui nous nommons ses rois,
Moitié dieux, moitié boue, à descendre indociles,
Impuissants à monter, créatures mobiles,
Notre nature mixte et d'éléments divers,
Trouble, de ses combats, la paix de l'univers.—

(*Manfred*, Chap. II.)

Mais pourquoi donc la sélection naturelle n'a-t-elle pas réglé cette absence d'harmonie entre nos instincts et les défauts de notre organisme qui entravent leur réalisation ? Ou bien cette sélection, qui a amené tant de belles adaptations dans le monde animal et végétal, serait-elle impuissante, lorsqu'il s'agit de l'appliquer à l'homme ?

On compare souvent les organismes, au sujet desquels la sélection naturelle a dit presque son dernier mot, avec l'homme où cette sélection est encore en pleine activité. Lorsqu'on songe qu'un quart des enfants qui naissent

¹ Ainsi de 343 cancers intestinaux, relevés à l'autopsie à l'hôpital de Vienne pendant 24 années, 164 se sont produits sur le colon, tandis que 17 seulement se sont développés dans l'intestin grêle. Nothnagel, *Die Erkrankungen des Darms*, 1898, p. 220.

n'atteignent pas leur deuxième année¹ ; que sur 100 hommes, 57 meurent avant l'âge de 50 ans ; que sur 1,000 individus, 67 seulement arrivent à l'âge de 90 ans, qui ne doit pas encore être considéré comme le terme final de la vie normale de l'homme, on verra bien que la sélection naturelle élimine un trop grand nombre de victimes.

La sélection naturelle agit continuellement sur l'homme ; seulement ses résultats ne s'acquièrent qu'au bout d'un temps très long. Pour se rendre compte de cette lenteur de la sélection naturelle, il n'y a qu'à jeter un coup d'œil sur son activité dans la série animale. On voit bien que, chez la plupart des oiseaux, les appendices cæcaux sont des organes inutiles, comme notre gros intestin. Chez certaines espèces ils ont complètement disparu ; chez d'autres, ils se trouvent sous forme de petits rudiments, incapables de servir à la digestion ou comme réceptacles de déchets ; mais chez un grand nombre d'oiseaux, on rencontre encore des cæcums plus ou moins bien développés.

En dehors de sa grande lenteur, la sélection naturelle chez l'homme éprouve encore des perturbations à la suite de l'ingérence de l'art humain. Voici par exemple l'appendice vermiforme de l'intestin qui est nuisible à l'homme. La sélection naturelle amène la survivance des individus chez qui cet appendice est le plus atrophié. Les personnes au contraire qui possèdent un gros appendice avec un canal qui peut s'infecter, grâce à la pénétration des parasites et des corps étrangers, devraient être éliminées par la sélection naturelle. Mais ici intervient l'art médical. Il guérit l'appendicite ou enlève cet organe par voie chirurgicale. Les descendants de la personne guérie ont la plus grande chance d'hériter d'elle l'appendice aussi peu atrophié et aussi défectueux.

¹ Wappaeus. *Allgemeine Bevölkerungs-statistik*, 1859.

Il est de toute évidence que l'homme ne peut pas abandonner son sort à la sélection naturelle. Pour l'élevage des animaux domestiques ou la culture des plantes, il a inventé la sélection artificielle, de même, pour sa propre espèce, il doit par des moyens artificiels arriver à mettre en harmonie ses instincts avec les propriétés de son organisme.

Pour la question qui nous intéresse d'une façon particulière, c'est-à-dire la flore de notre corps, l'art humain a un champ d'activité très vaste. Comme les éléments nobles sont ceux qui souffrent le plus des poisons microbiens de cette flore, il y a lieu de les renforcer dans leur résistance. Dans ce but, peuvent être d'une grande utilité les substances spécifiques, capables d'augmenter l'activité de la plupart des cellules de nos organes. Par une série de recherches, poursuivies durant ces trois dernières années, on a établi qu'il est facile de préparer des poisons particuliers qui, à fortes doses, détruisent les éléments divers. Ces mêmes poisons, ou cytotoxines, appliqués en faible dose, agissent au contraire d'une façon stimulante sur les cellules spécifiques. On a déjà obtenu des poisons vis-à-vis des globules rouges et blancs, des cellules rénales, hépatiques, nerveuses, etc. Chacun de ces poisons pourrait être employé pour augmenter l'activité des éléments correspondants.

Mais on peut lutter non seulement contre l'affaiblissement des cellules nobles, indispensables pour notre vie normale, mais encore contre les microbes de notre flore même. L'antisepsie en général et l'antisepsie intestinale en particulier n'ont pas donné de résultats satisfaisants. Mais cette voie ne doit pas pour cela être abandonnée. Il y a lieu de chercher des antiseptiques spéciaux qui peuvent être utilisés pour la destruction des microbes. Nous avons vu plus haut des larves de mites qui digèrent

des bactéries. Les ferments digestifs de ces insectes pourraient être employés pour nous débarrasser des microbes nuisibles de notre flore. J'ai cru un moment que les insectes qui se nourrissent avec des matières putréfiées, comme les larves des mouches et les staphylins, devraient produire dans leur tube digestif beaucoup de ces ferments bactéricides. Je dois avouer que jusqu'à présent mes tentatives n'ont pas été couronnées de succès, ce qui n'empêche nullement de continuer des recherches dans cette voie.

Il existe aussi des ferments qui détruisent les microbes, ferments qu'on obtient avec des sérums d'animaux immunisés contre des bactéries données. Ainsi, on prépare des sérums qui détruisent le vibrion cholérique, d'autres qui attaquent les bacilles typhiques et ainsi de suite. On ne connaît pas encore d'une façon suffisante tous les représentants de notre flore, mais on est déjà en bonne voie pour résoudre cette question. On pourra dès lors préparer des sérums microbicides contre les espèces nuisibles qui habitent dans notre corps. On peut également obtenir des sérums contre certains poisons microbiens, notamment contre les toxines.

Les méthodes microbiologiques peuvent donc être largement appliquées par l'art humain pour arriver au résultat qui n'a pas été réalisé par la sélection naturelle. Il faut espérer que ces méthodes suffiront pour arriver au but et qu'il ne faudra point recourir, comme "ultima ratio," à l'intervention chirurgicale. Tout le monde est témoin des progrès extraordinaires, réalisés par la chirurgie, depuis que Lord Lister, inspiré par les découvertes de Pasteur, a complètement révolutionné cet art. Qui pouvait soupçonner, il y a encore peu d'années, qu'on arriverait à enlever l'estomac et à éliminer presque tout le gros intestin et une grande partie de l'intestin

2 HOYLE AND STANDEN, *New Species of Sepia*.

and ending in a point. The *chitinous margin* is narrow on the ventral surface, broader on the dorsal, being about one-twelfth of the breadth of the shell in the middle, broader in front and narrower behind.

The *dorsal surface* (Fig. 3) is rugose, finely in front, more coarsely behind; along the middle line there passes a slightly elevated longitudinal rib, narrow behind, gradually widening as it passes forwards; on either side of it is a shallow groove, the remainder of the surface being evenly convex.

The *ventral surface* is but little elevated, the thickness of the shell being greatest about one-fourth back from the anterior extremity; the *last loculus* has an index of about 24; it has a shallow depression along the centre, and its posterior boundary is deeply emarginate, the two limbs being inclined to each other at an average angle of about 60°; the two limbs start from a sharp curve in the middle, diverge at first rather rapidly, then more gradually until, where they reach the margin, they become slightly convergent. The *striated area* is deeply grooved along the centre, with a prominent rounded elevation on either side. The *inner cone* is a broad flattened horny callus, coming to a point behind, excavated in front, the two limbs extending as narrow fillets along the sides of the striated area for about half the length of the shell. The *spine* is of medium size and curves slightly upwards.

<i>Dimensions.</i>		Koettlitz Specimen.	Brit. Mus. Specimen.	
Length (of the broken shell)	... ..	105	113	mm.
„ (restored)	... ..	115	117	„
„ of last loculus (restored)	... ..	25	30	„
Breadth	... ..	37	42	„
Length of inner cone	... ..	10	10	„
„ spine...	... ..	4	—	„

**VI. On a New Species of *Sepia* and other Shells
collected by Dr. R. Koettlitz in Somaliland.**

By W. E. HOYLE and R. STANDEN.

Received and read December 11th, 1900.

In the year 1898, Dr. Reginald Koettlitz joined an expedition which passed through Somaliland from Berbera to the Blue Nile. He gave an account of the journey to the Geographical Society of this city, which has appeared in its Proceedings (*Journ. Manch. Geogr. Soc.*, Vol. 16, Nos. 1—3, 1900). The collecting of mollusca was not one of the definite aims of the expedition, but a good many were obtained, partly on the shore before the party left for the interior and partly during the trip. All the marine forms are from Zeila, nearly opposite Aden, and were gathered on the beach, and hence many of them are not in good condition. The material was handed over to the staff of the Manchester Museum for examination and description, and the results seemed worthy of being laid before this Society. We have thought it well to indicate by our initials those portions of the paper for which we are severally responsible.

CEPHALOPODA.

Sepia koettlitzii, n. sp. (Plate I.)

The soft parts are unknown.

The *Shell** (*Pl. I., Figs. 1, 3*) has a narrow elongated oval *outline*, narrowing to a blunt termination in front, tapering at first gradually, then more rapidly backwards,

* The terminology is that adopted in the "Report on the Cephalopoda collected by the 'Challenger' Expedition (1886), p. 123.

July 10th, 1901.

2 HOYLE AND STANDEN, *New Species of Sepia.*

and ending in a point. The *chitinous margin* is narrow on the ventral surface, broader on the dorsal, being about one-twelfth of the breadth of the shell in the middle, broader in front and narrower behind.

The *dorsal surface* (Fig. 3) is rugose, finely in front, more coarsely behind; along the middle line there passes a slightly elevated longitudinal rib, narrow behind, gradually widening as it passes forwards; on either side of it is a shallow groove, the remainder of the surface being evenly convex.

The *ventral surface* is but little elevated, the thickness of the shell being greatest about one-fourth back from the anterior extremity; the *last loculus* has an index of about 24; it has a shallow depression along the centre, and its posterior boundary is deeply emarginate, the two limbs being inclined to each other at an average angle of about 60°; the two limbs start from a sharp curve in the middle, diverge at first rather rapidly, then more gradually until, where they reach the margin, they become slightly convergent. The *striated area* is deeply grooved along the centre, with a prominent rounded elevation on either side. The *inner cone* is a broad flattened horny callus, coming to a point behind, excavated in front, the two limbs extending as narrow fillets along the sides of the striated area for about half the length of the shell. The *spine* is of medium size and curves slightly upwards.

<i>Dimensions.</i>		Koettlitz Specimen.	Brit. Mus. Specimen.	
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„ (restored)	115	117	„
„ of last loculus (restored)	25	30	„
Breadth	37	42	„
Length of inner cone	10	10	„
„ spine...	... ..	4	—	„

The above description is taken from the example collected by Dr. Koettlitz. There is a shell in the British Museum (Natural History), [Reg. No., 69. 6. 14. 1] in the McAndrew collection from the Red Sea, which clearly belongs to the same species (*Pl. I, Fig. 2*).

It differs from the shell just described in the following points:—

1. The shell is more elliptical and not so oblong in outline.
2. The striated area is not so deeply channelled in the middle line, and the rounded swellings on either side are not so prominent. This may perhaps be due to the specimen having been much rubbed.
3. The hinder portion of the shell in front of the inner cone is more deeply concaved.

These characters do not seem to me of specific value but rather to indicate that Dr. Koettlitz's specimen is a male, the other a female.

This species apparently comes nearest to *Sepia singalensis* Goodrich (*Trans. Linn. Soc. (2)*, Vol. 7, p. 3, 1896), but differs in that (1) the chitinous margin on the dorsal surface is much narrower, and (2), the inner cone is flattened, and, if anything, rather concave and not convex as indicated in Goodrich's figure; it also approaches *Sepia aculeata* van Hasselt, which, however, also has the inner cone strongly convex, and the outline of the shell broader and more evenly oval. *Sepia zanzibarica* Pfeffer is another allied form, but here again the inner cone is elevated instead of flat.

W. E. H.

GASTROPODA.

PULMONATA.

Buliminus (Zebrina) albatrus Fér.

Lake Hanamaga.

Buliminus (Zebrina) revoili Brgt.

Dabus and Arabayo.

Burtoa nilotica Pfr.

Mendi.

Limicolaria caillaudi Pfr.

Mendi, and Beni Spongul country on west side
of Dabus River.

Limicolaria flammea Müll.

West side of River Dabus, and east of Lapa
Martin Camp.

OPISTHOBRANCHIATA.

Bulla ampulla L.

Atys naucum L.

PROSOBRANCHIATA.

Terebra (Subula) duplicata Lam.

Conus betulinus L.

Pyrula (Melongena) paradisiaca Mart.

Fasciolaria trapezium L.

Oliva (Strophona) inflata L.

Nassa arcularia L.

Nassa coronata Lam.

Murex tribulus L.

Murex (Phyllonotus) anguliferus Lam.

Murex (Chicoreus) ramosus L.

- Purpura (Stramonita) hæmastoma* L.
" " var. *bicostalis* Lam.
Aquillus pilearis L.
Aquillus (Gutternum) gallinago Rve.
Cassis (Semicassis) bisulcata Schub.
Cypræa erosa L., var. *nebrites* Melv.
Cypræa arabica L.
Cypræa turdus Lam.
Strombus (Canarium) floridus Lam.
Strombus (Canarium) gibberulus L.
Strombus tricornis Lam.
Cerithium columna Sow.
Cerithium cæruleum Sow.
Cerithium erythræense Lam.
Cerithium petrosum Wood.
Modulus tectum Gmel.
Turritella bicingulata Lam.
Melania tuberculata Müll.
Cleopatra bulimoides Oliv.
Blue Nile, Khartoum.
Ampullaria cf. revoili Bill.
Blue Nile, Khartoum.
Otopoma poirieri Brgt.
Dabus and Arabayo.
Natica (Mamma) mamilla L.
Nerita (Thelicostyla) albicilla L.
Phasianella (Eutropia) nivosa Rve.
Turbo (Sennectus) radiatus Gmel.
Turbo (Marmorostoma) coronatus Gmel.
Pyramidea dentata Forsk.
Euchelus tricarinatus L.

PELECYPODA.

- Spondylus gæderopus* L.

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Anomalocardia uropygmelana Bory.

Cardium (*Trachycardium*) *rubicundum* Rve.

Cardium (*Bucardium*) *lima* Gmel.

Chama rueppelli Rve.

Crista pectinata L.

Tapes (*Hemitapes*) *pinguis* Ch.

Paphia glabrata Desh.

Venerupis derelicta Desh.

Corbicula fluminalis Müll.

Blue Nile, Khartoum.

Asaphis deflorata L.

Macra olorina Phil.

Tellina (*Tellinella*) *rugosa* Born.

R. S.

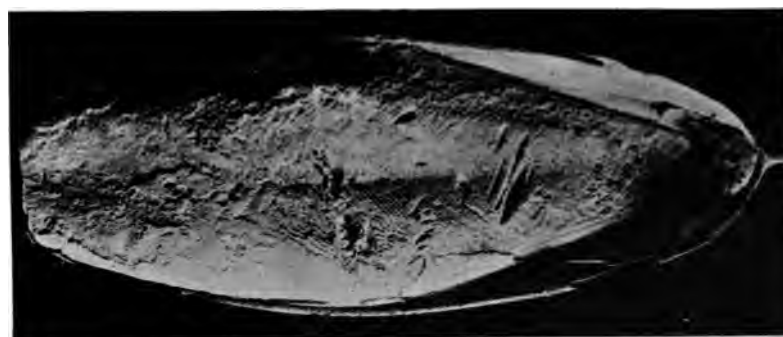
EXPLANATION OF PLATE I.

SEPIA KOETTLITZI.

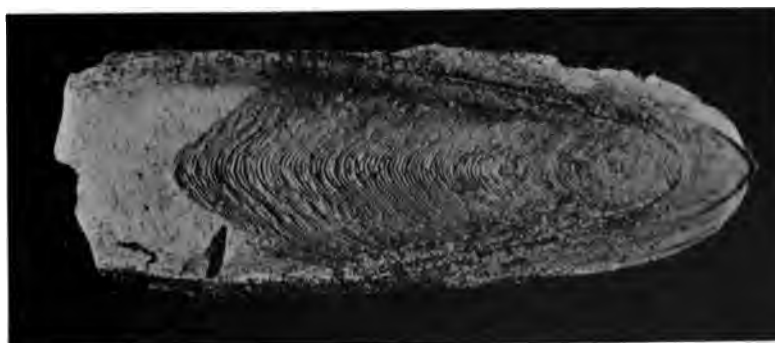
- Fig. 1. Dorsal view of the specimen collected by Dr. Koettlitz.
,, 2. Ventral view of the specimen in the McAndrew collection, British Museum (Natural History).
,, 3. Ventral view of the specimen collected by Dr. Koettlitz.
(The figures are about one-tenth less than the actual specimens.)



1



2



3

Muséum E. Le Doy, 78, Rue Claude Bernard, Paris.

SEPIA KOETTLITZI.



VII. On the Phloem of *Lepidophloios* and *Lepidodendron*.

By Professor F. E. WEISS, B.Sc., F.L.S.

Received and read October 30th, 1900.

The structure of the phloem in the genus *Lepidophloios* and in the nearly allied genus *Lepidodendron* has been the subject of much discussion and of considerable difference of opinion. This is mainly due to the fact that its delicate tissues are rarely found in a good state of preservation. For, while the dead and lignified elements of the wood are not liable to much injury, the phloem, composed as it is, in all plants, largely of delicate living cells, is much more subject to speedy decay on the death of the plant, and is therefore less commonly met with in the fossil condition in a good state of preservation. In the two genera referred to above it is often not preserved at all.

Examining, as I have done, a very large number of specimens of *Lepidophloios* and of *Lepidodendron* in the Cash, Hick, and Wild Collections of Coal Measure fossils in the Manchester Museum, I have found only a very few specimens in which the tissues of the phloem region were moderately well preserved, even when such delicate cells as those of the mid-cortex and of the cambium were fairly perfect.

The sections of *Lepidophloios fuliginosus* figured by Williamson under the name of *Lepidodendron Harcourtii* in his XIth Memoir on the Organisation of the Fossil Plants of the Coal-Measures¹ show the details of most

¹ Williamson W. C., *Phil. Trans.*, Part II., 1881.

July 10th, 1901.

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of the tissues very clearly, but are defective with regard to a portion of the phloem.

In *Fig. 11* of *Plate 49* it can be seen to consist of small-celled parenchyma with "large isolated cells." Even in the excellent preparations in the Binney Collection of Coal Measure Plants now at Cambridge, which have recently been described by Seward (I.)¹ the phloem region is only partially preserved. From an examination of these preparations Seward concludes that the large clear spaces which form so prominent a feature of *Lepidophloios* "cannot be satisfactorily explained as the result of decay previous to mineralisation." He considers that their appearance is suggestive of sacs or spaces formed, for the most part during the life of the plant, by the separation and partial disorganisation of thin-walled cells. "The constant occurrence of patches of dark brown substance in this zone" seems to him to point to a secretory nature of the tissue, and hence he terms the phloem region the secretory zone. This explanation is also advanced by Seward (II.)² for the appearance of similar large spaces in a "*Lepidodendroid* stem from the calciferous sandstone of Dalmeny, possibly identical with *Lepidophloios Harcourtii* (Witham)."

Among the specimens of *Lepidophloios fuliginosus* in the Manchester Museum I have come across three preparations, in the Cash Collection of Coal Measure Plants, which throw a little further light upon the structure of the phloem, by the excellent state of preservation of its tissues. The three preparations (No. 409, 645A, 645B) are all transverse sections cut from the same stem,

¹ Seward, A. C. (I.). *Proc. Camb. Phil. Soc.*, Vol. X., Part III., 1900.

² Seward, A. C. (II.). *Trans. Roy. Soc. Edinb.*, Vol. XXXIX., Part IX., No. 31, 1900.

which was about three inches in diameter, and very finely ground by Mr. James Binns. The original block was from the Halifax Hard Bed, and Mr. Cash is under the impression that he collected it at the Cinder Hill Pit, near Halifax.

A cursory examination of the preparations would not lead one to expect a very good state of preservation, as only a portion of the stem is preserved. But, as will be seen on closer examination, all its tissues are most wonderfully intact. The presence in the mid-cortex of innumerable well-preserved fungal filaments might seem hardly in accord with the undamaged condition of the tissues, but the fact that the delicate cells of this cortical region are practically uninjured leads me to suppose that the fungus was a parasitic and not a saprophytic form.

Fig. 1 (Plate 1) shows a portion of section No. 645A, which, being very thinly ground at this point, shows very clearly the excellent preservation of the tissues. In the bottom left hand corner is seen a portion of the primary wood, with the smaller protoxylem elements near the periphery. Separated from this by a crack is the secondary tissue, consisting of more or less regular rows of apparently parenchymatous cells, an appearance very typical of *Lepidophloios fuliginosus*. The presence of this secondary tissue shows that the stem had arrived at some state of maturity. A number of leaftrace bundles pass through the secondary tissue, which is bounded on the outside by a very clear and sharply defined layer of cells which have generally been identified as a secondary meristem, though differing in many respects from the cambium of recent plants and also from the cambium of other fossil cryptogams. This clearly defined layer of cells is not infrequently well preserved in this species, and gives us very distinctly the inner boundary of the

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phloem region which stretches from here to the somewhat dark band forming the boundary between the central vascular cylinder and the cortical region. The phloem which, as stated above, is usually very defective in *Lepidophloios*, sometimes indeed entirely disorganised, is here, as can be readily seen from *Fig. 1*, completely preserved, though its tissues are somewhat confused in the thicker portions of the section. It will be noticed at once that it is not characterised by those large spaces figured by Williamson¹ and which Seward regards as secretory sacs. The largest cells in the phloem are not as large as the cells of the cortex, while the so-called secretory sacs of the less well-preserved specimens are far larger than the cortical cells, as large indeed as the larger vessels of the primary wood. We can therefore only conclude that when such large spaces occur they are due to the decay, previous to mineralisation, of whole groups of cells. The only other alternative, namely, that the tissue was not yet fully mature, seems precluded by the presence of so large an amount of secondary tissue.

On closer examination of the phloem it will be observed, as is perhaps better seen in a more enlarged view (*Fig. 2*) of the thinnest portion of *Fig. 1*, that the largest cells of this tissue are generally surrounded by a somewhat regular and star-shaped group of cells. Two such groups are well seen towards the right-hand side of the phloem in *Fig. 1* and on a larger scale in *Fig. 2*. Separating such groups are cells of various sizes somewhat irregularly placed.

Another enlarged view of the phloem from a very thin portion not included in *Fig. 1* is represented in *Fig. 3*. Though the tissues in this portion of the phloem region seem somewhat confused, one or two groups

¹ Williamson, W. C., *loc. cit.* Plate 49, *Fig. 11*.

stand out clearly and are of special interest. They lie near the middle of the section and show a more definite arrangement of cells than is shown by the rest of the tissue. One of these groups is still further enlarged in *Fig. 4 (Plate II.)* This group has a clear-cut oval outline, formed by a darker cell-wall surrounding a group of six or seven cells. One can clearly distinguish a central cell surrounded by five or six peripheral cells. There seems to me little doubt that such a group of cells corresponds to one of the large spaces usually met with in the phloem region of this fossil, and this identification is rendered all the more probable from Mr. Seward's observation in Binney's slides of "The occurrence of a few smaller elements enclosed by the thin membranes which mark the outlines of the sacs."¹ These he figures in *Fig. 3* and they are also seen in the oblique section of a leaf-trace in *Fig. 5* on *Plate III.* The very definite oval outline of the group of cells before us in *Fig. 4* of the present communication would lead us to suppose that it had arisen from the sub-division of a single cell, in which a central and a number of peripheral cells had been cut off, very much as the nodal cell of *Chara* divides into a central and peripheral cells. Another and perhaps a more useful comparison might be made with the separation of a number of companion cells from a central sieve tube. I have examined the sections under consideration very carefully, to obtain, if possible, earlier stages of division than that shown in *Figs. 3* and *4*, and have been able to find a number of phloem cells divided by delicate walls into two, three, or more cells, but it was impossible to decide definitely whether these stages were preparatory to further division as illustrated in the special group referred

¹ *Vide Seward, loc. cit. (I.), p. 147.*

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to. It would, of course, be quite possible for the divisions to stop at this stage so that we should not obtain a definite central cell. There were, however, other groups of cells showing the same state of things as in the group in *Fig. 4*, but a little less clearly. The number of cells was not always the same. Sometimes as few as four were noted, and then, usually, no central cell occurred. Generally, however, they were more numerous, and in a specimen of *Lepidophloios* I have just received from my friend, Mr. William Cash, in which there are a great number of these divided large cells, the number of divisions is often very great, both the central and the peripheral cells having divided up into smaller cells. Indeed, the whole of the phloem region seems to have an active meristematic condition and to be undergoing considerable change, and the tissues have thereby become so irregular that they differ a good deal from the preparations figured in this paper. As the secondary thickening is only just commencing in the preparation lent me by Mr. Cash, it must be considered as younger in age than in the specimens from the Manchester Museum in which such division stages are much less numerous and the star-shaped arrangement more common. The increased number of groups of cells of this latter category in the older specimen suggests that after the subdivision of the cells the star-shaped appearance has been produced by an enlargement of the central cell and by further growth of the peripheral cells of a subdivided phloem cell, such as is figured in *Fig. 4*.

These star-shaped groups resemble very closely the sieve tubes, surrounded by small parenchymatous cells, as described and figured by Hovelacque¹ for *Lepidodendron*

¹ Hovelacque. "Recherches sur le *Lepidodendron* selaginoides." *Mém. Soc. Linn. Normandie*, xviii^{me} Vol., 1^{er} fas., 1892, pp. 49—50 and *Fig. 11*.

selaginoides. Whether such star-shaped groups can be derived from the divided phloem cells cannot, of course, be determined in the case of a plant known to us only in the fossil condition; but there seems a considerable degree of probability of such a development in the numbers of groups of cells showing an intermediate condition between the two groups of cells. The preponderance of the divided phloem cells in the younger, and of the star-shaped groups in the older specimen, as stated above, also favours this hypothesis. But whatever be the relationship of these different groups of cells, they both make up part of the phloem region of *Lepidophloios*, and the excellent state of preservation of these preparations shows us that, in the living condition, this phloem region was not occupied by large lysigenous secretory sacs, as seemed possible from less well-preserved specimens, but consisted of a definite tissue, which has much of the appearance of a true phloem, as indeed Seward¹ admits in his description of Binney's specimens. It bears a very marked resemblance to the phloem, consisting of sieve tubes and companion cells, in some aquatic stems such as *Potamogeton* or *Elodea*², and is very similar to the phloem figured by Bower³, around the central stem of *Psilotum* with which member of the living *Lycopodiaceæ* he considers the *Lepidodendra* have the greatest anatomical resemblance. There is no evidence of the partial disorganisation of the cell walls during the life of the plant, the probability of which has been suggested by Seward, and we must therefore consider such appearances as he describes in the case of the specimens in the Binney

¹ Seward, A. C. (II.), p. 155.

² *c.p.* Schenck, H. *Vergleichende Anatomie der submersen Gewächse*. *Bibliotheca Botanica*. No. 1, 1886.

³ Bower, F. O. *Annals of Bot.* Vol. vii., 1893.

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Collection, and as occur in most other preparations of *Lepidophloios*, as due to decay after the death of the plant and previous to its mineralisation. It might be argued that even if we have not in our specimens any evidence of a lysigenous formation of glandular tissue as has been suggested, yet some of the star-shaped groups of cells may be of the nature of schizogenous ducts or passages. To this it may be answered that the central space in such star-shaped groups is cellular, and not intercellular, as can be seen from the occurrence in many groups of transverse walls in all respects like those of other cells (*see Fig. 2*). Nor is there in most cases any appearance of an accumulation of secretion such as one would expect to find in a tissue with a secretory function.

It is a pity that we have no longitudinal sections taken from this well-preserved block, for it would be most interesting to ascertain the length and the course of the larger sub-divided cells described above or of the central cell of the star shaped groups. In less well preserved specimens of *Lepidophloios* the large lacunæ in the phloem region run for some considerable distance, as figured by Seward, and certainly have there the appearance of secretory sacs. But in all probability a number of transverse walls have become absorbed away, and in a specimen of *Lepidophloios* in my possession septa are seen at intervals either transverse or slightly oblique, and indicating probably the boundary of the elements which, in the imperfectly preserved specimens, have formed large spaces by absorption of their walls. These septa are seen in *Fig. 5*, where they are indicated by an asterisk.

The breadth of these septa indicates that they ran across the whole of one of the large lacunæ, and as these lacunæ are not represented in size by any single elements, we must assume that they corresponded, as I have in-

licated before, and as is seen from the preparations in the Binney Collection, described by Seward,¹ to a group of cells. Now since these large spaces are very numerous, and since the large subdivided cells are infrequent, it seems to me that both these latter and other groups of cells, probably the star-shaped groups, have become disorganised to form the large lacunæ region. Moreover, as the septa indicate, these groups of more elongated cells would follow each other in vertical series for some distance, and thus afford a tissue well adapted for conducting purposes. These groups of cells were closely set together, as can be seen both in the perfectly preserved specimens under consideration and also from those in which the lacunæ take the place of these groups of cells (*see Plate III., Fig. 3, in Seward's paper on *Lepidophloios**). Thus, though we do not get a complete vertical continuity, yet, by lateral passage of adjoining groups of conducting cells, continuous conduction would be possible. It seems to me, therefore, that the tissue occupying the phloem area of *Lepidophloios* would satisfy all the conditions of a conducting tissue and might be dignified by the name of phloem. It would consist of groups of more elongated cells, arranged for certain distances in vertical series. These groups consisted, as far as we can see from transverse sections, of a larger central and smaller peripheral cells, each group either oval or star-shaped in outline, and would seem by their mode of origin to correspond to the sieve tubes and companion cells of the higher plants. Besides these there were numerous short parenchymatous cells which surrounded the groups of conducting cells (the lacunæ in the defective specimens) and these short parenchymatous cells seem to have been more resistant,

¹ Seward, *loc. cit.* Fig. 5, p. 151.

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and are generally better preserved, than the conducting elements.

We have, of course, no proof that the conducting cells were actually sieve tubes, but we must remember that sieve tubes are not demonstrated to exist in all living *Lycopodiaceæ*. According to De Bary¹ "In the larger indigenous *Lycopodia* (*L. clavatum* and *annotinum*) there occur in the vascular bundles of the stem, organs which, in their position and width, have great similarity to members of the sieve tubes." But the sieve plates are, usually, so faint that neither he nor Hegelmaier² could find the sieve plates which had been described by Dippel³. Campbell⁴, too, describes the sieve plates as poorly developed and difficult to demonstrate.

This absence of the sieve plates in some forms and their want of distinctness in other cases must, I think, be considered in connection with the chemical and physical constitution of the cell wall, of the phloem elements in the *Lycopodia*. As is known, the cell wall of the phloem elements is, in these plants, not composed of cellulose but of amyloid. This substance is described by Cross and Bevan⁵ as a semi-hydrate of cellulose with the formula $n(C_{10}H_{22}O_{11})$ and as allied to mucilage. It is, therefore, in all probability, more readily permeable than cellulose, for though it has been asserted by some botanists that a mucilaginous layer impedes the passage of dissolved food material, Pringsheim⁶ states definitely that the result of

¹ De Bary. *Comparative Anatomy*, p. 181.

² Hegelmaier. *Bot. Zeitung*, 1872.

³ Dippel. *Ber. der 39. Versammlung deutscher Naturforscher zu Giessen*, 1864.

⁴ Campbell. *Mosses and Ferns*, 1895, p. 473.

⁵ Cross and Bevan. *Cellulose, an Outline of the Chemistry of the Structural Elements of Plants*, 1895, p. 53 and p. 224.

⁶ Pringsheim. *Jahrbuch für wiss. Bot.*, 1895, Bd. 28, p. 33.

experimental researches has established that the diffusion of salts takes place as rapidly in gelatinous masses as in water. A more readily permeable cell wall might very easily account for the greater simplicity of the phloem cells and for the reduction of the sieve plates.

Now, in view of the relationship of the *Lepidodendraceæ* with the existing *Lycopodiaceæ*, it seems not unlikely that the fossil ancestors or allies of this group of plants had phloem elements with walls of the same amyloid substance, and this must, I think, be taken as the cause of the great difficulty of preservation of this tissue and the frequent absence of all structure from the phloem region even when such delicate tissues as the cambium and the mid cortex were preserved.

For amyloid, such as it exists in the seeds of some leguminous plants, is of so mucilaginous a nature that it dissolves in boiling water and is partly soluble in cold. In the case of the *Lycopodia* though I could not get any solution of the cell walls in hot water, yet they swelled up considerably, so that we are dealing probably with a more resistant variety of this substance though one which is much more readily acted upon than cellulose.¹

Gilson,² in his memoir on the chemical composition of the vegetable cell wall shows that probably there are two such varieties of amyloid, one more easily soluble in water and the other not readily soluble. Probably amyloid stored as food material is of the former category, while amyloid forming the cell walls of conducting cells is of the second category. Still even this more resistant variety would be more yielding than a cellulose wall, and if in breaking down it formed mucilage, as seems likely, it would swell up with water, and this might account for the fact that the

¹ Cross and Bevan. *Cellulose*, p. 224.

² Gilson E. *La Cellule IX.* 2^e fascicule, 1893.

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groups of phloem cells in *Lepidophloios* which become disorganised are not generally compressed by the firmer tissues or by pressure during mineralization, but form wide and rounded passages, often compressing the surrounding tissues and showing that a force has been exerted from within the lacunae. A similar phenomenon may be noted where the phloem groups have become partially or entirely disorganised in *Lepidodendron selaginoides*, as can be seen from Hovelacque's *Figs. 1 and 2* on *Plate II.* of his memoir on this plant.

One further point arises in connection with the phloem of the stem, and that is, the question whether any part of it is of a secondary origin. The cell divisions seen in the cambial layer tend to show that it does add a little to the phloem. *Fig. 2* seems to show in the case of some cells towards the left hand side that they have been derived from the cambium. While some of the phloem elements near the outside seem to be compressed very much in the same way as in dicotyledonous plants with secondary thickening, where they ultimately form hardened masses of tissue described as *keratenchyma* by Tschirch.¹ It seems to me very likely that it is elements of this kind which have been described in the *Lepidodendra* sometimes as bast fibres, sometimes as by Bertrand² and Hovelacque³ as latex cells. They may be readily seen on the outside of the phloem in *Psilotum*, and one would expect them even more naturally in a stem in which secondary thickening has taken place. Should they be cells of this nature it would be more easy to explain their absence, or the uncertainty of their presence, in certain

¹ Tschirch A. *Angewandte Pflanzenanatomie*, 1889.

² Bertrand. "Remarques sur le *Lepidodendron Harcourtii* de Witham." *Trav. et Mem. des Facultés de Lille*, 1891.

³ Hovelacque M., *loc. cit.*

specimens, for such obliterated cells are very irregular in their appearance¹.

So far I have been dealing with the phloem as seen in the central vascular cylinder or stele of the stem. I pass now to a consideration of the phloem of the leaf trace bundles. These, as is well known, in passing outward through the phloem region, retain on the outer surface a certain amount of the tissues belonging to this region. The best preserved specimen of these cells accompanying the leaf trace are figured by Seward from the specimens in the Binney Collection. His *Fig. 1* on *Plate III*.² shows the tissues not only well preserved but extremely thinly ground. In this figure the tissue has an appearance not unlike that just described for the stem of *Lepidophloios* from Cash's specimens, and the appearance is not to my mind very suggestive of a secretory tissue, but much more of phloem cells. The cell walls are very distinct, and there is no appearance of lysigenous degeneration nor of any large amount of substance which could be looked upon as secretion. The account of these cells as seen in longitudinal section, and the figure he gives of them *Fig. 2, Plate IV*., is not against their being true phloem elements and concerned in conduction rather than in secretion. They are at any rate very different from the less well preserved tissue of the main axis, and approach more closely well preserved cells of the Cash specimens.

In Cash's specimens, however, the phloem of the leaf trace bundles does not present so clear an appearance as

¹ A good account of these cells (cellules nacrées) in both Phanerogams and Cryptogams will be found in Perrot's *Tissu criblé*, 1899, based chiefly on the work of Jules Leger's 'Recherches sur l'origine et les transformations des éléments libériens.' (*Mém. Soc. Linn. Normandie.*)

² Seward, *loc. cit.* *Plate. 3, Fig. 1.* See also Binney. *Trans. Palaeontograph. Soc.*, 1872.

in the Binney preparations. This is due partly to the bundles being cut somewhat obliquely, and partly to the greater thickness of the section at those points where the leaf traces are cut as nearly transversely as possible, *i.e.*, in the region of the inner cortex. In the mid-cortex the leaf trace bundles run almost horizontally in typical specimens of this species, but in the inner cortex they are sufficiently nearly vertical to be approximately transversely cut in a transverse section. Two such sections across the leaf trace bundles are shown in *Figs. 6 and 7*, and they both show the same features as regards the structure of the phloem, and this is shown in the case of other bundles not figured. It will be seen that the phloem consists of some three rows of large-spaced elements somewhat irregular in outline though with some regularity in their arrangement. These large cells are apparently not separated by smaller elements but adjoin each other, and in this respect the phloem resembles the arrangement of the tissue in the stems of many of the living *Lycopods*, where single rows of large sieve tubes adjoining each other, and with only a row of small elements at the top and bottom, run in between the xylem groups.

Whether this appearance was the actual condition of the living tissue is difficult to say in view of the difference between our figures and those of Binney and of Seward, and though the appearance does not seem to warrant it, a disorganisation of the tissue may already have set in in the leaf trace bundles. If, however, that is not the case, we have an interesting feature in the absence of the numerous small cells which separated the larger elements of the stem. If the smaller elements have the same function as the companion cells or of the phloem parenchyma of Angiosperms their absence or reduction in the leaf trace bundles should not surprise us; for they have been looked upon as collecting

from the sieve tubes and storing for the use of the cambium or of the developing wood cells, the food material which passes down the sieve tubes. Frank¹ and Blass² indeed consider the function of the phloem as a whole is more nutritive than conducting, but at any rate we should expect to find in the leaf trace bundles the conducting function outweighing the storage or nutritive function.

The difference in the aspect of the phloem in the figures of Binney and Seward as compared with those given in this paper, if not due to differences in the preservation, may be due to the fact that the bundles represented in the two cases are from different parts of their course.

The bundle figured by Seward and Binney is at the level of its passage through the mid-cortex, while the figures in the present paper are of bundles passing through the closer cells of the inner cortex. This may very possibly account for the difference in structure, for Bertrand has stated³ that in the case of the nearly related *Lepidodendron* the so-called laticiferous cells increase greatly as the leaf trace bundle passes outwards from the central cylinder. Such an increased complexity might therefore also occur in *Lepidophloios*.

I will now discuss briefly the phloem of *Lepidodendron*, basing my remarks chiefly on the examination of a very perfect specimen of *Lepidodendron selaginoides*, the species so admirably described by Hovelacque.⁴ As mentioned above, the phloem region in *Lepidodendron* appears generally even more defective than in *Lepidophloios*, and in most cases the phloem region is represented by large

¹ Frank A. B. *Lehrbuch der Botanik*, 1892, p. 184.

² Blass Dr. "Die Physiologische Bedeutung des Siebteils der Gefässbündel. *Jahrb. f. wiss. Bot.* xxii., 1891.

³ Bertrand, *loc. cit.*, p. 142.

⁴ Hovelacque, M., *loc. cit.*

and extensive lacunæ reaching from one leaf trace bundle to the next, these latter forming more solid bridges of tissue uniting the woody tissues with the hard inner cortex which is generally well preserved. Where the phloem tissues are present as in the case of some of the preparations examined by Hovelacque, its appearance as figured by him is not unlike that shown for *Lepidophloios* in *Plate I.* of this paper, and Hovelacque identifies the alternating larger and smaller elements as sieve tubes and companion cells. This interpretation is, I think, perfectly correct.

The specimen of this *Lepidodendron* in the Manchester Museum which shows the best preserved phloem, is a preparation in the cabinet of the late Thomas Hick (No. 67). It was labelled by him "standard," and a comparison of this slide with the figures of a specimen of *Lepidodendron selaginoides* reproduced by Williamson in his XIth Memoir,¹ shows that it is a section from the same stem which Williamson, and no doubt Hick, too, obtained from their mutual friend, Mr. William Cash, of Halifax.

A portion of this transverse section is reproduced in *Fig. 8*, and represents one bay of the phloem region with the adjoining tissues. Here too, as in the previous preparations described, a crack separates the primary wood from the remainder of the tissues, and it will be noted in this specimen there has not yet been any secondary wood formed. Thus the phloem region begins here a few cells from the crack, and can be seen to consist of a very definite group of larger elements, with only a few smaller ones, stretching out to the tangentially elongated cells forming probably the pericycle and endodermis. The smaller elements are often arranged around, or partially around, the larger elements of the phloem, but as these former are much fewer in number

¹ Williamson, W. C., *Phil. Trans.*, 1881, Plate 51, Fig. 2.

than in *Lepidophloios*, the large elements are often contiguous, an appearance suggestive of the arrangement of the sieve tubes in living Lycopods. Within the outer and distinct band of phloem elements, and separated by a dark band of tissue, are seen some smaller groups of soft bast cells, similar in structure to those nearer the outside, but less regular in arrangement. Besides these there are also two groups of smaller and harder elements which appear to be the commencement of leaf traces, one already partly imbedded in the phloem region. In other parts of the section can be seen the early stages of disorganisation of the phloem elements by a breaking away of the cell walls separating adjoining sieve tubes. This process, as has been stated above, results in this species of *Lepidodendron* in the complete disappearance of the phloem elements.

The phloem of the leaf traces is not sufficiently preserved in this specimen to enable me to ascertain the presence of what Hovelacque¹ described as laticiferous cells which occur more particularly in the phloem of the leaf trace bundles. They appear according to this author to be very variable in their number, and sometimes, as he says in his note on page 51. "Il faut même être prévenu qu'il peut y en avoir pour les découvrir." I have mentioned in a previous part of the paper what I consider to be the possible nature of such cells as seem to occur in the stem and leaf traces of various *Lepidodendra*.

SUMMARY.

Having now examined the cells making up the phloem region of *Lepidophloios* and *Lepidodendron* respectively in two of the best preserved specimens, I think we cannot but conclude that the arrangement of its cells, as seen at

¹ Hovelacque, *loc cit.*

least in transverse section, does not only not preclude them from being of the nature of true phloem elements, but makes it very probable that the function of this tissue was that of a normal phloem. In both cases we have the larger and smaller elements so characteristic of phloem and similarly arranged, the proportion of the two kinds of cells varying in the two genera, *Lepidophloios* having a greater number of the smaller elements.

It would be highly desirable to examine longitudinal sections of equally well-preserved specimens, so as to determine the suitability of the phloem elements for purposes of conduction of organic material; but we can see from the less well-preserved specimens (*Fig. 5*) that they occur in considerable vertical series, and as they are often contiguous, the vertical passage might be helped on by lateral diffusion. Phloem appearing in longitudinal section of the normal type has been shown by Maslen¹ to exist in the sporophylls of *Lepidostrobus*, and the transverse sections of similar leaf traces in the excellently preserved *Lepidostrobus Brownii*² shows that in this species the cells had the same arrangement as has been figured by Hovelacque for *Lepidodendron selaginoides*, so that here, too, we might suppose that a good longitudinal section might show the same arrangement as described by Maslen for *Lepidostrobus*.

In the vegetative axis showing secondary thickening we should expect a phloem of even greater complexity, as the requirements of organic food material would here be greater, and, as has been often pointed out, the phloem of *Dicotyledons* generally develops phloem-parenchyma³ for

¹ Maslen, A. J. "The Structure of *Lepidostrobus*. *Trans. Linn. Soc. Lond.*, Vol. V., Pl. II., 1899.

² Bower, F. O., *loc. cit.*, Fig. 4A, Pl. XVI.

³ *c.p.* Vines, S. *Text-book of Botany*, 181.

the purpose of storing food material to meet the requirements of cambial activity. Such elements we have seen occur in considerable numbers in the specimen of *Lepidophloios* in which secondary thickening was taking place, and might be more numerous in a specimen of *Lepidodendron* provided with an active cambial layer. This view is also supported by the great meristematic activity displayed by the phloem in the specimen of *Lepidophloios* recently sent me by Mr. Cash, in which secondary growth is just commencing.

Until it is disproved that the cells of this phloem region are of such a nature as not to be able to effectively conduct and store organic material for the use of the secondary meristem we must look upon it as functionally representing the phloem, though it may differ from it in construction. But as a matter of fact it does not seem to differ materially from the phloem of recent *Lycopodiaceæ* except in such particulars as are probably connected with the absence of secondary thickening in recent *Lycopods* and the consequent diminished need of storing organic material within the stele.

That some of the elements of the phloem region may have been of the nature of laticiferous cells or may have united to form mucilage ducts is, of course, quite conceivable, even when the bulk of the elements made up a true phloem. There seems to me, however, to be no evidence of such secretory tissue in this region in well preserved specimens of *Lepidophloios* and *Lepidodendron*. In the outer cortical tissue, however, in both genera just inside the periderm there can always be seen true lysigenous glandular patches. These have been figured by Seward for *Lepidophloios*, by Bertrand in *Lepidodendron Harcourtii*, and they are also clearly visible in the section of *Lepidodendron selaginoides*, from which the phloem

has been described in this communication. (Hick Collection No. 67). The character of this outer secretory zone is very distinct and different from the tissues I have described as phloem. These latter are much more in agreement with the tissues of a normal phloem, so that we can, I think, agree with the statement made by Dr. Scott¹ in his recently published *Studies in Fossil Botany*, that we are not justified in supposing that there was any fundamental difference in the structure of the phloem between the *Lepidodendra* and their recent allies.

Scott, D. H. *Studies in Fossil Botany*. 1900. p. 142 and 143.

EXPLANATION OF PLATES.

PLATE II.

Lepidophloios fuliginosus (Williamson).

Slide No. 645A of Cash Collection in the Manchester Museum.

Fig. 1. A portion of the transverse section of the stem to illustrate the general arrangement of the tissues. *ph* = phloem region. *cb* = cambium. *xy*² = secondary tissue mostly parenchymatous. *xy*¹ = primary xylem.

Fig. 2. A portion of section enlarged 60 diameters to show the phloem region in detail.

Fig. 3. Another portion of section showing the divided phloem cells. Two groups near the centre are particularly noticeable.

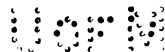
PLATE III.

Figs. 4, 6, and 7 from same slide as *Figs. 1, 2, and 3.*

Fig. 4. Showing very much enlarged the peculiar dividing of the phloem cells.

Fig. 5. A longitudinal section from a less well-preserved specimen of *Lepidophloios fuliginosus*, showing the remains of transverse and oblique septa across the large spaces so frequently found in the phloem region of this fossil. The septa are indicated by an asterisk (*).

Fig. 6. Transverse section of a leaf-trace when passing through the inner cortex, showing the arrangement of the

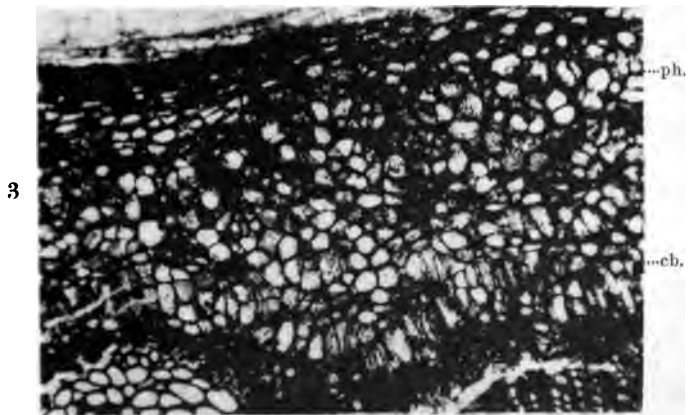
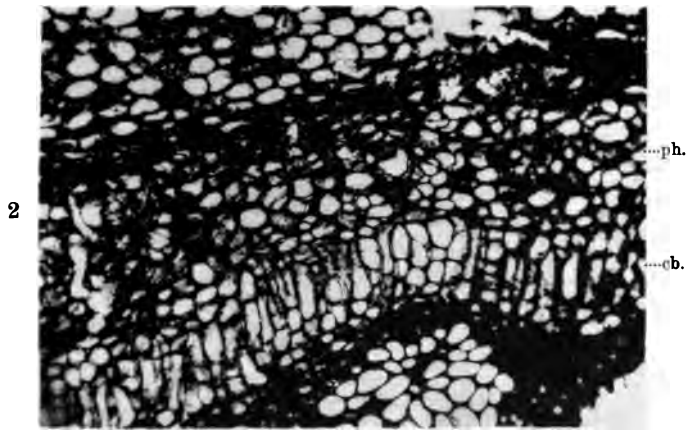
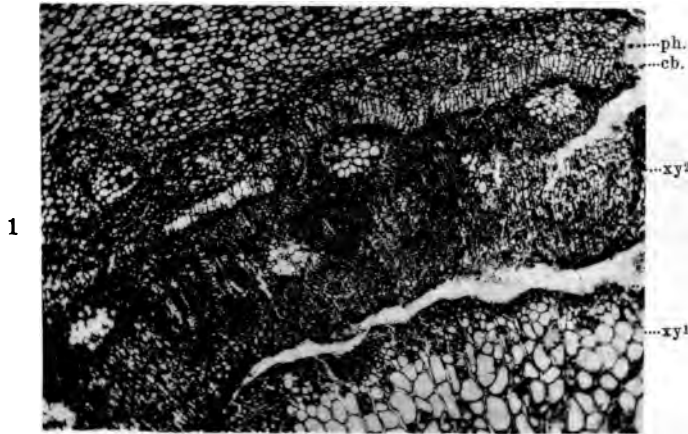


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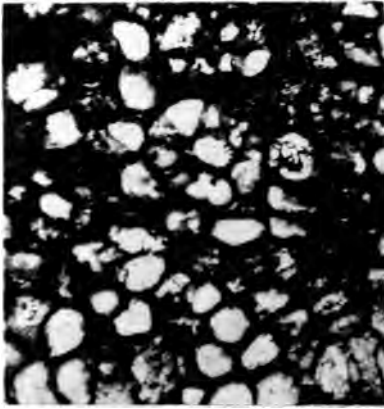
large cells of phloem at this point of leaf trace.
This is an enlarged view of the leaf trace near the
left-hand edge of *Fig. 1*. *ph* = phloem, *xy* = xylem.

Fig. 7. A similar leaf trace bundle as the one shown in *Fig. 6*,
with a similar arrangement of the phloem cells (*ph*).

Fig. 8. Portion of transverse section of *Lepidodendron selaginoides*
(Hick Collection No. 67) showing one of the bays
of phloem and the adjacent tissues. The smaller
elements on the inside of the phloem are leaf
traces. *ph* = phloem, *xy* = xylem.



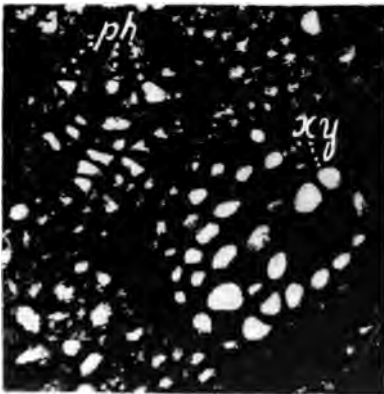
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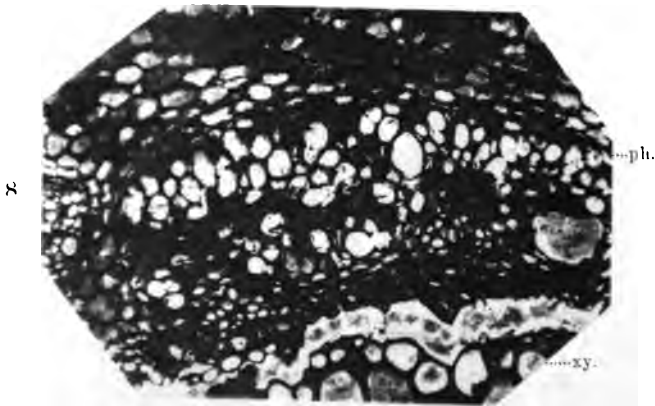
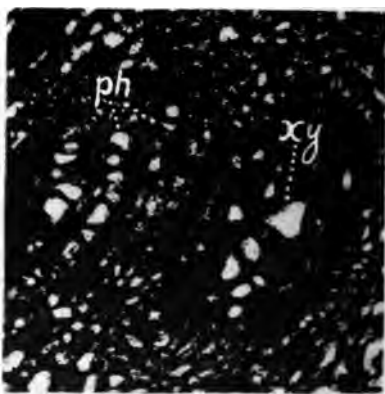
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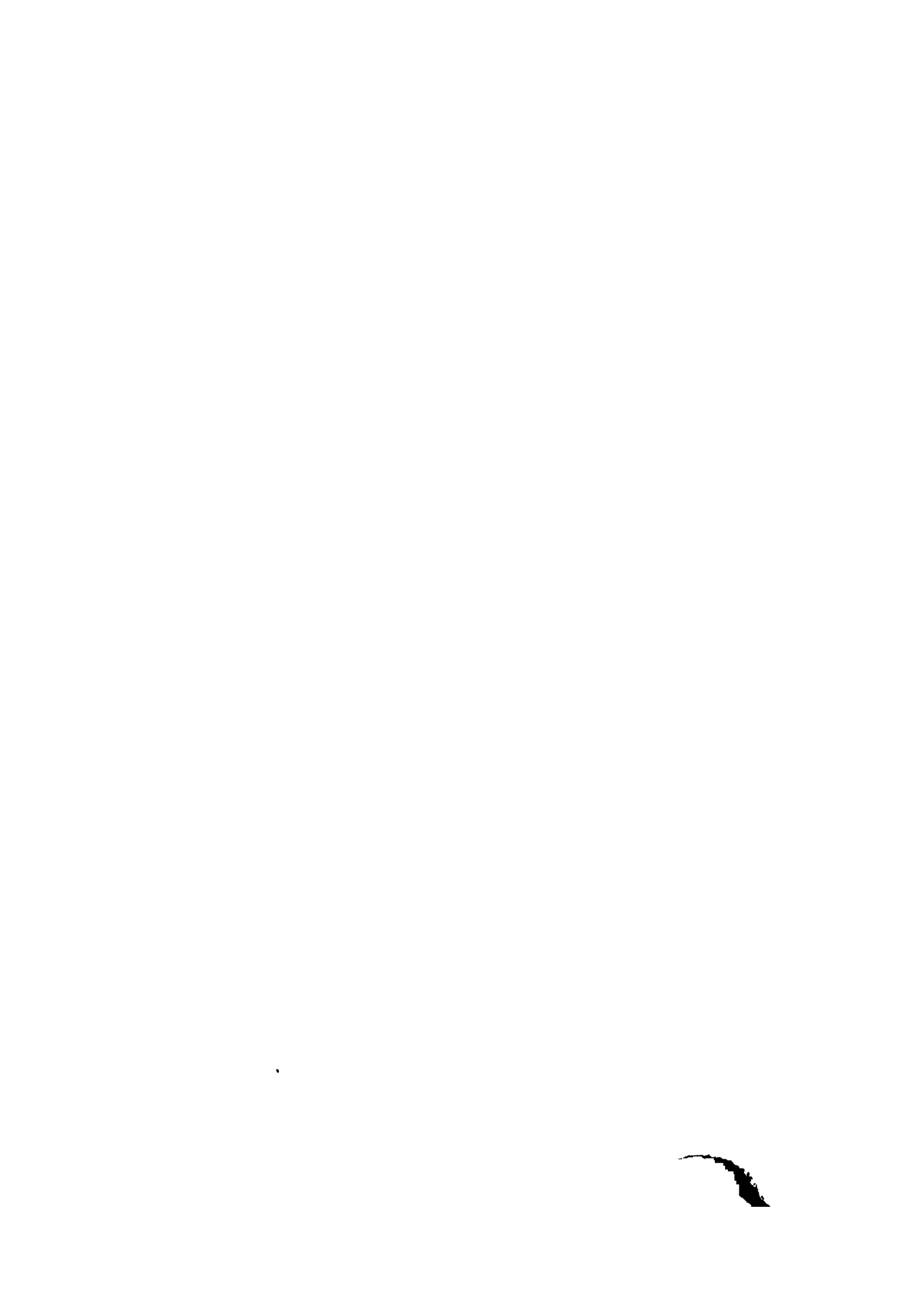


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**VIII. Selections from the Correspondence of
Lieutenant-Colonel John Leigh Philips, of
Mayfield, Manchester. Part III.**

By W. BARNARD FARADAY, LL.B.,
Barrister-at-Law.

Read November 27th, 1900. Received in its present form January 15th, 1901.

The letters comprised in the present series, which are those written by Captain Samuel Cable, R.N., to Lieutenant-Colonel Leigh Philips, while they can scarcely be claimed to possess the definite historic importance which attached to those of Mr. Thos. Taylor, are nevertheless interesting and valuable, as showing, in the minutest detail, the conditions of life prevailing in the Isle of Man, and the relations between that island and the other parts of the British realm at the end of the eighteenth century. Apart from this, it may be claimed for the following letters that, being the composition of a humorous and well-informed man, they are in many cases intrinsically amusing and graphic in their account of current events, and that, being in large measure the life story of a character whose personality and situation were alike interesting, they form a "human document" of considerable attractiveness and some pathos.

The Isle of Man, at the period when these letters were written, was a place very different from that with which the holiday-makers of the present time are so familiar. It was, over its greater extent, very thinly peopled, the total population being only about thirty thousand, and

July 10th, 1901.

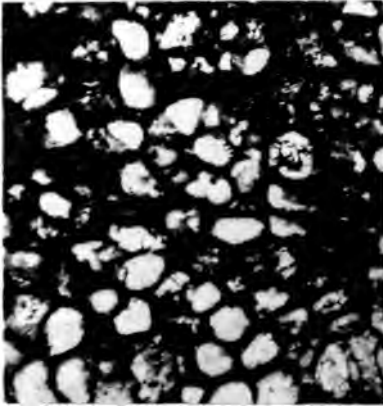
the manners of the inhabitants were extremely primitive. A considerable proportion of the people used the Manx language, a Celtic tongue strongly engrafted with Norse; and they were purely an agricultural and fishing population, with hardly any amusements but sport, and no literature. The better educated classes, who were few in number, were centred in and about Douglas, at that time a town with about 3,000 inhabitants, which possessed a weekly newspaper—the *Manx Weekly Mercury*.

The Isle of Man was originally a feudatory kingdom, granted by Henry IV. to the Stanley family, which retained many proofs of regality until 1726. In that year an Act was passed prohibiting the import of goods into Great Britain from the Island. In the meantime, the Lordship of Man passed by descent to Lady Mary Sophia, youngest daughter of the seventh Earl of Derby, and wife of John, Marquis of Atholl. Her grandson, the second Duke of Atholl, died in 1764. During his reign as Lord of Man, the Island was made a base for the smuggling trade, and the British Government, alarmed at the progress of this illicit commerce, made attempts to purchase the rights of Lordship, but were evaded. His daughter, Lady Charlotte, married her cousin John, who became third Duke of Atholl, and in 1763, arrangements were made by the British Government for the purchase of the Lordship of the Island, by which "John, Duke of Atholl, and Charlotte his wife, Baroness Strange," and their Trustees agree to surrender for the sum of £70,000 all their rights in the "Island, Castle, Peire, and Lordship of Man, and all the Islands and Lordships to the said Island of Man appertaining," comprised and granted in the letters patent of Henry IV. and James I. The same "to be vested inalienably in His Majesty, his heirs and successors." It may be said that the Act of Parliament called the

Revesting Act) which brought about this result, only deprived the Dukes of Atholl of their political dominion over the Island, and left them their manorial rights. It has often been said that for many years this measure did more harm than good to the people of the Island, at all events there was much dissatisfaction. In 1793 this was to some degree alleviated, when the then Duke was made Governor, for, in spite of several tiffs with the House of Keys, he was very popular throughout the Island. Much of the trouble arose through the question of the Customs. The Royal Commission appointed to enquire into the matter before the passing of the "Revesting Act," reported that "vast quantities of foreign goods were continually imported into the Isle of Man, and from thence clandestinely brought into Great Britain." These goods included brandy, wine, East India goods, cambrics and lawns, tobacco, wool, rum, and coffee. It will be seen, then, that the Island was a very real thorn in the side of the Government, and its purchase was a necessity. Most readers of Scott will recall Dirck Hatteraick, whose name in real life was Captain Yawkins, and who was a typical Manx smuggler, with his headquarters at Ramsey. It goes without saying, that this curtailment of their privileges of "fair-trading," as they called it, was a great grievance to the Manx. Customs regulations, extending to the Isle of Man, were passed shortly after the purchase of the Island, and, after numerous experiments, a fairly satisfactory arrangement was made. In 1792 a commission was appointed to enquire into grievances alleged by the Duke, and in 1825 the remaining property, and the manorial and ecclesiastical rights of the Atholl family in the Isle of Man, were sold to the Crown by the fourth Duke for £417,144.

One of our main sources of information respecting

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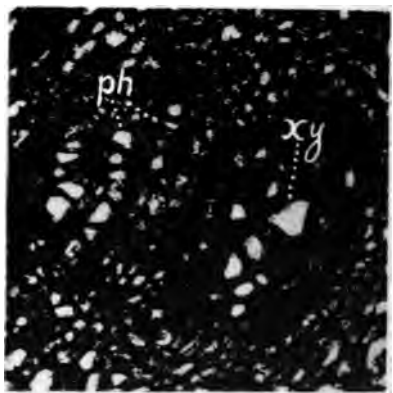
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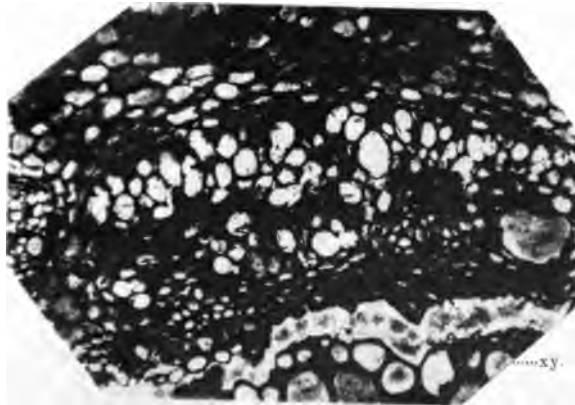
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the manners of the inhabitants were extremely primitive. A considerable proportion of the people used the Manx language, a Celtic tongue strongly engrafted with Norse; and they were purely an agricultural and fishing population, with hardly any amusements but sport, and no literature. The better educated classes, who were few in number, were centred in and about Douglas, at that time a town with about 3,000 inhabitants, which possessed a weekly newspaper—the *Manx Weekly Mercury*.

The Isle of Man was originally a feudatory kingdom, granted by Henry IV. to the Stanley family, which retained many proofs of regality until 1726. In that year an Act was passed prohibiting the import of goods into Great Britain from the Island. In the meantime, the Lordship of Man passed by descent to Lady Mary Sophia, youngest daughter of the seventh Earl of Derby, and wife of John, Marquis of Atholl. Her grandson, the second Duke of Atholl, died in 1764. During his reign as Lord of Man, the Island was made a base for the smuggling trade, and the British Government, alarmed at the progress of this illicit commerce, made attempts to purchase the rights of Lordship, but were evaded. His daughter, Lady Charlotte, married her cousin John, who became third Duke of Atholl, and, in 1765, arrangements were made by the British Government for the purchase of the Lordship of the Island, by which "John, Duke of Atholl, and Charlotte his wife, Baroness Strange," and their Trustees agree to surrender for the sum of £70,000 all their rights in the "Island, Castle, Pele, and Lordship of Man, and all the Islands and Lordships to the said Island of Man appertaining," comprised and granted in the letters patent of Henry IV. and James I. The same "to be vested inalienably in His Majesty, his heirs and successors." It may be said that the Act of Parliament (called the

Revesting Act) which brought about this result, only deprived the Dukes of Atholl of their political dominion over the Island, and left them their manorial rights. It has often been said that for many years this measure did more harm than good to the people of the Island, at all events there was much dissatisfaction. In 1793 this was to some degree alleviated, when the then Duke was made Governor, for, in spite of several tiffs with the House of Keys, he was very popular throughout the Island. Much of the trouble arose through the question of the Customs. The Royal Commission appointed to enquire into the matter before the passing of the "Revesting Act," reported that "vast quantities of foreign goods were continually imported into the Isle of Man, and from thence clandestinely brought into Great Britain." These goods included brandy, wine, East India goods, cambrics and lawns, tobacco, wool, rum, and coffee. It will be seen, then, that the Island was a very real thorn in the side of the Government, and its purchase was a necessity. Most readers of Scott will recall Dirck Hatteraick, whose name in real life was Captain Yawkins, and who was a typical Manx smuggler, with his headquarters at Ramsey. It goes without saying, that this curtailment of their privileges of "fair-trading," as they called it, was a great grievance to the Manx. Customs regulations, extending to the Isle of Man, were passed shortly after the purchase of the Island, and, after numerous experiments, a fairly satisfactory arrangement was made. In 1792 a commission was appointed to enquire into grievances alleged by the Duke, and in 1825 the remaining property, and the manorial and ecclesiastical rights of the Atholl family in the Isle of Man, were sold to the Crown by the fourth Duke for £417,144.

One of our main sources of information respecting

the social life in the Isle of Man is found in Colonel Richard Townley's *Journal in the Isle of Man*. Colonel Townley, who was a member of the well-known Lancashire family of that name, lived at Belfield Hall, and was in 1752 High Sheriff of the county. He married, first, Miss Ann Weston, of Liverpool, second, Mary, the daughter of Mr. James Penny, of Penny Bridge. He says that in the Isle of Man the people of the higher classes were, in the main, civil and attentive to strangers, while the ladies were "exceedingly affable, civil, and polite; very sprightly in conversation, and uncommonly neat and smart in their dress." He adds that many of the Manx women were very pretty and some very accomplished. The middle class people, "when they are sober and cool, are decently civil." The lowest class, however, were "rude, ungovernable, and uncivilized, far beyond the common people in any country" he had had occasion to visit. This, however, applied only to Douglas, the country people being "as civil and obsequious as could be wished." That Manxmen at this time suffered from a confirmed laziness and were grossly intemperate, is an opinion echoed by nearly every contemporary writer on the Island. The houses in which the majority of the people lived were of the most wretched description, being one-roomed hovels constructed of sods, the walls six or seven feet high, the one window only about a foot square, the chimney a clay-daubed barrel, and the roof rudely thatched. The clergy, though in the main they seem to have been well-educated men, were almost equally poor, the usual yearly income among them being only some fifty or sixty pounds.

Much of the interest in the following letters arises from the curious relations then existing between the Isle of Man and the countries surrounding it. As a place

somewhat difficult of access, and existing under a distinct government, it seems to have been regarded as a harbour of refuge for suspicious characters from the four points of the compass. Scotch adventurers, English defaulters, and Irish bankrupts thronged the place from year's end to year's end, and contributed an unrest to the local society which was much disliked by the more permanent residents. The state of war, in which the kingdom then existed, and the general turbulence of the times, made the Isle of Man in reality a kind of No-man's Land, a scene of periodical turmoil and constant hostility.

It must be remembered, in reading these letters, that we are dealing with a place of not much more than parochial importance, and that, as is the case to-day in small country towns of the same population, both quarrels and scandal were magnified to an absurd extent. Local society had not that wise guidance which made Manchester, Liverpool, and Norwich at the same period such notable examples of public spirit and elegant culture. The consequence was that the Manx people and their "foreign" residents concentrated most of their attention in quarrelling, and in making each other's weak points the targets for shafts of slander. The author* of the *Itinerant* describes the Manx character as unamiable, "they are unfriendly, cunning, and avaricious; yet with all this very devout in their way; before they go to sea on the most trifling excursion, you see them laid upon their oars, with their hats off, making a long prayer. To finish their character, they are deplorably ignorant, ridiculously superstitious, and believers in fairies and second sight." He continues: "The inhabitants of Mona are very backward in noticing strangers, yet this can scarcely be called a fault, when we consider the number of unprincipled refugees who fly to the island

* S. W. Ryley, the Actor, see Part I. of these *Selections*.

as a place of sanctuary. Of this description were several of the most dashing inhabitants at this period, who lived in *stille* upon the means that ought in justice to have been appropriated to their creditors." Indeed, the state of the Island, socially and otherwise, was just what might have been expected; the long wars waged against England ended in the retardation of the development of the more remote parts of the United Kingdom, and the Manx people, indolent in themselves, and deprived of that incentive to improvement which we possessed in Lancashire, seem to have drifted into a condition of apathetic poverty and vulgar self-conceit. The advantage which Lancashire possessed was, that her population, by nature energetic, found an outlet for their talents in laying the foundations of the vast cotton industry, and, in truth, footing the war-bill for the rest of England. A passage from Mr. Rolt might be added to this; "the Manxmen had a natural respect for the people of Lancashire, in which county the Earls of Derby had their usual residence, and from thence were principally supplied with their principal officers of government."

Still, the foreign element was very undesirable, and, in 1814, the Manx Legislature passed a law providing that debtors of this class, who had fled to the Island for Sanctuary, who took up their abode in the Island during and after that year, might be prosecuted for the liabilities they had incurred elsewhere. Of course this had a great effect upon the influx, and for several years there was a decline in the population. The end of the Napoleonic wars, however, threw a large number of naval and military officers out of employment, and many of these, finding the Island a cheap and tolerably pleasant abode, took up their residence there.

Very little information respecting Captain Cable him-

self remains extant. We first hear of him as one of the Burgesses of Clitheroe in 1790. Mr. Eastham, the present Town Clerk of Clitheroe, has very kindly provided me with particulars of Cable's connection with that town. He finds that in the year 1790 Samuel Cable, described as an Esquire, was admitted a burgess under a conveyance from Assheton Curzon of the free Borough Croft called Major Parrock. Then in 1791 he was elected the Out Bailiff. "This," says Mr. Eastham, "may be taken to mean that he was a supporter of the Curzons, and held a sort of faggot vote at their command. The Out Bailiff was elected from outside burgesses, and it may, therefore, be inferred that Cable did not reside in Clitheroe at all, and possibly lived in Preston, where the agent for the Curzons then resided." Following these dates there is a long gap in Cable's history, and then his name appears in a list of a meeting of the leading inhabitants of Liverpool on February 9th, 1795, so he appears to have had some connection with that town. It is possible, indeed, that Cable Street is called after some member of his family, though in that case the connection with the town must date back a long way, as Cable Street was known by that name at all events as early as 1700. On May 18th, 1795, the *Liverpool Advertiser* has the following notice: "Mr. Samuel Cable, lieutenant in the Navy, to be master and commander." I can find no account of Cable in the *Naval Chronicle*. On receipt of his promotion he repaired to Douglas, Isle of Man, where he was in charge of the Naval Station maintained there during the War. He seems to have had many friends in North Lancashire, and to have had good family connections. Unfortunately, however, he never alludes to the latter by name, so that it is well nigh impossible to trace him, as he does not appear to have borne arms. A Mr. C. P. Cable;

midshipman on board the *Orion*, was wounded at Trafalgar; it is possible he was connected with the Captain. Captain Cable was apparently a friend of Mr. John Philips, of Bank (the Colonel's father), and from this, and other evidence in the letters themselves, we should infer that he was considerably older than Colonel Leigh Philips. Captain Cable lived on the Island during the whole of the period covered by the letters (1795—1803). The last few letters record the progress of the disease which at last terminated fatally. He was married, and had one daughter, Miss Sarah Cable, a young girl some twelve years of age at the time the letters begin. Captain Cable seems to have seen some active service before going to the Island. The meeting of Liverpool citizens alluded to above is rather interesting. Towards the end of 1794, the disastrous condition of the French Army was patent to all the enemies of that country, and there was a strong movement in France in favour of peace.* The British Government, however, resolved to continue hostilities, deeming it better to seize the opportunity, and annihilate the traditional enemy. Accordingly in several places what may be termed a "Stop the War" movement was inaugurated. In Manchester, several persons petitioned the Borough-reeve and Constables, and in Liverpool others petitioned the Mayor and Corporation, to call a Town's Meeting to protest against the continuance of the War. In each case the town authorities refused. Counter-petitions were published, of a very much more influential nature, urging the continuance of the war and promising support to the Government. Among the

* A statement, published in the press at the time, of the French Army during the period Jan. 2, 1792—Jan. 1, 1795, is:—"Slain and Prisoners, 610,000; Died in Military Hospitals, 177,000; Requisition Men, did not join, 119,000; Deserted, 53,000; Remaining Force, 841,000; Total, 1,800,000."

War-party in Manchester we find John Leigh Philips, Francis Philips, Charles Lawson, the Rev. John Radcliffe, and the Rev. John Clowes ; while, in Liverpool, we find Samuel Cable, Samuel Newton (Philips' agent), James Penny (Philips' father-in-law ?), Clayton Tarleton, and many other well-known names. Messrs. Wakefield and Okell* were in favour of peace.

Although our knowledge of Cable is very meagre, yet in his own letters he gives us such a graphic picture of his life and habits, and lays bare his character so completely, that it is almost possible to say that no further details are necessary. His chief amusements appear to have been fishing, shooting and riding, varied by whist and reading. He was undoubtedly a man of very active mind and much originality, and he must have been a most interesting and entertaining friend.

The first letter is dated October 9th, 1795, and begins with some references to the visit made by Col. Philips to the Isle of Man that summer :—

Douglas, Octr 9th 1795

My dear Sir,

I rec^d your Letter yesterday by the Duke of Atholl, together with a Shrimp Net, Rose Tree and Burton. A curious Cargo. I began to be uneasy at not hearing from you sooner, as several Vessels had arrived from Liverpool in the course of the preceding Week ; but I imagine your letter was put on board Brew the day after it was wrote of course it was not likely to find its way hither untill he arrived. He came in eight hours from the N.W. Buoy. I was disappointed in finding you did not get in the Night you sail'd ; though I was rather apprehensive that the wind wou'd fail you in the Offing. However, upon the whole, you wound up the excursion very well ; and I feel much flattered that your stay in the Island proved pleasant to the whole party. If we live to put our Scheme to the Hebrides in execution I make no doubt but we shall find it equally pleasant. I assure you I look forward to it with great pleasure. You know you are to form the party ; I am to take care of the Navigation, Provisions, etc.

The Monday after you left the Island Riley again exhibited his Brooms, which produced him about seven pounds more. He pleased the People of Douglas greatly by making Gobbock rhyme to Havock, and introducing their

* *Vide* Part II.

10 FARADAY, *Correspondence of Lieut.-Col. Philips.*

other favourite, Herring. He talks of making another Sweep at Christmas, which, I hope, will prove as productive as the last. He, & his Rib, spent the evening with us the day we lost you. Indeed I know no other company that I cou'd have put up with on that day; but his knowledge of, and his respect for, you render'd him quite agreeable. He was, as usual, quite pleasant & quite unaffected.

I have not yet been able to procure such a Poney as I cou'd wish. I have seen several, but none of them answer'd: they have either been too large, or not handsome. In the course of the Winter I dare say I shall get one.

The Weather has been so very bad since the Shrimp Net arrived that we have not been able to try it; but you may be sure I shall take the earliest opportunity of doing it. Owing to the same cause (bad Weather) I have not been able to get any Rock Cod: the first I propose, if an opportunity offers, I shall send to Wakefield, whom I seem to look upon as an old friend although I never saw him in my life.

Mrs. Cable and Sarah unite with me in most friendly and sincere wishes for the health and happiness of yourself, Mrs Philips, and every branch of your family. Accept my best thanks for your kind presents, & believe me to be, with great esteem, your sincere & faithful friend

SAM CABLE

The "Riley" mentioned in this letter is S. W. Ryley,* the Actor. In his *Itinerant* Ryley describes at some length his adventures in the Isle of Man, and throws some light upon the doings of some of the people mentioned in these letters. His mother was a schoolfellow of Lady Jane Stanley, who was for many years his patroness, and who seems to have been distantly related to his wife, with whom, by the way, he eloped when she was a schoolgirl of sixteen, and married at Gretna Green. Ryley was well acquainted with Leigh Philips, and from him received many introductions to well-known people in the Isle of Man, and the appearance of whom on the quay to welcome him on his landing at Douglas in September, 1795, he records with gratitude. Ryley had a "lecture or entertainment" entitled, "New Brooms, Narrative, History, Satire, and Sentiment, occasionally interspersed with songs." It is mentioned in the letter, and the

* *Vide Itinerant*, Vol. III.

Liverpool papers of the time speak of it in terms of praise. "Gobbock" was the dog-fish, which Manx people, with somewhat singular taste, at this time preferred to any other form of food. The theatre at Douglas is said to have been a pretty little building, and was originally intended for private amusement. The proprietor was Mrs. T——n, "a charming lively widow."

The trip to the Hebrides, of which mention is made in the letter, was never made. It was the intention of Philips and his friend to take a prolonged excursion among the islands, to study the Natural History of them. Circumstances, however, prevented the execution of the proposal.

On December 23rd, Cable writes :—

Douglas.

My dear Sir,

Yours of the 23rd ult. I rec^d last week by Mr. Brew, together with the specimens of swivels etc. for which I thank you. I think, with you, that the Iron wire will be good enough to fit up a Long line and I shall be much obliged to you if you will promise me ten dozen of them. If our intended excursion takes place we shall find plenty of use for it, as well as for Nets, and other fishing gear, which Major Taubman promises to furnish. He seems very desirous to be of the party, & I think he will be a proper subject ; for he is very fond of fishing, is very civil, and plays a tolerable game at Whist. From the present appearance of things in the political horizon, I really believe that a very few months will determine whether our excursion will take place or not. I am inclined to think that we shall certainly have peace before Summer. If this is the case we may turn our broad Swords into Ploughshares, & our Small Swords into fishing hooks. Can they be applied to a better purpose do you think ?

I was yesterday favoured with the company of Mr. and Mrs. Riley ; they are going to England, as soon as the weather will permit, to buy furniture to fit up a large house at Peel in which they are to enact the parts of Landlord and Hostess. In other words they are going to open an Hotel. It is one of her wild schemes, and she is as sanguine about the success of it as if she was endowed with Prophetic knowledge. As for poor Riley he seems to be quite passive, and rather desponding. He has lived so long at Peel, without Society, that the Blue Devils have got compleat hold of him. I hope they will meet with some friends in England to persuade them off this project. I shall return your Burton by him. I assure you I have been much entertained by it. It is not a book that one cou'd sit down to read quite through, but there are such gleams of wit scatter'd up & down the work that it is impossible to avoid being pleas'd and diverted by it.

[Appended.]

Mr. Livesey was invited to dine with Col. Dawson at Strangford, where he met Ld. Henry Murray, Mr. Stuart, Capt. Cable, & Mr. Jno. Backhouse. we pass'd a very pleasant day, in the course of which a song was proposed, Capt. Cable was ask'd to sing, & I among the rest solicited him, but he declin'd, Col. Dawson & Ld. H. Murray each sung a song as an example, and then Capt. Cable began a song but did not finish it, I press'd him much to continue, & said to him in joke (as I solemnly declare I had no intention of giving him offence) now don't be conceited, but sing, or something to the same purpose.—We continued at our wine some time after, and a little before we parted, Capⁿ Cable said I had used him very ill, in which he was join'd by Mr. Backhouse, (both Capⁿ Cable & Mr Backhouse were very much in Liquor) I immediately applied to Col. Dawson (as Master of the House) Lord H. Murray, & Mr. Stuart, to know in what I cou'd have given offence to Capⁿ Cable; *they all* agreed that I had not said anything that he cou'd possibly be offended at.—some words afterwards passed between Mr Backhouse & myself during which he said as much as amounted to a challenge, which I immediately accepted; Lord H. Murray told him he had behaved very ill, & that if he expected him (Ld. H. M.) to go out with him he shou'd not; Mr Backhouse replied he did not want him, or Words to that purpose—Capⁿ Cable & Mr Backhouse left the room, in their absence, I said I was a stranger in the island, & had no one, that I cou'd ask to attend me; Col. Dawson very politely & friendly said I shou'd not want a second, for he would go out with me. Some time after Mr Backhouse return'd to the Dining Parlour, & put a Note into my hands, which I put into my Pocket without opening, & soon after took my leave of Col. D. etc. when Mr. Stuart & I return'd to Douglas.—on opening Mr. B.'s note, I found it an appointment to meet at 6. o'clock the Morn^g follow^g behind the Church; as I was uncertain which Church it was (after having settled a few affairs) I return'd to Col. Dawson's to show him the Note, & consult with him.—I then left the Coll^l to retire to rest; I awoke at half past 4 o'clock, & at 5 o'clock I call'd up Col. Dawson & ordered the Chaise to take us to the ground; we arrived there a few minutes before 6 o'clock & found Capⁿ Cable & Mr Backhouse; after the salutation of Good Morrow Col. Dawson showed Mr Backhouse the note he had given me, & ask'd him if it was his writing, & what commands he had with me, to which Mr Backhouse replied, it was.—A conversation then ensued, in which Mr Backhouse left the Business entirely to my Second Coll^l Dawson to settle, who said that whatever had happen'd, cou'd only have originated from a great deal of Wine being drank, & that we shou'd say we were sorry for what had pass'd & shake hands; to which neither Mr. Backhouse nor myself objected; Mr Backhouse said as he was the younger man he shou'd first say he was sorry, & step'd forward to shake me by the hand, I met him, we shook Hands; and here the matter ended, returning to Douglas & breakfasting together.

Signed

THOS. DAWSON

Douglas Decr 20th 1795.

Mr. John Livesey, of the well-known Blackburn family of that name, was living in Douglas at this time. He is somewhat ill-naturedly alluded to by Colonel Townley:—*

“I saw that very *extraordinary* personage Mr. John Livesey, of Blackburn, on the opposite side of the harbour, near the Douglas head coffee-house, where he resides; (& has resided for a considerable time) under the name of Warren; but I find most people *here* know his real name, as well as his real character. He gave a dinner, yesterday, to a party of gentlemen.”

There were two main factions in Isle of Man society at this time, and as the Island was a favourite subject for “book-makers,” it was the object of each side to capture one of these peripatetic critics as he arrived, and so lead him to endorse their views and actions. Speaking candidly, Colonel Townley seems to have fallen into the hands of the Philistines, at least as viewed by Captain Cable and his friends; consequently, they make extremely different estimates of the same people. It is gratifying to find that the statements of our hero, Captain Cable, have been endorsed by a subsequent and authoritative writer, who says of Townley’s *Journal* (the chronicle of the opposite faction), that it is a “trivial record of little things,” and that “it is difficult to make out why it was ever written.” The friendship between Cable and Philips and Livesey endured for many years, as will subsequently be seen. Livesey belonged to the family of Liveseys who took such a notable part in the history of calico printing in Lancashire. I learn from Abram’s *History of Blackburn* that they were a collateral branch of the Liveseys, of Livesey, a territorial family known in Lancashire in the thirteenth century, who held land by grant of Henry III. Mr. John Livesey, like his brother Thomas, began trading at Blackburn, and in 1780, founded the firm of Livesey, Hargreaves, Anstie, Smith, and Hall, and started a print works at Mosney. The

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[*Appendix.*]

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manager was Mr. Thomas Bell, a Scotchman, the original inventor and patentee of the cylinder calico printing process, the patent being dated November 17th, 1783. Mr. Livesey, therefore, whose capital was instrumental in founding this great industry in Lancashire, is entitled to the regard of posterity, the more so as his venture, in the end, turned out badly for himself. At first the Mosney firm rapidly extended their works, and for some years they did a flourishing trade, but a series of pecuniary losses shook their credit, and in 1788 they became bankrupt. John Livesey married Mary, the daughter of Samuel Clowes, of Broughton Hall, Manchester, in 1772, and had three sons and three daughters. Thomas Livesey married, first, Miss Elizabeth Livesey, of Manchester, a kinswoman, second, Miss Lydia Bancroft of the same place. His sister, Alice, married in 1763, Mr. Henry Sudell, of Blackburn.

The Mosney Works was purchased by William Assheton, of Cuerdale Hall, in 1792, and he sold it to Richard Colrow, who built his house at Walton Lodge from the bricks of the old building. The Liveseys had bleach works at Bamber Bridge and a cotton mill at Higher Walton. As a trader, it should be noted that Mr. John Livesey had benefit of even the imperfect bankruptcy law of that time, and his residence in the Isle of Man should not be attributed, as Colonel Townley said it must, to inability to pay his debts. Mr. Livesey probably lived at Douglas for the same reason that Captain Cable did—lack of sufficient means to live elsewhere. There is little doubt that the aspersions upon his character are foundationless, and viewed from this distance of time he seems an attractive and simple-minded man. It should not be forgotten that his venture at Mosney gained him many enemies, especially among the more unprogressive

part of the population, and that upon his failure the chorus of "I told you so's" was very loud. His son, Lieutenant Thomas Livesey, R.N., died of yellow fever, in the West Indies, in September, 1803.

Richard Dawson was Lieutenant Governor of the Isle of Man in 1776. His son, Colonel Thomas Dawson, of Strangford, is the gentleman alluded to in the letter.

Lord Henry Murray, the fourth son of the third Duke of Atholl, at this time lived in the Isle of Man as his brother's agent. He died when quite a young man, as Ryley says in his *Itinerant*, "a martyr to dissipation" early in 1805. He was born in 1767. In 1786 he married Elizabeth, the daughter of Mr. Richard Kent, of Liverpool, by whom he had one son and five daughters. About the time of these letters, Lord Henry Murray was Colonel of the Second Royal Manx Fencibles, who were sent to Ireland during the disturbances which culminated in Vinegar Hill. Lord Henry Murray was the acknowledged leader of Manx society, and failed to injure his popularity even by a confirmed love of practical joking.

Mr. John Backhouse was Lord Henry's brother-in-law, and his companion in the escapades he perpetrated at the expense of friend and stranger alike. Apart from this he was a kindly and well-meaning man, and like his intimate he died sooner than he should have done. Ryley's first performance at Douglas was interrupted by Mr. Backhouse in what we should consider a somewhat strongly flavoured manner.

The Mr. Stuart mentioned is in all probability Captain Robert Stuart of the Second Royal Manks Fencibles.

The next letter is dated February 2nd, 1796:—

It has been entirely owing to the late very heavy Gales of Wind, which has greatly interrupted the correspondence of this Island, that I have not before this acknowledged the receipt of your Letter which accompanied the

Swivells for fishing. Give me leave to thank you once for all for the Cheese, fishing Tackle, and the rest of your very friendly remembrances Sarah likewise begs I will return her best thanks to Mrs. Philips for a very elegant little Memorandum Book which she says she shall always set a high value on.

I shall send this to Liverpool by Brew, who will sail the first fair wind, and I shall send you Burton by the same conveyance, directed to the care of your Agent, Sam. Newton who, I dare say, will take care to forward it to you. I wish I cou'd accompany it myself: but I fancy it wou'd not be right nor fitting for us to have everything we wish for, so I will endeavour to be a little bit of a Philosopher.

Whitehurst has entirely lost my good opinion. For some time back he has evinced a disposition not at all consistent with my Ideas of a true Clerical Character, but of late there has happen'd a circumstance which has proved him to possess the most vindictive temper. A poor wretch of a Parson happened to say something about W. being a Republican, which according to the rule of Tittle Tattle was brought round to him. Our friend, thinking that this might possibly prevent his being invited to some houses, employed a Manx Lawyer to threaten him with a prosecution for Scandal, & talked of carrying it into the Consistory Court at York which, as most other Religious Courts do, abounds in terrible consequences to any unfortunate Wight who happens to fall into their Clutches. This language, together with a most ferocious deportment, and the words Base, Villianous, Malicious, Infamous, &c, &c, &c, so terrified the poor wretch that, under the impression of terror, he was induced to sign a most ample recantation of his Errors, drawn up by Mr. W. on the spot, acknowledging himself Base, False, & Malicious. This paper has, according to the true spirit of forgiveness which the Ministers of the Gospel preach, been most industriously circulated by his Rev'd Brother; and I am glad to find that it has the effect which it deserves. People begin to enquire who Mr. W. is? What brought him here? and a number of other awkward questions, which nobody can answer except W. himself, who does not seem inclin'd to satisfy their enquiries.

As to Æneas Anderson I have seen him often, & have been in his company once. He is a very poor creature. Take my word for it he never wrote the Book in question. He is not capable. Perhaps he may have furnished the Matter, which has been worked up into its present appearance by some able Book-wright, a trade which flourishes greatly in London. This aforesaid Æneas has lately cut a conspicuous figure in the annals of Manx Scandal.

I am sorry to add, by way of Postscript, that the Nunnery Mill was entirely destroyed by fire in one Night between last Thursday and Friday. It is not known how it happen'd, but, because Blundell was insured about £2000 some people, very charitably, suppose that it must have been done by design, although there is not the least probability of its being more than half the value.

In another part of the letter there is a long story that Æneas Anderson had sold his wife for £50 to Cæsar Tobin. This was a *canard* circulated by Lord Henry Murray, and it seems strange that it should have been believed, and that the victim should not have been liked by Captain Cable. Æneas Anderson, to whom Cable alludes as the Chinese Traveller, belonged to a well-known Manx family, and may be considered a clever and experienced man. In the years 1792-4, he accompanied Earl Macartney, British Ambassador to China, and published a most interesting account of the Embassy, which, it may be noted, went to Peking by way of the Pacific, and returned round the Cape of Good Hope, so that they completed the circuit of the globe. Anderson afterwards served under Sir Ralph Abercromby in the Mediterranean, at which time he was a lieutenant in the 40th Regiment. In 1802 he published an excellent "Journal of the Forces in Egypt under Sir Ralph Abercromby." Mr. Anderson afterwards resided in London, where it is to be hoped he found more congenial society. Cæsar Tobin and Lord Henry Murray were respectively Captain and Colonel in the same Manx Regiment in which Anderson, at the date of these letters, also had a commission. The whole story, therefore, favours the idea of a messroom jest. It is sufficiently interesting as showing the boisterous mood of the period. The belief that the sale of a wife is a valid contract survives even to this day in certain remote quarters of the North of England, though, of course, there has never been any justification for the idea.

On March 13th, Cable writes :—

After a number of fruitless enquiries I have at last met with a little Poney, which I think will suit my friend John : and as Brew means to sail this day I shall put it on board his vessel, and consign it to the care of Mr

Wakefield. It is a small Bay Mare, three years old next May, with a full Tail and Mane, & I believe (for I have not measured her) that she is ten hands in height. In short it is such a one as I have never before seen on this Island, and I flatter myself she will please both my young friend and his father.

As there is at Present no signs of Peace I had almost given up all hopes of seeing you this year, but your last letter has renewed them again; and I have, in consequence of it, enlarged my Boat considerably. I have added six feet to her keel & rais'd her near a foot, so that she is now a compleat four-oared Boat, & has good accommodation for five or six people. If the same party who accompanied you last year should repeat their visit this summer I flatter myself that I shall be able to make their Water Parties much pleasanter than I cou'd do before. If you come I must beg you will give me a little previous notice that I may have time to look out for Lodgings for you, in order to prevent your being turn'd out of doors as you was before. I have frequently indulged Twentyman by telling him how much money you paid Clague; and, in order to please him more, nearly doubled the sum. He always seems devilish sore to think that he suffered so much to go by him; &, by way of excuse, he says it was a mistake. That he expected the Man in Black and his party wou'd have spent more money than you & your party cou'd do; and I really believe was you to try him again he wou'd take you in.

“Friend John” was, of course, Colonel Leigh Philips' son, afterwards Lieut. John Philips. R.N. Messrs. Clague and Twentyman were Manx houseowners, who were in the habit of letting their premises to visitors.

On July 3rd, Cable writes:—

I own I ought to be ashamed for not writing long e'er this, to thank you for the books that you was so good as to send me; and likewise for the attention that you showed to Mr Farrill, my Midshipman, who call'd upon you sometime since at Manchester. He is a very worthy fellow, and I shou'd most certainly have given him a Letter of introduction to you had I known of his intention, to visit your town, sooner. He is now in England again, and perhaps may again call upon you; and you possibly may think it strange that you have never heard his name mention'd by me. I know but little of his History; what I do know has given me good impressions in his favour, & his behaviour in the station which he holds under my command has ever been perfectly correct. So much for Farrill.

Do you know that I have a very great longing to see you again in Manxland? I am become a very great Fisherman. Five or six days in the Week I am upon the Water. My Boat turns out to be a fine sea boat and my men are very fond of her, because they catch an amazing quantity of Fish

in her. For this Month past Skate has been the order of the day. We have caught from twenty to thirty each day on the long line; besides Cod, Whiting, Pollock, and other Fish. The Whiting here are far superior to any that I have met with elsewhere. I have had several that weighed upwards of four pounds each and one that was near five pounds: and as these fish bite extremely free, the sport, of course, has been excellent. If you can possibly break loose, do let me see you this summer. I had hopes of seeing you in England before this time. A very excellent friend of mine had applied to Lord Spencer, in my behalf, for promotion; and his Lordship had promised him that I should have a Ship and another step; but the business is now over, and I am like to stay here during the War; so, if we are to meet, you must come & see me, for I cannot leave my Station.

For the last three months we have been greatly alive in Mona. The Duke and Duchess of Atholl & family have been here since the beginning of April: the consequence has been that we have danced like Devils, & drank like Fish; Not to mention that we have been cramming ourselves with eating, Noon & Night. I am heartily tired with the business, and am glad to hear that they take their departure from hence in about a fortnight.

The second Earl Spencer, on his return from his embassy to Vienna in 1794, was made First Lord of the Admiralty, an office he held for six years, in some respects the most remarkable period in our Naval history. At this time all promotion in the Navy was based upon influence at headquarters, hence Cable's anxiety to get a word or two privately into his Lordship's ear.

Apparently Philips was unable to accept his friend's invitation, as will be gathered from the next letter:—

Douglas, Sept^r 18th, 1796.

I rec^d Mrs Philips' kind present of Fruit by Brew. Except being rather too long on their Passage they arrived in good order: the Melons, only, had suffered damage; and from what I could judge of them, even in that state, the Crimean Melon promises to be a valuable acquisition in Gardening. The Seeds were very fine, and I gave them to the Major's gardener who seemed extremely well pleased with them. They were enough to plant an Acre of Ground, of Course he will not want any more this Season.

I hope you will have no great occasion to regret the loss of the *Sisymbrium Monanz*, for I think I have got you an entire Plant, Root, Leaves, Seeds, & Flowers. I will send it by the first opportunity. By the bye, Farrill is going to England soon, and as he talks of seeing Manchester I believe I shall send it by him. He seems extremely anxious to get forward in the World, & wants to borrow money upon his annuity. I have lent him

Thirty Pounds on his own Note, which even if I lose I shall not care much about, but I have no Idea of advancing him more. It is very probable that he may consult you on the subject, but I beg you will not let your friendship for me induce you to do anything in the business. I do not know him sufficiently to rely on him; nor do I know how he has contrived to get rid of his fortune, which, I am told, was once very ample. All I know of him is that has behaved very well in his present situation, and that his manners are those of a Gentleman; but as I have never had occasion to try his bottom I do not know whether it is good or bad.

Mrs Cable & Sarah have been in the Country about ten days. I got them comfortable accommodations at Banks, with whom I am become very well acquainted. You have seen him, and must remember him to be a great oddity. Mrs C. continues extremely ill. I shall be much obliged to you if you will consult Ferriar in the Case, and give him a guinea if you think it enough. Be so good as to let me hear from you as soon as possible.

The *Sisymbrium Monanx* is, Mr. Charles Bailey tells me, the *Brassica Monencis*, or "Isle of Man Cabbage." It is now fairly common on the West Coast of Lancashire.

On October 7th, 1796, Cable writes:—

Your letters and kind presents have all arriv'd safe, except the Turtle, which stunk abominably. I sent it, by way of a *Genteel Present* to Major Taubman, the instant I got it on shore, without examining it, and the moment it was open'd they were obliged to throw it to the Dung-Hill. Green Fat and all. I hope you will not attempt, in future to send any perishable commodities to this Place. The Passage, you know, is very uncertain; and the close hold of a Vessel has a great tendency to bring on putrefaction. I shall, however, be much obliged to you if you will execute, or cause to be executed, for me a small commission; which is to send me a piece of Handkerchiefs, of the Pullicat kind, for the Pockett, tolerably coarse—a Bottle of James' Powder, and if you can spare me a piece of printed Callicoe for a Camp bed it will add to the obligation. The price about from 2/- to 2/4^d. Sarah wishes it may have Men & Women on it. The Colour either Blue & White, or Purple & White, whichever is the most likely to Wash best.

The suggested design for the calico was a very familiar one in times past.

On November 11th, Cable writes:—

The Conjuror arrived in due time, and his abilities were tried the day he arrived. He performs to a miracle. I hope to give you various specimens of his talents the next Summer; for I take it for granted you will repeat your visit to Mona, & that you will come in force. Indeed, unless you come in Person you are not likely to get the small plant from Douglas head. There is such a multiplicity of these small leaved plants that I cannot

distinguish one from another. The *Sisymbrium Monanx* was of a different description and I could not well mistake it.

The Flying Squirrel is perfectly alive, & a very great favourite with Sarah & the rest of us. She & I amuse ourselves most evenings with a Squirrel hunt which the little Animal seems to enjoy much, although he does not *wag his little Tail*.

The *Conjuror* is a reference to a box of chemical and physical apparatus which Colonel Philips had sent to Cable, who was very fond of such scientific recreations.

The next letter is dated December 4th :—

Since I wrote to you last I have rec^d seven silk pocket handkerchiefs together with some strawberry plants for Major Taubman, and a most glorious Cheese for Messrs. Arthur Brew and Co., which has been divided among them to their entire satisfaction and astonishment. Poor Arthur was almost overcome with gratitude. Lewthwaite “grinned horribly a gastly smile.” Corlett seem’d ready to guillotine anyone who seemed inclin’d to ravish the prize from him ; and Cantanhasons himself was much moved. In short they all entered into a Covenant to fish for you, and with you, as often as you desired. You know a Manx Man has not a single Idea void of Fish ; and of all Fish, Herring & Gobbock seem to have occupied most of their minds, so you may be assured they wish you plenty of both.

We have had some very capital quarrelling lately between Mr Whaley’s Vassall, and mine Ancient. It shou’d have terminated in a Duel, but Whaley & his slave made so much Noise about it, that Fleming was put under an arrest ; and I gave him orders not to leave the Island ; which by the bye, I do not believe he meant to do ; after which, the other party, very consistently, posted him for a Coward and a Scoundrel. In short it has been a true Irish business from first to last. An heap of Blunders, Noise, and inconstence. Fleming has since published a state of facts between himself & Vassall. This is done in somewhat better a manner, it having been revised by a person of the name of Carr, whom you saw here under the name of Cooper. Besides this business there has been one or two bye battles. Midford versus the Bishop : & Midford & Whitehurst versus the same. An Anonymous Letter has been written to the Archbishop of York against our Right Reverend, & Midford & Whitehurst are grievously suspected to be the Authors. Lastly there has been a Copy of Verses handed about accusing Speed of Atheism ; and Livesey of Gluttony. If I can procure a Copy of them I will send them to you. You will find by the above that this Island is not entirely a scene of still life. Indeed it is far from being so. We have had a large importation of strangers since you left us, & they have introduced dissipation, & whatever else has a tendency to make the place unpleasant. As for my part I am only an indifferent Spectator ; and I have hitherto kept myself clear of their Society. I sometimes, though not often, see the [*Major*]. He is by far the

best acquaintance I have. He is obliged to you for the Plants, & hopes to treat you with some of the fruit at some future period, I hope next Summer. The James's powder and Callicoe are not yet arrived.

The Powder which your brother sent is most excellent. Pray to tell him that I am greatly obliged to him for it. It has kept my larder constantly furnished with Game. I have likewise enlarged my establishment by the addition of 12 Lobster pots, which perform to a miracle.

Messrs. Arthur Brew, Lewthwaite, and Cantanhasons were connected with the Naval Service, and were serving under Captain Cable. Mr. Whaley, an Irishman, was a neighbouring landowner. Fleming seems to have been a kind of mixture—half clerk, half boatswain. Mr. Carr was, apparently, a schoolmaster at Peel, a “tall spare figure, dressed in a rusty black coat, and a woollen night-cap.” Ryley, whose own favourite study at Peel was “Zimmerman on Solitude,” further says that Carr was one of the most profound moralists and philosophers of the day. Carr used to instruct all the children in the neighbourhood for nothing, though his house is said to have been little better than a pigsty. Mr. Carr's strong denial of the Athanasian Creed struck the Manxmen dumb with alarm, and till the day of his death they expected to see him carried off bodily by the powers of darkness. He was a vegetarian, at that time a great rarity, and among other accomplishments had considerable medical skill, wherewith he doctored the country people for nothing. The identity of this worthy with Philips' acquaintance is not clearly established, but for many reasons it is very probable. The Bishop at this time was Dr. Claudius Crigan, appointed in 1784.

On January 7th, 1797, Cable writes an extremely pressing invitation, and continues :—

We have been very busy here, for this Week past, in putting on our fighting face. I am entrusted with the direction of the Batteries, and have got the old Fort, and the two guns in it, quite serviceable. I have likewise constructed a pretty little Battery of two 18 pounders just beyond Whaley's

Garden. If I had but a Corporal Trim I could almost fancy myself an Uncle Toby. As it is I must content myself with an *Arthur* and a *Luther*.

“Luther” is Martin Luther, a man attached to Captain Cable’s establishment. The next letter explains the purpose of the batteries :—

Douglas, March 9th, 1797.

My dear Sir,

Yours of the 14th Ult. found its way hither on the 28th. Pretty quick travelling, you will say : but as it had remain’d a week or more in Liverpool it may, in some measure, be accounted for.

From the repeated visits of the French in this Neighbourhood I am not surprised at your account of the Arming, or armament, which appears in the Manufacturing parts of the Kingdom. Indeed it behoves every Man. at this time, to set his hand to the Plough ; or rather to change his Ploughshare into a Sword. From the knowledge which you have of the Apathy of Manx Men you will not expect great things from us. For my own part I expect nothing. To be sure I am not greatly apprehensive of a visit from the Goths & Vandals ; but shou’d such an event take place, I think our only defence wou’d be our long eighteen pounders, of which we have now six ready for use ; although I must confess there is one thing which prevents me from having any great reliance on them. The reason is trifling, to be sure ; but it is a reason. We have little or no powder here : and I have never heard that even a long eighteen pounder cou’d do any great damage without powder. It is true we have shot enough, & wads, but still a long eighteen pounder, even with the help of shot & wads, cannot do what it ought to do, without powder. However, as this is a Land of Genius’s, some of them, perhaps, may strike out something new in that way, and shew us that Powder is absolutely needless. Great things, you know, have been found out by Great Genius’s. I own my greatest reliance is in our own insignificance, & the situation of this Island ; I mean its Geographical situation which seems to be in the very bosom of the British Empire. You will give me credit, I daresay, when I tell you we have been sufficiently alarmed already.

I have been in rather an awkward situation since I wrote to you last. The business is this. Somebody had written a letter in Joe Bacon’s name, desiring to be employed ; an answer was rec^d from the Secretary to the Duke of York saying that his request shou’d be complied with. Bacon, knowing that he had not written himself, was, of course, very angry, and wrote to Colonel Browning stating the forgery, and requesting to have the Letter sent to him, which was done, & being shewn to everyone who wish’d to see it, was among others, seen by Livesey, who produced a Letter of mine which bore a strong resemblance to the one in question. This, you may think, rais’d a loud Clamour against me, though I am sure you will acquit me of any such imperitine. This clamour continued until it was superseded by matters of as great consequence. But enough of this.

Pray do you know, or have you heard, of a Person of the name of Limburgh? My reason for asking is this: A Woman came to Farril's house last Night who says her name is L. that she & her husband liv'd a little while since in, or near, Manchester, & that they have been unfortunate. She showed a letter to Farril's Wife (for Farril himself has been in England 7 or 8 weeks, God knows what about) directing her to come to Mr. Farril in the Isle of Man, & there wait the arrival of her Husband. This appears so very mysterious that Mrs. F. does not know What to do, having never heard her husband mention any person of the name. In short, she is at a loss how to act, her husband not having written to her these three weeks. If he shou'd chance to call upon you, pray endeavour to come at the bottom of it.

Mrs. Cable & Sarah unite with me in every friendly wish for yourself, Mrs. Philips, Mrs. Potter (who we heartily wish may meet with pleasure in her London excursion) and every other part of your family to whom we are known. I am, my dear Sir, ever yours

SAM. CABLE.

I have hardly room left to acquaint you with the Melancholy account of the Death of our poor little Squirrel, which set out on a visit to its father about six weeks since. Sarah did not quite loose her senses on this occasion, although she was very near it.

What do you think of Sir John Jervis's affairs; Is he not a noble fellow? We were terribly alarmed last night by two of our Frigates, & a Sloop, which were off the Calf and Castletown. We all put on our fierce looks, but as the night was very cold it is not to be wonder'd at that some of the terrible ones shou'd shake a little. As for my own part, I have been confin'd this fortnight, I contented myself with giving orders from my Fire-side like a great commander. Adieu.

The last attack made by the French upon the Island had been in the year 1755.

Banks's, May 12th, 1797.

After being detained eight days at Liverpool by contrary winds, and two whole days and nights on my passage, I arrived here on Monday morning, much fatigued both in body & mind. In Mind I say: for I cou'd not divest myself of the Idea of falling in with some of those Privateers which infest this Channel, One of which had taken, only two days before we left Liverpool, a Smack belonging to Peel on her Passage from Ireland to that place: and as our tract lay nearly across the place where the Privateer was left, there was, at least, a possibility of our sharing the same fate. For you know very well that the Nelly and Betty falls somewhat short of a line of Battle Ship in her appointments; and she is not quite so fleet as Achilles in her going. Added to which, I was off my Station without leave, and had I been taken I do not know what the consequences might have been. These Ideas, added to my bodily Infirmity, had a prodigious effect on my whole frame, and I wou'd not again undergo what I suffered during those two day

for more than I dare mention. I am happy to say that I found my two dear friends here as well as I could wish. To say, barely, that we were all glad to meet each other, wou'd very poorly express what we felt. The meeting was such as might naturally be expected between People who Love each other as we do. I believe we shall, neither of us, wish to leave the Island again until we can all do so together. . . . The truly friendly attention I received from you both while I was under your Roof will be ever remember'd by me with the greatest pleasure and the warmest gratitude.

From the above we gather that Captain Cable had made a stolen visit to his friends at Mayfield, and that he returned to the Island by the "Nelly and Betty," a cargo boat plying between Liverpool and Douglas, under the command of Captain Quayle. During the summer Cable was in the habit of leaving his house in Douglas and retiring into the country, a fact which accounts for the change of address. The next letter is a spirited account of various trivialities:—

Balla-na-How, June 9th 1797.

I hasten to mention a business which we all have much at heart: I mean your Visit, this Summer, to Mona. The Town of Douglas is so full of Irish, & other Strangers that I believe there is scarce a Bed to be procured there. However I have made a sort of Conditional agreement with your old Landlord, Twentyman, who now lives at the Hague: he has three decent Bedrooms and a pretty Parlour, together with tolerable Garretts for Servants. He asks a guinea a week for these, & will either find you in Provisions, or you may find yourselves as you like best. He says the Cook which he has at present is not so good a one as he cou'd wish; but in every other respect he will accommodate you on the same terms he did last year. Now as you do not want to come from home to see the beauties of Douglas; and as the Hague has the advantage of good air, is in the neighbourhood of the Sea, and not more than three hundred yards from this said place of Balla-na-How (is it not a most unchristian-like, beastly name?) I say for all these good reasons you will be infinitely better accommodated there, and much more in your own way, than you cou'd possibly be in Douglas. Besides, my Boat, the famous Mona of Douglas, comes up to Banks's Harbour every morning, and Messrs. Arthur, Luther & Co. will be happy to lend you all the services in their power to make a few weeks pass away agreeably. I have promised Twentyman to give him an answer as soon as possible, and in the meantime have agreed to pay him a Guinea for waiting until I have your Letter, as there are people continually coming here and, of course, wanting Lodgings. You will, therefore let me hear from you by return of Post. And if you shou'd agree to come soon, which, by the bye, I wou'd recommend, John Brew is now

in Liverpool and will waft you over, as you very well know, in the best stile. As for the French Privateer that took the Peel Smack, I find she was never within a hundred miles of this place. It was off Youghall bay, which is only about thirty miles to the northward of Cork. And in order to avoid the impossibility of any inconvenience on that head you may easily procure a Passport from Mr. Massey, certifying that you are a Citizen of America. But you may be assured that there has never been an enemy's vessel within a hundred miles of this place during the War.

Sporting Intelligence.

I hooked a monster of a Red Cod the day before yesterday, & after a very severe battle my hook broke. N.B. it was one of the largest of those you gave me at Manchester. Mem, Gymp is an excellent Snood.

The Hague is in Oncan parish, a mile or two north of Douglas, on the shore. Feltham mentions a Mr. James Bancks living at Houstrake, which is close by. A Captain Cook, who is mentioned also by the Duke of Rutland, would seem to have been living at the Hague at this time.

Colonel Philips accepted this invitation, and took his family for a stay of some weeks at the Island, as we see by the next letter :—

Balla-na-How, Augst. 19th, 1797.

My dear Sir,

The Surrey arrived here last Monday, and brought me abundance of things from you, none of them more valuable than your Letter which gave me an account of your safe arrival at Liverpool. I rejoyce, most sincerely, my dear friend, to find that your excursion has terminated so favourably; especially as I have, myself, experienced so many bad passages: and, I hope, both yourself, Mrs. Philips, and the Children, have laid in a sufficient store of health to carry you through the Winter. By this time, I suppose, you are comfortably fix'd in your own habitation; and I flatter myself that you sometimes think of your friends in Mona. I am sure you have none in any other part of the World who are more sincerely so, or who are more interested in your welfare. Indeed, since you left us I feel as if I had lost a principal Limb; and a Loss of that sort, you know, is not easily supplied. In this place, I need not say, there is no substitute. The Grapes you sent were excellent. I wish I had anything to send Wakefield in return; but, unluckily, even the Herrings seem to have forsaken us, there not having been even one tolerable Night this Season; and, at present, the best Fishers say there is no Sign. If they (that is the Herrings) do not pay us another visit, you know, we must, of course, be all ruin'd. The Congers, however, are on this Coast in force. I took one, on the Long line, the day before yesterday, that weighed thirty two pounds; and upwards of a dozen others of a smaller

size. It is the only time I could get bait since you left the Island. The Congers were, in general, Duplicates; all the large ones having swallowed one of a less size. So much for Fishing.

I want to know a great number of things. Is your Sister Potter married! And, if she is, are they gone to Arley? Is Bessy more kind to G. L.? Is Rattcliffe got fix'd at Oxford? And do you think that the Election for a Secretary to the Infirmary will terminate according to your wishes? I must own I was pleas'd with the respect the Trustees paid you, in adjourning the Board. It was a proper compliment, but it will subject you to some inconvenience. But you know how to manage these matters as well as most folks; and, I trust, you will see your way through.

Mrs. Cable and Sarah unite with me in every kind, every friendly wish for the health & happiness of you all. That we may, at some future period, be settled somewhere in your Neighbourhood is the sincere wish of my heart. Adieu. Believe me most truly your friend

S. CABLE.

I forgot to say that the Money, Basketts etc, arrived safe and that I drew upon you in favour of 20 Man for 50 Guineas the day after you left us. Do let me hear from you soon.

Colonel Leigh Philips' connection with the Manchester Infirmary was fully explained in Part I. of these "Selections." "Bessy," alluded to in the letter, was his younger sister Elizabeth, who in 1798 married her cousin, the Rev. George Leigh, A.M.

There are a number of letters from Mr. John Radcliffe, of Brasenose College, Oxford, preserved with Philips' other correspondence. From these it appears he was on very intimate terms with Cable, and thought highly of him. From a letter from Radcliffe to Philips, dated July 26th, we gather that he had been spending the summer at Douglas in 1797. The following letter, dated Aug. 24th, 1797, tells of some characteristics of the Manx population:—

Last Monday being the finest day we have had this Season, and Banks not having above six Acres of Hay cut, thought he cou'd not do better than *go upon the Fish*, he being, as he told me, *as tired as a Dog with staying on shore*; he accordingly went out in the *Cat*. His sons being, I suppose, as tired as their father with doing nothing, and having nothing at all to do with the Hay, very properly took to the Mountains, the natural situation of Savages, and in the Evening return'd with four brace and a half of Moor Game, three

brace of which I got from them, and Mrs. Cable & Sarah have contriv'd to stuff them into two Pots along with Spices, Butter &c &c. Yesterday Lewthwaite had a whole day of Shooting. He brought home two Brace of Golden Plover, a Partridge, a Snipe, & a fine Rail. These I wou'd have ventured in their feathers along with the Moor Game but the Wind is come to the Southward this morning, and I am afraid Quayle will have a long Passage. However, upon second thoughts, I will send a Brace of Plover and the Land-Rail; these, if pack'd in Straw, cannot harm the Moor and their feathers may be of use in fishing.

And now to return to friend Banks's day's work. He return'd in the Evening, with a small Rock-Cod which I gave him sixpence for, and a few Bollans; these were the joint produce of himself & one of his best Haymakers. He is, indeed, a choice fellow. I asked him the other day what he was going to do that day? "Indeed, says he, "there is no day lost here." If they are not lost I wonder what the devil he does with them. I fancy your friend Wakefield wou'd think his days lost were he to spend them like my Landlord.

The next letter (dated Sept. 11th) refers to the death of Wright, the painter, of Derby:—

The weather has been miserable ever since you left us. No Fish on the Coast, but most enormous long faces on shore. We certainly shall all be ruin'd, but that, you'll say, is a trifle, for if the whole Island was sunk it would be so much clear gain to England.

With regard to Banks, I must inform you that he finish'd his Hay Harvest last Saturday; having begun it three Weeks before you left the Hague. He told me, the other day, "Indeed everything is trouble." He meant about a farm; for he certainly delights to go *upon the Crab, and the Cod.*

Alas! poor Wright! I have just been reading in Gore's Liverpool paper, the account of his death, drawn up, I believe, by you. I can say all impartial people will think the account perfectly fair. That he was the first of English Painters I most sincerely believe. Apropos! did not you say you wou'd send a print of his Dead Soldier to Taubman? You cou'd not send him a handsomer, or more proper, present.

I have always suspected that I was not cut out for a conjuror. In my last essays I have had very bad luck. I have spoiled a whole Well of water opposite our door with that damn'd vile liquid Phosphorous; and almost blinded myself with those rascally *Prince Ruperts Drops*, and what is worse I have frightened Nobody but myself.

The Herring is, of course, in most minds, inevitably associated with the Isle of Man, and even so long ago as the end of the last century, was a favourite subject for jesting; the Manx, however, found in the fishery the

source of their greatest profit, and they treated it with a solemnity quite as laughable as the jeers of their foreign visitors.

The next letter is very quaint and gossipy :—

Douglas, Octr. 13th, 1797.

We have had a very bad Herring fishing indeed. Not a Fish cured for sale in the whole Island : but Gobbock have been, and still continue to be, in great force. Some of them are from six to seven feet long. They play the very Devil with the Herring Nets, generally making three very large holes, each of them.

I have recd all your favours, the Lines included : they appear to be very good ; but the Weather has been so cold, and the Fish so very scarce, that I have not yet wetted them. My present amusement is riding. I have bought a very ugly, black, Irish Horse, with a bald Face. He carries me my pace (which is a Walk) very well, and, as he does not appear to have any of his countrymen's bad Tricks, I believe we shall agree very well.

I have spoken to 20 about some Potatoes. He offers to lay them at Liverpool at 2/2^d a Bushel of 90 pounds weight. I told him it was too dear, but as I promised to write to you on the Subject, I could not avoid mentioning it. I will make further inquiries, and let you know if I hear anything worth your notice. At present it is too early to dig them for winter store, so that there will be time enough to make enquiries.

The person that 20 wrote to you about has, at length, made his appearance. He brought a Note from our friend G. Hulme, who I shall be extremely happy to oblige by showing Mr. Gatliff what little attentions I can. It seems he has brought his wife along with him. Her I have not yet seen. He appears to be rather eccentric. I wish you wou'd take the trouble of letting me know something about him. I dare say that Mr. Hulme would not have given him an introduction without knowing him ; but as he does not say a word about a wife I don't know what to make of it ; especially as we have such a number of ripples and scamps here. This is only to yourself.

Mons^r Huquier has been making duplicates of myself, Mrs Cable, & Sarah. He intends being in Manchester e'er long, & will, I dare say, give you an early call. He appears to be an intelligent, facetious, old man. He has been very happy in his likenessess of Mrs. C. & Sarah ; and they say of me also. They wou'd not sit without I wou'd, & so they have persuaded me to be a fool once more.

I shou'd have told you that I have broke up my Summer camp and am now in my Cottage in Town. We have been removed something more than a Week. You, I suppose, are taking the wiser measure of leaving the Town for the Country. I wish you every enjoyment in your new purchase. I only wish it had been somewhere in this Island. I wou'd most certainly have been your Neighbour. Here is a nice estate upon sale at present. I believe

about 500 acres, it is called Balla-Fletcher. Kirk-Braddon is almost in the centre of it. It is to be sold either altogether or separately. I am told the whole has been offer'd for six thousand pounds. Unfortunately, like all other estates in this Island, there is no house on it.

* * * * *

Heath's Engraving is arrived safe. The Major is very much obliged and I am the same. *Wright's Dead Soldier is Alive.*

"Mr. Gatliff" is the renowned Parson John Gatliffe, of the Collegiate Church, Manchester. Mrs. Linnæus Banks says he was "a fine man, a polished gentleman, an eloquent preacher, but a *bon vivant* of whom many odd stories are told." He was appointed a Fellow of the Collegiate Church, March 13th, 1798, in place of Dr. Maurice Griffiths, D.D., the rector of St. Mary's, and rural dean, who died on February 25th.

Jacques Gabriel Huquier, the son of Gabriel Huquier, was born in Paris, in 1725, and received his art education in his father's studio. He afterwards came to England, and exhibited several times in the Royal Academy during the years 1771-86. He took portraits in crayons, and engraved large numbers of plates, some of them in conjunction with his father. He lived in London and Cambridge, and died at Shrewsbury in 1805.

On November 3rd, Cable writes:—

I shall send along some seeds of the *Ornithopus* & some Roots of that bold Purple flower which grew in my Garden, I don't know its name, but it is something like a Fox glove. You must find out yourself what it is good for.

Yesterday I was honor'd with my quondam Landlord's Company at Dinner who, I thank God, had not lost his appetite, for I really believe he eat more than all my Family could eat in a Week, but he seems to differ in some respects from most other Savages for he is by no means so fond of Liquor as he is of meat. The Beef, the Fish, the Pudding, & the Tater seem to be more to his taste, and I think he had them all upon his plate at once. I told him that I had lately heard from you, & that you desired to be remembered to him. "He is welcome," was his answer. He is indeed a most curious Savage, and if you had him in Manchester I think you might make money of him. I am sure none of your Neighbours ever saw such a one.

Mons. Huquier leaves this place to-morrow morning in the Duke of Atholl. He has taken three extreme good likenesses of Self & Co which were very near visiting Manchester, he not having any frames here; but I talked of non payment until Delivery of Goods, so he contriv'd to procure Frames & Glasses. By the Bye, he turns out upon acquaintance to be a mere Frenchman. He is very forward; and, I think, sometimes very rude. You will do well to keep him at Arm's length for he will intrude if you will let him.

I am glad to find things stand so well at Arley. Indeed I never doubted but the Church wou'd gain a complete victory over the Presbyterians. To be sure our friend, George, is quite another sort of a Subject to what Mrs. H. has been used to. He has bottom. Potter was rather washy. I am heartily glad she has escaped the whole tribe. If we live to see the end of the War, we must certainly contrive to pay them a visit. I think it may be as amusing as our long talked of voyage to the Hebrides; and as there is a Canal so near Arley we may possibly contrive to make our journey by Water.

I have not seen Mr. Gatliff since I wrote to you; he has taken Lodgings at Castletown, & has not been in Douglas since. I fancy retirement is his plan; if so he may live as retired as he please there.

You have never once mentioned whether Mr. Jervis has been with you. If he came I dare say you amused him much, either by a Tour of the Gardens, or by some other means. I was much diverted by the papers making Lord St. Vincent an Irishman, when all the world knows he was born in Staffordshire.

* * * * *

Huquier has certainly very Vagabond principles.

I wonder whether little Natty was born when Wright painted his Dead Soldier. The Child is extremely like him.

Mr. J. Jervis, of Darlaston, Staffordshire, was an old friend of Colonel Leigh Philips; they had probably become acquainted through the fact that the latter was himself a member of an old Staffordshire family. There are two letters from him in the present collection, the first of which, dated February 18th, 1783, is chiefly concerned with matters relating to the writer's garden. The other, dated May 23rd, 1785, relates to the subject of fruit culture.

The next letter is dated December 10th.

Yours of the 14 Ult^{mo} arrived here in about 17 days after it was wrote; and it was a great chance whether it ever arrived or not; for our worthy friend, John Brew, had very nearly gone to *Davy's Locker*. He was out two days

in the very worst weather we have had this Winter, and at last was driven on Shore in Derby Haven. Luckily his Vessel was a stout one & no lives were lost, and very little damage done the Duke. Farril was in her at the time, and arrived two days after I had got my orders to strike my Flag, & shut up my Rendezvous; so he found himself out of Pay, after a very long absence from home. I fancy it is very low water with him. How we shall manage about our Money, I can't tell, but fear it will be long before he can make it convenient to pay.

In my last I told you I was in Treaty for the purchase of a House: luckily I miss'd buying; for as I am now quite out of employ, I possibly shou'd not have liked my bargain. I offer'd 350. The High Bailiff ask'd me 500 guineas. The price was exorbitant. My offer was something more than it is worth. Since then, Taubman has offer'd me a little estate of his, about a mile from Town; and has promised to build a decent House upon it. If he is sincere I perhaps may take it: but I cannot depend upon him. How many times do you think we have been invited to his house since you left the Island? not once. Upon our coming to town we took a very early opportunity of calling upon him, and inviting the Family to dine. They came and appear'd very cheerful, but we were never invited again from that time to this. What a fine specimen of the Major's sincere Friendship!

As I have the house I at present live in until May next I shall not be in a hurry to come to any determination. It certainly will require much deliberation, and I shall not, in haste, resolve to come to England. Mr. Pitt has quite alarmed me with his budget.

It was in Pitt's Budget of 1797, that the famous Triple Assessment was introduced. On Dec. 16th Cable writes:—

I tell you, as a piece of News, that I have sold my Horse. I gave twelve Guineas for him, have kept him about a quarter of a year, rode him about twelve or fourteen times, & have sold him for ten, not guineas, but ten gallons of Rum, three gallons of Whiskey, and four dozen of White Wine. Have not I done well? My Infantry being discharged it would have been wrong to have kept up my establishment of Cavalry. Besides, he had such a Devilish great Appetite. If he wou'd have liv'd without Hay indeed! Good Night. The Packett will come in some of these days, and then we shall say something more. John Brew will sail when he is ready, and when he thinks the weather is settled good, and not a day before. Your Potatoes are with him.

21st. The Packett has come in, and has brought yours of the 14th, but as my arrangements were previously made I shall not alter them. Your Potatoes will leave this place in a day or two.

I have forgot to tell you that poor Whitehurst is dead. He died about 3 Week's ago. As he left no money and was in debt, we buried him by subscription. I hope his obligations are buried with him.

24th. The Surrey is just come in. I have got your Pine Apple, which is very handsome, & which I thank you for. I shall astonish some of the Natives with it to-morrow. Sherman, Grice and his Wife (for he is married to a Miss Cribbin since you was here) dine with me to-morrow. I love to astonish People, and who does not. I believe there is another Parcell, or Package, for me on board the Surry, but the first being the most perishable my anxiety has been greatest to get the Apple.

The "Surrey" was a trading vessel of the island belonging to Captain Clegg. Mr. T. Sherman was the naval storekeeper at Douglas. On January 12th, 1798, Cable writes recommending "a sort of Clerk," who was among the other parts of his late establishment, and who wants employment in England; and on March 29th, he says:—

I hope you are by this time perfectly settled in your new habitation, where I wish you may enjoy every comfort and happiness. The removal of your Garden has, no doubt, been attended with great trouble; but I must own I do not pity you, for I know you take great pleasure in such sort of trouble. Besides it will do you a great deal of good: you have plenty of confinement, and this must necessarily bring you much into the air, and give exercise both to the body and spirits. That is what it is good for, let George Hulme say what he will.

It was only the other day that I was informed of Martin Luther being with you. If you can make him useful to you, well. But he has shewn himself an ungrateful Vagabond to me since our party has been broke up; and I am told has been very negligent of his family. He has killed a great deal of Game this Winter with my Gun, but I have never had the offer of more than one Hare, the rest have been taken to Farrer. I mention this only to shew you how much he is to be depended on; and to shew you that he had not the sanction of my name when he applied to you, though it is possible he might have used it. The fellow, however, you know, can make himself useful on many occasions: only don't depend upon him.

The reason why I have not written to you of late has been because I have alter'd my Nature. I have open'd a correspondence with no less than three Peers of the Realm, One Duke, one Earl, and one Baron. My Part, like that of the Lord High Treasurer in the Critick has been to Think. It is, however, a great Secret. Nobody has the least Idea of the Matter. I do not know whether I shall *think* to any purpose, but the business is simply this. I want to turn the Calf of Man into a place of confinement for Prisoners of War, and am at this time actually corresponding with the Duke of Atholl, the Earl Spencer, and Lord Curzon on this Subject. There is not, there cannot be, any difficulty but one; and that is a want of buildings to shelter

them from the Weather. Put twenty thousand on Shore there & I wou'd be bound to keep them there with a small, a very small force, indeed. I expect an Aye, or a No, by the next Packett. At present I need say no more than that it is a *Real Secrett*. You shall know the result a few days after I do.

In a former letter you mentioned a list of Wright's works, which, by the bye, never arrived; and a business of Colonel Drinkwater. If he is in your neighbourhood do the polite thing for me. I have got a most shining frame for the poor Soldier which cutts a great dash.

The Lord Curzon mentioned in the letter was the first Viscount, father of the well-known traveller. He was the third son of Sir Nathaniel Curzon, M.P. for Derby (said to have been the only member of Parliament who disapproved Sir Robert Walpole's theory that "every man has his price") and Mary, daughter of Sir Ralph Assheton, of Middleton, Lancashire. His elder brother John was created Lord Scarsdale in 1761, while Assheton Curzon, who was born in 1729, was Baron in 1794, and Viscount Curzon, in 1802. His son received the Howe peerage through his mother.

The Colonel Drinkwater alluded to is apparently General Drinkwater (at the time of this letter Lieut.-Colonel) the hero of Gibraltar, and author of the famous "History of the Siege." He afterwards assumed the name of Bethune. He was the eldest son of John Drinkwater, M.D., of Salford, and Elizabeth Andrews, his wife. It was he who erected the monument in Trinity Church, Salford, "to the memory of his brother Thomas Drinkwater, Major of His Majesty's 62nd Regiment of Foot, who perished at sea, on his return from the West Indies, the 23rd of April, 1797, aged 32 years." Dr. John Drinkwater, himself, who was one of the founders of the Manchester Literary and Philosophical Society, died in March, 1797.

On June 28th, Cable writes :—

In my last I think I told you of my scheme for securing the French Prisoners. In consequence of my representation an Enquirer was sent

hither by the Admiralty who approved of the Place, but objected to it on account of the Expense of building Barracks for their Accommodation. This was what I had mentioned to Lord Spencer, who, I dare say was not displeas'd at me for the trouble I had given him, for, by the last Packett but one I recd orders again to procure Men. I have accordingly recommission'd the Mona of Douglas, and she now makes her appearance in the dress of a Dutch Scout; commanded as before, and mann'd with her usual Crew, save & excepting Martin Luther who has betaken himself to a seafaring life, having entered on board an Irish Revenue Cutter where he receives the enormous sum of twenty six shillings per month. We have been much pester'd with a number of very suspicious looking Irish-folks, who have attempted to land on this Island, many of whom have been prevented coming on Shore, others have been reship'd & sent back again; some however have evaded the vigilance of the Guards and got nestled into the country. It is to be hoped that they will be discover'd & routed, means being used to find them out by mustering the different Parishes, and taking an account of all strangers.

I am, at present, in treaty for Balla Broie, but I am afraid the Landlord will not put the premises into so good repair as I wish, & without which I will not go to it. I have a man there to-day surveying the wants & distresses of the House, which are manifold.

I have, along with this, returned your Bewick's Book of Birds. It has given me much amusement. It is the most beautiful thing of the sort I ever saw. The Tail pieces, in particular, are charmingly grouped; and there is an appearance of a very sporting fancy throughout the whole. I mean to send along with it a book of a different description, being entirely Manx Manufacture. You will do me the favour to *enrich* your Library with it. It will, at least, be a curiosity to have a book that grew in the Isle of Man; and if you study hard you may in time become an excellent Manx Lawyer. I heartily wish that our English Statute Book could be compressed to such a size, we shou'd much better understand what we were about. But this is no time for experiments. We have had a dreadful example of the consequences of it; and when it will terminate fills one with awful suspense.

I congratulate you on your Military promotion, and think that if you & your Battalion escape the Press Gangs, you may do well enough

The Manx Statutes, at the time of these Letters, were easily contained in a single octavo volume of 500 pages.

On September 16th, Cable writes:—

In the first place I have to inform you that I am alive, which is what I cou'd not have promis'd you at this time a week ago, for at that time my life was threatened by more than one. In order that you may the better understand this business you are to know that some time since, my very good masters, the Lords Commissioners of the Admiralty, sent a Vessel here for the purpose of Impressing a number of Men out of the Manx Herring Boats,

they having been inform'd by somebody, that several thousands were employed in that Trade, and that there was no apparent reason why a Manx Fisherman shou'd not be as liable to the Impress as an English one. I suppose their Lordships were convinced by these arguments, for they ordered the Spider, Schooner, commanded by a Lieut. Harrison to proceed on this Station for the above purpose, and last Friday Night, but one (dreadful to relate) he carried their orders into effect by impressing about fifty of those sacred persons. Had an Earthquake happen'd or any other Convulsion of Nature, it cou'd not have had a more terrible effect on the Inhabitants of this Isle. That they were entirely ruin'd was past a doubt, and that this ruinous business was occasioned by Captain Cable was another truth which no one cou'd pretend to deny. His throat, of course, ought to be cut at least, and his House pulled about his ears. In the meantime he, honest man, showed no concern nor took any precautions about the matter. The bustle is now, I believe a little subsided, & there has been no throats cutt, nor any houses pull'd down. The Keys have, however, had a meeting about the business, and they have memorialised the Admiralty representing I suppose that the persons of their fishermen ought to be held sacred, and demanding that this terrible business shou'd be no more repeated. And now you have got a history of the most eventful circumstance that ever happened to the Isle of Man.

The Press Gang was a grievance of long standing in the Isle of Man. In 1795, the Duke of Atholl, as Governor, added greatly to his popularity there by writing to the British Government, and inducing them to promise protection in the matter to the Manx fishermen. The result of this is seen in the letter.

The next letter tells of the death of Mrs. Cable :—

Douglas, Dec. 5th 1798.

My dear friend,

This will be the shortest, and the most melancholy Letter I ever wrote to you—Mrs. Cable is no more, she died last Wednesday after about three weeks illness, of a low Putrid Fever, from which I am but just recover'd. This Event will cause me to leave the Isle of Man : for as neither my dear Sarah nor myself have anyone to lean to except each other, the Survivor of us wou'd be in a dreadful situation upon the Death of either : an event which must necessarily happen some time or other. I mean to come to England in a very short time to consult yourself, and those few friends I have, about a Situation. As I hope to see you e'er long I shall say no more than that I am and shall ever remain, your, & Mrs. Philips's, most sincere & affectionate friend.

SAM. CABLE.

Sarah begs I will make her most affectionate regards to you both.

Farril is broke all to pieces. I am afraid your £50 and my £40 is entirely lost. He does not appear to me in a very favourable light.

The postscript contains a very natural conclusion.

The next letter is dated January 1st, 1799:—

I this day rec^d your very friendly letter of the 28th Ult.^{m.}, and have taken the earliest opportunity of thanking you for it. When we are in trouble the Friendly Offices and expressions of those whom we Love & Esteem are doubly acceptable, and make the deepest impression; and such an effect has your kind letter had both upon Sarah and myself. She looks up to you & Mrs. Philips as to the two dearest friends she has in the World after me; and begs that I will offer her sincere thanks to you both for your very friendly invitation, which, I hope, we shall be enabled to expect in the course of Next Summer; when we flatter ourselves that we shall be lucky enough to persuade you both to accompany us back to the Island, where we can accommodate you perfectly well for a few weeks. I have got another Bed Chamber added to my House, and I can procure a Bed for any Servant you bring along with you close by. This is a measure that we have set our hearts upon, and shall be much disappointed if it is not carried into effect. I mean to put off my Voyage to England until May, when I purpose to bring Sarah along with me and to spend about a month or six weeks with my friends at Liverpool, Manchester, & Blackburn: at the end of that time I think it will be about your vacation, and you can return with us. The Season then will be at the best for your favourite amusement, & it will give us the greatest pleasure to have you and Mrs. Philips for our Guests. I assure you it has afforded us great pleasure in talking of this scheme. Pray God nothing may happen to prevent its being carried into effect.

I thank you for your advice about remaining in the island during the War. It is exactly what Sarah & I thought wou'd be proper, and I am quite confirm'd in my opinion by your letter. Ten per cent upon a small Income makes a very sensible difference, and must at least curtail some enjoyment or other. Besides it is possible that the Rendezvous may again be open'd this next Summer as it was the last and it is better to be upon the spot than to have the trouble and expense of removing.

As you are among people of Letters I wish you wou'd get me a few lines compos'd, to be inscrib'd on Mrs. Cable's Tomb, stating her Conjugal affection, her Sincerity as a Friend, her Indulgent kindness as a Mistress—Charity to the Poor, and above all as being a truly good Woman & a Real Christian. All which you know she was. I think Ferriar is an Elegant Poet & cou'd do it properly if he wou'd have the goodness to undertake it.

After the failure of the Triple Assessment the Income Tax was introduced, and at the outset the rate was ten per cent. as referred to in the letter. Cable continues to

hope for a visit from his friend, and on March 15th, he writes :—

As I have not lately been in the highest spirits, I have had the more time to think, the result of those Cogitations has confirmed me in my former opinions that England is not the place for a man of small Fortune, out of Trade, and of genteel Ideas. My Connexions and Friendships are, all of them, People of Large Fortunes, and I shou'd not perhaps be quite comfortable always to feel my own insignificance. Here I am upon a quite different footing. I can live as I like, see either much company or none at all. Taxes we have none, or next to none, & living is certainly much cheaper than in any genteel town in England. If I was to come to England now I shou'd be almost starved ; for I have been so long used to Wine that I shou'd not be comfortable without it, and I cou'd hardly afford myself a Pint a day. Besides I am so fixed that a voyage to see my friends wou'd not be attended with much expense ; and I can afford to entertain any who will come & see me without any expense at all. Do once more let me beg you will come over if you possibly can. I will promise to return with you if that will be any inducement. You will please to understand that when I say you I mean the whole of you, that is yourself & Mrs. Philips ; without her I shou'd think I only saw half of you.

On March 28th, Cable writes :—

Since I wrote to you last we have had a week of dissipation. The Strangers here have got a touch of the Benevolent Mania. Two of them, a Mr. May (cher ami to the Bird of Paradise) and a Mr. Gooch (son of the celebrated Mr. Gooch) have been performing the parts of Lothario, & Horatio for the benefit of some distressed Actors & Actresses who have been left here in Pawn by their Party. The House was full, & the profits enabled the distressed wretches to have a Good Supper and leave the Island with Flying Colours. To-morrow there is to be two Theatrical Performances performed entirely by Gentlemen & Ladies for the benefit of a poor deserving English woman who has been deserted by a worthless Husband. High Life below Stairs, & the Prize, are got up, & I am told, will be presented in High Stile. The whole house is already taken. Sarah has made me promise to accompany her there. She is gone this Evening to an Assembly at my earnest request, for she is as great a Mope as myself, & wou'd continually stay at Home if I was not to invite her out. As for my own part, although that great Alleviator Time has much softened my Grief for the Loss of one of the best of women, yet I feel not the least inclination to partake of any Publick amusements.

On May 7th, he writes :—

As the Season is approaching for our intended excursion to England, I think it necessary to apprise you of it, and to enquire whether you can make it perfectly convenient to give Sarah & myself board & lodging for a short

time ; my reason for making these enquiries is owing to what you mention'd in a former Letter about Enlarging your Habitation, which if it is rather too confin'd for your own family, must of course be more so when you are encumber'd with additional Guests. As for Sarah, she will be happy to take Part of Miss Caroline's Bed if she can make it convenient to spare part of it, so that if I can find a Cabbin & Cot for myself I hope we may continue to do pretty well. It remains for you to say whether your avocations will answer to receive us sometime about the beginning, or middle, of June, at which time we think of being with you. Do let me hear from you on this Subject shortly.

I am highly delighted with the account you give of the pleasing prospect your American Estate affords. I most sincerely wish these prospects may be realised. If your Masts are the Dimension you mention, and if you get them ship'd without too much expense, they will be invaluable, both to yourselves & to the Country. At all events your Brother James sets out well—may it continue.

What do you think of Miss Jacobs having brought an action of breach of promise of marriage? who do you think is the defendant? as it is impossible you shou'd ever guess I must acquaint you : it is old Sherman, who has been extremely foolish on the occasion, & now is going to be held up to ridicule, as well as Miss & her Father.

“ Miss Caroline,” mentioned in the letter, was Colonel Philips' only daughter. Strange to say, no account is given of her in Foster's *Pedigrees*. From a letter written by Sir Hungerford Hoskyns in 1810, we gather that she had long been in failing health, while Meadows Taylor* leads one to understand the same by his phrase, “a happy release, but a sad life.” She could not have been more than twenty when she died, towards the end of 1812. In the summer of 1799, Captain Cable and his daughter take their long intended trip to see their friends in Lancashire.

Blackburn, July 22nd 1799.

I have been expecting an answer from Mr. Parker, the Bowbearer of Bowland forest, for some days past which has hitherto prevented me from writing to you. Yesterday I rec^d the enclosed from Mr. Wilson of Clitheroe, which I apprehend will answer your purpose. I have to add for your information that minnows abound both in the Hodder and in all the adjacent Brooks, so that you need not fear getting Bait. Mr. Cottam of Whalley informs me that he has had many days of good sport this Season,

* Part II., p. 49.

and that he has seldom, or never missed taking fish, let the water be ever so fine & small, with a scour'd Brandling. He says, likewise, that he shall be glad to attend you whenever you go to Whitewell if you will do him the favour of calling upon him as you go through Whalley. Mr. Wilson also requested I wou'd make his compliments to you & hop'd to see you if you cou'd make it convenient to call upon him at Clitheroe. He has just returned from Liverpool, where he has been introduced to Roscoe, of whom he speaks in very high terms.

The family of Parker, of Browsholme, in the Forest of Bowland, has been known in Lancashire since the beginning of the 15th century, and the office of Bowbearer of the Forest seems to have been hereditary in the family for many generations. Mr. John Parker, Cable's friend, was born in 1755. He was a Fellow Commoner of Christ's College, Cambridge, and sat as M.P. for the borough of Clitheroe, though his return as member was the subject of Parliamentary inquiry in 1780. He was married at Giggleswick, in 1778, to Beatrix, the daughter of Thomas Lister, of Gisburne Park, Yorkshire, and sister of the first Lord Ribblesdale. His father, Edward Parker, married Barbara, the daughter of Sir William Fleming, of Rydal Hall, Westmoreland.

As to Mr. Wilson, we learn from the *Liverpool Advertiser* of January 6th, 1795, that the "Marine Society held their Anniversary, when the members went in procession, honoured by his Worshipful the Mayor, and his officers with the Regalia, to St. George's Church, where an excellent sermon was preached by the Rev. Mr. Wilson, of Clitheroe. The Society afterwards dined at the Exchange with great unanimity and happiness." Thomas Wilson (who must be distinguished from Senhouse Wilson, the Isle of Man and Liverpool merchant), was born at Hutton in 1741, his father being a highly respected yeoman. Educated at Sedbergh Grammar School, Wilson acted as Reader in

several neighbouring parishes, but never proceeded to the University. He was generally accounted a profound scholar. In 1771, he was ordained, and two years later was elected headmaster of Slaidburn Grammar School. In 1775, he became headmaster of Clitheroe Grammar School, a position he held for nearly forty years. Late in life he was presented to the living of Claughton. Wilson married Susannah Tetlow, the daughter of the Rector of Bolton-by-Bowland, and he died in 1813. One fact of interest in his life is that in 1791, he was presented with a silver snuff-box by the Corporation of Clitheroe. The inscription on the lid is signed by Samuel Cable and Henry Hayhurst, Bailiffs. Wilson wrote several poems. Mr. Cottam, of Whalley, I have had difficulty in tracing. The Cottams or Cothames, though never very numerous, appear at intervals throughout Lancashire history, and the Cottams of Cottam, near Preston, though long extinct, were a well-known family. At different times we find Cottams at Dilworth, Bilborrow, Clitheroe, and Whalley. Thus, in 1642, William Cottam warned the borough of Clitheroe against an attack by Sir William Hoghton: this William seems to have been connected with Thomas Cottam, a Jesuit, who suffered for his religion in 1542. Mr. Wm. Cottam, of Burnley, died at Hardshaw Hall in 1798. He was probably the father of Cable's friend, who was still living at Whalley in 1821.

In the next letter Cable says:—

Liverpool, July 25th 1799.

We arrived here last night safe, & tolerably sound, though the roads were in many places extremely rough and uneasy. I find, upon enquiry this morning, that a Vessel will sail for our Island to-morrow or next day; I write therefore to request you will have the goodness to order your Servant to forward Sarah's Box, which she left at Mayfield, as soon as he can make it convenient, as it contains all her Sea Wardrobe, & she will, of course, be rather incommoded without it. If Mrs. Philips will, at the same time, forward the other trifles Sarah will feel herself much obliged to her, as well

as for the polite attention she experienced while under your roof. As for myself, I shall say but little about it, being a *Man of Few Words*. When you will give me an opportunity I will endeavour to settle the account as well as I can, but I am afraid it will be a running account with the Balance always against me.

I forgot to mention, in my Note from Blackburn, that I had been at Mr. Sudell's place at Woodfold, I walked through his Garden & Hot-Houses. The quantity of fruits he has, in various stages, is really astonishing; to give you an Idea of quantity respecting the Peaches Nectarines & Grapes I ought to make use of the terms Tons or Waggon Loads: and he has them in all their various stages from the first setting, to their being quite ready for the Table. In short it was a Glorious sight. There is, however, a much more glorious sight from this place at present—the homeward bound Jamaica fleet just coming up the River; and I have just heard, as Glorious News, that there is a Gazette account of Buonaparte's Army, together with himself, being all sent to the Devil, where let him rest in peace if he can. May all the foes of Britain join him there!

The "Gazette" mentioned recorded the defeat sustained by the French under Buonaparte at the hands of Sir Sydney Smith, at St. Jean d'Acre, in June, 1799.

The family of Sudell has been known for something like three centuries in the neighbourhood of Blackburn, where they have held considerable landed estates and also engaged in trade. Mr. Henry Sudell of Blackburn married Miss Alice Livesey. He died in 1764. His posthumous son Henry, who is the one mentioned in the letter, became a great merchant at Blackburn, married Maria, the daughter of Thomas Livesey, and purchased large estates in Mellor, Salmesbury, and Pleasington. In 1799 he enclosed Woodfold Park at Mellor and built the Hall, a large building in the architecture of the period. His affairs continued to prosper, and in 1820 he was accounted a millionaire. Then came his downfall. He lost heavily in German and American Speculations, and in 1827 (losses in American Speculations were the proximate cause of the panic of 1825) suspended payment; his large Lancashire estates were sold, and he went back to Blackburn, and,

after getting the remnants of his fortune together, retired to Wiltshire. He survived until 1856, when he died, at the advanced age of 92, at Ashley House, Bath. He left several children. Thomas Livesey was eventually heir to a considerable estate and, unlike his kinsman and partner John, died fairly wealthy. Hermann Boaz, referred to in a short postscript to the letter, was also at times one of Philips' correspondents; he was an actor.

The next letter tells the result of the Breach of Promise "Tryal":—

Douglas, Oct. 19th 1799.

The continued Rains & Wind have almost spoil'd the whole of the Corn in this Island, and will cause everything eatable to be extremely dear. It has made me feel very comfortable that my situation has not been in the Country, which is nothing but a heap of Mud & Dirt; and although you find Charms in the Country, that is in *your* Country, yet I fancy, was you obliged to live in this Island all the year round, you wou'd choose a Villa situated somewhere in the middle of Douglas. And even in your own country I do suppose you find an abundant quantity of the above mention'd articles Mud & Dirt. I will answer for it your fish pond has had regular supplies of water, without your being under the necessity of stopping up the Brook. For my own part I am so well satisfied with Douglas that I am upon the point of purchasing a House here and I believe I shall actually agree for it. The purchase money will be about four hundred pounds, Can you make it convenient to let me have that sum about next May? Perhaps it may not be quite so much: I am sure it will not be more. Pray let me here from you soon on this subject.

The important Tryal between Miss Jacobs and Sherman is at length terminated, and has ended in a complete victory on the side of the Fair Lady: she has come off with Flying Colours, and Two Hundred pounds Brit. He attempted to set up a very ungallant defence, which, for the honour of Manx Land, wou'd not be admitted. It is said that a Mr. Archdale, formerly a lieutenant of mine had before paid his addresses to her. This the jury thought irrelevant & therefore refused to hear it. He now wanders about, generally alone, and looks like a hunted Devill. It touches him to the quick to part with his money.

The Whaleys, the Daleys, & the rest of the vagabonds are continually quarrelling & Brawling, & afford constant subjects for conversation; and which, as we have no matters of greater consequence to discuss, serve to pass away time. The rest of the people and places remain in much the same situation as when you left us, save & except that I have an elegant Villa building in the heart of Duke Street where I hope to see you & your Fair

Dame next Summer. I shall just have one spare room which I assure you shall be comfortable.

One cannot help feeling some sympathy with old Mr. Sherman, whose pay was only £100 a year. It is somewhat difficult to understand the Captain's rather obscure hints about his new residence ; they appear to be contradictory. On January 27th, 1800, Cable writes :—

I recd. a Letter by the last Packett from our friend Radcliffe, announcing the approach of a piece of Oxford Brawn, which is since arrived in great perfection, and which enabled me to send a handsome treat to his Grace of Atholl ; who, by the bye, has spent his Christmas here, and I understand does not leave the Island until March. While he has been here the Inhabitants of the Town have given him & his Family a Ball & Supper at which were assembled about 120 persons. The whole went off very well while their Graces & their Suite stayed, but after they were gone a parcel of vagabond Irish, who had contriv'd to be of the party, kick'd up a Row, in the manner of their Country, which has given some business to the Deemster. Luckily I was come home before the Uproar began. This, as you will easily imagine has afforded great scope for conversation & scandal. Indeed, I don't know what we shou'd do for conversation in the absence of the Packett were it not for these Irish Emigrants. They are a precious Gang, that's for certain.

As a piece of news I tell you that your unfortunate Townsman and I have made matters up. He din'd with me on New Year's Day, & we began the New Year by drinking a Glass to Oblivion. As we shall never be upon so intimate a footing again as we have been, there is reason to hope we shall continue upon decent terms in future.

On May 5th Cable writes :—

We are just on the point of removing into a neat, snug, comfortable Box where I have a very good spare Bed Chamber, and where I can accomodate you and Mrs. Philips more conveniently than you have ever been lodged in this country, and where it will give me the greatest pleasure to see you whenever you can make it pleasant to take a trip to Douglas. My House I assure you, is finished in a manner far superior to any you have seen in this Island ; it being Stiled and Lath'd (as the workmen call it) from top to bottom throughout the whole House, which no other House that I know of in this Island has. Sarah begs me to say that if you can bring Miss Philips along with you she shall be extremely glad to see her, and will accomodate her with half of her Bed, & will endeavour to make the excursion as agreeable as possible. Therefore, if you can spare time from your more serious avocations of Trade & War, do, for God's sake, come see us this Summer.

The next letter treats of several interesting matters :—

Douglas, July 25th 1800.

I shou'd have written to you long e'er this, but have put it off from time to time in expectation of seeing you, for about a month ago I recd a Letter from the Transport Office saying thar Lord Spencer had nam'd me for an Agent of Transport, & requesting to know whether I had any objection to serve in that Capacity. I answer'd that I certainly cou'd have no objection to serve in any capacity his Lordship thought proper to appoint me to; and I, of course, expected to be immediately called upon; but last post brought me a very polite letter from Commissioner George, of the Transport Office saying that my remote situation prevented me from getting to London in time, as the emergency was very pressing; and the troops at that time already embarked; & that the vacancy was obliged to be immediately filled up; but that if any other appointment under that board offered he wou'd take care to give me timely notice. And thus has ended the bustle which this Letter caused in our household. I don't know whether I am most pleased or displeas'd by this disappointment for there is much to be said on both sides. However, I am well pleas'd with one part of the business, & that is knowing that it originated with my good friend Lord Curzon, who has recommended me to Lord Spencer so that it is not improbable that I may yet be called once more into actual service. My way upon these occasions is to make myself perfectly easy, & say "whatever is *right* is *right*, the Devil a bit further will I submit to.

I wonder whether there is any chance of seeing you on this side the Herring Pond this year? Your old friend Banks will add to your stock of information by reciting the adventures he has lately gone through in an enchanted Castle where he was convey'd by certain Magicians, in the Shape of Parsons. The truth is Mr Banks has a settled aversion to the Clergy as well as to every other of the Liberal professions, & he was indulging himself by giving vent to some of the bile which overloaded his stomach, in one of the Clergy Courts here, when the Vicar-General & his brethren caused him to be placed in Castle Rushen for a fortnight, & a penalty of Ten Pounds Brit: to be levied on his goods & chattel. I have not seen him since he came from *Colledge*, but I hear he is very amusing, & it is not impossible but he may get another journey thither if he is not a little more cautious in his expressions. There are various other scenes and stories for your recreation if you will but be at the pains of taking a trip to Mona to collect them.

The fanciful way in which the arrest and imprisonment of Banks is described is due to the former Manx superstition that Castle Rushen, which was the general prison of the Island, was originally built and inhabited by fairies. The Clergy in the Isle of Man had an even greater civil

jurisdiction than they had in England, and Mr. Banks paid the penalty of his boldness in combining slander of the Church with Contempt of Court. An Act of Tynwald of 1647, provides "Whosoever shall accuse or speak any scandalous speeches against any Chief Officer of this Isle, Spiritual or Temporal, . . . and be not able to prove it, shall be fined for every time so offending Tenn Pounds, and their Ears to be cut off for punishment besides."

In addition to the ordinary ecclesiastical jurisdiction in Probate and Divorce, the Manx Religious Courts, for various offences, had the power, not only of inflicting Church censures, but also of detaining the offenders in the ecclesiastical prison, which, says Mr. Moore, "was a subterraneous vault in the Castle of Peel, in order, after an examination of a jury of six (whom they were authorised to impanel), to be delivered, if judged necessary, for further trial and punishment to the temporal power; and not only did they commit to their dungeon for the purpose of such detention, but confinement there was sometimes ordered, by their definitive sentence, in affairs merely spiritual." The greater part of the Manx spiritual jurisdiction was swept away in 1884, and Castle Rushen was condemned as a prison in 1886. There were, it should be said, three classes of Manx Ecclesiastical Courts, Summary, Chapter, and Consistory. Appeals lay to York.

Evidently Colonel Philips was too busy to take a holiday, for on August 14th, Cable says :—

I assure you I rejoyce sincerely in the prospect which appears opening upon you on the other side the Atlantic. I hope & trust you will in a short time draw a very fine Revenue from your estate at Philipsburg. The account you have rec^d from your brother James is very flattering & I have no doubt but the Navy Board will be glad to treat with you for all the Mast Timber you can supply them with. The means I wou^d advise you to use is

to go to London yourself and get introduced to Lord Spencer, which you may easily do either through the medium of your friend Mellish or by the introduction of Lord Grey or by either of the members for Lancashire. You might show Lord Spencer *as much* of your Brother James's Letter as you think proper, and I doubt not but his Lordship will be much pleased with the prospect of such a supply of Masts, especially as the prospect of a supply from the North of Europe, at present, does not seem very flattering. The only difficulty that appears is the mode of conveying them to Europe; for your brother says there are no ships large enough in America to take them on board. The main mast of one of our first rates is about 110 feet long, and there are few merchant ships, except East India Men, of that length. If some of our old 50 gun ships were fitted up for that purpose they might answer very well; and by having their upper deck Guns on board they wou'd be able to fight a good battle if they were attacked, and this wou'd preclude the necessity of Convoys, especially if they had King's Officers put on board them. You might hint this mode of conveyance to Lord Spencer, who wou'd, in all probability, take it into consideration. And, if you possibly can, agree to deliver the Masts at Baltimore and let Government take what measures they think proper to get them from thence. In short, this seems a most favourable time to push the business, and one half hour's conversation with Lord Spencer may do more than half a year's writing cou'd. Before you wait upon Lord Spencer I would have you wait upon some principal ship builder & get information from them respecting the present value of masts, timbers, &c. I know very well, that previous to the present War the price of a 74 Gun Ship's Main Mast was upwards of £500, that is the *whole expense* of Timber, iron, workmanship, &c. But this you will be enabled to learn by being on the spot, much better than I can tell you. If, when you are in London, you do not agree with Government, I should recommend, as the next best market, the East India Company, and there I dare say your friend Mellish may be able to assist you greatly. At all events I think a trip to London may be of essential service, & I sincerely hope you will find it so

Although I have only mentioned Lord Spencer above, yet I know very well that he will do nothing in this business by himself; he will probably get some of the Commissioners of the Navy to treat with you; or at least to be present at your conference, and I wou'd advise you to get introduced to that board previous to your seeing his Lordship.

On December 6th Cable writes:—

I am much obliged to you for your information about the best means of preserving eggs, which I dare say may be useful to those people who live in a country where they are to be had; but that country is by no means the Isle of Man. An Egg, for sale, is here a natural curiosity. I have been told, by Old People, that such things were formerly to be bought; but since the prodigious Influx of Strangers they have vanished and they are no more to be met with in the Markets. Indeed, the prospect of Starvation stares us

full in the face, and if I cou'd procure a sleeping dose that would last until next Summer, I think it wou'd be the best mode of passing the ensuing months. I detest Salt Meat, & yet I have this day bought a Quarter of Beef, to salt down for food after Christmas, without which I know not, seriously, how we shou'd live for I dare say we shall not be able to procure either Beef or Mutton after that season. You see that scarcity is not confin'd to your Neighbourhood ; we have plenty of it here.

What you say about W. is, I believe, partly true. I mean that he is dead ; but I fancy the mode was not as you have been inform'd. He was very ill when he left this place, & was going to Bath, or Bristol, attended by his Wife for the recovery of his health, but was arrested by the Grim Tyrant in his passage at Knutsford. Still there are many people here who will not believe that he is dead. They say that he has played this trick several times before in order to elude his creditors, and that he is playing the same game over again. At the worst, if he is gone, the world will continue to do special well without him.

I have had the Devil to do since I wrote to you last. No less than Bullets, Powder, & Pistols. A Scoundrel was instigated by another greater Scoundrel to attack me one Night, on my returning home, with a large Bludgeon, & used me like a Ruffian. As there is no chance of Justice or Satisfaction in this Country, I had no other course but to call him out. He came attended by his second, but such was their eagerness for fighting I suppose that they loaded their Pistols with the Bullets which I lent them, for they had forgot to bring any along with them, and in their hurry forgot to put Powder into the Barrils ; or at least put the Bullets in before the Powder. The consequence was they burnt priming. T. M. was my antagonist & he was urged on by Speed who is too thoroughpaced a Coward to meet any Man in this way.

In a letter dated July 20th, 1801, Cable says :—

The Herrings have made their appearance this Year much earlier than usual, & the energies of the Manx men have been called forth and exercised in a most surprising manner. For this week or ten days past my senses have been constantly assailed by Herrings, and even at this present moment while I am writing the smell of them is rather too strong to be pleasant. It is really surprising to see the immense quantities of them that have been taken. Eighty, ninety, & even an hundred stones in a Boat ; & those, by far, the finest fish I ever saw. They have been sold at Peel, where the chief Fishing is at present, so low as eightpence a hundred ; this, together with an abundant supply of Potatoes, has caus'd an appearance, & indeed it is more than an appearance, it is in reality Plenty. I wish you cou'd contrive to come over & see a land of Plenty again. It is long since you saw such a sight. Quite a novel thing. As soon as the Red Herrings are cured I will take care to send you half a dozen kitts of them, and if you will let me know what quantity you shall want I will endeavour to engage them on the best terms I can.

And now we are upon business let me request you will have the goodness to procure me a piece of Cambrick muslin, a yard and a half wide, of about four shillings, or four & sixpence, a yard. I don't know what the length of the piece is but I suppose it to be from twelve to twenty yards, either will do.

Since I wrote the above I have seen Mr. Leece, who is very deep in the Herring Line, he says that it will be a difficult thing to find an *Honest Man* in that department, but he will endeavour to act like one. I will send you some Herrings in Kitts for a sample as soon as they are fit to be pack'd, which will be in about 10 days or a fortnight.

This was Mr. William Leece, of Douglas, nephew of the senior partner of the firm of Leece and Drinkwater, of Liverpool. He married a Miss Callow, and died at Douglas, March 1st, 1807. Mr. Drinkwater owned a pottery in Liverpool, and married Miss Leece, the daughter of Captain Leece, after whom Leece Street is called.

On August 5th, Cable writes :—

I think I forgot to mention in my last that I have again had a prospect of being employ'd, and have again been disappointed. My very good friend Lord Curzon applied to the Admiralty for me, and had as flattering an answer from Lord Spencer as I cou'd wish ; which Letter he transmitted to me, & I expected to have a call every post. This was so long ago as last Christmas ; but after waiting many months in vain, I found, at last, his *veracious* Lordship had resigned his office. So there is an end to all my hopes. I thought Lords had not told lies to Lords, however they might indulge in that laudable propensity to Commoners. I believe your friend Mr. Jervis is not upon terms with his relation, Lord St. Vincent, otherwise I might request your friendly offices with him, especially as I have something to offer to his Lordship's notice. An Improvement in Night Signals & one which I think may be of great consequence. But this, as I said before, can't be, as I know they are not upon friendly terms.

Our Great Man has been in this Island lately. He left this place last Wednesday. Yesterday week we had a grand Drunken-party upon account of his laying the Foundation Stone of a new house for himself at the Lough House. It is very large, & is estimated by Stuart to cost ten thousand pounds, but if that estimate is like other estimates it will cost a great deal more ; and this is the opinion of all the Wise Men of Mona.

Mr. Stewart, spelt by Cable 'Stuart' above, was also the architect of Douglas Pier.

On January 25th, 1802, Cable writes :—

52 FARADAY, *Correspondence of Lieut.-Col. Philips.*

Livesey got back again to his Cottage the last week, after an absence of more than four months: he brought the Cambrick muslin with him, which Mrs. Philips was so obliging as to procure for Sarah, & for which she is much obliged to her. It is really very beautiful, & we think, very cheap. While our Manufacturers can work cotton so fine as this, & afford to sell it so cheap, there is no fear of the French rivalling them in this branch of trade; whatever they may do in others. And now we are on this topic let us settle our accounts.

	£.	s.	
I think you say the Muslin Cost	5	15	5 . 15
Paid Leece & Bell for Red Herrings	2	5	2 . 10
Do. for One Kitt white do.	0	5	£3 . 5 Dr to
	2	10	Mrs Philips.

Here you have an account settled in a manner which you may not probably match in your Counting House. To go on by deducting the aforesaid £3. 5s. from £42, the interest due to me, I find you are indebted to me £38. 15. for which sum I shall draw upon you to-morrow the 26th, at Messrs. Mellish's in favour of Capt. Sam. Cable at a month's date. And so there's an end of business.

And now pray how goes on your Mast Project? Have you any arrivals yet? Or do you expect any &c &c &c. I am afraid you started too late. The freight & other expences must eat all your profits; added to which, the Russian Trade being thrown open again, & the Peace following so close upon it altogether seems to be against the scheme; but as I know you are not very sanguine in your expectations of any thing which is only possible, I hope you will not feel any very great disappointment should it turn out a blank. Livesey told me likewise that there was a report about one Mr. Philips of Manchester, who was just returned from America and who found his affairs in very great disorder when he arrived in England. My anxiety for what concerns your family leads me to fear that it may be your brother James who is implicated, as I know he was in America. Surely the American Air has something in it infectious to your family. In your next have the goodness to tell me if my suspicions are right or wrong. I should be most heartily glad to hear it was the latter.

The Peace has not as yet had any effect on the Settlers in this Island, although many of them threatened to leave us whenever it took place. I fancy the one thing needful will be found wanting among them all; which I wish they had, & that the whole of the new comers were on the move, for there has not one family settled here since I came that has in the least contributed to the improvement of society—at least not of mine.

On Thursday last we had a most tempestuous day, the Wind I think was louder & stronger than I ever knew it on shore. Many houses were entirely unroofed & few escaped without some damage. A homeward bound

West Indiāman belonging to Greenock was stranded at Kirk Michael, & a sloop with corn near Peel. As I have not been out of the house these ten days, I have not heard of any other damage done on this Island. I am afraid we shall hear of much damage on the Coast of England.

If you have any quantity of Segars, I shall be much obliged to you for a few—via Sam Newton.

Mention has already been made of one notable improvement in the Lancashire manufacture, and Cable's admiration of the muslin calls to mind the statement of Mr. Thomas Ellison, that the period with which we are dealing was the era of invention, and that improvements in every department of the cotton trade were being made almost every year. The "Segars" are worthy of notice.

Colonel Philips had several brothers. Francis was dealt with in Part I. Of the rest, Henry Philips, born in 1767, lived at Philadelphia. He married Sophia, the daughter of Judge Chew, of the Court of Errors and Appeals in that city. He died in 1800, and his only daughter and heiress, Sophia Philips, was married in New York. Another brother, Nathaniel George, was born in 1770, and died at New York in 1793. James Philips was born in 1777, and died unmarried in 1810. Thomas Philips was born in 1781, and died unmarried in 1806. Hardman Philips, of Philipsburg, Pennsylvania, was born in 1784, and in 1821 married a daughter of the Rev. Ed. Lloyd, of Fairfield. He died in 1854. The sisters, Elizabeth and Sarah, are mentioned elsewhere.

On March 29th, 1802, Cable writes:—

It gave me great concern to find that my suspicions about your brother James were but too true for I know that such a business could not fail to give you all a great deal of concern & trouble, & nobody wou'd feel more than yourself. It is a great comfort however to find that he has come through with honour, & without having his character the least injured.

About the middle of last month I rec^d your kind present of a cheese, part of which I hope you will eat in Mona in the course of the Summer. A little Sea Bathing will do Mrs Philips much good, & we have now two very decent bathing machines which makes bathing infinitely more commodious than it has ever yet been in this Island. Tell her this for her comfort.

I don't recollect whether I ever mentioned that my old friend, & landlord at Whalley Mr. Cottam, spent a few days with me the last Summer. He came in the course of the very fine weather in August, & returned in time to take the field the first of September. He promised to send you some game in the course of the Winter, but as you did not say anything about it, he possibly may have forgot, although he is not a man used to have forgot what he has promised. If you can spare a few days this Spring for fishing, I am sure he will accompany you with pleasure to Whitewell, where, I doubt not, you would meet with excellent sport. And it is not impossible but I might be of the party in that case; for you must know that I have been very unwell for more than two months, and the Doctor advises me to take a trip across the Channel when the weather is a little warmer. Which is as much as to say I am ill but he does not know what is to do with me. If I do go to England it will be about the latter end of April, and I shall spend a few days with my friend Cottam while there, so you see we may make Whalley the place of rendezvous. This is at present only in speculation. If I get better I will try to do without the journey.

Poor Livesey too, has been extremely ill for near five weeks; he was attacked with a violent inflammation of the lungs & has continued in a frightful condition. Appearances began to alter yesterday for the better & upon the whole he is much better to day, but he will require much attention still. If you could, with any convenience to yourself, contrive to let his sister, Mrs. Clowes of Hunt's Bank, know how he is to-day, I make no doubt but it would give her great pleasure for this is the very latest account she can hear of him.

The subsequent letters become far less interesting than those already given. Cable, to judge by the change in his handwriting, was evidently ageing rapidly, and his letters are, besides, querulous and trifling. He was undoubtedly extremely ill during the years 1802—1804, and, as has already been said, died in the latter year. A letter written on June 26th, 1802, tells of his return to Douglas, and contains a reference to Dr. Brandreth,* of

* Dr. Joseph Brandreth was born at Ormskirk in 1746, and graduated M.D., Edinburgh, in 1770. He succeeded to the practice of Dr. Mathew Dobson, at Liverpool, and became eminently successful and popular. He established the Liverpool Dispensary in 1778, and paid great attention to the Infirmary. Like his neighbour, Dr. Currie, he was greatly interested in fevers, and was the author of a work "On the Advantages arising from a Topical Application of Cold Water and Vinegar in Typhus, and on the Use of Opium in Large Doses in Certain Cases." He lived in School Lane, and died at Liverpool on April 10th, 1815.

Liverpool. On July 22nd he writes again, in reference to some commercial misfortune which Philips has suffered in his American enterprise ; and Cable, by way of comfort, gives Tim Bobbin's famous dictum—" Nowt that's owt con cum out when a mon has to do wie rascally Fowk." On August 16th he writes to ask if Mrs. Philips will get two white ostrich feathers for Sarah, who is going to a dance ; they are to be a surprise for the yong lady ; the price, he believes, will be from ten to fifteen shillings. The subsequent letter, written on October 27th, is rather amusing. Mrs. Philips was evidently horrified at the idea of feathers at that price, for Cable says :—

Sarah is much pleased with the feathers and both she and I are much obliged to Mrs Philips for the pains & trouble she has been about them. I have been perplexed, sometimes, since I first wrote about them for fear I should have tied Mrs Philips down by mentioning the price I did, which was entirely through mistake. I thought the price of these articles were like a sixpenny loaf, and I was sadly disappointed one day when I learnt by something that Sarah said that there were Ostrich feathers as high as two Guineas or more. It is very fortunate that Mrs Philips knew what was proper for I look upon shabby finery as one of the most ridiculous things in the world.

On October 14th, 1802, Cable writes :—

Upon the whole I think I am rather better than I have been, but am still far, very far, from being well, and the approach of winter affords me but a dreary prospect. If I cou'd continue to get a few degrees further to the southward I fancy I shou'd find benefit from it, but this cannot be, the season is too far advanc'd to think of a removal, and there are many other obstacles in the way. I continue to use exercise on Horseback, which with small doses of calomel & moderate good diet, I hope will enable me to weather the Winter.

From your long silence I am pretty certain you have been from home, and I am afraid you have found out some watering Place which you like better than the Isle of Man. If that is the case I shall not remain long here, for independent of the pleasure I received from seeing you here a few times, and the constant expectation of seeing you oftener, I do not know that I have one inducement to stay here. The society is of the very worst kind, and every necessary of life is almost as dear as it is with you, & by no means to compare with your provisions in goodness. But was I to leave the Isle of Man I certainly shou'd not think of fixing in a country so overrun with Cotton Manufactory as yours is—I would endeavour to find some pleasant

village in the south of England, where no manufactures were carried on, and surely many such are to be found, where the soil and climate are infinitely better than what we have to boast of. The inundation of vagabonds which overspread the face of this Island is really astonishing, and adds greatly to the price of every necessary of life, for as they generally bring a little ready money with them, they spend it most wantonly while it lasts, and give extravagant prices to whatever they buy : the consequence of this is that the natives make the more sober sort of us pay as extravagantly for what we have had as the strangers have paid. Upon the whole, I am heartily tired of this Country, and I as heartily despise its inhabitants. You know I had a wretched Garden, for which I paid an extravagant price, but as it was near my house it was very convenient. A scoundrel Red Herring curer took this Garden over my head the other day and nobody thinks he has acted otherwise than they would have done themselves. My house was taken in the same manner a few years ago, and my servants are tamper'd with, every year, in order to induce them to leave me. In such a country, and among such a rascally set of inhabitants, who would live unless he was absolutely obliged to it? But I will trouble you with no more of my complaints.

On January 8th in the following year he writes :—

I have been within an ace of breaking up my Camp here and removing to Whalley ; it was but yesterday that we came to the resolution of remaining where we are. You know that for the last year my health has been very bad & I have long thought this Climate does not agree with me. It is certainly too damp, & if I thought that I was to remove to a drier situation I should be better. The House which I formerly lived in becoming vacant & having had an offer of it, together with as much land as will keep a Horse & too Cows for Thirty guineas pr Ann. I was almost induced to accept it, but reflecting that it was in the heart of a manufacturing country, in the neighbourhood of Pendle Hill which in the winter generally furnishes plenty of Cold, added to which the dread of fellows with Ink bottles in their button holes, all these things consider'd frightened me, & made me resolve rather to bear the ills that I know, than fly to others that I know not of. It is true that if I had fix'd at Whalley I shou'd have been within thirty miles of you, & I shou'd probably have seen you sometimes. which I can hardly hope for while I remain here, and I shou'd likewise have been in a country I like, & among people that have always been friendly to me. But, on the other hand, the trouble fatigue & expense of removing, & the certainty of increase of expense of Living, & the mortification I shou'd feel on giving up my snug comfortable house to a Vagabond fellow, for such is my Landlord, altogether made us resolve to tarry here a little longer, & if we ever do remove, to go to the southward after a warmer & more genial climate.

Writing from Douglas on May 4th Cable says :—

If I had been well enough to have left home, a thing has offer'd that wou'd have suited me very well ; it was the offer of one of the Block Ships

that are to be stationed at the mouth of the Thames. It was offered through Lord Curzon but I found myself so very unfit to leave home that I declin'd it, & now I have given up all hopes of evermore applying for employ.

On June 3rd, Cable writes again. He is a little better, he says, possibly "owing to the shift of my Doctor, which he is very ready to believe."

On June 26th, he writes that he is worse in health than ever, and that he wishes to consult the surgeons at the Manchester Infirmary, "and particularly Symmons." He attributes his bad health to the effects of the typhus fever, which he had shortly after the death of Mrs. Cable. In the postscript Cable asks, "whether Philips' sister has yet become Lady Hungerford." Miss Sarah Philips, it may be mentioned, married Sir Hungerford Hoskyns, Bart., of Harewood, Herefordshire. She died in 1860.

Another letter is written on July 16th. It contains nothing of interest, and in the last letter, dated September 8th, 1803. Cable announces that he is going to buy an annuity for Sarah, "I think if I sink about five hundred pounds it will leave her more independance." In this letter, too, he tells of the desperate condition of health he is in, and adds, "was it not for Sarah I should be quite adrift. She is my surgeon, my nurse, and my all." There is a touch, too, of the ruling spirit: "You know the Manxmen are not too fond of work, nor of anything that savours of enterprise. They are a set of lazy, idle, dogs enough." In the last paragraph he gives a list of recent deaths in the Island: Old Dr. Scott (the Manx regimental doctor), Captain Jacobs and his daughter, and Mr. Sherman (thus the hero and heroine of the Breach of Promise case died within a few days of each other). "Major Taubman, too, has lost his father and his mother, and his only son is following fast. He is in the last stage of consumption."

The last letter I give in the present series is one written by Livesey to Philips, telling of the death of their mutual friend. It shows very plainly the real characters of Livesey and Cable, and tells very clearly the relations between them. Both of them middle-aged, disappointed men, they had their quarrels, but were friends at heart ;—

[*Endorsed "Account of Poor Cable's Death."*]

My dear Sir

It is with real concern it falls to my lot to announce to you the melancholy intelligence of the death of our late mutual and very worthy friend Captⁿ Cable who died last night between nine and ten o'clock, after a confinement of near six months to the house, a very great part of which time was passed in excruciating pain, increasing as the close of life drew nearer. If I had not been a witness of it I could not have thought human nature could have supported itself under such very severe sufferings, with such heroic patience & resignation, as our worthy did.

. Our friend must naturally have had a very strong constitution as for the last sixteen or seventeen days he never put anything solid into his mouth and life was supported by opium and liquids. My dear young friend his amiable daughter desires me to make her very best regards to you, Mrs Philips and Family, wishing you and yours every good, she only received your last kind letter to her father the day he died, if she is able she will answer it by the next packet ; our packet was so long detained on your side the water that we had three mails due which makes an insular situation disagreeable, particularly at this very momentous crisis. I shall feel a very severe loss by the death of my valuable friend, as will every one who had the pleasure of his acquaintance, nor will it ever be obliterated from my memory the very kind attention he showed me two years past. I then thought he would have had to have performed for me the last sad melancholy office I shall have to execute for him on Monday morning. I am with regard

Dear Sir

Yours very sincerely etc.

Douglas, 28 Janry 1804.

JNO. LIVESEY.

On the 16th of October, 1809, Livesey again writes to Philips and invites him to the Island, saying that though he is not nearly so rich as he once was, he is yet able to entertain a friend. He then says : "If my dear friend Miss Cable is with you, I beg you will make my kindest regards to her." Captain Cable's daughter, then, after the death of her father, would appear to have crossed to England, and made her home, at all events for part of the time,

with Colonel and Mrs. Philips. We may also infer that she was living, and unmarried, at the end of 1809. Livesey himself died Feb. 14th, 1810, aged 64. He is buried in St. George's Churchyard, Douglas.

No excuse is needed for rescuing the foregoing record from oblivion ; the letters from which it is made up are in themselves pleasant reading, and would have been of interest had they been penned from any locality, admittedly domestic and prolix though they may be. But the Isle of Man—before the days of steamships, lost in the fogs of the Irish Sea, cut off from all sources of external development, and, until very recent years, the scene of barbarism and ignorance—has few sources extant from which history, even so recent as that of the eighteenth century, can be gathered. Cable's letters throw a brilliant sidelight upon local society, and help to fill up the gaps in the other existing records. We may thus fairly claim that they are of value to the historian as well as to the student of human nature. Many characters appear and disappear in his pages, depicted with realism, and stamped with life.

The Captain has drawn his own picture, and any comment is superfluous. An intelligent, irascible man, constantly quarrelling and making friends again, loyally tender and affectionate to wife and daughter, open-hearted as a correspondent. He bore his frequent disappointments manfully, and to the last proved his contentment and his courage. Perhaps the keynote of his nature is his loyalty—especially to his native county of Lancaster. And so at the end he passed away, with his daughter and his oldest friend at his bedside. He was buried on January 30th, 1804, in St. George's Churchyard, Douglas.

NOTE.—I must express my thanks to Tom Garnett, Esq., of Radecliffe, Clitheroe, and John Eastham, Esq., of Clitheroe, for their kind assistance to me in unravelling the story of Captain Cable.

W. B. F.

IX. On the Generic Names *Octopus*, *Eledone*, and *Histiopsis*.

By WILLIAM E. HOYLE.

Received and read March 5th, 1901.

I. OCTOPUS AND ELEDONE.

The replacement of these time-honoured names in a recent list of British Marine Mollusca (:01) by the less familiar *Polypus* and *Moschites*, demands a few words of explanation.

In the Report on the "Challenger" *Cephalopoda* ('86, p. 152), I called attention to the fact that by Jeffreys ('69, p. 130) the genus *Loligo* was attributed to Schneider and not, as usual, to Lamarck. No reference, nor even date, was given, and the only paper by that author then accessible to me contained nothing that could fairly be called a definition of the genus. Happening to mention this circumstance to my friend, Mr. C. Davies Sherborn, he very kindly offered to look up the question in the MS. of his forthcoming "Index Animalium," and a few days later sent me the proper title of the paper and an abstract of its contents. I have since been successful in procuring a copy of the work. The result to which it leads being subversive of two old-established names, it seems, therefore, worth while to place the facts before my fellow-naturalists. The full title of Schneider's paper will be found in the Bibliography at the end of this article (1784), and as it is somewhat rare I extract here the more important passages. After criticising the definitions of the group of *Cephalopoda*, for which he adopts the name

July 10th, 1901.

2 HOYLE, *Generic Names Octopus, Eledone, and Histiopsis.*

OCTOPODIA, he characterises it as follows [p. 108]:—
“*Caput cum oculis inter pedes et ventrem. Os in mediis pedibus eminent rostro accipitrino. Pedes octoni vel deni os circumdantes, acetabulis interius asperi [? aspersi]. Venter vesica atramentifera instructus, infra scissura transversa ad basin apertus, supra quam fistula excretoria eminent.*”

The subdivisions proposed by him are as follows:—

“CLASSIS I. *Pedes octoni breves, promuscides binae; venter pinnatus, ossiculum dorsi* [p. 108].

SEPIA I. *Ventre latissimo rotundato undique pinna cincto osse dorsali maximo* [p. 109].

LOLIGO II. *Ventre stricto subulato, pinna angulari media, osse dorsali penniformi* [p. 110].

TEUTHIS III. *Ventre depresso caudato ancipiti* [p. 113].

SEPIOLA IV. *Ventre parvo rotundo, pinnula rotunda ad latera, dorso ex osse* [p. 116].

CLASSIS II. *Pedes octoni longi basi palmati, absque promuscidibus, pinnis et osse dorsali* [p. 108].

POLYPUS V. *Acetabulorum in interna pedum superficie ordine duplici, in basi singulis acetabulis, paullatim incrementibus* [p. 116].

MOSCHITES VI. *Pedibus longissimis, unico acetabulorum ordine* [p. 118].

NAUTILUS VII. *Singulari acetabulorum, ordine, testa inclusus* [p. 120].

POMPILUS VIII. *Pedibus lobatis seu digitatis absque acetabulis*” [p. 128].

With the diagnosis of the genus *Polypus* just quoted, it is interesting to compare that given by Lamarck (1799) of the genus *Octopus*, which is as follows:—

“Corps charnu, obtus inférieurement, contenu dans un sac dépourvu d’ailes, et n’ayant dans son intérieur ni os spongieux, ni lame cornée. Bouche terminale, entourée

de huit bras égaux, munis de ventouses sessiles et sans grimpes.”

It is abundantly clear that Schneider's genera *Polypus* and *Moschites* are equivalent to Lamarck's *Octopus*: it is true the former author does not enumerate any species, but his references to Linné and older authors leave no doubt as to what he had in view.

It is noteworthy also that the genus *Loligo* Lamarck includes no less than three genera of Schneider, namely—*Loligo*, *Teuthis* and *Sepiola*. Of these the second is almost invariably regarded by modern writers as included in the first, and in any case the name would be invalid, having been previously used by Linné for a fish. The first and last genera, however, are quite clearly characterised by Schneider and should be attributed to him.

Of Schneider's two remaining genera, the first *Nautilus* is equivalent to *Argonauta*, and the second *Pompilus* to *Nautilus*, but as these had been previously named and characterised by Linné, the commonly accepted nomenclature will not be disturbed as regards them.

It is very difficult to account for the neglect with which Schneider's contribution to knowledge has been treated. Partly it is due no doubt to its being included in a volume whose title gives no clear idea of its subject, and which has neither table of contents nor index; it is, however, included in the Bibliography given by Keferstein in his edition of Bronn's "Thierreich" ('66). Jeffrey's attribution of the genus *Loligo* to Schneider might seem to indicate that he was acquainted with it, but on that hypothesis it is difficult to explain why he quotes *Sepiola* as of Leach and is quite silent as to the prior names for *Octopus* and *Eledone*.

Leach's treatment of the matter ('17) is rather strange. He adopts the generic name *Polypus*, but quotes

4 HOYLE, *Generic Names Octopus, Eledone, and Histiopsis.*

it as "ΠΟΛΥΨΟΥΣ *antiquorum*" and "POLYPUS *Rondeletii*." In a later work ('52) the word "*antiquorum*" appears as a specific name, giving colour to the supposition that he looked back to Aristotle as the creator of the genus, which is rendered still more likely by his quoting *Eledone* as "'ΕΛΕΔΩ'ΝΗ *Aristotelis*." There is no evidence that he was acquainted with Schneider's work.

Gray ('49), curiously enough, adopts the genus *Teuthis*, and gives a correct reference to Schneider's work (except that the page should be 113 not 112); in the synonymy of the genus *Sepiola*, however, is an entry "Octopodia sp. *Schneid. Samml. Verm. Abh.* 116, 1784": under *Eledone* we have "Moschites *Schneider, Samml. Verm. Abhandl.* 1835" and under *Eledone moschatus* we find "Moschites *Schneider, Collect de div. Dissert.*," which suggests very strongly the idea that Gray was quoting at second hand. This is confirmed by finding a precisely similar form of reference in Férussac and d'Orbigny's monumental work ('35). We may therefore fairly conclude that Gray knew nothing of Schneider's memoir, but merely filled up his pages with unverified references.

In any case the fact remains that a serious contribution to our knowledge of these animals has been most unaccountably neglected. In answer to the question "Why rake it up again?" I can only say that there appears to me to be only one hope for deliverance from the Babel which now reigns in zoological nomenclature and that is a rigid application of the law of priority as far back as the tenth edition of Linné's "*Systema naturæ*" (1758). There is only a limited amount of literature to be examined; much of the work has been already done, and what remains will be greatly facilitated by the issue of Mr. Sherborn's invaluable index. Then we may hope

to have leisure from barren discussion of names to devote to more profitable investigation.

II. HISTIOPSIS.

The name *Histiopsis* which I proposed in 1885 ('85, p. 201) has recently (:00) been criticised by M. Maurice Cossmann in an article entitled "Rectifications de nomenclature," in the following terms :—" M. W. Hoyle a décrit, en 1885, parmi les Céphalopodes des dragages du "Challenger," un genre *Histiopsis*, qui fait double emploi avec *Histiops* (*Pet. Mamm.*, 1869); je propose pour le Céphalopode, la denomination *Hoylea nobis*."

M. Cossmann is so polite that it seems almost discourteous in me to criticise his procedure ; but I trust he will forgive me if I point out that he has himself been guilty of just that sort of changing of names without adequate enquiry which causes such needless complication. When I proposed the name *Histiopsis*, I was quite aware of the existence of *Histiops* : it is given in Scudder's "Nomenclator" ('82) and no zoologist who wishes his generic names to have a chance of vitality will neglect to see whether they may not be already contained in that useful index. I was then (and am still) of opinion that the existence of *Histiops* does not invalidate *Histiopsis*. It is quite true that they are etymologically similar, but both forms are admissible, and they are not so much alike that there is any danger of confusion, particularly as one is a Mammal and the other a Mollusc.

In any case M. Cossman's procedure does not mend matters, and greatly as I appreciate the compliment paid by his proposing to rename it after myself, I am constrained to point out that, if he had looked in the indexes to the *Zoological Record*, he would have found in the volume for 1885 the name *Hoylea* de Rochebrune, and

6 HOYLE, *Generic Names Octopus, Eledone, and Histiopsis.*

certainly, whether or no *Histiops* invalidates *Histiopsis*, there can be no doubt that *Hoylea* "fait double emploi avec" *Hoylea*.

There is, however, another reason why M. Cossmann would have done well to make further enquiries before burdening our lists with another name. It is probably not needed at all. The impression has been gradually growing in my mind that *Histiopsis* is merely a young form of *Histioteuthis*. The chief difference between the two forms is the varying extent of the web between the arms, and there seems reason to believe that this is a character which undergoes change as development proceeds. From a conversation with my friend Dr. Pfeffer, I learn that he has independently come to the same conclusion. At present there is not sufficient published evidence to prove the identity of the two forms, though I notice that Dr. Pfeffer has reduced *Histiopsis* to the rank of a synonym in his recent revision of the *Cegopsida* (:00).

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**X. On the Construction of Entropy Diagrams from
Steam Engine Indicator Diagrams.**

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AND

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Received and read February 5th, 1901.

The examples of steam engine entropy diagrams which have appeared from time to time in the Proceedings of Engineering Institutions, and in the professional journals, are constructed, in each case, to represent the heat changes which take place, for the total amount of steam and water in the cylinder. This quantity usually varies for each cylinder in Compound, Triple or Quadruple Expansion Engines. It is therefore necessary, under this system, to use different scales of entropy for each diagram, if the same water and steam lines are to be utilised throughout. From this it follows that the relation of the combined area of the indicator diagrams, when converted in this manner into entropy diagrams, to the area which represents, in the same diagram, the total heat received, does not represent the efficiency of the steam. In this respect also, therefore, the entropy diagram, as at present constructed, is at a disadvantage when compared with the reduced and combined *p.v.* diagrams for the same engines.

That it would be an advantage to deal with the same

September 10th, 1901.

quantity of mixture throughout the combined diagrams, instead of an amount which varies in different parts of the figure, will be generally admitted ; and, with respect to indicator diagrams, methods of eliminating the effect of clearance have been proposed and used for many years by different engineers. In this connection, the constructions advocated by A. C. Kirk¹, W. Schönheyder², Professor Unwin³, and Prof. Osborne Reynolds⁴, may all be mentioned. In the case of entropy diagrams, the hypothetical diagram for one pound of steam was discussed by Willans, but the authors have been unable to find any actual diagrams in which any method of reduction was given, or in which any reductions of this nature have been made. Without laying down any opinion as to the practical utility of entropy diagrams, founded, as they are, upon assumptions which are regarded by many as questionable, it may, nevertheless, serve a useful purpose to call attention to the above point, and to indicate a method whereby, without any serious amount of labour, this required reduction can be performed. The *p.v.* and entropy diagrams will then represent the changes which take place in one pound of mixture passing through the engine, and hence admit of direct comparison with the diagrams obtained from any other engine in a manner which is not possible under the present system.

It may here be recalled that, if the indicator card is to disclose anything relating to the quality of the mixture, it is necessary that its expansion line shall be placed in the correct position, with respect to the corresponding saturated steam curve for that quantity of steam and

¹ *Trans. Inst. Naval Architects*. Vol. xxiii. (1882), p. 33.

² *Proc. Inst. C.E.* Vol. xciii., p. 230.

³ " " " p. 208.

⁴ " " Vol. xc., p. 31.

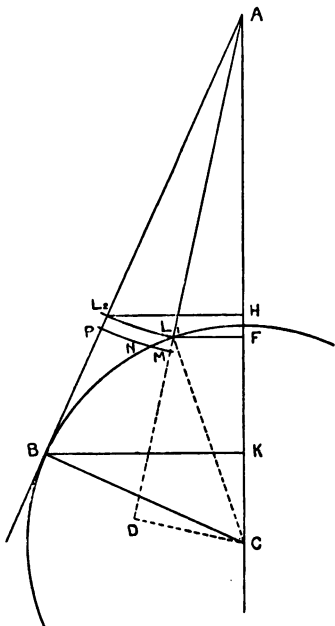
water in the cylinder. To do this, the dryness of the mixture must be known at some point during expansion or compression. In the absence of definite information, the usual practice seems to be that of assuming a certain value for the dryness fraction at the point of compression. From this assumption, the weight of clearance mixture shut in at compression can be obtained, and the indicator card then placed in its true position with respect to the saturation curve for the steam and water present in the cylinder.

The method adopted by Professor Reynolds, which is fully explained in the paper to which reference has already been made, can be found in standard text-books on the steam engine. Shortly stated it is as follows. Through the compression-point in the diagram an ideal compression-curve is drawn for the clearance steam. The volumes obtained in this manner for the clearance steam are then deducted from the total volume of clearance and cylinder steam as shewn by the diagram, that is to say, the diagram is "set back" by these quantities.

It would seem that the question is one of the relative conditions of clearance steam and cylinder steam during expansion. The experiments of Callendar and Nicolson* show that steam in holes and crannies of the cylinder may be superheated during most parts of the stroke. This would apply in particular to the ports, but how far it would affect the total clearance steam is doubtful. In the same experiments, temperature measurements made in the main body of the steam did not show this to nearly such a marked extent. At first sight it might appear that discussion of the point is immaterial, but quite appreciable differences in the dryness fraction will result according to the law of expansion assumed for the

* *Proc. Inst. C.E.* Vol. cxxxi., p. 168.

2 STROMEYER, *Projection on a Conical Mantle.*



to L_1C and MN is normal to L_1D , therefore the angle $L_1NM = CL_1D$, and therefore the two triangles are similar.

$$\therefore \frac{L_1M}{L_1N} = \frac{CD}{CL_1}$$

From the pairs of similar triangles CAD , L_1AF and CAB , L_2AH , we find

$$\frac{CD}{L_1F} = \frac{AC}{AL_1}$$

$$\text{and } \frac{CB}{L_2H} = \frac{AC}{AL_2}$$

But $CB = CL_1$ being radii of a sphere, and $AL_1 = AL_2$ being radii of a sphere. Substituting the values for CD and CL_1 , we have

$$\frac{L_1M}{L_1N} = \frac{AC \cdot L_1F}{AL_1} \quad \frac{AL_2}{L_2H \cdot AC} = \frac{L_1F}{L_2H}$$

but $L_1M = L_2P$, therefore

$$L_1N \cdot L_1F = L_2P \cdot L_2H.$$

Q.E.D.

The above is the geometrical construction, giving a projection which has been long known in its analytical aspect. Professor Lamb has pointed out to me that the analytical solution is to be found in Craig's "Treatise on Projections," p. 112. The particular case when the vertical angle of the cone is a right angle has been called by Germain, "Lambert's isospherical stenoteric projection."

of volume and pressure respectively. K is the point of compression, and C that of release. R is the point where rK , which is drawn parallel to OX, meets ST. The dotted curve represents a saturation curve through K. It is then necessary to assume the quality of the steam at K, the customary procedure being to assume it dry at this point, *i.e.*, at the beginning of compression.*

Then the weight of mixture shut in at compression is $\frac{rK}{rR}$ pounds, and the total weight in the cylinder will be $\left(1 + \frac{rK}{rR}\right)$ pounds.

The volume occupied by the clearance steam at any pressure PN during expansion will be

$$\frac{\frac{rK}{rR}}{1 + \frac{rK}{rR}} \times Pn \text{ cubic feet,}$$

Pn being the total volume occupied by the mixture at the pressure PN.

Hence, in order to obtain the clearance steam expansion curve GHJ, it is only necessary to determine this

* The error in assuming the steam dry at compression may be seen as follows:—

Let the fraction of the clearance steam which is water at K be α . Then the percentage correction to be applied to the dryness fraction as formed above will be very approximately

$$-100\alpha \frac{rK}{rR + rK} \% \text{ of the dryness fraction.}$$

On the figure, if the error in assuming the dryness at K was 10%, this would be

$$-100 \times \frac{1}{10} \times .15 = -1.5\%$$

showing how the error is reduced. Thus in *Fig. 3*, on this assumption, the dryness would be 57.5%, instead of 58.4%, which still leaves a difference of 5% between the two methods.

fraction $\frac{r_K}{r_R + r_K}$ once. The volume occupied by the clearance steam at any pressure during expansion will then be the total volume given by the card multiplied by $\frac{r_K}{r_R + r_K}$.

In this manner the expansion curve GHJ has been constructed down to J, at the pressure corresponding to release pressure.

Between J and K the expansion line must be put in by guesswork. It may be somewhat as shewn by the thick line JK, or may proceed by expansion to I and evaporation at approximately constant pressure to K, or it may follow the expansion curve CD, thus necessitating compression back to the pressure of K before the re-evaporation at constant pressure takes place. In the diagram, the simplest line JK has been assumed to avoid complicating the figure, especially since, as previously explained, it does not affect those parts of the diagram from which information is required. Thus the clearance steam diagram is GHJKAG, and its area gives the net work done on the clearance steam per pound of cylinder feed, together with the loss due to partially resisted expansion of admission steam if compression is not complete.

If the compression is complete up to admission pressure, this latter loss is eliminated, but there is still a resultant transference of heat to the cylinder walls by means of the work done on the clearance steam, and this could only be zero if the dryness of the clearance steam during expansion and compression were the same at each stage; that is to say, if the curves coincide.

The elimination of the clearance steam is obtained by setting back each point P and p in *Fig. 1* by the volume nH occupied by the clearance mixture at that pressure. The area of the indicator diagram is unaltered, and the

result is a diagram for one pound of mixture as in *Fig. 2.*

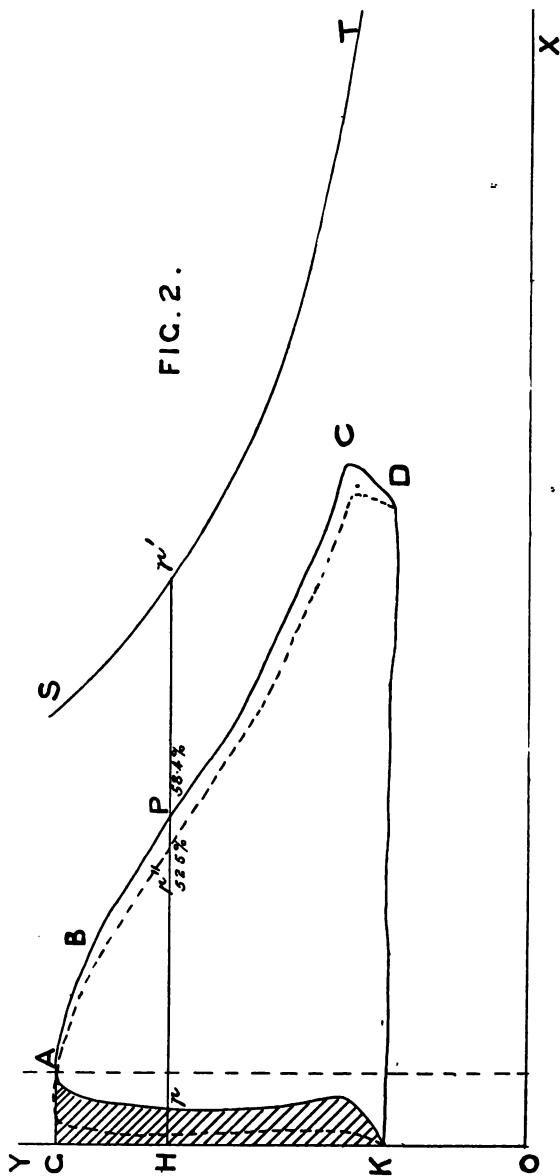
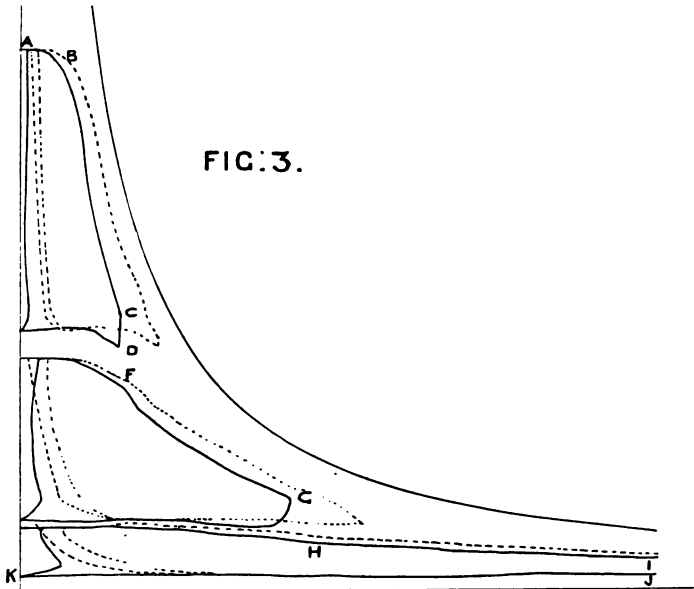


FIG. 2.

Here the shaded portion represents the net effect of the clearance steam, whilst the dryness fraction is $\frac{PH}{\rho'H}$. The dotted curve represents the result of using a saturation curve for the expansion of the clearance steam.

The cycle of changes may be considered as follows: heating of water from K to G; evaporation from G to B, expansion from B to D, and condensation from D to K. The total amount of work obtained in that case is repre-



sented by the area KGABCDK, whilst of this the work represented by KGA ρ K has to be deducted, as done upon clearance steam, and, although apparently lost, must finally partially reappear in its influence on the form of the expansion curve.

In the case of two or more cylinders, if the variations of pressure and volume in the receiver are known, the complete cycle for the passage of the steam through the

engines could be traced, and the various losses definitely analysed.

Fig. 3 is an example of the mean diagrams from a Triple Expansion Engine trial compounded in this manner, the low-pressure diagram being uncompleted for reasons of economy of space. The dotted line shews the diagrams before setting back with the clearance expansion lines in position. Diagrams such as *Fig. III.* can be converted into entropy diagrams by the graphical method introduced by Professor Boulvin.*

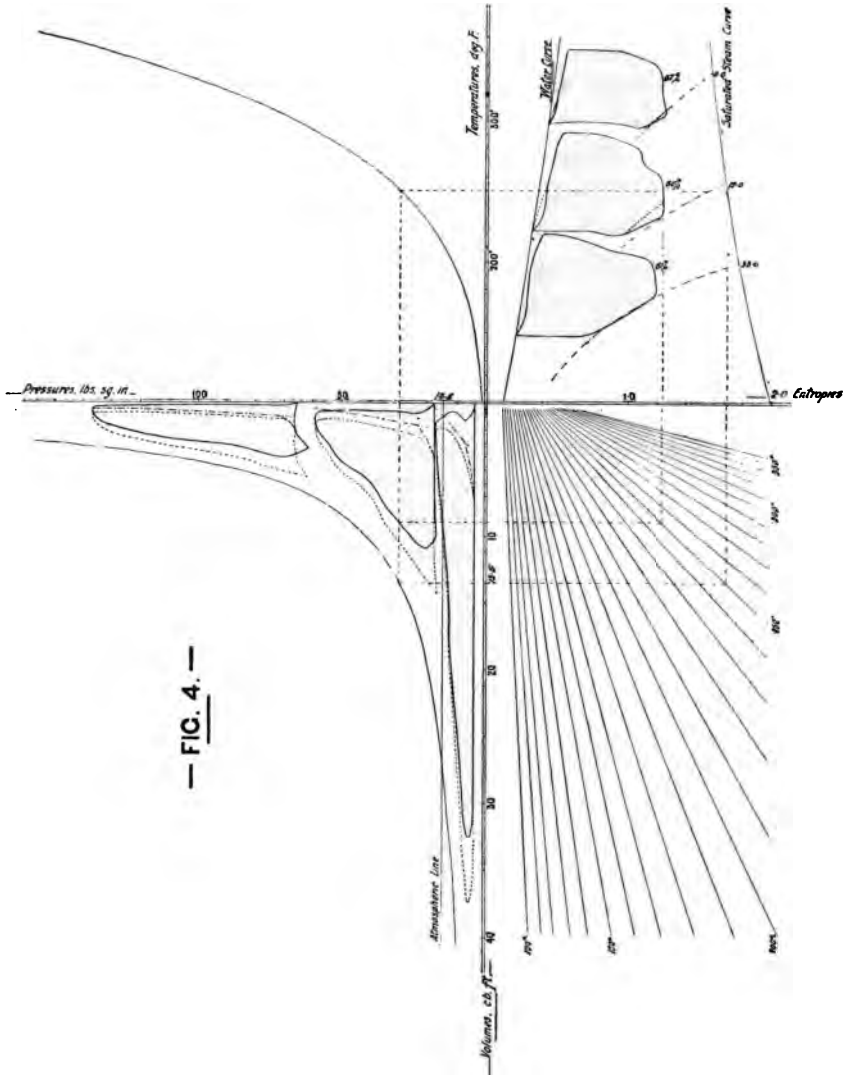
Fig. 4 is such a diagram from the mean cards of a set of diagrams taken from the engines of the steamship "Tartar," the trials of which were described in the *Proceedings of the Institution of Mechanical Engineers* for 1890 and 1894. It will be noticed that the expansion lines of the diagrams by this method are roughly in coincidence with the adiabatic expansion line, thus shewing that the jackets were doing little more than preventing the conduction of heat away from the cylinders. Considering the small ratio the jacket water bore to the cylinder feed (3.94%), this is only what might have been expected.

The position of the expansion line with regard to the adiabatic line also seems to corroborate the assumption, which was generally made, in the discussion of this trial, to explain the magnitude of the missing steam, viz., that there had been a large amount of priming. For, had initial condensation been the only factor, the expansion line ought to have left the adiabatic as the temperature fell, on account of the heat regained from the walls of the cylinder.

Constant volume curves have been drawn in for the steam during expansion after release. In the low pressure

* *Engineering*, 1896.

engine this corresponds with the actual line very fairly. In the intermediate and high-pressure diagrams this cor-



— FIG. 4. —

respondence is absent. This is due to the point of release for these cards being unknown, and, as the diagrams show

the point which was assumed has turned out to be too late in the stroke. The dotted curves shew the result of taking an earlier release, with its corresponding alteration in the clearance work.

The dryness fractions, as obtained from these diagrams, agree very fairly with those calculated by Mr. Longridge. They do not, however, agree with those calculated by Captain Riall Sankey, probably because the latter gentleman assumed a quality for the steam at cut-off rather than at compression. On measurement, the area of the diagrams as drawn was found to agree with that given by the indicator cards within reasonable limits.

Analysis of the heat losses has not been attempted, partly because of the uncertainty in the amount of the priming water, and the lack of information regarding the points of compression and release, but chiefly because it has been the intention of the authors to indicate the method of reduction rather than to investigate the performance of any particular set of engines.

**XI. The Representation on a Conical Mantle of
the Areas on a Sphere.**

By C. E. STROMEYER, M.INST.C.E.

Received and read February 5th, 1901.

This problem is solved as soon as it is shewn how to project zones of latitude from a sphere on to a cone, so that the areas of the two zones are equal.

Solution.—Place the conical mantle over the sphere so that the two touch each other tangentially: then the areas of two zones on the sphere and on the cone, produced by their intersection with two spherical surfaces whose common centre is at the apex of the cone, are equal.

This can be proved when the difference of length of radii of the two intersecting spherical surfaces is infinitesimally small, and by summation can be shewn to be true for wider zones.

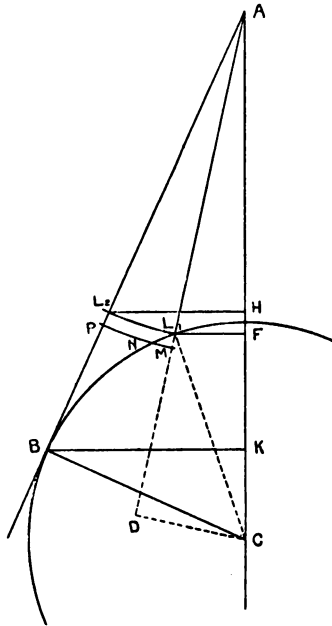
Let C be the centre of the sphere, while A is the apex of the conical mantle, which touches the sphere tangentially along the latitude BK. Let L_1F be the radius of a zone whose width is L_1N , being infinitesimally small. With A as centre, draw the arcs L_1L_2 and NP, prolonging the latter to M, on AL produced. Also draw L_1F and L_2H normal to AC, then it is required to prove that

$$L_1N \cdot L_1F = L_2P \cdot L_2H.$$

To prove this, prolong AL_1 through M to D; draw CD normal to ALD, and join L_1C .

Comparing the triangles L_1MN and CDL_1 , we have the angle $L_1MN = L_1DC$, being right angles. L_1N is normal

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to L_1C and MN is normal to L_1D , therefore the angle $L_1NM = CL_1D$, and therefore the two triangles are similar.

$$\therefore \frac{L_1M}{L_1N} = \frac{CD}{CL_1}.$$

From the pairs of similar triangles CAD , L_1AF and CAB , L_2AH , we find

$$\frac{CD}{L_1F} = \frac{AC}{AL_1}.$$

$$\text{and } \frac{CB}{L_2H} = \frac{AC}{AL_2}.$$

But $CB = CL_1$ being radii of a sphere, and $AL_1 = AL_2$ being radii of a sphere. Substituting the values for CD and CL_1 , we have

$$\frac{L_1M}{L_1N} = \frac{AC \cdot L_1F}{AL_1} \quad \frac{AL_2}{L_2H \cdot AC} = \frac{L_1F}{L_2H}.$$

but $L_1M = L_2P$, therefore

$$L_1N \cdot L_1F = L_2P \cdot L_2H.$$

Q.E.D.

The above is the geometrical construction, giving a projection which has been long known in its analytical aspect. Professor Lamb has pointed out to me that the analytical solution is to be found in Craig's "Treatise on Projections," p. 112. The particular case when the vertical angle of the cone is a right angle has been called by Germain, "Lambert's isospherical stenoteric projection."

XII. The Macro-Lepidoptera of Sherwood Forest.

By J. RAY HARDY.

(Communicated by *W. E. Hoyle, M.A., F.R.S.E.*)

Received and read March 19th, 1901.

The following list of Macro-Lepidoptera (made out to the end of the Geometrina) does not profess to be anything like a complete summary of the species to be found in Sherwood Forest. It only contains my own captures, but is, nevertheless, a fairly satisfactory record of the results of many journeys from Manchester, and many days of keen and systematic collecting in each year from March, 1879, up to September, 1900. As the species have been collected they have all been placed in the British cabinet at the Manchester Museum, Owens College.

The district worked forms a triangle between Worksop, Edwinstowe, and Checkerhouse, and I invariably made Edwinstowe my headquarters. The fine old timber of the district, with its abundant cover, makes it an ideal collecting ground, and, as might be expected, some rare and local forms occur, e.g., *Apatura iris* and *Triphæna subsequa*.

RHOPALOCERA.

<i>Pieris brassicæ</i> , L.	<i>Gonopteryx rhamni</i> , L.
<i>Pieris rapæ</i> , L.	<i>Argynnis paphia</i> , L.
<i>Pieris napi</i> , L.	<i>Argynnis euphrosyne</i> , L.
<i>Anthocharis cardamines</i> , L.	<i>Vanessa atalanta</i> , L.
<i>Colias edusa</i> , Fb.	<i>Vanessa io</i> , L.

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<i>Vanessa polychloros</i> , L.	<i>Thecla betulæ</i> , L.
<i>Vanessa urticæ</i> , L.	<i>Thecla quercus</i> , L.
<i>Apatura iris</i> , L.	<i>Thecla rubi</i> , L.
<i>Pararge egeria</i> , L.	<i>Polyommatus phlæas</i> , L.
<i>Pararge megæra</i> , L.	<i>Thanaos tages</i> , L.
<i>Epinephele ianira</i> , L.	<i>Hesperia thaumas</i> , Hufn.
<i>Cænonympha pamphilus</i> , L.	<i>Hesperia sylvanus</i> , Esp.

HETEROCERA.

<i>Acherontia atropos</i> , L.	<i>Gnophria rubricollis</i> , L.
<i>Chærocampa porcellus</i> , L.	<i>Nudaria mundana</i> , L.
<i>Chærocampa elpenor</i> , L.	<i>Nudaria senex</i> , Hb.
<i>Smerinthus ocellatus</i> , L.	<i>Arctia caja</i> , L.
<i>Smerinthus populi</i> , L.	<i>Phragmatobia fuliginosa</i> , L.
<i>Macroglossa stellatarum</i> , L.	<i>Spilosoma menthastri</i> , Esp.
<i>Trochilium apiformis</i> , Clerck.	<i>Spilosoma lubricipeda</i> , Esp.
<i>Sesia tipuliformis</i> , Clerck.	<i>Callimorpha jacobææ</i> , L.
<i>Sesia culiciformis</i> , L.	<i>Lasiocampa rubi</i> , L.
<i>Ino statices</i> , L.	<i>Lasiocampa quercus</i> , L.
<i>Zygæna filipendulæ</i> , L.	<i>Eriogaster lanestris</i> , L.
<i>Cerura furcula</i> , L.	<i>Odenestris. potatoaria</i> , L.
<i>Cerura bifida</i> , Hb.	<i>Saturnia pavonia-minor</i> , L.
<i>Cerura vinula</i> , L.	<i>Cilix spinula</i> , Schiff.
<i>Notodonta dromedarius</i> , L.	<i>Drepana falcataria</i> , L.
<i>Notodonta ziczac</i> , L.	<i>Psyche nigricans</i> , Stt.
<i>Pterostoma palpina</i> , L.	<i>Thyatira derasa</i> , L.
<i>Leiocampa dictæa</i> , L.	<i>Thyatira batis</i> , L.
<i>Leiocampa camelina</i> , L.	<i>Cymatophora diluta</i> , Fb.
<i>Pygæra bucephala</i> , L.	<i>Cymatophora flavicornis</i> , L.
<i>Orgyia antiqua</i> , L.	<i>Bryophila perla</i> , Fb.
<i>Orgyia gonostigma</i> , Fb.	<i>Acronycta tridens</i> , Schiff.
<i>Porthesia chrysorrhæa</i> , L.	<i>Acronycta psi</i> , L.
<i>Lithosia complana</i> , L.	<i>Acronycta leporina</i> , L.
<i>Lithosia complanula</i> , Bdv.	<i>Acronycta megacephala</i> , Fb.

<i>Acronycta ligustri</i> , Fb.	<i>Triphæna interjecta</i> , Hb.
<i>Acronycta rumicis</i> , L.	<i>Triphæna subsequa</i> , Hb.
<i>Acronycta menyanthidis</i> , View.	<i>Triphæna orbona</i> , Hufn.
<i>Leucania turca</i> , L.	<i>Triphæna pronuba</i> , L.
<i>Leucania lithargyria</i> , Esp.	<i>Noctua augur</i> , Fb.
<i>Leucania comma</i> , L.	<i>Noctua plecta</i> , L.
<i>Leucania impura</i> , Hb.	<i>Noctua c. nigrum</i> , L.
<i>Leucania pallens</i> , L.	<i>Noctua brunnea</i> , Fb.
<i>Nonagria fulva</i> , Hb.	<i>Noctua festiva</i> , Hb.
<i>Nonagria typhæ</i> , Esp.	<i>Noctua baja</i> , Fb.
<i>Gortyna flavago</i> , Esp.	<i>Noctua xanthographa</i> , Fb.
<i>Hydræcia nictitans</i> , Bork.	<i>Panolis piniperda</i> , Panz.
<i>Hydræcia micacea</i> , Esp.	<i>Tæniocampa gothica</i> , L.
<i>Xylophasia rurea</i> , Fb.	<i>Tæniocampa instibilis</i> , Esp.
<i>Xylophasia polyodon</i> , L.	<i>Tæniocampa gracilis</i> , Fb.
<i>Xylophasia hepatica</i> , L.	<i>Tæniocampa munda</i> , Esp.
<i>Neuria saponariæ</i> , Bork.	<i>Tæniocampa cruda</i> , Tr.
<i>Heliophobus popularis</i> , Fb.	<i>Orthosia lota</i> , Clerck.
<i>Mamestra brassicæ</i> , L.	<i>Orthosia macilenta</i> , Hb.
<i>Mamestra persicariæ</i> , L.	<i>Anchocelis rufina</i> , L.
<i>Apamea basilinea</i> , Fb.	<i>Anchocelis pistacina</i> , Fb.
<i>Apamea connexa</i> , Bork.	<i>Anchocelis litura</i> , L.
<i>Apamea gemina</i> , Hb.	<i>Cerastis vaccinii</i> , L.
<i>Apamea oculatea</i> , Gn.	<i>Cerastis spadacea</i> , Hb.
<i>Miana strigilis</i> , Clerck.	<i>Scopelosoma satellitia</i> , L.
<i>Miana fasciuncula</i> , Haw.	<i>Hoporina croceago</i> , Fb.
<i>Caradrina morpheus</i> , Hufn.	<i>Xanthia cerago</i> , Fb.
<i>Caradrina cubicularis</i> , Bork.	<i>Xanthia gilvago</i> , Haw.
<i>Rusina tenebrosa</i> , Hb.	<i>Xanthia ferruginea</i> , Esp.
<i>Agrotis suffusa</i> , Hb.	<i>Tethea subtusa</i> , Fb.
<i>Agrotis segetum</i> , Schiff.	<i>Tethea retusa</i> , L.
<i>Agrotis exclamationis</i> , L.	<i>Cosmia trapezina</i> , L.
<i>Triphæna ianthina</i> , Esp.	<i>Cosmia affinis</i> , L.
<i>Triphæna fimbria</i> , L.	<i>Dianthæcia carpophaga</i> , Bork.

The parapodia of the 28th segment of *G. congoensis*, and *G. hupferi* correspond with the median parapodia (about 100th segment) in the species from the Falkland Islands and Norway, in that the notopodium is a well developed structure.

The lower limb of the notopodium of this species differs markedly from that of the tropical *G. congoensis*, in that in the latter the notopodium bears no capillary bristles, their place being taken by two fairly stout acicula which just appear above the surface. This form is like another tropical form, ? *G. longicirrata*, in the presence of multi-acicula and the absence of capillary bristles in the notopodium.

In the Falkland Islands specimen the lower limb of the notopodium does not appear until the 56th segment, when it has the form of a small finger-shaped process, devoid of bristles, which, however, as previously stated, are present on the succeeding segments. In a specimen of *G. norvegica* which I have examined, the lower limb of the notopodium appears on the 35th segment.

Throughout the Polychæta, a typical parapodium consists of a notopodium and a neuropodium, each bearing, in addition to the ordinary bristles, a single aciculum. The extra-tropical species of *Goniada* have typical parapodia, but in two tropical forms (one of which, owing to the absence of characteristic features, Arwidsson doubtfully places in this genus) the parapodia are modified, in that the notopodium is multi-aciculate and the ordinary bristles are absent. Therefore we may assume that the form of parapodium possessed by extra-tropical forms is the primitive one, and that from it the modified form seen in some tropical species has been derived; that is to say, the parapodium of extra-tropical forms has remained true, while that of tropical forms shows a tendency to variation.

The specimen from the Falkland Islands agrees with those from Norway in size, colour, and general conformation of the body, in the form and arrangement of the parapodia, and in the minute anatomy of the bristles. The proboscis, with surface papillæ, ring of larger papillæ at the tip, and the arrangement of the multi-cusped teeth are similar in both cases.

The two points of difference—the number of teeth, and arrangement of papillæ on the proboscis—between the Norwegian and Falkland Islands specimens, are not sufficient to necessitate the separation of the latter into a distinct species, for Darwin (*Origin of Species*, p. 169), on the authority of Bronn, states that “distinct species never differ from each other in single characters, but in many parts.” Therefore we may assume that the two forms belong to one species, and that the variation has been brought about by a difference in the conditions of life, probably in the character of the food material.

But even if we do not regard the two forms as belonging to one species, the fact still remains that the two extra-tropical forms are more closely related to each other than to any known intervening tropical form.

SPIONIDÆ.

Polydora polybranchia. Haswell ('85), p. 273. Carazzi ('93), p. 15. Ehlers ('96), p. 87.

Found in a hollow root of *Macrocystis* from 3 fathoms, also removed from the bottom of a lighter beached for cleaning (the vessel had not left the harbour for many years); also from a small piece of water-logged timber at low water spring tides.

Distribution.—Sts. of Magellan, Sydney, Naples. New to Falkland Islands, not taken within the tropics.

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<i>Dianthæcia cucubali</i> , Fues.	<i>Hadena thalassina</i> , Rott.
<i>Polia chi</i> , L.	<i>Calocampa solidaginis</i> , Hb.
<i>Miselia oxyacanthæ</i> , L.	<i>Xylina petrificata</i> , Fb.
<i>Agriopis aprilina</i> , L.	<i>Cucullia chamomillæ</i> , Schiff.
<i>Phlogophora meticulosa</i> , L.	<i>Cucullia umbratica</i> , L.
<i>Euplexia lucipara</i> , L.	<i>Anarta myrtilli</i> , L.
<i>Aplecta herbida</i> , Hb.	<i>Brephos parthenias</i> , L.
<i>Aplecta occulta</i> , L.	<i>Plusia chrysitis</i> , L.
<i>Aplecta nebulosa</i> , Hufn.	<i>Plusia festucae</i> , L.
<i>Aplecta tincta</i> , Brahm.	<i>Plusia iota</i> , L.
<i>Aplecta advena</i> , Fb.	<i>Plusia gamma</i> , L.
<i>Hadena adusta</i> , Esp.	<i>Gonoptera libatrix</i> , L.
<i>Hadena protea</i> , Bork.	<i>Amphipyra tragopogonis</i> , L.
<i>Hadena dentina</i> , Esp.	<i>Mania typica</i> , L.
<i>Hadena suasa</i> , Bork.	<i>Mania maura</i> , L.
<i>Hadena oleracea</i> , L.	<i>Euclidia mi</i> , Clerck.
<i>Hadena pisi</i> , L.	

Geometrina.

<i>Uropteryx sambucaria</i> , L.	<i>Amphidasys betularia</i> , L.
<i>Epione apicaria</i> , Schiff.	<i>Boarmia repandata</i> , L.
<i>Rumia crategata</i> , L.	<i>Boarmia rhomboidaria</i> , Hb.
<i>Venilia maculata</i> , Schiff.	<i>Boarmia roboraria</i> , Schiff.
<i>Angerona prunaria</i> , L.	<i>Tephrosia crepuscularia</i> , Hb.
<i>Selenia illunaria</i> , Hb.	<i>Geometra papilionaria</i> , L.
<i>Selenia lunaria</i> , Schiff.	<i>Hemithea thymiaria</i> , Gn.
<i>Odontopera bidentata</i> , Clerck.	<i>Ephyra porata</i> , Fb.
<i>Crocallis elinguarua</i> , L.	<i>Ephyra trilinearia</i> , Bork.
<i>Ennomos tiliaria</i> , Bork.	<i>Ephyra orbicularia</i> , Hb.
<i>Ennomos angularia</i> , Bork.	<i>Venusia cambrica</i> , Curt.
<i>Himera pennaria</i> , L.	<i>Acidalia scutulata</i> , Bork.
<i>Pligalia pilosaria</i> , Hb.	<i>Acidalia bisetata</i> , Hufn.
<i>Amphidasys prodromaria</i> , Schiff.	<i>Acidalia imitaria</i> , Hb.
	<i>Acidalia remutaria</i> , Hb.

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|--|--------------------------------------|
| <i>Acidalia aversata</i> , L. | <i>Eupithecia dodoneata</i> , Gn. |
| <i>Acidalia emarginata</i> , L. | <i>Eupithecia rectangulata</i> , L. |
| <i>Cabera pusaria</i> , L. | <i>Thera variata</i> , Schiff. |
| <i>Cabera rotundaria</i> , Haw. | <i>Hypsipetes elutata</i> , Hb. |
| <i>Cabera exanthemata</i> , Scop. | <i>Melanthia ocellata</i> , L. |
| <i>Macaria alternata</i> , Curt. | <i>Melanthia albicillata</i> , L. |
| <i>Macaria notata</i> , L. | <i>Melanippe hastata</i> , L. |
| <i>Halia wavaria</i> , Fb. | <i>Melanippe rivata</i> , Hb. |
| <i>Fidonia atomaria</i> , L. | <i>Melanippe montanata</i> , Bork. |
| <i>Bupalis piniaria</i> , L. | <i>Melanippe fluctuata</i> , L. |
| <i>Abraxas ulmata</i> , Fb. | <i>Anticlea rubidata</i> , Fb. |
| <i>Abraxas grossulariata</i> , L. | <i>Anticlea badiata</i> , Hb. |
| <i>Abraxas adustata</i> , Schiff. | <i>Coremia propugnata</i> , Fb. |
| <i>Abraxas marginata</i> , L. | <i>Coremia ferrugata</i> , Clerck. |
| <i>Hybernia rupicapraria</i> , Hb. | <i>Camptogramma bilineata</i> , L. |
| <i>Hybernia leucophearia</i> , Schiff. | <i>Cidaria miata</i> , L. |
| <i>Hybernia progemmaria</i> , Hb. | <i>Cidaria corylata</i> , Thnb. |
| <i>Hybernia defoliaria</i> , Clerck. | <i>Cidaria russata</i> , Bork. |
| <i>Anisopteryx æscularia</i> , Schiff. | <i>Cidaria inmanata</i> , Haw. |
| <i>Cheimatobia brumata</i> , L. | <i>Cidaria suffumata</i> , Hb. |
| <i>Oporabia dilutata</i> , Bork. | <i>Cidaria prunata</i> , L. |
| <i>Larentia didymata</i> , L. | <i>Cidaria testata</i> , L. |
| <i>Larentia miaria</i> , Bork. | <i>Cidaria fulvata</i> , Forst. |
| <i>Eupithecia venosata</i> , Fab. | <i>Cidaria pyratiata</i> , Fb. |
| <i>Eupithecia centaureata</i> , Fb. | <i>Eubolia mensuraria</i> , Schiff. |
| <i>Eupithecia castigata</i> , Hb. | <i>Eubolia bipunctaria</i> , Schiff. |
| <i>Eupithecia nanata</i> , Hb. | <i>Anaitis plagiata</i> , L. |
| <i>Eupithecia vulgata</i> , Haw. | <i>Tanagra atrata</i> , L. |
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XIII. A Collection of Polychæta from the Falkland Islands.

By EDITH M. PRATT, M.Sc. (Vict.),

Honorary Research Fellow, Owens College, Manchester.

(*Communicated by Professor S. J. Hickson, M.A., F.R.S.*)

Received and read April 23rd, 1901.

For this collection of Polychæta, from the Falkland Islands, I am indebted to Mr. R. Vallentin, of New Quay, formerly of Falmouth, who made the collection towards the end of the year 1898 and in the beginning of 1899. It includes specimens of the following genera and species:

APHRODITIDÆ.

Hermadion magalhensis. Kinberg ('55).

= *H. kerguelensis.* M'Intosh ('85).

= *H. longicirratum.* Kinberg, Baird.

= *H. longicirratum.* Kinberg, M'Intosh.

Three specimens found living in a hollow root of *Macrocystis* from 3½ fathoms.

Distribution.—Sts. Magellan, Kerguelen (numerous at 60 fath.), Falkland Islands (3-10 fath.). The genus appears to be restricted to the southern hemisphere.

PHYLLODOCIDÆ.

Eteone spathocephala. Ehlers ('96), p. 32.

One specimen, bright green in colour when alive, without anal cirri, found under a stone at low water.

Distribution.—Sts. Magellan. New to Falkland Islands.

Genus. Occurs in northern and southern temperate and cold waters, but up to the present has not been taken within the tropics.

September 10th, 1901.

SYLLIDÆ.

Autolytus simplex. Ehlers ('00).

Taken in tow-net at the surface and at a depth of $3\frac{1}{2}$ fathoms, also common on fronds of *Macrocystis* from 2 fathoms.

Distribution.—Sts. of Magellan. New to Falkland Islands.

Genus. 11 species have been taken in temperate and cold waters of the northern and southern hemisphere, and one doubtful species has been taken in the Red Sea, so that the genus is almost exclusively extra-tropical. The occurrence of a doubtful species of this otherwise extra-tropical genus in the Red Sea leads one to believe that it is an escape from the Mediterranean, where the genus is well represented. Keller and Brandt have shown that many Mediterranean forms have increased their range of distribution in that direction since the formation of the Suez Canal.

NEREIDÆ.

Platynereis magalhensis. Kinberg ('65).

= *Platynereis antarctica.* Kinberg ('65), p. 177.

= " *patagonica.* " " "

= *Nereis antarctica.* Verrill ('76).

= " *eatoni.* M'Intosh ('76), p. 320.

= " *magalhensis.* Ehlers ('96), p. 63.

Two specimens found living in a hollow root of *Macrocystis* from $3\frac{1}{2}$ fathoms, and two, with egg masses containing developing embryos, within folded fronds of *Macrocystis* from 2 fathoms in Stanley Harbour.

Distribution.—Sts. Magellan, Kerguelen, Falkland Islands, Fernando Noronha, Marion Island.

The genus is cosmopolitan.

GONIADÆ.

Goniada norvegica Örsted, var. *falklandica*. Arwidsson ('99), p. 38. (New variety).

A single mature specimen, with ova, consisting of about 182 segments, found living in a hollow root of *Macrocystis* taken at a depth of 3 fathoms. The tail end missing in the preserved state.

Length about 180 mm.; without proboscis, 140 mm. Breadth at the widest part, including parapodia, 10-11 mm. The breadth is greatest in the middle of the body, mainly due to the increase in size and development of the parapodia in this part of the body.

Colour. The specimen was well preserved in formalin; dorsal surface, greenish-brown; ventral surface, brownish. The whole surface of the body, including proboscis, covered with a thin transparent cuticle having an iridescent metallic lustre. In these respects it closely resembles the Norwegian species.

As this affords a good example of the same species occurring in the north and south temperate regions but not in the tropics, I have given a detailed examination of the form. Through the kindness of Dr. Appellöf, of Bergen, I have been able to examine specimens of the species from Norway, and to compare them with the specimen from the Falkland Islands. It was important that an actual comparison of these forms should be made, for, in the discussions on the Bipolar Theory, there has been an uncertainty (due to the vagueness of the published accounts of species) as to the degree of resemblance between extra-tropical forms, and it was doubtful whether some should be classed as varieties or as individual species.

Prostomium. Conical, nearly twice as long as broad, with 9 segments, the basal one being the largest; at the tip are 4 small tentacles. In form the prostomium closely

resembles that of the Norwegian specimens, but it is rather more broadly conical.

Proboscis. Cylindrical, about 40 mm. in length, everted portion about 20 mm. The surface of the proboscis covered with an iridescent cuticle, is almost universally studded with small papillæ, not quite so numerous near the base of the proboscis, and each of which appears to have a chitinous tip.

Teeth. Four pairs of small, laterally placed, V-shaped teeth (see *Fig. 2*). At the tip of the proboscis there is a ring of 17 papillæ, and below this, the multicusped teeth, characteristic of the genus, are arranged more or less in a circle. There are:—15 dorsal micrognatha, 2 large macrognatha and 17 ventral micrognatha. Total = 34 (see *Fig. 6*). The everted proboscis is not so broad as that of a Norwegian specimen, from which it also differs in the arrangement of papillæ. In the latter they are more numerous on the dorsal than on the ventral surface, while in the specimen from the Falkland Islands they are almost universally scattered over the surface of the proboscis. The ring of papillæ at the tip of the proboscis, and the circle of multicusped teeth below this ring, are similar in arrangement to those of the Norwegian specimens (see *Figs. 5 and 6*).

Ehlers records a new species, *Goniada eximia*, from the Sts. of Magellan, which is like the Falkland Islands specimen in the possession of 4 pairs of V-shaped teeth, but differs from it in the number of multicusped teeth. The description of the species is not sufficiently definite to determine whether these two forms are identical in other respects. The most important point of difference between the specimen from the Falkland Islands and those from Norway is in the number of V-shaped teeth on the proboscis. The following table will show that it differs also from the tropical forms in this respect.

NUMBER OF V-SHAPED TEETH.

Falkland Islands.	Norway.	Tropical.			
<i>G. Norvegica</i> , var. <i>falklandica</i> .	<i>G. norvegica</i> .	<i>G. congoensis</i> .	<i>G. hupferi</i> .	<i>G. multi-dentata</i> .	<i>G. pausidens</i> .
4	17—18	13	14	90	13

The *Parapodia* are large, well-marked structures, which, in the middle of the body, take up at least two-thirds of the breadth of the animal. In the anterior parapodia the notopodium is represented only by a curved dorsal cirrus; the neuropodium is here a well-marked triramous structure with a lancet-shaped ventral cirrus. About the 56th segment a small finger-shaped process grows out below the dorsal cirrus; on this segment the process is devoid of bristles, but on the following segment this portion of the notopodium bears a single capillary bristle. The parapodia continue to grow larger towards the middle of the body; the notopodium becomes a well marked structure; the dorsal cirrus becoming smaller in comparison with the increased size of the notopodium. The capillary bristles of the notopodium are quite distinct from the jointed bristles on the neuropodium, which also increase in size in this part of the body.

Posteriorly the parapodia diminish in size, and there is a corresponding reduction in the number of bristles borne by the notopodia and neuropodia respectively. Throughout the whole length of the body the triramous neuropodium is a larger and more important structure than the notopodium.

The most important feature of the parapodia is their

XIV. Some Notes on the Bipolar Theory of the Distribution of Marine Organisms.

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(Communicated by Professor S. J. Hickson, M.A., F.R.S.)

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Théel is supposed by many to be the first zoologist to notice the resemblance between the north and south polar faunas, but as early as 1847 Sir James Ross noted that several species which inhabit the Arctic occur also in Antarctic waters. Many years later Selenka ('83) and De Guerne ('88) observed that certain Gephyrea inhabiting the north polar seas are very nearly related to those in the south polar seas. In 1886 Théel compared actual specimens of Holothurids from Arctic and Antarctic waters, and of them he says (p. 260) "It is a fact that, "with regard to Holothurids, several forms occur in the "Arctic sea which are most closely allied to those of the "Antarctic."

In explanation of the curious similarity between the north and south polar faunas Pfeffer ('91) proposed the "Bipolar Theory," which maintains that the many points of resemblance existing between Arctic and Antarctic faunas are sufficient to indicate a nearer relationship of these faunas to one another than to the intervening tropical fauna. He also states that the littoral marine fauna is the primitive one, and from it the deep sea, brackish and fresh-water faunas are derived.

In 1896 Sir J. Murray* investigated the distribution

* A short abstract of Murray's paper is contained in my previous paper on the marine fauna of the Falkland Islands (Pratt, '98).

September 10th, 1901.

of forms obtained by the *Challenger* expedition, and, by drawing up a long list of bipolar forms, supported Pfeffer's theory. Furthermore, by a consideration of former different climatic conditions affecting the nature of the surface of the earth, he shows how this relationship may have been brought about. He maintains that if there were once a nearly universal climate over the whole of the ocean, then it is possible that there was a universal littoral marine fauna. The cooling of the earth at the poles would cause vast migrations of forms towards the tropics, where the struggle for existence would be extremely severe, and metabolism would be great. This would result in modification of old, and rapid formation of new, species in the warmer waters. Many forms with free-swimming pelagic larvæ, by limiting their reproductive process to the summer season, would be able to live on in the temperate regions, where metabolism would be less than in the warmer waters, and would remain more or less true. Thus the likeness of many littoral, temperate, extra-tropical forms to each other would be explained.

With the migration of forms from the poles, their place would be taken by organisms from the deeper mud-line, few of which have pelagic larvæ. This would explain the likeness between Arctic and Antarctic forms.

The theory put forward by Pfeffer and strongly supported by Murray, met with considerable opposition from Ortmann, Professor D'Arcy Thompson, and others. In the following pages I have attempted to discuss briefly the evidence for and against the theory.

Ortmann ('96-'99) contends that the cooling of the waters at the poles did not arrest metabolism, and maintains that the tropical fauna has remained more or less true, while the temperate and polar forms are derivatives from ancestral forms. He maintains that the likeness

between extra-tropical forms does not indicate a common descent, but is in many cases a "secondary reappearance." He holds that an interchange of polar forms may take place through the deep sea, on the ground that among the crustacea the cosmopolitan genus *Pontophilus* shows a tendency to retire into deep water, and only occurs in the tropics in the deep sea. He suggests that many bipolar forms may occur in the tropics in deep water and have thus escaped extermination.

This point, however, is by no means proved, for in the case of many littoral bipolar forms we have no evidence that they ever retire into deep water.

In explanation of the distribution of such forms, he maintains that an interchange of supposed bipolar forms may take place through the tropics along the western shores of America, where, owing to cold ocean currents, etc., the temperature of the tropical waters is lowered. This would explain the occurrence of some, but not all, similar forms in the north and south temperate Pacific.

On the ground that a variety of the European *Maia squinado* (*M. squinado capensis*) has been taken at the Cape of Good Hope, Ortmann further maintains that a similar interpassage of forms takes place along the western shores of Africa. This, however, is by no means proved, and it is within the province of this paper to show that a variety of a northern European species (*Goniada norvegica*)* may occur in the south Atlantic (Falkland Islands), while the genus is represented in the tropics, *i.e.*, along the western shores of Africa, by several distinct and modified species.

That an interchange of extra-tropical forms takes place along the western shores of America and Africa is only proved for such forms as have actually been taken in

* *Manchester Memoirs*, Vol. 45, No. 13, p. 3.

the warm waters of the Panama region and in the Gulf of Guinea, where the littoral fauna is of a distinctly tropical character.

In a second paper ('99) in opposition to the theory, Ortmann gives a short extract from Buerger's paper on the Nemertines on the subject of bipolarity, with the following comments:—

“As regards the genera, all Antarctic genera are also found in the Arctic; Buerger says that ‘a general similarity of both Polar faunas is thus indicated,’ but the lack of 12 Arctic genera in the Antarctic does not support this view, and since he says further that neither of the faunas seems to possess very characteristic types, as do (*sic*) the tropics, it is evident that these 9 genera, common to both polar faunas, are also represented in the tropics. There is one genus that seems to be bipolar: *Carinoma*, which has been found on the west coast of England (*C. armandi*), and in the Straits of Magellan (*C. patagonica*).”

We have no evidence in support of Ortmann's statement that “it is evident that these 9 genera, common to both polar faunas, are also represented in the tropics.” When we consider how little is known of the Antarctic fauna, the fact that 12 Arctic genera have not yet been taken in Antarctic waters must not be regarded as an important piece of evidence against the bipolar theory.

If there were once a universal fauna, modification and specialization, after the lapse of ages, would lead to the formation of species which would be more or less limited in their range of distribution; some forms would survive and be prolific in species in the north, which in the south would become extinct or form only few species, or *vice versa*; and, as a fact, at the present time, we have many species which are peculiar to the northern or to the

southern hemisphere. Yet, notwithstanding the changes through which species have passed, we should expect to find some forms, not very numerous perhaps, but still some forms, which have remained more or less true to their ancestral structure. Therefore, points of similarity in extra-tropical forms, which are not shared with tropical forms, have a most important bearing upon the "Bipolar Theory." It is but natural that the similarity would be more marked in some groups than in others.

It is to be greatly deplored that, owing to a want of uniformity in the recognition of specific and even of generic characters on the part of authors, many forms have been regarded as new and distinct species or genera which further investigation has shown should have been included with previously described forms. Murray and other writers have shown this to be a great obstacle in the identification of many *Challenger* species. Therefore, in order that the relationship between extra-tropical forms may be ascertained, it is imperative that, wherever possible, an actual examination and comparison of these forms with tropical representatives—where they do occur—should be made.

In a paper supporting Ortmann's view in opposing the theory, Professor D'Arcy Thompson ('97) states that many of the forms included in Sir John Murray's list of bipolar forms are recorded, not as identical, but as distinct varieties, and maintains that this fact weakens the evidence in support of that theory.

It is admitted that the "Bipolar Theory" does not necessarily depend upon *the specific identity of bipolar forms*, but upon the relationship of these forms to each other. Therefore, the fact that Arctic and Antarctic specimens of the same species do show some constant variation from one another strengthens the evidence in

support of the theory, for it shews that a species which is absent or modified beyond recognition in the tropics has remained almost true in extra-tropical waters.

In an account of the Holothurians of the Straits of Magellan, Ludwig ('98) says "there are no bipolar species in the group." He calls attention to a certain general likeness of the faunas expressed by the mutual prevalence of certain genera and the mutual lack of others as compared with the tropical faunas. Ortmann does not regard this as being of any consequence, and states that it has no connection with the question under discussion.

The similarity in character between the Arctic and Antarctic plankton, noted by Sir John Murray, is also commented upon by I. C. Thompson ('98) who records the following northern species of Copepoda from Antarctic waters: (1) *Metridia longa*; (2) *Oithona spinifrons*; and (3) *Ectinosoma atlanticum*.

In the same paper he says:—

"The well-known *Calanus finmarchicus* so commonly distributed through our northern latitudes, appears to be equally common about the Antarctic, and occurred in 16 of the gatherings."

Prof. D'Arcy W. Thompson states that *Calanus hyperboreus* is closely allied to, if not merely a large variety of, *C. finmarchicus*, which is known to occur off the Canaries in 30° N. lat., as well as off Australia in 37° S. lat., and which, according to I. C. Thompson, is also present in the Antarctic together with the species *hyperboreus*; it is therefore not 'bipolar' but 'cosmopolitan.'

Of this I. C. Thompson says:—"Associated with *C. finmarchicus*, and fairly plentiful in some of the bottles, was the large red Arctic species *C. hyperboreus*, formerly passed over as a mere Arctic variety of *C. finmarchicus*,

“but now separated by Giesbrecht as a distinct species. “Besides being of a uniformly larger size than *C. finmarchicus*, it differs from the latter in having lateral “nipple-shaped projections at the terminations to the “cephalothorax, in the large square-shaped first joint of “the abdomen, and in the form of the basal serratures of “the 5th pair of feet.”

Even if this form be classed as a variety of *C. finmarchicus*, the species cannot be called “cosmopolitan,” for it has not been taken within the tropical belt. The close relationship between the two forms gives strong evidence in favour of Murray’s bipolar hypothesis, for we have a single distinct species occurring in Arctic and Antarctic waters, which in the warmer waters approaching the tropics becomes so far modified as to form—on the authority of Giesbrecht—another species. We cannot consider the form inhabiting warmer waters to be the one from which the form occurring in Arctic and Antarctic waters has been derived, for, although modification might proceed on parallel lines in a form so widely separated, when subjected to similar conditions of temperature, etc., yet we could not expect it to lead to an identical result in the two cases.

In a paper on the mutual relations of Arctic and Antarctic faunas, Pfeffer, (’99 and :01) maintains that the relationship between extra-tropical forms is confirmed by palæontological evidence.

Of the fauna of the deep sea he says : “The peopling “of the deep sea from the polar zone has been an un- “interrupted process from the Mesozoic age until now.” He holds that the migration of bipolar forms into the deep waters of the temperate zone is not recent, for at the present time, owing to sub-oceanic upheavals, “the polar “zone in the Pacific is absolutely, and in the Atlantic

“almost entirely, shut off from the deep water of the temperate zone.” On p. 317 he says: “It would seem that the time which has elapsed since the present surface-water species of the higher north and south descended to the depths has not sufficed for a migration beyond the equator to the opposite hemisphere.”

For the littoral fauna he maintains that, although the connection of northern and southern faunas was continuous through the tropics in mid-tertiary times, actual observations at the present time show that “littoral” species occurring in north and south higher latitudes have, in general, in the tropics, an interrupted discontinuous distribution.

The fauna of the West Coast of America, from the temperate southern to the temperate northern zone, he states to be “of a nearly homogeneous character, interrupted only in the narrow province of Panama, where the littoral fauna is of a tropical character. In general character it may be described as a cool water fauna, but it has undergone quite remarkable local differentiation. . . . This fauna springs apparently from the southern hemisphere . . . and has crowded out, more or less, the members of the universal fauna.” The narrowness of the continental slope and the presence of the mouths of subterranean rivers would readily afford an opportunity for an interruption of faunal continuity.

In conclusion he says (p. 322): “Faunas of higher latitudes represent the coeval relics of the almost uniformly developed and almost universally distributed early-tertiary faunas, as they have been evolved under the influence of the cooling of the climate by a process of separating out and selection. The similarity of the operating causes secured that the same components of the old fauna remained behind in both north and south, and

“thus has arisen the great, and still well-marked, similarity
“of the two faunas.”

In his revision of the *Echiuridæ*, Shipley ('99. p. 355) gives a list of the species belonging to the genus *Echiurus*, showing their geographical distribution. In all, there are four species :—

<i>Echiurus chilensis.</i>	Punta Arenas. Straits of Magellan.
„ <i>forcipatus.</i>	Off the coast of Greenland.
„ <i>pallasii.</i>	North Sea, N. Atlantic, and English Channel (in soft sand, mud, or clay).
„ <i>unicinctus.</i>	Japanese waters (in the mud near the shore).

Shipley says “It is thus evident that this genus is a
“denizen of the colder seas, and reaches from the Arctic
“to the cooler waters of the temperate regions of both
“hemispheres.”

Fischer ('96, p. 7) has drawn up a table showing a comparison of sub-antarctic American Gephyrea with allied arctic forms, from which the following is derived:

Antarctic.	Arctic.
1. <i>Phascolosoma margaritaceum</i> , Sars.	1. * <i>Phascolosoma margarita</i> <i>ceum</i> , Sars.
var. <i>antarcticum</i> , Mich. South Georgia.	Greenland(?) North America, Spitz- bergen, Norway, North Sea.
„ <i>fuscum</i> , Mich. South Georgia.	var. <i>papillosum</i> , Thomps. Ireland.
„ <i>georgianum</i> , Mich. South Georgia.	
„ <i>capsiforme</i> , Baird. Falkland Islands, Sts. of Magellan, Tierra del Fuego, Picton Isl.	

Antarctic.	Arctic.
2. <i>Phascolion</i> sp. ? Smyth Channel.	2. ?
3. <i>Echiurus chilensis</i> , Müll. Sts. of Magellan.	3. <i>Echiurus uncinatus</i> , von Drasche. Japan, Amurland.
4. <i>Priapulus caudatus</i> , Lam. var. <i>antarctica</i> , Mich. South Georgia, Tierra del Fuego, Sts. of Magellan, Falkland Isl.	4. <i>Priapulus caudatus</i> , Lam. Arctic seas of North America, Green- land, Iceland, Norway, Baltic, North Sea.
5. <i>Priapuloides australis</i> , De Guerne. Tierra del Fuego.	5. <i>Priapuloides typicus</i> , Kor. & Dan. Greenland, Iceland, Spitzbergen, Nor- way.

Of five species of Gephyrea taken in southern waters, two (*Phascolosoma margaritaceum** and *Priapulus caudatus*) occur also in northern seas; two (*Echiurus chilensis* and *Priapuloides australis*) are represented in northern waters by the closely allied species *Echiurus uncinatus* and *Priapuloides typicus*; whilst one southern form has not been taken in the northern hemisphere.

In the distribution of these species of Gephyrea and the genus *Echiurus*, which have not been taken in the tropics, we have no evidence of an interpassage of species along the western shores of America or Africa.

An interesting list of nine extra-tropical species of Polychæta from the Straits of Magellan is given by Ehlers ('96, p. 11). Of them, three occur also in Arctic waters:

* *Phascolosoma margaritaceum* was taken by Sars, presumably off Norway, at a depth of 300 fathoms, but it has not been taken at any depths at intermediate stations between Ireland and the Straits of Magellan, so we must regard it as extra-tropical.

Nephtys longisetosa, Örsted ; *Notomastus latericeus*, Sars ; *Scolecolepis vulgaris*, Johnst. One, *Glycera americana*, Leidy, occurs on the east coast of North and South America. Five are common to north and south extra-tropical Atlantic, but have not been taken in the Pacific : *Syllides longocirratu*s, Örsted ; *Chætopterus variopedatus*, Ren. ; *Capitella capitata*, Fabr. ; *Terebellides strömii*, S. ; *Serpula vermicularis*, L. (to 175 faths.). In addition to these species, there are three southern species which are very closely related to three northern species : (1) A new species of *Arenicola* (*A. assimilis*) from the Straits of Magellan, which Ehlers believes to be identical with a form taken on the Californian coast. It is very probable that *A. assimilis* will prove to be a variety of *A. marina* or *A. claparedii*, both of which are European forms. The remarks on the distribution of *A. claparedii* (p. 15) would then also apply to this form. (2) *Travisia kerguelensis*, M'Intosh. This form closely resembles, if it is not entirely identical with, the European *T. forbesi*. (3) *Scoloplos kerguelensis*, M'Intosh. Ehlers states that this is clearly very nearly related to *S. armiger*.

In describing a collection of forms from the Falkland Islands, Pratt ('98) notes four extra-tropical species :—

(Polyzoa) *Beania magellanica* ; *Cellepora pustulata*.
(Porifera) *Sycon ciliata*. (Crustacea) *Orchestia chilensis*.

(Gephyrea) *Phascolosoma capsiforme* has since been shown to be a variety of the northern *P. margaritaceum*, var. *capsiforme*.

(Polychæta) *Lagisca magellanica* has been shown to be a synonym of *Harmothoë spinosa*, which appears to differ from the northern *H. imbricata* only in the position of the eyes.

I have shown that, in addition to Pfeffer and Murray, the following writers have noted the similarity between

north and south extra-tropical forms:—Selenka, De Guerne, Fischer, and Shipley, for the Gephyrea, Théel for the Holothurids, Ehlers for the Polychætes, I. C. Thompson for the Plankton, and Pratt for certain littoral forms. Giesbrecht has shown the bipolar *Calanus hyperboreus* to be distinct from the species inhabiting warmer seas (*C. finmarchicus*). Therefore, we cannot accept Ortmann's statement that "all the results of investigations in special groups of animals tend to show that the theory held by Pfeffer and Murray, that both polar faunas are more closely related to each other than to any of the intermediate ones, is without support."

This appears to bring to an end the published evidence bearing upon the "bipolar" controversy.

For the following account of the distribution of *Scalibregma inflatum* I am indebted to Dr. J. H. Ashworth, of Edinburgh. Further information on the subject will be found in his memoir on the "Anatomy of *Scalibregma inflatum*." *Quart. Journ. Micro. Science* (in the press).

Dr. Ashworth examined 40 specimens of *Scalibregma inflatum*, 26 of which were from the United States National Museum, the remainder from the museums of Bergen and Stockholm. Those obtained from Scandinavia were collected chiefly on the Atlantic coast of that peninsula, the U.S. specimens along the east coast of the American continent, the most southerly station at which these were obtained being 40° N. and the most northerly 44° 23' N.

Distribution. *Scalibregma* occurs eastward as far as Cape Grebeni (the most southern point of Waigatsch Island), western shores of Spitzbergen, Nova Zembla, western coast of Norway, and western coast of Sweden (in

Christiania and neighbouring fjords), N.E. and W. coasts of Scotland, the most southerly limit being Millport on the Clyde. It has also been taken on the other side of and the Atlantic, *viz.*, on the western shores of Greenland, and along the eastern coast of the United States (previously mentioned).

M'Intosh, in the *Challenger Reports* ('85, p. 359), states that his specimens are much smaller than the European examples, the largest measuring only 18 mm. Size is not a character of much importance in this connection, for 12 specimens from Norway and Sweden have the following approximate lengths: (1) 56 mm. (this is almost the largest recorded specimen); (2) 35 mm.; (3) 26 mm.; (4) 22 mm.; (5) 16 mm.; (6-12) 7 specimens all of which are between 13 and 14.3 mm. long. Thus of 12 European specimens, 8 are less than M'Intosh's *Challenger* specimens. M'Intosh states that the southern specimens have a more fusiform outline and are less inflated. This, again, is not a character of any constancy, for the shape varies enormously in a series of specimens from the same locality.

He also states that there is a prominent and continuous fold behind the head in British and Norwegian forms, but in the *Challenger* specimens the head has a greater antero-posterior diameter and there are two papillæ.

In Dr. Ashworth's opinion, this is due to the fact that, in the southern specimens, the musculature was comparatively relaxed at the time the animals died, and the head is therefore more completely expanded in those specimens. As far as he is able to judge without seeing the actual specimens, M'Intosh's southern forms agree with the northern forms in the sculpturing of body wall, peculiar furcate sitae (M'Intosh ('85), pl. xxii.A, fig. 21) head, parapodia, cirri, etc.

Scalibregma has not been taken in tropical waters. Off New Zealand it has been taken at a depth of 700 fathoms, and may therefore be classed as a member of the subsurface fauna. It is possible that it may pass through the tropics by means of the deep sea, but as it has not been taken at intermediate stations between the north and south extra-tropical waters, we must regard it as a "bipolar" form.

The controversy on the "Bipolar Theory" has been limited, more or less, to a discussion of the distribution of forms known to occur in deep water. As the littoral marine fauna is supposed to be the most primitive, and therefore the one from which all other faunas are derived, it was thought that an investigation of the distribution of littoral forms would be interesting, in that it would increase the evidence for or against this theory. With this object I have studied the distribution of the Polychæta from the shores of the Falkland Islands.

The collection of Polychæta from the Falkland Islands numbered 13 species; of these:

One is cosmopolitan: *Spirorbis borealis*, Daud.

Eight have been taken in the southern hemisphere: (*Hermadion*) *magalhænsis*, *Thelepus spectabilis*, *Autolytus simplex*, *Eteone spathocephala*, *Sabella ceratodaula*, *Promenia jucunda*, *Platynereis magalhænsis*, *Sabellaria macropalea*.

Four are represented in temperate waters of the northern hemisphere but have not up to the present been taken within the tropics:

(i.) *Goniada norvegica*, var. *falklandica*.

Common to Norway and the Falkland Islands. The genus is cosmopolitan in temperate and tropical waters, but has not been taken in very deep water.

The similarity in general structure between the northern and southern specimens of *Goniada*, and especially the remarkable resemblance in detail of the parapodia, proves that they had a common origin. The absence of a species showing the same details in the tropics makes it difficult to believe that a migration is taking place or can have taken place since the restriction of the tropical belt, either from north to south or from south to north.

As the genus *Goniada* has not been taken in the deep sea, we have no evidence that a passage has been made through the tropics by this means.

The evidence, with regard to the distribution of this genus, therefore, supports the Bipolar Theory for littoral temperate waters.

(ii.) *Arenicola claparedii*.

Distribution: Naples, California (Crescent City, 41° 44' N. lat., marks its northern limit), Straits of Magellan(?). New to the Falkland Islands. The genus is cosmopolitan in shallow waters.

The distribution of this shore-dwelling form is interesting. Its occurrence on the Californian coast and at the Falkland Islands seems to support Ortmann's view that the existence of a passage of cool water along the western shores of America enables an interchange of northern and southern temperate forms to take place, but, as this form has not yet been taken in an intermediate locality, we have no proof of its transmission. Its occurrence at the Falkland Islands and in the Mediterranean cannot be explained by Ortmann's view that a similar interchange of forms takes place along the western shores of Africa, for it has not been taken on the west African shores.

It is worthy of note that this species in the adult stage is a burrowing shore-dwelling form, therefore its

ness of the lead glazes used by potters may be judged. The standard proposed is that the "solubility" of the glaze as regards lead, determined under the conditions described in the foot-note (p. 1), shall not be greater than two per cent. This limit is based upon a study of the quantity of lead yielded to dilute acid under the specified conditions by a number of lead fritts used in pottery manufacture both at home and abroad.

Practical Bearing.—So far as the practical aspect of this question is concerned, the reply to Messrs. Jackson and Rich's contention is obvious. Suppose that workable glazes can be obtained, which, when ground to the degree of fineness necessary in practice, are within the selected limit of solubility. Then it is of no consequence that their solubility is smaller when the glazes are more coarsely ground. This is all that is involved in the point under discussion.

Now, as a matter of fact, such glazes are in use. This is shown by the list given in certain Reports to the Home Secretary on the "Use of Lead in the Manufacture of Pottery" (Parliamentary paper No. Cd. 527, p. 10), which shows the solubility of the lead in a number of glazes together with the statements of the manufacturers regarding the degree of fineness in each case.

It is true that this list may possibly not include examples of the most finely ground glazes ever employed by the potter, though it may do so. But it certainly includes some which are in at least an average condition of fineness; and the difference between these and the most finely ground glazes can be but small.

Influence of fineness a subordinate matter only.—As regards the more theoretical aspect of the matter, it is in the first place quite easy to show that the solubility of the lead in fritts does not depend merely, or even largely,

The four cases are:—

Two genera: (Crustacea) *Crangon*. (Nemertinea)
Carinoma.

Two species: (Annelida) *Terebellides strömii*
(Mollusca) *Janthina rotundata*.

From the references given in this paper, it is clear that there must be added to these the following:—

(Crustacea) *Calanus hyperboreus*, shown by Giesbrecht to be distinct from the tropical
C. finmarchicus.

Maia squinado.

(Gephyrea.) Genus *Echiurus*. (Shipley).

Phascolosoma margaritaceum. (Fischer).

Priapululus caudatus.

The following species recorded by I. C. Thompson:—

Metridia longa.

Oithona spinifrons.

Ectinosoma atlanticum.

Polychæta recorded by Ehlers.

Nephtys longisetosa.

Notomastus latericeus.

Scolecoplepis vulgaris.

Glycera americana.

Syllides longicirratus.

Chætopterus variopedatus.

Capitella capitata.

Serpula vermicularis.

Arenicola assimilis (probably *A. marina*); together
with

Scalibregma inflatum. (Ashworth.)

(Polyzoa) *Beania magellanica*. (Pratt.)

Cellepora pustulata. „

(Porifera) *Sycon ciliatum*. „

(Crustacea) *Orchestia chilensis*. „

Further, Polychæta, described in the preceding paper :

Species :—

Goniada norvegica.

Arenicola claparedii.

Bispira marizæ, and,

doubtfully, *Polydora polybranchia.*

Genera :—

Eteone.

Promenia.

Polydora (species also extra-tropical).

Bispira " " "

? *Autolytus* almost exclusively extra-tropical, but has been taken in the Red Sea—probably an escape from Mediterranean.

The following northern species of Polychæta are very nearly related to southern species.

- | | | |
|----------------------------------|------------|--------------------|
| Southern. | | Northern. |
| 1. <i>Travisia kerguelensis</i> | related to | <i>T. forbesi.</i> |
| 2. <i>Scoloplos kerguelensis</i> | " " | <i>S. armiger.</i> |

The following northern species of Gephyrea are very nearly related to southern species.

- | | | |
|--------------------------------|------------|----------------------|
| Northern. | | Southern. |
| 3. <i>Echiurus uncinatus</i> | related to | <i>E. chilensis.</i> |
| 4. <i>Priapululus typicus.</i> | " " | <i>P. australis.</i> |

To the "four littoral cases of bipolarity" acknowledged by Ortmann we must, then, add 28 cases—22 of species, and 6 of genera—making a total of 32 littoral bipolar forms, or 19 of species and a total of 29 cases if we exclude the three species *Polydora polybranchia*, *Scalibregma inflatum* and *Phascolosoma margaritaceum*. The two latter are typically littoral forms, but each has been once taken in sub-surface waters, *Scalibregma* off New Zealand in 700 fathoms, and *Phascolosoma* off Norway in 300 fathoms.

None of the species has been taken in the tropics in deep or shallow water.

I have mentioned four cases in which southern species are very nearly related to northern species.

In only two cases (*Arenicola assimilis* (?) and *A. claparedii*) have we any evidence whatever of an inter-passage of forms along the western shores of America, and, as these forms have not been taken at intermediate stations along the Pacific coast between California and the Straits of Magellan, the generality of such transference is by no means proved.

On the other hand, both these species occur on European shores, and, as I have previously stated, their free-swimming larval stage is limited to so short a period that it is impossible that they could cross the Atlantic. Moreover, as 41° N. appears to be the northern limit of the genus, it is impossible that these forms could find their way into the Atlantic along the northern shores of North America.

In no case have we any evidence of an interchange of species along the western shores of Africa, and I have shown that, in the genus *Goniada*, the same species may be present in the temperate north and south Atlantic, but along the tropical western shores of Africa the genus is represented by several distinct and modified species.

These results, to my mind, increase the evidence in favour of the Pfeffer and Murray "Bipolar Theory" for the littoral fauna.

The work in connection with these papers has been done in the zoological laboratories of the Owens College with the help of a grant from the Government Grant Committee of the Royal Society. My research has been supervised by Professor Hickson, to whom I am greatly indebted for much valuable assistance and advice. My

thanks are also due to Dr. Gamble and Dr. Ashworth for information on *Arenicola*, and to the latter also for notes on the distribution of *Scalibregma*, to Dr. Appellöf, of Bergen, for the loan of specimens of *Goniada norvegica*, and to Dr. Willey, who drew my attention to certain "bipolar" Polychæta which I had overlooked.

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under closely similar conditions of fineness to that shown by the last three, yield to acids a relatively small proportion only of lead. These classes are sharply distinguished by differences of chemical composition, and it is this latter circumstance which is the primary factor determining the solubility. The effect of fineness is a matter apart from this, and altogether subordinate to it.

Action not that of a solvent on a single substance.—It is tacitly assumed by the writers in question that the process of solution involved is one in which a single substance, one chemical individual, is attacked by a solvent acting at the surface only of the particles (*loc. cit.*, pp. 9, 10).

If this were so, then, after a first treatment of a fritt with dilute acid, if the solvent be removed and the residue again treated with a fresh quantity of the solvent, the amount of lead dissolved should be practically the same as at first.

Experiment shows that this is not the case. The quantity of lead extracted on the second treatment is only a fraction of that first yielded :—

Silicate.	Lead oxide present.	Lead oxide dissolved.	
		1st treatment.	2nd treatment.
No. 1	22·4 %	0·7 %	Traces
2	19·0 „	1·2 „	„
3	53·2 „	2·0 „	0·4 %
4	49·3 „	1·5 „	0·2 „
5	24·5 „	0·6 „	0·2 „
6	41·4 „	0·8 „	0·2 „
7	41·3 „	0·7 „	0·2 „

“*Protective Layer*” Hypothesis.—Messrs. Jackson and Rich endeavour to explain this behaviour by supposing that an insoluble coating of silica is deposited upon the particles, and that this protects them from further action of the solvent (*loc. cit.*, pp. 9-15).

Silica does not form a “protective layer.”—Now, it is demonstrable that in many cases no such “protective” layer is formed. In these cases the lead is not “protected” by the silica or any other compound: it is wholly, or almost wholly, removed on treatment with dilute acid. The following experiments prove this point:

Fritt.	Lead oxide present.	Lead oxide dissolved by 25% HCl.
No. 1	71.2 %	70.0 %
2	70.4 „	67.3 „
3	70.3 „	70.3 „
4	46.8 „	39.5 „
5	48.7 „	40.1 „

It is beyond question that in such cases as the above the silica does not form an effective protecting layer. It is difficult to see what reason can be adduced to show why silica should act differently in other cases.

If it be said that the quantity of silica in the above fritts is too small to act as a protective layer, the reply is that some of them contain more silica than other fritts which have much smaller solubility. For instance:—

	SiO ₂		PbO		PbO
	present.		present.		dissolved.
No. 5...	33.4	.....	48.7	.....	40.1
6...	29.8	.....	59.3	.....	5.0
Other examples are:—					
7...	35.7	.....	45.8	.....	10.8
8...	34.9	.....	57.3	.....	2.6

And with nearly equal percentages of silica :—

9...	37·6	.....	37·9	.....	28·0
10...	37·9	.....	53·2	.....	2·0

Thus two fritts, A and B, may have the same quantity of silica, yet A is largely attacked and B but slightly (Nos. 9 and 10). Or A may have *more* silica than B, and still be unprotected (Nos. 5 and 6 ; also 7 and 8). Finally A may have *less* silica than B, and nevertheless be the more largely attacked (Nos. 5 and 10). It is difficult to give much credence to a theory of protective action which is certainly not exercised at all in many cases, and in others exhibits so much caprice as to render impossible a reliable forecast of its probable effect.

Fritt not a single compound.—Underlying the whole of Messrs. Jackson and Rich's argument is the assumption that a fritt is a single chemical entity. There is evidence to show that this is probably an erroneous assumption. A fritt would appear, in fact, to be usually a mixture of at least two lead compounds. The proportion of one of these, however, may be small compared with the main bulk of the fritt.

The considerations which suggest this are as follows :—

I. *Chemical.*—In so far as a fritt is attacked by a solvent, its soluble constituents, if the fritt is a single compound, will be found to bear the same proportion to one another in the solution as in the original fritt. Whether the silicic acid be dissolved or not, this relation will hold for the base-oxides. If, however, the bases in the dissolved portion be found to have a different proportion from one another than exists in the original fritt, then the result is evidence that the fritt was not a single compound. Applying this deduction to the case of seven specimens of fritts whose composition had been ascertained, together with that of the dissolved portion given on treating the fritts with excess of dilute hydrochloric acid, the following comparisons were obtained :—

These results show that in the soluble portion the constituents do not bear the same proportion to one another as obtained in the original fritt. The lime and alkalis are as a rule higher; the lead oxide and alumina somewhat lower. Hence it would appear that some process of selective solution has occurred, and that the fritt was therefore not originally a single chemical body.

II. *Physical.*—If a fritt consisted of only one chemical compound it could not by any process of grinding and levigation be separated into fractions having different densities. But there is experimental evidence to show that such fractions do result when some fritts are ground and elutriated. Thus determinations were made of the specific gravity of three elutriated fractions, α , β , and γ , of the same fritt, the results being :—

Specific Gravity	$\left(\frac{15^{\circ}5}{15^{\circ}5}\right)$	of α	3'683
" "	" "	" β	3'742
" "	" "	" γ	3'606

Had the fritt been a single compound the three results should have been the same, within the limits of experimental error.

Thus the facts adduced, both chemical and physical, tend to show that, at least in some kinds of fritt, there is present a certain proportion—which, however, may be but small—of a readily-soluble lead compound in a state of admixture with the bulk of the fritt.

Explanation of Messrs. Jackson and Rich's elutriation experiments.—This consideration suggests the explanation of some results obtained by Messrs. Jackson and Rich, and displayed on the table on p. 5 (*loc. cit.*). That table purports to show that a fritt "A" has a solubility of 1·5 per cent. when in the condition of fineness corresponding

to a pressure of 100 cm., and that when reduced to the state of subdivision denoted by 1 cm. pressure the solubility is increased to 17.5 per cent.

But this conclusion is fallacious if the specimen is a mixture of two or more substances. The argument of the authors is based upon the assumption that they are dealing throughout with the same compound in different states of subdivision. It has no validity if more than one compound is present, since the solubilities found do not all relate to the same substance.

Now, it is well known that the more soluble kinds of lead silicate are of softer texture than the more insoluble. In the process of grinding a fritt which contains a small admixture of such soluble silicate, this more soluble portion will on account of its softness be ground to finer dimensions than the bulk of the fritt. Consequently, when the powder is separated into finer and coarser fractions by elutriation, a great part of the soluble compound will be found concentrated in the finer portions. These finer portions will therefore show a solubility greater than the average for the whole fritt, while the coarser fractions will have a solubility less than the average; which is precisely what is shown by the experiments adduced by Messrs. Jackson and Rich.

Thus the experiments in question do not prove that the differences of solubility obtained are due to mere differences of dimensions of the particles. They can only do this if the various fractions are shown to have the same chemical composition, and on this point the authors offer no evidence whatever.

In the concluding section of their paper (*loc. cit.*, pp. 12-13) the writers describe an experiment in which a specimen of glaze was found to be continuously acted upon by acid when mixed with pebbles and rotated for 22 hours

ness of the lead glazes used by potters may be judged. The standard proposed is that the "solubility" of the glaze as regards lead, determined under the conditions described in the foot-note (p. 1), shall not be greater than two per cent. This limit is based upon a study of the quantity of lead yielded to dilute acid under the specified conditions by a number of lead fritts used in pottery manufacture both at home and abroad.

Practical Bearing.—So far as the practical aspect of this question is concerned, the reply to Messrs. Jackson and Rich's contention is obvious. Suppose that workable glazes can be obtained, which, when ground to the degree of fineness necessary in practice, are within the selected limit of solubility. Then it is of no consequence that their solubility is smaller when the glazes are more coarsely ground. This is all that is involved in the point under discussion.

Now, as a matter of fact, such glazes are in use. This is shown by the list given in certain Reports to the Home Secretary on the "Use of Lead in the Manufacture of Pottery" (Parliamentary paper No. Cd. 527, p. 10), which shows the solubility of the lead in a number of glazes together with the statements of the manufacturers regarding the degree of fineness in each case.

It is true that this list may possibly not include examples of the most finely ground glazes ever employed by the potter, though it may do so. But it certainly includes some which are in at least an average condition of fineness; and the difference between these and the most finely ground glazes can be but small.

Influence of fineness a subordinate matter only.—As regards the more theoretical aspect of the matter, it is in the first place quite easy to show that the solubility of the lead in fritts does not depend merely, or even largely,

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**XV. The Influence of Grinding upon the Solubility* of
the Lead in Lead Fritts.**

By T. E. THORPE, C.B., LL.D., F.R.S.,

AND

CHARLES SIMMONDS, B.Sc.

Received May 13th, 1901. Read May 28th, 1901.

A paper dealing with this subject was communicated to the Manchester Literary and Philosophical Society on October 30th last, by Messrs. Jackson and Rich, of the Victoria Institute, Tunstall.

The main purport of the paper was to show that, in the case of lead fritts, "solubility in dilute acid is "greatly influenced by the degree of fineness to which "the particles have been ground." (*Manchester Memoirs*, vol. 45, part I., No. 2, pp. 6-7). Starting with the assumption that solution is possible only from the surface of the particles, the authors contend that, since the extent of surface of any given weight of fritt is increased by decreasing the size of the particles, the action of the solvent is also increased. They adduce certain experimental results which are considered to support this contention.

In connection with the matter under discussion it should be pointed out that the Home Office has recently suggested a criterion whereby the comparative harmless-

* Throughout this paper the term "solubility" denotes the weight of lead, calculated as monoxide, dissolved from a powdered fritt or glaze when the fritt or glaze is shaken for an hour with 1000 times its weight of 0.25 per cent. hydrochloric acid and allowed to settle for a further hour before being filtered.

September 10th, 1901.

ness of the lead glazes used by potters may be judged. The standard proposed is that the "solubility" of the glaze as regards lead, determined under the conditions described in the foot-note (p. 1), shall not be greater than two per cent. This limit is based upon a study of the quantity of lead yielded to dilute acid under the specified conditions by a number of lead fritts used in pottery manufacture both at home and abroad.

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Influence of fineness a subordinate matter only.—As regards the more theoretical aspect of the matter, it is in the first place quite easy to show that the solubility of the lead in fritts does not depend merely, or even largely,

upon the extent of surface exposed—that is, upon the fineness of the particles.

The following specimens of fritts were all reduced to nearly impalpable powder in an agate mortar before being submitted to the action of the solvent. They were therefore in closely similar, if not identical, conditions of fineness. Hence, if the solubility were merely a function of the extent of surface, the solubilities should all approximate to the same value. If subdivision were even a considerable factor, there should be some approach to similarity in the results—they should be quantities of much the same order of magnitude. It will be seen that there is no suggestion of any such uniformity :—

Fritt.	Solubility of Lead. Percentage on Fritt.
1	0·7
2	1·2
3	2·1
4	28·0
5	40·1
6	67·3
7	70·0

Thus the fineness alone of a fritt is not the chief factor in determining the solubility of the lead. The last three specimens belong, in fact, to a class of silicates which, whether ground moderately fine or extremely so, readily give up practically the whole of their lead to dilute acids. The first three belong to a class which,

under closely similar conditions of fineness to that shown by the last three, yield to acids a relatively small proportion only of lead. These classes are sharply distinguished by differences of chemical composition, and it is this latter circumstance which is the primary factor determining the solubility. The effect of fineness is a matter apart from this, and altogether subordinate to it.

Action not that of a solvent on a single substance.—It is tacitly assumed by the writers in question that the process of solution involved is one in which a single substance, one chemical individual, is attacked by a solvent acting at the surface only of the particles (*loc. cit.*, pp. 9, 10).

If this were so, then, after a first treatment of a fritt with dilute acid, if the solvent be removed and the residue again treated with a fresh quantity of the solvent, the amount of lead dissolved should be practically the same as at first.

Experiment shows that this is not the case. The quantity of lead extracted on the second treatment is only a fraction of that first yielded :—

Silicate.	Lead oxide present.	Lead oxide dissolved.	
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It is beyond question that in such cases as the above the silica does not form an effective protecting layer. It is difficult to see what reason can be adduced to show why silica should act differently in other cases.

If it be said that the quantity of silica in the above fritts is too small to act as a protective layer, the reply is that some of them contain more silica than other fritts which have much smaller solubility. For instance:—

	SiO ₂ present.	PbO present.	PbO dissolved.
No. 5...	33·4	48·7	40·1
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Other examples are:—			
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8...	34·9	57·3	2·6

And with nearly equal percentages of silica :—

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Thus two fritts, A and B, may have the same quantity of silica, yet A is largely attacked and B but slightly (Nos. 9 and 10). Or A may have *more* silica than B, and still be unprotected (Nos. 5 and 6; also 7 and 8). Finally A may have *less* silica than B, and nevertheless be the more largely attacked (Nos. 5 and 10). It is difficult to give much credence to a theory of protective action which is certainly not exercised at all in many cases, and in others exhibits so much caprice as to render impossible a reliable forecast of its probable effect.

Fritt not a single compound.—Underlying the whole of Messrs. Jackson and Rich's argument is the assumption that a fritt is a single chemical entity. There is evidence to show that this is probably an erroneous assumption. A fritt would appear, in fact, to be usually a mixture of at least two lead compounds. The proportion of one of these, however, may be small compared with the main bulk of the fritt.

The considerations which suggest this are as follows :—

I. *Chemical.*—In so far as a fritt is attacked by a solvent, its soluble constituents, if the fritt is a single compound, will be found to bear the same proportion to one another in the solution as in the original fritt. Whether the silicic acid be dissolved or not, this relation will hold for the base-oxides. If, however, the bases in the dissolved portion be found to have a different proportion from one another than exists in the original fritt, then the result is evidence that the fritt was not a single compound. Applying this deduction to the case of seven specimens of fritts whose composition had been ascertained, together with that of the dissolved portion given on treating the fritts with excess of dilute hydrochloric acid, the following comparisons were obtained :—

These results show that in the soluble portion the constituents do not bear the same proportion to one another as obtained in the original fritt. The lime and alkalis are as a rule higher; the lead oxide and alumina somewhat lower. Hence it would appear that some process of selective solution has occurred, and that the fritt was therefore not originally a single chemical body.

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Specific Gravity	$\left(\frac{15^{0.5}}{15^{0.5}}\right)$	of α	3.683
" "	" "	" β	3.742
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Had the fritt been a single compound the three results should have been the same, within the limits of experimental error.

Thus the facts adduced, both chemical and physical, tend to show that, at least in some kinds of fritt, there is present a certain proportion—which, however, may be but small—of a readily-soluble lead compound in a state of admixture with the bulk of the fritt.

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to a pressure of 100 cm., and that when reduced to the state of subdivision denoted by 1 cm. pressure the solubility is increased to 17.5 per cent.

But this conclusion is fallacious if the specimen is a mixture of two or more substances. The argument of the authors is based upon the assumption that they are dealing throughout with the same compound in different states of subdivision. It has no validity if more than one compound is present, since the solubilities found do not all relate to the same substance.

Now, it is well known that the more soluble kinds of lead silicate are of softer texture than the more insoluble. In the process of grinding a fritt which contains a small admixture of such soluble silicate, this more soluble portion will on account of its softness be ground to finer dimensions than the bulk of the fritt. Consequently, when the powder is separated into finer and coarser fractions by elutriation, a great part of the soluble compound will be found concentrated in the finer portions. These finer portions will therefore show a solubility greater than the average for the whole fritt, while the coarser fractions will have a solubility less than the average; which is precisely what is shown by the experiments adduced by Messrs. Jackson and Rich.

Thus the experiments in question do not prove that the differences of solubility obtained are due to mere differences of dimensions of the particles. They can only do this if the various fractions are shown to have the same chemical composition, and on this point the authors offer no evidence whatever.

In the concluding section of their paper (*loc. cit.*, pp. 12-13) the writers describe an experiment in which a specimen of glaze was found to be continuously acted upon by acid when mixed with pebbles and rotated for 22 hours

in a cylinder. The quantity of lead oxide dissolved was 2·28 per cent. of the weight of the glaze after a quarter of an hour's action, 11·16 after twelve hours, and 13·32 at the end of the twenty-two hours. This is considered to support the hypothesis that silica forms a protective layer; since the friction with the pebbles, it is argued, would continuously remove this layer and allow the acid to act without cessation upon the particles of fritt.

The experiment as described is, however, of very doubtful value. No information is given as to the behaviour of the glaze under the same conditions but without the pebbles. Nor are details furnished of the composition of the glaze. Only two-fifths of the usual volume of acid was employed, and the strength of this small volume would be very considerably reduced by the acid-neutralising constituents of the glaze. It is quite possible that the acid thus weakened would act only slowly on certain kinds of fritts, altogether irrespective of any supposed layer of silica and its removal by pebbles. Moreover, if, as is commonly the case, the glaze contained calcium carbonate, the effect of this when the acid was very weak would be to render the action still slower by the tendency to form insoluble lead carbonate. Thus the gradual action of the acid described by the authors is explicable on quite other grounds than those alleged by them; and in the absence of further data the experiment must be looked upon as inconclusive. Very similar objections may be urged also against the second experiment, with "commercial di-silicate," described on p. 14.

Unsatisfactory fritts and glazes used in Jackson and Rich's experiments.—Finally, it is to be especially noted that the glaze experimented with was one which, from the figures given, would evidently if tested by the standard method have furnished a solubility-figure of at

least 5 to 6 per cent., or about one-third of the whole quantity of lead present. Any argument legitimately derived from the behaviour of this glaze is thus an argument against the employment of glazes yielding a solubility-figure of so high a value as 5 or 6 per cent. But this argument has no necessary validity against glazes whose solubilities are less than 2 per cent., since the lead fritts used in the two cases must be of different chemical composition if the glazes have the same lead-content. It is useless to base a contention against the 2 per cent. limit upon the behaviour of a glaze which is obviously outside that limit.

In this connection it may be pointed out that the chief experiments upon which Messrs. Jackson and Rich rely are made with fritts having somewhat considerable initial solubilities. Thus the fritts A and B on p. 5, and the di-silicate of p. 14, have solubility-figures of 7.0 (mill-ground), 5.0, and 8.2 respectively. It would have been more to the point if the experiments had been carried out on fritts of low solubility—say 1 or 2 per cent. Even if it be admitted for a moment that the experiments are satisfactory, they only show that it is possible to select fritts of a certain character which shall behave in the manner indicated. They prove nothing, and they can prove nothing, with respect to the behaviour of fritts having lower solubility, and therefore different chemical composition.

Effect of grinding of no importance.—Turning again to the practical side of the matter; it has never been contended that fineness of sub-division is absolutely without effect upon the quantity of lead dissolved. It is a mere commonplace to admit that when solvent action occurs, it is exerted more readily upon an impalpable powder than upon the same substance in the form of coarse granules.

What is maintained is, that within the limits of fineness occurring in actual practice the variation of solubility is too small to be of serious moment. This may be shown by reference to the following experiments, described on p. 9 of the Parliamentary Paper (Cd 527) "On the Use of Lead in the Manufacture of Pottery."

Equal weights of six specimens of fritt, having solubilities ranging from 1.1 to 3.2 per cent., were ground together for 24 hours in a hand-mill. The powder was then of fully an average working degree of fineness, and its solubility was 2.8 per cent. After being reduced to what must be regarded as a somewhat extreme state of sub-division, by further grinding for 12 hours, the solubility was 3.6 per cent.

Now the percentage of lead oxide contained in the mixed fritts was 46.0. If, therefore, the mixture in the first state of division were used to supply the lead in a glaze containing 15 per cent. of lead oxide, the solubility of this glaze would be 0.91 per cent. If it were used in the second or extremely fine state of sub-division, the solubility would be 1.17 per cent. The difference is by no means an inappreciable one, but it is certainly not a matter of importance. Both figures, it will be seen, are much below the suggested limit of 2 per cent.

Summary.—It has been shown :—

(1) That a fallacy underlies Messrs. Jackson and Rich's conclusions, inasmuch as a fritt does not, as they assume, necessarily consist of a single chemical compound.

(2) That the hypothesis of a protective layer of silica, essential for the authors' explanation of the observed behaviour of fritts, is not in accordance with certain easily-demonstrated facts.

(3) That some of the authors' experiments are in-

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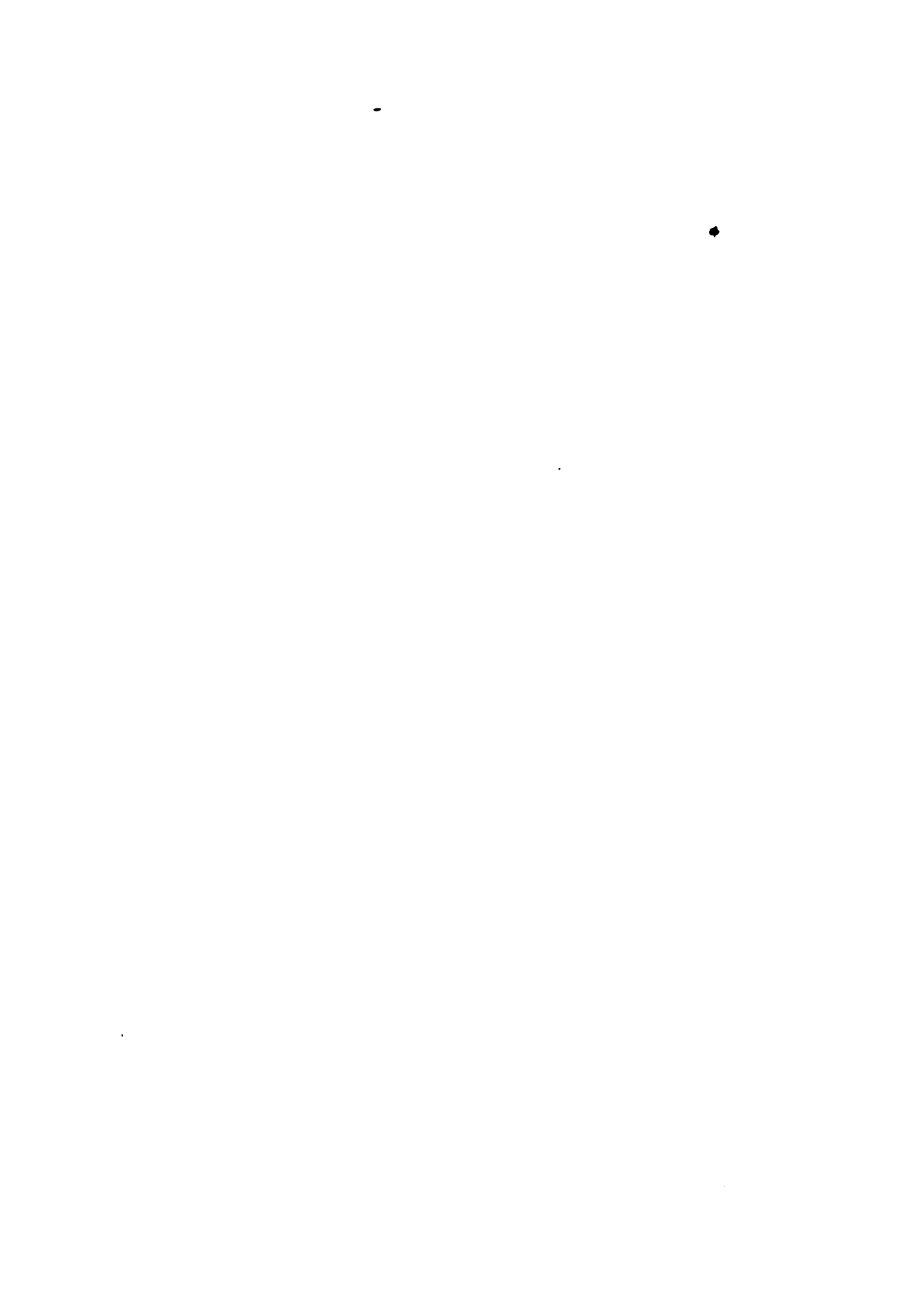
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conclusive, and do not necessarily bear the interpretation placed upon them.

(4) That, even if Messrs. Jackson and Rich's conclusions were established for the specimens dealt with, these specimens are mainly of somewhat high solubility, and arguments based on them would not of necessity, and do not as a fact, apply to fritts of lower solubility, since these have a different chemical composition.

(5) That, granting a very fine powder to be somewhat more soluble than a very coarse one, the variations of solubility of slightly-soluble glazes, between the limits of fineness occurring in actual practice, are of inconsiderable magnitude and of only theoretical importance.

(6) That, whether or not the solubility varies to some extent with the fineness, the matter is of no practical consequence, since glazes can be obtained, and are in use, which are of the fineness required in working, and which conform to the suggested limit of solubility.



PROCEEDINGS
OF
THE MANCHESTER LITERARY AND
PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 2nd, 1900.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The nominations of the following gentlemen for membership in the Society were read:—Mr. J. H. Grindley and Mr. R. S. Hutton.

Mr. THOMAS THORP described a method of producing a spectrum-like band from a bolometric curve by the use of a photographic camera with cylindrical lens, and also gave a brief account of the solar eclipse of May last, as seen in Algiers.

Mr. WILLIAM BURTON, F.C.S., read a paper entitled "**Plumbism in Pottery Workers.**"

The paper is printed in full in the *Memoirs*.

The paper was illustrated by a number of articles of pottery and by specimens of lead fritts, and was followed by a discussion, in which the President, Dr. Dixon Mann, and others participated.

General Meeting, October 16th, 1900.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

Mr. J. H. Grindley, M.Sc., Owens College, and Mr. R. S. Hutton, M.Sc., Owens College, were elected ordinary members of the Society.

Ordinary Meeting, October 16th, 1900.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Prof. H. B. DIXON, F.R.S., communicated a summary of the results of experiments, conducted in conjunction with Mr. F. W. Rixon, B.Sc. on the specific heat of gases at high temperatures.

As part of a larger investigation, the authors have determined directly the specific heat of carbonic acid, up to 400°C ., at constant volume. The gas is screwed up in a mild steel cylinder, which is heated in a gas oven running on rails. The oven and cylinder can thus be brought quickly over the calorimeter, into which the cylinder falls through trap doors forming the bottom of the oven. The transference is thus effected with a minimum loss of heat. The difficulties arising from splashing and from escape of steam, are overcome by dropping the cylinder into a glass tube dipping some distance below the water. The glass tube breaks at a crack made in the neck, and thus ensures a complete immersion of the hot cylinder at a good depth in the water, which closes over the cylinder in a cataract.

A similar experiment being performed with the empty cylinder, the difference gives the heating effect of the gas.

The results given below for CO_2 shew that the method, which it is hoped may still be improved, is a workable one.

Initial Temp. of Gas.	Final Temp.	Mean Temp.	Spec. Heat.
115	16	65.5	.200
192	16	104	.211
298	21	159.5	.288
398	21	209.5	.356

The authors are now measuring the specific heat of nitrogen in the same way.

Ordinary Meeting, October 30th, 1900.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

A paper on "**The Solubility of certain Lead Glasses or Fritts used in the Preparation of Pottery Glazes,**" by WILLIAM JACKSON, A.R.C.S., and EDMOND M. RICH, B.Sc., was read by the latter.

This paper is printed in full in the *Memoirs*.

The paper was illustrated by lantern slides, and was followed by a discussion, in which the President, Mr. William Burton, and Mr. T. Turner (organising secretary to the Technical Committee of the Staffordshire County Council) participated. The last-named stated that the paper represented the first-fruits of researches carried out at the laboratory at Stoke, recently established by the County Council.

Professor F. E. WEISS, B.Sc., read a paper on "**The Phloem of *Lepidophloios* and *Lepidodendron*,**" which was also illustrated by a series of lantern slides.

The paper will be printed in full in the *Memoirs*.

Ordinary Meeting, November 13th, 1900.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

Professor OSBORNE REYNOLDS mentioned a curious appearance which he had noticed on one occasion during the past summer, in the form of a narrow beam of light, proceeding vertically to a height of about 30 degrees from the setting sun. The beam remained visible for about half-an-hour after the sun had set. In the discussion as to the cause of the phenomenon, it was mentioned by Mr. Thorp that a similar appearance was seen by him when crossing the Mediterranean on returning from the observation of the solar eclipse in Algeria, on May 29th.

There being no paper before the Society, Dr. C. H. LEES

called attention to the following formula, due, apparently, to Schlömilch, which provides a useful and rapidly converging expression for the circumference of an ellipse whose semi-axes are known—

$$\text{perimeter} = \pi(a+b) \left\{ 1 + \frac{1}{4} \left(\frac{a-b}{a+b} \right)^2 + \frac{1}{64} \left(\frac{a-b}{a+b} \right)^4 + \dots \right\},$$

where a and b are the semi-axes of the ellipse. No engineering text-book used in this country has included this formula, which is superior to those ordinarily employed for the purpose. The error of the first three terms of the series as above stated is found

when $b = \cdot 2a$ to be less than $\cdot 05$ per cent.

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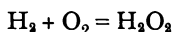
„ $b = 0$ „ „ „ „ $\cdot 4$ „ „

Mr. THORP described a method by which he has succeeded in silvering his diffraction films, the crucial point of which was the device adopted to agitate the silvering fluid in a closed and completely full vessel. The celluloid films having been obtained from plane gratings, were naturally not optically perfect when applied, as in the specimens exhibited, to curved surfaces. Mr. Thorp explained a device by which he expects to remedy this defect and to secure even films from concave surfaces, the surface from which the copies are taken being rotated while the celluloid is in process of solidification. He mentioned that he proposed to apply the designation *prismatic* to the gratings known as *échelon* gratings, as he considers that name more accurately descriptive of these gratings.

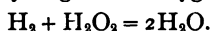
Professor DIXON referred to the reversal of the lithium line observed by Professors Liveing and Dewar (*Proc. Roy. Soc.*, Vol. 36 (1884), p. 472) when spectroscopically examining the light produced as an explosion-wave travelled towards the observer along a tube in which salts of lithium had been spread. The reversal of the line was taken by Professors Liveing and Dewar as showing that the front of the advancing wave was cooler than the following part. By photographing the explosion-

wave on a very rapidly moving film, Professor Dixon has shown that the wave is reflected back from the end of the tube, this reflected wave being of great luminosity. The phenomenon observed by Professors Liveing and Dewar may therefore be due to the light of the *retreating* wave passing through (and suffering absorption in) the cooler gas in the rear of that wave. This is made probable by the fact that photographs of the advancing wave do not show any reversals of the calcium and other lines, *when the end of the tube next the slit is open*, and when therefore no reflected wave is sent back. All the photographs of the explosion-wave show that the front of the wave is exceedingly sharp, and that the maximum brightness is reached immediately.

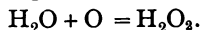
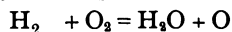
Professor DIXON further referred to the formation of hydrogen peroxide in several cases of combustion, and discussed the bearing of the facts on Mendeléef's theory as to the nature of the action which takes place when hydrogen and oxygen combine. Mendeléef's idea is that gases combine primarily in equal volumes, so that in the case of hydrogen and oxygen the reaction first gives rise to H_2O_2 , thus :—



and subsequently the hydrogen and oxygen peroxide interact :—



If the gaseous products are quickly cooled by making the hydrogen flame play on to water or ice, then some of the peroxide escapes reduction and is found in the water. A second view is that the hydrogen molecules break up the oxygen molecules, liberating atoms of oxygen, some of which may combine with the steam forming hydrogen peroxide :—



Professor DIXON made some suggestions for an experimental investigation of the question, and stated that he had begun some experiments with a view of deciding, if possible, between the two hypotheses.

Ordinary Meeting, November 27th, 1900.

J. J. ASHWORTH, Treasurer, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. F. J. FARADAY referred to the popular belief of a relation between the changes of the moon and the changes of the weather. As illustrating the continued prevalence of the belief in question, he quoted a passage from the cotton circular of Messrs. Hubbard Bros. & Co., of New York, dated October 30th, 1900, in which they say: "The trade watches for the time of full moon as the period most likely to bring colder weather, and therefore feels that we are apt to have a cold wave by November 6 to 8." It was a curious fact that November 8 was the date on which the first really cold weather was experienced on both sides of the Atlantic, and on which the first "killing" frost in the cotton belt of the Southern States of the Union occurred.

Some discussion followed.

Reference was made by Mr. W. H. JOHNSON to the recent occurrence of numerous cases of arsenical poisoning among beer-drinkers in this neighbourhood, and some discussion took place as to the source of the poison. Mr. TAYLOR stated that though "commercial" sulphuric acid, manufactured from pyrites, is certainly cheaper than that prepared from Sicilian sulphur, the difference of price is quite trifling when considered in relation to the whole cost of brewing, since the amount used is small.

Dr. G. WILSON mentioned a remarkable feature in connection with the bursting of gauge-glasses on the experimental engines in the laboratory of the Owens College. He had not personally verified it, but had been informed by one of the firemen that the final collapse of the tube is preceded by the appearance of a crack of two or three inches in length down the side of the tube. Steam may be seen to issue from this crack sufficiently long before the tube finally bursts to allow of turning off steam in the interval, and thus reducing the danger and inconvenience arising

from the burst. DR. WILSON inquired if this interval had been observed by others. It was suggested that the subject might be brought up again when some members possessing wide special experience might be present. No satisfactory explanation of the delay in the bursting was suggested.

Mr. W. BARNARD FARADAY read a paper on "**Selections from the Correspondence of Lieutenant-Colonel John Leigh Philips, of Mayfield, Manchester. Part III.**"

The paper will be printed in the *Memoirs*.

Ordinary Meeting, December 11th, 1900.

OSBORNE REYNOLDS, M.A., LL.D., F.R.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. THOMAS THORP mentioned a somewhat unpleasant experience he had had the previous day. Having prepared a quantity of silvering solution (nitrate of silver, potassa and ammonia) about a week before, but finding it not so good as usual, he had poured a small portion into a measuring glass with the intention of testing it to find out, if possible, the reason of its poor quality. The bottle was lightly corked and laid down on the bench, when, after about a couple of minutes, the contents exploded. On examining the glass of the bottle in question, a considerable portion was found to be pulverised, the rest being in more or less small pieces having a shattered appearance. No flash was seen, but apparently a misty aureola, whilst the glass and liquid were projected several yards away. Taken by itself the explosion was a puzzling one, but a similar event happened some months ago, only in this case the bottle containing the solution was in a cupboard, and the fact of an explosion having occurred was only discovered when the solution was required; in this case, also, the glass was pulverised. Mr. Thorp considered them to be instances of spontaneous explosion.



Ordinary Meeting, January 8th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT announced that the Council had made the following awards: the Wilde medal for 1901 to Dr. Elie Metchnikoff, of Paris, for his researches in comparative embryology, comparative anatomy, and the study of inflammation and phagocytosis; the Wilde premium to Mr. Thomas Thorp for his paper on "Grating films and their application to colour photography" and other communications made to the Society. The Dalton medal for 1901 had not been awarded. The presentation of the Wilde medal and premium will take place on February 5th, when Dr. Metchnikoff will deliver the Wilde lecture on "La flore microbienne du corps humain."

The PRESIDENT also mentioned that it was proposed that the members of the Society should entertain the Wilde lecturer at dinner after the lecture.

Reference was made to the loss the Society had sustained in the death of Lord Armstrong, one of its honorary members.

Two portraits of former members, the Rev. William Johns and the Rev. William Gaskell, which had been presented to the Society by Dr. Schunck, were exhibited.

With reference to the explosion of silvering solution mentioned by Mr. T. Thorp at the previous meeting, Mr. R. L. TAYLOR stated that both Berthollet and Faraday had prepared an explosive compound of silver from a mixture similar to that employed by Mr. Thorp for photographic purposes.

A discussion was introduced by Mr. W. H. JOHNSON upon the method of navigation employed by the Norsemen on their voyages between Northern Europe and Greenland and Iceland before the mariner's compass was known.

Mr. W. E. HOYLE communicated a paper entitled "**Note on D'Orbigny's figure of *Onychoteuthis dussumieri*.**"

This paper is printed in full in the *Memoirs*.

Ordinary Meeting, January 22nd, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT referred to the loss sustained by the Society through the death of Professor Ch. Hermite, one of its honorary members since 1892.

There being no paper before the Society, Mr. FRANCIS JONES showed the mode of detecting small quantities of arsenic by Marsh's, Reinsch's, and Gutzeit's methods. He also showed the results obtained by the action of light on the hydrides of arsenic and antimony in contact with sulphur, constituting a further test of the presence of these metals. The mirror of arsenic obtained recently from a glass of beer by Marsh's test was also exhibited, together with a sample of invert sugar containing arsenic.

Mr. R. L. TAYLOR referred to a subject to which, about the year 1882, he called attention by letters to the Manchester newspapers, namely, the occurrence of arsenic in large quantities in green tapers. The garlic-like odour of the tapers when burning or smouldering attracted his notice. Out of seven samples obtained from different shops, four contained arsenic. The amount in one taper he had found to be two-thirds of a grain of white arsenic, equal to 9 grains in one ounce of tapers.

Mr. TAYLOR further said that in the course of the last week he obtained six samples of green tapers from Manchester and the immediate neighbourhood, and two of these were found to contain arsenic. The green tapers which are free from arsenic are bluish-green in colour and semi-transparent, while those containing arsenic are bright green and quite opaque. The amount of arsenic is quite as great as in those examined previously, and is probably present in the form of Scheele's green. When the tapers are burned the arsenic passes into the air in the form of the white oxide and would be inhaled by persons

in the room. The danger from the use of such tapers might not be great, but opinions as to the effect of continued small doses of arsenic have lately been profoundly modified.

The tapers were shewn and the presence of arsenic in them demonstrated, a piece not more than an inch long sufficing to give marked characteristic reactions.

Dr. C. H. LEES mentioned a very compact formula for the circumference of an ellipse, viz. :—

$$\text{perimeter} = 2\pi \left(\frac{a^{\frac{3}{2}} + b^{\frac{3}{2}}}{2} \right)^{\frac{2}{3}}$$

where a and b are the semi-axes of the ellipse. Dr. Lees stated that he had found the error of this formula to be as follows :—

when $b = .4a$ less than .1 per cent.

„ $b = .3a$ „ „ .2 „

„ $b = .2a$ „ „ .3 „

„ $b = .1a$ „ „ .7 „

„ $b = 0$ „ „ 1.0 „

the formula giving a result less than the true perimeter in each case. The formula, which was established in a communication to the *Messenger of Mathematics* in Feb. 1883, by Mr. Thomas Muir, is readily calculated with the aid of Barlow's tables.

called attention to the following formula, due, apparently, to Schlömilch, which provides a useful and rapidly converging expression for the circumference of an ellipse whose semi-axes are known—

$$\text{perimeter} = \pi(a+b) \left\{ 1 + \frac{1}{4} \left(\frac{a-b}{a+b} \right)^2 + \frac{1}{64} \left(\frac{a-b}{a+b} \right)^4 + \dots \right\},$$

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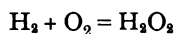
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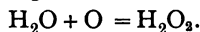
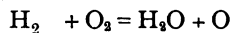
Professor DIXON further referred to the formation of hydrogen peroxide in several cases of combustion, and discussed the bearing of the facts on Mendeléef's theory as to the nature of the action which takes place when hydrogen and oxygen combine. Mendeléef's idea is that gases combine primarily in equal volumes, so that in the case of hydrogen and oxygen the reaction first gives rise to H_2O_2 , thus :—



and subsequently the hydrogen and oxygen peroxide interact :—



If the gaseous products are quickly cooled by making the hydrogen flame play on to water or ice, then some of the peroxide escapes reduction and is found in the water. A second view is that the hydrogen molecules break up the oxygen molecules, liberating atoms of oxygen, some of which may combine with the steam forming hydrogen peroxide :—



Professor DIXON made some suggestions for an experimental investigation of the question, and stated that he had begun some experiments with a view of deciding, if possible, between the two hypotheses.

Ordinary Meeting, November 27th, 1900.

J. J. ASHWORTH, Treasurer, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. F. J. FARADAY referred to the popular belief of a relation between the changes of the moon and the changes of the weather. As illustrating the continued prevalence of the belief in question, he quoted a passage from the cotton circular of Messrs. Hubbard Bros. & Co., of New York, dated October 30th, 1900, in which they say: "The trade watches for the time of full moon as the period most likely to bring colder weather, and therefore feels that we are apt to have a cold wave by November 6 to 8." It was a curious fact that November 8 was the date on which the first really cold weather was experienced on both sides of the Atlantic, and on which the first "killing" frost in the cotton belt of the Southern States of the Union occurred.

Some discussion followed.

Reference was made by Mr. W. H. JOHNSON to the recent occurrence of numerous cases of arsenical poisoning among beer-drinkers in this neighbourhood, and some discussion took place as to the source of the poison. Mr. TAYLOR stated that though "commercial" sulphuric acid, manufactured from pyrites, is certainly cheaper than that prepared from Sicilian sulphur, the difference of price is quite trifling when considered in relation to the whole cost of brewing, since the amount used is small.

Dr. G. WILSON mentioned a remarkable feature in connection with the bursting of gauge-glasses on the experimental engines in the laboratory of the Owens College. He had not personally verified it, but had been informed by one of the firemen that the final collapse of the tube is preceded by the appearance of a crack of two or three inches in length down the side of the tube. Steam may be seen to issue from this crack sufficiently long before the tube finally bursts to allow of turning off steam in the interval, and thus reducing the danger and inconvenience arising

from the burst. DR. WILSON inquired if this interval had been observed by others. It was suggested that the subject might be brought up again when some members possessing wide special experience might be present. No satisfactory explanation of the delay in the bursting was suggested.

Mr. W. BARNARD FARADAY read a paper on "**Selections from the Correspondence of Lieutenant-Colonel John Leigh Philips, of Mayfield, Manchester. Part III.**"

The paper will be printed in the *Memoirs*.

Ordinary Meeting, December 11th, 1900.

OSBORNE REYNOLDS, M.A., LL.D., F.R.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. THOMAS THORP mentioned a somewhat unpleasant experience he had had the previous day. Having prepared a quantity of silvering solution (nitrate of silver, potassa and ammonia) about a week before, but finding it not so good as usual, he had poured a small portion into a measuring glass with the intention of testing it to find out, if possible, the reason of its poor quality. The bottle was lightly corked and laid down on the bench, when, after about a couple of minutes, the contents exploded. On examining the glass of the bottle in question, a considerable portion was found to be pulverised, the rest being in more or less small pieces having a shattered appearance. No flash was seen, but apparently a misty aureola, whilst the glass and liquid were projected several yards away. Taken by itself the explosion was a puzzling one, but a similar event happened some months ago, only in this case the bottle containing the solution was in a cupboard, and the fact of an explosion having occurred was only discovered when the solution was required; in this case, also, the glass was pulverised. Mr. Thorp considered them to be instances of spontaneous explosion.

Professor DIXON suggested that more precise information as to the conditions of the explosion was needed before the desired explanation could be given with certainty.

Mr. CHARLES BAILEY, F.L.S., having taken the Chair,

Mr. J. H. GRINDLEY, M.Sc., read a paper entitled "**The Thermodynamical Properties of Superheated Steam and the Dryness of Saturated Steam.**"

The paper is printed in full in the *Memoirs*.

Several members contributed to the discussion which followed the reading of the paper.

A paper on "**A new species of *Sepia* and other shells collected by Dr. R. Koettlitz in Somaliland,**" by W. E. HOYLE, M.A., and R. STANDEN, was communicated by the former.

This paper will be printed in full in the *Memoirs*.

Ordinary Meeting, January 8th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT announced that the Council had made the following awards: the Wilde medal for 1901 to Dr. Elie Metchnikoff, of Paris, for his researches in comparative embryology, comparative anatomy, and the study of inflammation and phagocytosis; the Wilde premium to Mr. Thomas Thorp for his paper on "Grating films and their application to colour photography" and other communications made to the Society. The Dalton medal for 1901 had not been awarded. The presentation of the Wilde medal and premium will take place on February 5th, when Dr. Metchnikoff will deliver the Wilde lecture on "La flore microbienne du corps humain."

The PRESIDENT also mentioned that it was proposed that the members of the Society should entertain the Wilde lecturer at dinner after the lecture.

Reference was made to the loss the Society had sustained in the death of Lord Armstrong, one of its honorary members.

Two portraits of former members, the Rev. William Johns and the Rev. William Gaskell, which had been presented to the Society by Dr. Schunck, were exhibited.

With reference to the explosion of silvering solution mentioned by Mr. T. Thorp at the previous meeting, Mr. R. L. TAYLOR stated that both Berthollet and Faraday had prepared an explosive compound of silver from a mixture similar to that employed by Mr. Thorp for photographic purposes.

A discussion was introduced by Mr. W. H. JOHNSON upon the method of navigation employed by the Norsemen on their voyages between Northern Europe and Greenland and Iceland before the mariner's compass was known.

Mr. W. E. HOYLE communicated a paper entitled "**Note on D'Orbigny's figure of *Onychoteuthis dussumieri***."

This paper is printed in full in the *Memoirs*.

Ordinary Meeting, January 22nd, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT referred to the loss sustained by the Society through the death of Professor Ch. Hermite, one of its honorary members since 1892.

There being no paper before the Society, Mr. FRANCIS JONES showed the mode of detecting small quantities of arsenic by Marsh's, Reinsch's, and Gutzeit's methods. He also showed the results obtained by the action of light on the hydrides of arsenic and antimony in contact with sulphur, constituting a further test of the presence of these metals. The mirror of arsenic obtained recently from a glass of beer by Marsh's test was also exhibited, together with a sample of invert sugar containing arsenic.

Mr. R. L. TAYLOR referred to a subject to which, about the year 1882, he called attention by letters to the Manchester newspapers, namely, the occurrence of arsenic in large quantities in green tapers. The garlic-like odour of the tapers when burning or smouldering attracted his notice. Out of seven samples obtained from different shops, four contained arsenic. The amount in one taper he had found to be two-thirds of a grain of white arsenic, equal to 9 grains in one ounce of tapers.

Mr. TAYLOR further said that in the course of the last week he obtained six samples of green tapers from Manchester and the immediate neighbourhood, and two of these were found to contain arsenic. The green tapers which are free from arsenic are bluish-green in colour and semi-transparent, while those containing arsenic are bright green and quite opaque. The amount of arsenic is quite as great as in those examined previously, and is probably present in the form of Scheele's green. When the tapers are burned the arsenic passes into the air in the form of the white oxide and would be inhaled by persons

in the room. The danger from the use of such tapers might not be great, but opinions as to the effect of continued small doses of arsenic have lately been profoundly modified.

The tapers were shewn and the presence of arsenic in them demonstrated, a piece not more than an inch long sufficing to give marked characteristic reactions.

Dr. C. H. LEES mentioned a very compact formula for the circumference of an ellipse, viz. :—

$$\text{perimeter} = 2\pi \left(\frac{a^{\frac{3}{2}} + b^{\frac{3}{2}}}{2} \right)^{\frac{2}{3}}$$

where a and b are the semi-axes of the ellipse. Dr. Lees stated that he had found the error of this formula to be as follows :—

when $b = .4a$	less than	.1	per cent.
„ $b = .3a$	„ „	.2	„
„ $b = .2a$	„ „	.3	„
„ $b = .1a$	„ „	.7	„
„ $b = 0$	„ „	1.0	„

the formula giving a result less than the true perimeter in each case. The formula, which was established in a communication to the *Messenger of Mathematics* in Feb. 1883, by Mr. Thomas Muir, is readily calculated with the aid of Barlow's tables.

Ordinary Meeting, February 5th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

Before proceeding to the ordinary business of the meeting,

The PRESIDENT said : " It would, I think, hardly be consonant with the feelings of those present if some reference were not made to the matter which has occupied all our minds for the last fortnight. The death of Her late Majesty Queen Victoria occurred almost simultaneously with the last meeting of the Society. The days that have intervened have been marked by many striking tributes to her memory ; I will not attempt, therefore, to say anything as to the personal qualities of the late Sovereign, or even as to the wider political aspects of her life which have nowhere, to my mind, found more eloquent appreciation than in the address of the Bishop at the Memorial Service in our Cathedral. But in a Society like this, which claims some antiquity among provincial learned societies, it may be excusable to dwell for a moment on the fact that the period of the late Queen's reign has been a period also of great scientific discoveries, and (a matter in which we are no less interested) of remarkable developments in the application of science to practical uses. If we look at the records of the Society, we find that the Queen's accession took place during the long presidency of Dalton, whilst among his successors we note such names as those of Hodgkinson, Fairbairn, and Joule, as well as of Schunck and of others who happily are still active amongst us. It might perhaps be debated whether a period of profound internal peace, or one of revolutionary excitement, is more favourable to the birth of great scientific ideas ; history would doubtless furnish instances on both sides. But there can be no question as to which conditions are more favourable to the

practical applications of science ; and from this point of view we must gratefully acknowledge that the immense progress of this kind which has marked the late Queen's reign would have been impossible except for the tranquil conditions which have obtained amongst us, largely in consequence of her own character and influence."

The PRESIDENT referred also to the loss sustained by the Society in the deaths of two of its ordinary members. Mr. Richard Copley Christie had been a member since 1854 ; his munificent gifts for the encouragement of learning in this city were too recent and too well-known for further remark, but it was pleasant to the Society to recall that he had at one time held office as their Secretary. Sir John William Maclure was elected a member in 1859.

The PRESIDENT nominated Mr. Thomas Thorp and Dr. C. H. Lees to be Auditors of the Society's accounts for the session 1900-1901.

Professor FLUX referred to the records of a recent American report on water, gas, and electricity undertakings, so far as they showed the rate of return on the capital invested in each case. The rates were grouped most thickly about 3 to 3½ per cent. for each class of enterprise, more closely in the case of water and (in a less degree) of gas than in the case of electricity. The total number of undertakings contributing to the result named was 1,351, and the lowness of the figure representing the most frequent rate seemed rather striking.

Mr. THOMAS THORP mentioned that he had made further progress with an instrument designed to yield a pure monochromatic image of the sun, and had been able to obtain results of an encouraging nature. He hoped to be able to perfect the instrument in a short time and to exhibit it to the Society.

Dr. GEORGE WILSON read a paper, prepared by himself and Mr. H. Noble, B.Sc., entitled "**Note on the Construction of Entropy Diagrams from Steam-engine Indicator Diagrams.**"

The paper will be printed in full in the *Memoirs*.

Mr. C. E. STROMEYER read a paper on "**The Representation on a Conical Mantle of the Areas on a Sphere.**"

The paper will be printed in the *Memoirs*.

The PRESIDENT announced at the close of the meeting that the date of the Wilde Lecture and presentation of the medal had, owing to the death of the Queen, been postponed until after Easter, and that April 22 had been provisionally fixed for the lecture. The dinner which had been arranged to follow the delivery of the lecture would be held on the same date.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, October 22nd, 1900.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

Mr. H. HYDE exhibited a portion of a sunflower in fruit, and drew attention to the extreme symmetry and regularity of the seeds. Mr. Melvill mentioned the probability of the sunflower becoming of great economic value, owing to the seeds containing an oil, which may be used in the manufacture of soap, so that the cultivation of the sunflower on a large scale, for industrial purposes, may be one of the possibilities of the future.

Mr. ROGERS exhibited a collection of shells recently received from Australia.

Mr. STIRRUP read a paper entitled "Examples of the genus *Cerithium* from the tertiary deposits of the Paris basin." Specimens of the genus, collected on a visit to Grignon arranged by the International Congress of Geology in the past summer, were shown, together with examples from numerous localities lent by Mr. Melvill.



[*Microscopical and Natural History Section.*]

Ordinary Meeting, November 19th, 1900.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

Mr. JOHN MULLEN presented the Section with a second series of rock sections for the cabinets, illustrating igneous rocks, limestones, and coal-measure plants.

Mr. JOHN BOYD contributed a paper on the anatomy of feathers, illustrated by diagrams and microscopic specimens.



[*Microscopical and Natural History Section.*]

Ordinary Meeting, December 17th, 1900.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

A collection of insects illustrating insect parasitism, sent by Mr. PETER CAMERON, was exhibited, and an explanatory note relating to the specimens was read.

Mr. M. STIRRUP read a paper on the mistletoe, mainly describing the experience and opinions of French botanists.

Mr. BROADBENT, M.R.C.S., drew attention to plant remains, found in the deep excavation below Hanging Bridge, which included several mosses, elderberry, gorse, birch, and numerous specimens of a perforated seed, oblong and pointed at each end.

Manchester Memoirs, Vol. xlv. (1899-1900).

ADDENDA.

Omitted from the List of Honorary Members :—

1899, April 25. Palgrave, R. H. Inglis, F.R.S., F.S.S. *Belton, Great Yarmouth.*

1899, April 25. Ramsay, William, Ph.D., F.R.S., Professor of Chemistry.
12, Arundel Gardens, Notting Hill, London, W.

Ordinary Meeting, February 19th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. CHARLES BAILEY made the following communication
“**On *Ranunculus Bachii*, Wirtgen, as a form of *Ranunculus fluitans*, Lamk.**”

Ranunculus fluitans, Lamk., like all the members of the *Batrachium* section of the genus, is a very polymorphic aquatic plant, as is plainly to be seen from the series of British examples now exhibited. In the south of England, as in the Avon at Christchurch, the stout stems are several feet in length; the leaves and peduncles are from six inches to a foot long; and the flowers are as large as a shilling or a florin. It is a frequent plant in the Herefordshire Wye, and in the Severn; but in our immediate neighbourhood I have gathered it in but one station, namely, in the Derbyshire Derwent, at Whatstandwell. The plant of the Derbyshire Wye, at Buxton, Miller's Dale, Lathkill Dale, &c., is another species—*Ranunculus pseudo-fluitans*, “Bab.,” Hiern. The *R. fluitans* also occurs in canals and in swift running brooks, but its most congenial station is a well-filled river. It becomes less frequent in Great Britain as we ascend northwards, and it just manages to occupy a few of the southern counties of Scotland.

In many of its stations there occur smaller examples to which the name of *Ranunculus Bachii* has been given; in this state, as in some of the examples from the Severn and the Tweed, it occasionally produces small tripartite floating leaves. During a holiday in Berwickshire last July, I had a good opportunity of studying this small-flowered form, as the water-courses of that

county produce it in abundance. In many places the streams in the flowering season are white over with its abundant flowers, as at the junction of the Blackadder Water with the Whiteadder Water, at Allanton. I also found it in plenty in the Eye Water, especially between East Renton and Ayton. From the comparatively small size of its flowers (not exceeding half an inch in diameter) the plant looked as if it might have been *R. circinatus*, Sibth., or *R. Drouetii*, Godron, rather than the robust plant of the south of England. The late Dr. George Johnston, in the *Terra Lindisfarnensis: the Natural History of the Eastern Borders*, Vol. I., *Botany*, page 26 (London, 1853), refers to this plant under the name of *R. fluitans*, for this reduced form had not been recognised as British at the time he wrote; he says that it is frequent in rapid streams in that district, "flowering throughout summer very frequently in some years, while in other seasons the plant is mostly barren." My visit to Berwickshire occurred, therefore, in one of these favourable seasons; I saw, however, no heads of mature fruits, although they were specially looked for.

Dr. Ph. Wirtgen separated this small form from the type, as a species, under the name of *Ranunculus Bachii*, in *Verhandl. des natur. Vereins der preussischen Rheinlande und Westphalens*, Jahrg. II., p. 22 (Bonn 1845); but in his *Flora der preussischen Rheinprovinz* (Bonn 1857), pp. 15, 16, he reduced it to a variety, giving the type the name of *R. Lamarckii*, Wtgn., and this smaller form, β , the name of *R. Bachi*, Wtgn; but he printed the name with one "i," not two as printed when he first described the plant, and as in the "London Catalogue," edition vi. (1867) and subsequent issues. It would appear to have been first recorded as a British plant in the third edition of *English Botany*, Vol. I., p. 18 (London, 1863), by Boswell Syme, but the reference which he cites "F. Schultz, *Archives de Fl.*, Vol. I., p. 292," is incorrect, as the plant is neither described nor named on the page stated. There is a casual reference to the plant on page 199 of the *Archives*, but no description. Syme knew the Berwickshire plant, as he gives "the Whitadder in

Berwickshire," as the northern limit for this diminutive form of the type. Wirtgen describes it as occurring in the valley of the Sayn, and in the ditches which run into it, between Sayn and Isenberg, and also as not being scarce in the valley of the Alf. In the third edition of "W. D. J. Koch's *Synopsis der deutschen und schweizer Flora*" Vol. I., p. 27 (Leipzig, 1890) it is reported as growing in the Rhine at Schaffhausen, Coblenz, Ladenburg, &c.

My conclusions respecting this plant accord with Wirtgen's later view of it, namely, that the differences between it and the type are merely comparative. In the Eye Water at Ayton many of the stems of freely-flowering examples were from six to eighteen inches long, varying with the depth of the water in which they grew. At a point above the weir at Ayton Law, a water sluice runs from the river to feed the paper mill at Ayton, and in this sluice of swiftly-running water the plant, while still retaining its slender habit and small-sized flowers, produced leaves three to four inches, and stems five or six feet, in length. I gathered the same form, 17th July, 1900, but slightly more robust, in the River Tweed on the Northumberland side of the river, at Wark, opposite Coldstream; and the range of examples now exhibited shews that there are all intermediates between the diminutive form collected at Ayton in the north, and the nine or ten feet plant of the New Forest in the south.

The plants which Wirtgen distributed many years ago from the Rhine Provinces included examples of this plant, but in my set it was missing. By the kindness of Mr. J. Cosmo Melvill I am able to exhibit some sheets of Wirtgen's collecting, which were in Syme's herbarium of continental plants, now in Mr. Melvill's possession.

It may be as well to put on record that *Mimulus luteus*, Linn., is established along the course of the Eye Water, and, although it is a poor bramble district, I added two species to the county during my visit, viz. : *Rubus Rogersii*, Linton, and *Rubus radula*, Weihe.

A discussion followed, in which Messrs. Melvill, Weiss, and Nicholson took part.

Mr. R. S. HUTTON exhibited an almost exact reproduction of Moissan's electric furnace, which has been set up at the Owens College. There it is possible, with a 50 h.p. engine, to produce a current of 700 ampères at 50 volts, and by that means it is anticipated that researches at the high temperatures thus available—viz., 3,500 deg. Centigrade or higher—will shortly be able to be carried out. Graphite prepared in electric furnaces was also shown, as well as specimens of various carbides, carborundum, &c., from the Niagara works. Specimens of chromium and manganese were shown, illustrating the facility with which some of the rarer metals now become available. A modern form of the Lippmann electrometer was also exhibited by Mr. Hutton.

Ordinary Meeting, March 5th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mention was made of the fact that the Society completed 120 years of its existence on February 28th, and the first minute-book of the Society was handed round for inspection.

Mr. F. J. FARADAY exhibited a rare volume (from the Henry Watson musical library) printed at Sheffield in 1788. The work consists of a description by Dibdin of a musical tour in 1787-8, and extracts were read relating to the composer's experiences in Manchester, contrasting the people of Manchester very unfavourably with those of Liverpool. Messrs. Barnes, Nicholson, and W. B. Faraday joined in a discussion of the matters raised.

Mr. W. E. HOYLE called the attention of the members to an English Grammar published in 1801 by John Dalton, then Secretary to the Society, and presented by him to the Society. Mr. Hartog mentioned that Priestley also published an English Grammar before devoting himself to science.

Mr. C. E. STROMEYER referred to the results of a study of tidal waves which he had published in "Nature" in 1895, and which indicated that, in the majority of cases of which records were available, the tidal waves appeared to proceed from the Faraday Reef. Particulars of the tidal wave which recently struck the "Teutonic" were not yet to hand for comparison with former records.

Mr. W. E. HOYLE read a paper entitled "**On the Generic Names Octopus, Eledone, and Histiopsis.**"

The paper is printed in full in the *Memoirs*.

Ordinary Meeting, March 19th, 1901.

CHARLES BAILEY, F.L.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. E. F. MORRIS exhibited some sketches of recent excavations in the Roman forum, and gave the following explanations and information in reference to them. One of them represented the rostra discovered in October, 1900, by Signor Boni, which belong to the last period of the Republic, and are stated to be those from which Antony delivered his famous speech. The monument hitherto believed to be the only rostra erected under Julius Cæsar may now, probably, be assigned to about the period of the Flavians and Trajan. The newly-discovered rostra consist of five little vaulted rooms, exactly as seen on the well-known medal of Palikanus, built, in *opus reticulatum*, of tufa and concrete.

Other sketches represented the shrine and fountain of Juturna. The former is an *ædicula* in brickwork, running in a North and South direction, its front decorated with two marble columns supporting an architrave on which is carved the name of the deity to which it was consecrated. In front of the shrine is a circular well with an elegant marble head, ornamented with a carved cornice on which is an inscription stating that the well was consecrated to Juturna by Marcus Barbatius Pollio. Professor Vaglieri affirms that this Pollio is the personage mentioned by Cicero, who was quæstor of Lucius Antonius in 41 B.C. Before the well is a marble altar with a sculptured front on which are figures of Mars and of a female deity, Juno or Venus. Signor Boni is of opinion that the scene is taken from Virgil, and represents Juturna taking her final leave of her brother Turnus.

The skill of Signor Boni in directing the excavations has also

brought to light the celebrated Fountain of Juturna, so highly appreciated by the Romans for the salubrity of its waters. A spacious rectangular construction in tufa work (*opus reticulatum*) of the Republican epoch encloses the spring. The construction is internally covered with marble slabs. A short flight of steps, which leads to the spring, has been rebuilt at a much later date. The water gushes out abundantly at the present time, fresh and clear. The following interesting monuments were found in the room which encloses the spring :—(1) A marble altar the four faces of which bear sculptures of the Dioscuri, of Jupiter holding the sceptre and thunderbolts, of Leda with the swan, and of a feminine figure, probably Vesta or Diana Lucina, holding a long torch. The association of the fountain of Juturna with the sanctuary of the Vestals is a well-known fact. (2) A life-sized statue of Æsculapius in white marble (now standing at his shrine); this statue was placed there on account of the health-giving qualities of the waters of the fountain. (3) A white marble bust of Jupiter, very well preserved. (4) A splendid head and body of a horse in Pentelic marble, conjectured to be the work of a Greek artist of the fifth century B.C., and to have belonged to a group representing Castor and Pollux and their horses. (5) A torso of Apollo in Greek marble, archaic in style, but clearly a Roman imitation, perhaps of the time of Hadrian.

Mr. THOMAS THORP exhibited photographs of the spectrum of the new star in Perseus, showing the bright lines very clearly, and he mentioned that the star has now faded to about the fifth magnitude.

Mr. THORP also described a variation in the ordinary arrangement of a star spectroscopic, which he has devised.

Mr. J. R. HARDY read a paper on "**The Macro-Lepidoptera of Sherwood Forest,**" which was communicated through Mr. Hoyle.

The paper is printed in full in the *Memoirs*.

Ordinary Meeting, April 2nd, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

Mr. W. E. HOYLE exhibited an old form of dial, bearing the name "Nathaniell Jeynes," and the date "1678," which had on one side a small circular rotating plate inscribed with the circum-polar constellations.

Mr. HOYLE also showed a silhouette portrait of Dr. Thomas Percival, one of the founders of the Society.

Mr. C. E. STROMEYER mentioned that on several occasions he had seen the sun's rays converging to a point directly opposite to the sun. In one case, when the sun was very low on the western horizon, some very marked rays, caused by a low bank of clouds, converged towards a point above the eastern horizon.

Mr. J. J. ASHWORTH (Treasurer) having taken the Chair,

The PRESIDENT communicated some numerical illustrations of the Diffraction of Sound. These were intended to show the extreme facility with which sounds of relatively large wave-length can make their way round obstacles or through apertures. Thus, with a wave-length of 4 feet, a wire $\frac{1}{80}$ of an inch in diameter dissipates only the fraction 6.6×10^{-8} of the energy which falls upon it; a spherule of water $\frac{1}{10000}$ of an inch in diameter scatters only 1.3×10^{-16} . Again, a perforated screen or grating may present hardly any obstacle to the transmission of sound, although the apertures occupy only a small proportion of the total area. Reference was made to the bearing of such results on the attempts made to improve the acoustic properties of buildings by hanging wires, and on current notions as to the possibility of the reflection of sound from clouds.

A discussion ensued, in which Messrs. Barnes, Lees, Stromeyer, and others participated.

Special Meeting, April 22nd, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President in the Chair.

The PRESIDENT, in making the presentation of the Wilde Medal and the Wilde Premium, said :—

“The Wilde Medal for 1901 is awarded to Dr. Élie Metchnikoff, of the Pasteur Institut, Paris, for his services to zoological science (i.) in the field of comparative embryology, in which he was a distinguished pioneer ; (ii.) in the department of comparative anatomy ; (iii.) in the study of inflammation and phagocytosis and of the pathology of infectious diseases generally.

To him we are indebted for our first accurate knowledge of embryology in the case of many animal forms, such as sponges, various jelly fishes, marine worms, the scorpion and the book scorpions, various insects, crustaceans, starfishes, and ascidians, in fact, there is no important group of Invertebrata whose embryology has not been elucidated by his investigations.

He has paid special attention to certain small forms of doubtful affinity which have been much neglected by other writers. One of the most important instances of the alternation of generations, a characteristic phenomenon of parasitic life, was first demonstrated by him, namely, the metamorphosis of the *Ascaris* of the frog's lung into a free-living worm of the genus *Rhabditis*.

The importance of the results announced in his paper on the “Ancestral History of Inflammation,” results both theoretical and practical, ranks it as one of the most brilliant contributions to science of modern days. It gave rise to the theory of phagocytosis, which furnishes an explanation of many of the phenomena of inflammation, and of the immunity from bacterial diseases conferred by inoculation, and established a link between Virchow's cell theory of disease and the Darwinian principle of

natural selection. This theory has been the source of important controversies, which have led to the discovery of certain protective properties of the blood which are now extensively used for the diagnosis and prevention of disease."

"The Wilde Premium for 1901 is awarded to Mr. Thomas Thorp for his paper on 'Grating Films and their Application to Colour Photography,' and other communications to the Society."

The presentations were suitably acknowledged by Dr. Metchnikoff and Mr. Thorp.

Dr. METCHNIKOFF then delivered the Wilde Lecture, "**Sur la Flore du Corps Humain.**"

The lecture is printed in full in the *Memoirs*.

The lecturer was afterwards entertained at dinner by the members and friends.

ANNUAL GENERAL MEETING, APRIL 23RD, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

Dr. ÉLIE METCHNIKOFF, For. Mem. R.S., of the Pasteur Institute, Paris, was elected an honorary member.

The SECRETARY announced, in accordance with Rule 22 of the Articles of Association, that the name of Samuel Joyce had been erased by the Council from the register in consequence of non-payment of his subscription.

The Annual Report of the Council and the Statement of Accounts were presented, and it was moved by Professor S. J. HICKSON, seconded by Mr. R. F. GWYTHER, and resolved:—"That the Annual Report, together with the Statement of Accounts, be adopted, and that they be printed in the Society's *Proceedings*."

It was moved by Mr. CHARLES BAILEY, seconded by Professor S. J. HICKSON, and resolved:—"That the system of electing Associates of the Sections be continued during the ensuing session."

The following members were elected officers of the Society and members of the Council for the ensuing year :—

President : CHARLES BAILEY, F.L.S.

Vice-Presidents : OSBORNE REYNOLDS, M.A., LL.D., F.R.S. ; HORACE LAMB, M.A., LL.D., F.R.S. ; J. E. KING, M.A. ; C. E. STROMEYER, M.Inst.C.E.

Secretaries : FRANCIS JONES, F.R.S.E., F.C.S. ; A. W. FLUX, M.A.

Treasurer : J. J. ASHWORTH.

Librarian : W. E. HOYLE, M.A., M.Sc., F.R.S.E.

Other Members of Council : J. COSMO MELVILL, M.A., F.L.S. ; H. B. DIXON, M.A., F.R.S. ; FRANCIS NICHOLSON, F.Z.S. ; R. L. TAYLOR, F.C.S., F.I.C. ; F. J. FARADAY, F.L.S., F.S.S. ; CHARLES H. LEES, D.Sc.

Ordinary Meeting, April 23rd, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

The PRESIDENT referred to the loss sustained by the Society through the death of Professor F. M. Raoult, of Grenoble, and of Professor H. A. Rowland, of Baltimore, U.S.A., two of the Society's honorary members.

Mr. F. J. FARADAY called attention to the danger which may arise from the fall of the counterpoise of an ordinary electric lamp, owing to the fusing of the conducting (and supporting) wires, due to a short circuit at the point of attachment to the lamp. The probable cause of the short circuiting, and the means of preventing such an accident, were discussed.

Professor S. J. HICKSON communicated two papers by Miss E. M. PRATT, M.Sc., on "**A Collection of Polychæta from the Falkland Islands,**" and "**Some notes on the Bipolar Theory of the Distribution of Marine Organisms.**"

Both papers are printed in full in the *Memoirs*.

Ordinary Meeting, May 28th, 1901.

HORACE LAMB, M.A., LL.D., F.R.S., Vice-President, in the Chair.

The thanks of the members were voted to the donors of the books upon the table.

A paper on "**The Influence of Grinding upon the Solubility of the Lead in Lead Fritts,**" by T. E. THORPE, C.B., LL.D., F.R.S., and CHARLES SIMMONDS, B.Sc., was, in the absence of the authors, read by the Secretary.

The paper is printed in full in the *Memoirs*.

After the reading of the paper,

MR. BURTON pointed out that, even if grinding be productive of variations in solubility of only about 50 per cent. of its amount, a fritt not far within any fixed standard limit would be dangerous or safe according to the fineness of its grinding. He denied that the more soluble fritts are the softer, stating that the contrary is the fact. He further referred to the danger of lead-poisoning from inhaled lead dust, a matter in which the imposition of a standard of solubility of the substance affords no safeguard.

MR. JACKSON stated that the finer portions of the fritts dealt with by himself and Mr. Rich contained not more, but less, lead oxide than the coarser portions. He had himself determined the solubility of different grindings of the same fritt, a fritt which was passed as within the Home Office standard, at amounts varying from below 2 per cent. to about 5 per cent. He exhibited some photographs showing the result of the action of hydrofluoric acid on glasses, which displayed crystalline forms suggestive of distinct heterogeneity, even in the clearest glass. He protested that he had not treated the fritts as single chemical substances.

Professor DIXON and others joined in the discussion.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, January 14th, 1901.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

Mr. JOHN R. RAGDALE, C.C., was elected Treasurer in the place of Mr. Mark Sykes. A vote of thanks and regret was unanimously accorded to Mr. Sykes.

Mr. SYKES described the work done by himself, in conjunction with the Hon. Secretary, during the past eighteen months, in systematically arranging, labelling and cataloguing the slides of microscopical objects in the Section's two cabinets, which have been acquired since the formation of the Section in 1858. All the slides, numbering about 1,400, have now been arranged for reference and study. Every name has, as far as possible, been verified, and a MS. catalogue has been prepared and presented to the Section. Each slide bears an official label marked "A" or "B" for the cabinet, together with the number of the tray and a consecutive number for each tray. It will now be possible to keep the slides in order, and to replace in their proper position any that may be removed.

The thanks of the Section were voted to Mr. Sykes and the Hon. Secretary for their joint labours, and it was resolved that the MS. catalogue be bound for ease of reference.

Mr. THOMAS ROGERS exhibited a collection of Hymenophyllums and Trichomanes from the Blue Mountains, Jamaica.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, February 11th, 1901.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

Mr. HENRY HYDE submitted some examples of leaves, mounted under glass, for the purposes of art teaching.

Mr. MARK STIRRUP, F.G.S., exhibited a series of fossil insects from France, which he had obtained last year from the coal measures of Commentry, in the department of the Allier.

Some curious pupa-cases from Natal, belonging to the Lepidopterous group Psychaidæ, were shown by Mr. THOMAS ROGERS.

Mr. CHARLES BAILEY made a communication on *Ranunculus Bachii*, Wirtgen, as a form of *Ranunculus fluitans*, Lamk., and illustrated his remarks by a series of British examples linking the extreme forms of both plants.

[*Microscopical and Natural History Section.*]

Ordinary Meeting, March 11th, 1901.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

Mr. MARK STIRRUP, F.G.S., made some remarks upon a large series of eocene shells from the well-known deposit at Grignon, near Versailles, which he had collected in that locality during the visit of the members of the International Geological Congress at Paris, in 1900.

Some examples of the shaddock were exhibited by Mr. THOMAS ROGERS.

Mr. HENRY HYDE submitted specimens of *Sagittaria lancifolia* from the West Indies, and of *Gastonia palmata* from the East Indies.

Mr. J. FENWICK ALLEN explained the uses and manufacture of the following metals, illustrating the same by examples, viz. :—silicon, metallic manganese, chromium, ferro-titan, and silicon copper containing 25 % of silicon.

Mr. J. COSMO MELVILL, M.A., exhibited Tasmanian examples of the rare and beautiful alga, *Claudea elegans*, Lam.

Mr. CHARLES BAILEY brought a series of examples of a somewhat rare mint, which he had had in cultivation for many years in his garden at Ashfield, Whalley Range, and which Dr. John Briquet, of Geneva, had recently identified as *Mentha gentilis*, L., var. *Hachenbruchii*, Briq.

Mr. PETER CAMERON sent specimens of *Sphex flavo-vestita*, from Borneo, illustrating its habits. He considered this insect to be but a form of the common Indian species *Sphex aurulentus*. All the species of *Sphex* have the same habits; they feed their young with grasshoppers, which they store in their cell-shaped nests. The peculiarity of their method of providing food for their young consists in the fact that the grasshoppers are not killed, but merely benumbed and rendered motionless by three pricks of the ovipositor—one in the neck, one in the joint between the meso- and metathorax, and one in the base of the abdomen, the seat of the nerve ganglions. The consequence is that the grasshopper does not die and decay, but remains fresh for weeks until its time comes to be devoured by the larva of the *Sphex*. Three or four grasshoppers are put in each cell for one larva, and some species store up as many as 100 for their entire brood, the whole process taking about one month.

Chlorion lobatum, of which specimens were also sent, has similar habits.

[*Microscopical and Natural History Section.*]

Annual Meeting, April 15th, 1901.

CHARLES BAILEY, F.L.S., President of the Section, in the Chair.

The Council presented the following report of the Section for the session 1900-1901 :

“Your Council, in presenting a report for the past session, has to record a slight reduction in the membership of the section, its numbers now amounting to 17 members and 11 associates, as against 17 and 13 respectively, at the corresponding period of the previous session.

“The following is a list of the existing membership :—

Members :—J. J. ASHWORTH, CHARLES BAILEY, F.L.S., JOHN BOYD, G. H. BROADBENT, M.R.C.S., HENRY BROGDEN, DR. A. BROWN, EDWARD COWARD, R. E. CUNLIFFE, HASTINGS C. DENT, F.L.S., DR. A. HODGKINSON, C. J. HEYWOOD, W. E. HOYLE, M.A., F.R.S.E., J. COSMO MELVILL, M.A., F.L.S., FRANCIS NICHOLSON, F.Z.S., J. R. RAGDALE, C. H. SCHILL, MARK STIRRUP, F.G.S.

Associates :—J. F. ALLEN, DR. BOOTH, PETER CAMERON, PETER CUNLIFFE, L. W. HUNT, HENRY HYDE, JOHN MULLEN, THOMAS ROGERS, THEODORE SINGTON, WILLIAM STANLEY, JOHN WATSON.

“The cash in the bank at the credit of the section at this date amounts to £24. 5s. 5d., as will be seen from the Treasurer's account, as against the sum of £24. 12s. 3d, at the beginning of the session.

“The usual meetings have been held regularly each month, and their interest has been fully maintained by the papers read and the objects exhibited. But your Council regrets to record that the attendance continues to slowly decline ; this must be attributed to the specialisation which has taken place in natural history and microscopical studies, each branch of science forming a separate organisation to foster its special pursuits.

“Your Council is sorry to report the resignation of Mr. Theodore Sington as Honorary Secretary, an office which he has held for the last nine years, and the duties of which he has discharged with considerable zeal and efficiency.”

Treasurer's Statement of Accounts.

<i>Dr.</i>	SESSION 1900-1901.		<i>Cr.</i>
To Balance at Bankers and Cash in hand	£	s. d.	
„ Subscriptions and Arrears....	24	12 3	
„ Bank Interest	10	5 0	
	0	9 6	
	£35	6 9	
			By Books and Periodicals
			„ Tea, Coffee, &c., at Meetings 2 13 10½
			„ Printing and Stationery 2 11 9
			„ Postages, &c. .. 1 13 2
			„ Balance, April 15th, 1901 24 5 5½
			£35 6 9

Audited, April 15th, 1901.

Signed) { JOHN BOYD.
{ J. FENWICK ALLEN.

The Annual Report and Statement of Accounts were duly approved and passed,

The following Members and Associates were appointed the Council for the ensuing year :—

President - - - - CHARLES BAILEY, F.L.S.

Vice-Presidents - - JOHN BOYD ;

MARK STIRRUP, F.G.S. ; and
THOMAS ROGERS,

Treasurer - - - - JOHN R. RAGDALE, C.C.

Honorary Secretary : J. COSMO MELVILL, M.A., F.L.S.

Council - - - - J. FENWICK ALLEN ;

R. E. CUNLIFFE ;

W. E. HOYLE, M.A., F.R.S.E. ;

HENRY HYDE ;

FRANCIS NICHOLSON, F.Z.S. ; and

C. H. SCHILL.

Mr. THOMAS ROGERS exhibited a number of fossil ferns and mosses which had been found in the débris of Roman Manchester during the excavations of recent years, and he described the localities where they were found and the conditions under which the plants must be assumed to have grown.

MANCHESTER
LITERARY AND PHILOSOPHICAL SOCIETY.

Annual Report of the Council, April, 1901.

The Society began the session with an ordinary membership of 154. During the present session 3 new members have joined the Society; 10 resignations have been received, and the deaths have been 4, viz.: Sir WILLIAM CUNLIFFE BROOKS, Bart., Mr. RICHARD COPLEY CHRISTIE, Professor DANIEL JOHN LEECH, and Sir JOHN WILLIAM MACLURE, Bart., whilst 4 members have been removed from the list for non-payment of their subscriptions. This leaves on the roll 139 ordinary members. The Society has also lost 2 honorary members by death, viz.: Lord ARMSTRONG, C.B., F.R.S., and Professor CH. HERMITE, For. Mem. R.S. Memorial notices of these gentlemen appear at the end of this report.

The Treasurer commenced the year with a balance in favour of the Society of £153. 1s. 2d. (including £124. 5s. 11d. balance of the Wilde Endowment Fund), and reports that the total balance, exclusive of the amount still owing by the Natural History Fund, but including the Wilde and Joule Funds, at the bankers and in hand, at the close of the year, is £119. 6s. 9d.

The Council has to thank Dr. Wilde for proposing certain alterations in the Trust Deed of the Wilde Endowment Fund. These alterations, which give additional discretionary powers to the Council in the award of the Wilde Medal and Premium, and in the disposal of the balance of the Fund, have been embodied

in a supplementary Deed which has been unanimously approved by the Council.

The Council has also to record its thanks to Dr. Schunck for presenting to the Society portraits in water-colour of the Rev. William Johns, formerly Secretary of the Society, and the Rev. William Gaskell, formerly Vice-President. These have been framed and placed in the Council Room.

The Librarian is pleased to report that the re-cataloguing of the Society's library is now practically completed. There yet remain a few volumes of tracts and the collection of dissertations, and these will be catalogued as opportunity offers. During the session, 1,594 volumes have been catalogued, stamped, and pressmarked, 792 of these being serials, and 802 separate works. There have been written 1,326 catalogue cards, 306 for serials, and 1,020 for separate works. The total number of volumes catalogued to date is 25,448 for which 8,381 cards have been written.

Satisfactory use is made of the library for reference purposes, but the number of volumes consulted is not recorded. During the session, 195 volumes have been borrowed from the library, as compared with 205 volumes in the previous session; it is hoped that, as the card catalogue now affords every facility for quickly finding any work required, members will make further use of the valuable collection of books possessed by the Society.

Attention has continued to be paid to the completion of sets. with the result that 49 volumes or parts have been obtained which render 17 sets complete, whilst 51 volumes have been acquired which partly complete 13 sets. These 100 volumes, with the exception of 6 purchased, were presented by the respective societies publishing them. Since the commencement of the re-cataloguing of the library, a total of 788 missing volumes has been obtained, resulting in the completion of 94 sets.

Considerably more binding has been done than in the previous year, 612 volumes having been bound in 446, whilst several volumes have undergone repair.

A record of the accessions to the library shows that, from April, 1900, to March, 1901, 625 serials and 80 separate works were received, a total of 705 volumes. The donations during the session (exclusive of the usual exchanges) amount to 17 volumes and 127 dissertations; 2 books have been purchased (in addition to the periodicals on the regular subscription list).

During the past session the Society has arranged to exchange publications with the following: Western Society of Engineers, Chicago; Lloyd Library of Botany, Pharmacy and Materia Medica, Cincinnati; Naturhistorisk Forening, Copenhagen; University of Durham Philosophical Society, Newcastle-upon-Tyne.

The University of Glasgow having requested the Society to appoint delegates to be present at the celebration of the Ninth Jubilee of the University, from June 12th to 14th, 1901, the Council has nominated Dr. Henry Wilde, F.R.S., and Professor Horace Lamb, LL.D., F.R.S., to represent the Society on the occasion.

At the request of the Council, Professor A. Sheridan Delépine, M.B., B.Sc., and Mr. Alexander Hodgkinson, M.B., B.Sc., have agreed to act as delegates of the Society to the British Congress on Tuberculosis, to be held in London from July 22nd to 26th, 1901.

The Council has awarded:—

The Wilde Medal for 1901 to Dr. Élie Metchnikoff, for his researches in comparative embryology, comparative anatomy, and the study of inflammation and phagocytosis.

The Wilde Premium for 1901 to Mr. Thomas Thorp, for his paper on "Grating Films and their application to colour photography," and other communications made to the Society.

Dr. Metchnikoff was appointed to deliver the Wilde Lecture.

The Council arranged for the Medal and Premium to be presented and the Wilde Lecture to be delivered on Monday, April 22nd, 1901.

WILLIAM GEORGE ARMSTRONG was born in Newcastle on November 26th, 1810, where his father was a well-to-do corn merchant. He was trained for the legal profession, and until 1847 was partner with a firm of solicitors. Through his marriage with Margaret Ramshaw, he was brought into contact with engineers like her father, and he soon grew to be much interested in their many experiences and new problems, until at last, seeing sufficient prospect of success, he, in company with Potter, Donkin, Cruddas, and Lambert, founded what has grown to be the Elswick Works. His first attention was directed to hydraulic machinery, which he greatly improved, and to this day his firm has retained its early lead in the manufacture of these appliances. Shortly afterwards everybody's attention was riveted on our shortcomings in the Crimean war, and Armstrong set about improving our artillery, which then consisted of bronze or cast-iron smooth-bore guns. He copied the sporting guns of the day, both as regards rifling and coiled construction, and added his well-known breech-loading device. His claims to the invention of this type of gun were strongly attacked at the time, until he made a present of it to the nation, for which act he was rewarded with a knighthood and appointed Director of Rifled Ordnance, with permission to remain partner in his own firm. This arrangement was also violently attacked, and in 1862 he voluntarily retired from the official position and devoted his time and energy to his own works and to scientific researches. He was a firm believer in the superiority of guns over armour, and increased their weight up to 110 tons. By that time, however, our naval and military departments had given up the Armstrong breech block, reverting to muzzleloaders, and about the same time mild steel had been invented, so that the coiling of wrought iron bars for gun barrels has now been quite given up, and thus two of the principal inventions with which Armstrong's name will always be associated are things of the past.

The varied successes of Lord Armstrong were not due entirely to qualities which go to make a good business man, but partly also to a power which he possessed, in a marked degree,

of making himself acquainted with mechanical principles and details. In fact, he seems to have prepared himself for each invention by a careful study of the subject, both theoretically and experimentally; it is therefore not surprising to find that, in spite of his busy life, he devoted much time to scientific researches. Even as far back as 1840, he experimented on the production of electricity by means of jets of steam, and made some interesting discoveries, which have, however, led to no commercial developments. He received many honours, not only from our own learned societies, but also from foreign countries.

In 1887 he was created Baron Armstrong of Cragston. He died 27th December, 1900. Lord Armstrong had been an honorary member of our Society since 1887.

C. E. S.

CHARLES HERMITE was born in 1821. Already, whilst a student at the École Polytechnique, he entered into a mathematical correspondence with the veteran Jacobi, and received from the latter the most flattering encouragement. His earlier researches had reference to the theory of algebraic forms, and he took part with Cayley and Sylvester in the development of the theory of invariants; he also occupied himself with the theory of elliptic and other cognate functions. He became a member of the Institut de France in 1856, and in 1862 was appointed Professor in the École Normale. He subsequently occupied posts in the École Polytechnique and in the Sorbonne; and greatly developed and modernised the teaching of advanced mathematics in these institutions. Among his later achievements may be mentioned the proof that the number e is transcendental. That e is irrational had long been known; but the definite proof that it is not an algebraical number at all, *i.e.*, that it cannot be the root of any algebraic equation with integral co-efficients, was reserved for Hermite. This paved the way for Lindemann's demonstration of the transcendental nature of π , which appears to be the last word of mathematics on the secular problem of "squaring the circle." Hermite's scientific activity

continued even in advanced age, and his personality and his example were held in peculiar veneration by the present brilliant school of French mathematicians. He was a foreign member of the Royal Society, and had been an honorary member of our own Society since 1892.

H. L.

SIR WILLIAM CUNLIFFE BROOKS was born on September 30th, 1819. He was educated at Rugby, under Dr. Arnold, and at St. John's College, Cambridge. He read for the Bar, and was called in 1847. Later in life he entered Parliament, representing East Cheshire from 1869 till 1885, and North Cheshire from 1886 till 1890. In 1886 he was created a baronet, and, in addition, was a magistrate and deputy-lieutenant for Lancashire, and a magistrate for Cheshire and for the city of Manchester. He became the first president of the Manchester Bankers' Institute on its foundation in 1895. The bank of which he was the head was then the only private bank surviving in Manchester, and, as is known, after three generations in private hands, it has since ceased to be privately owned. Sir William had been a member of the Literary and Philosophical Society since January 23rd, 1844; and at the time of his death, on June 9th, 1900, shared with only two other ordinary members the distinction of a membership in the Society of over half a century.

RICHARD COPLEY CHRISTIE, M.A. OXON. (1855), Hon. LL.D. Vict. (1895), was a member of this Society from 1854 until his death, which occurred on January 9th, 1901. He was born at Lenton, near Nottingham, in 1830, was educated at Lincoln College, Oxford, where Mark Pattison was at the time tutor, a small college which has supplied Manchester with a Bishop, a Chancellor of the Diocese, a Principal of Owens College, and a Professor of Philosophy, and more than one High Master of the Grammar School. In 1853 Mr. Christie obtained a first class in Law and History, and the next year was appointed Professor of History in Owens College, to the duties of which post he shortly

added those of Professor of Political Economy. His academic work was naturally much hindered by the claims of a rapidly growing practice at the Chancery Bar; and it would be impossible to speak of his teaching as founding a school in either of his subjects, in the sense in which this might be said of his immediate successors, Dr. Ward and Professor Jevons, or of those who have followed them. But his lectures were thoroughly scholarly both in form and substance; he held up before his pupils a high standard of clearness, accuracy, and stimulating force. In 1886 he resigned the Professorship of History and Political Economy, and accepted that of Jurisprudence, in which he was, before long, succeeded by Professor Bryce. In his career as a Chancery barrister he was distinguished for his sensitive personal and professional honour, and was recognised for many years as one of the leaders of the local bar. For twenty-one years, from 1872 onwards, Mr. Christie was Chancellor of the Diocese of Manchester, and was by common repute quite exceptionally fitted to discharge the delicate duties of the office. Much time was also devoted to the service of Owens College on its Council, and the institution of the body of associates was due to Mr. Christie's suggestion. After his removal to London he took an active interest in the Royal Holloway College. As one of the three residuary legatees of the late Sir Joseph Whitworth, he took very great pains to expend the large sums placed at their disposal for the good of the community, and it would be difficult to draw up a complete list of their benefactions. In the same capacity he acted for ten years as the Chairman of Sir Joseph Whitworth and Co., Limited. But, apart from his professional work, Mr. Christie's taste turned mainly to bibliography. It was the accomplished printer as much as the religious reformer whom he honoured in his admirable work on Etienne Dolet, the Martyr of the Renaissance; though not a few passages show that passion for freedom and justice breaking out, which was usually strictly repressed. The work, published in 1880, was translated into French, and re-edited with many additions in 1899.

Mr. Christie was President of the Chetham Society from 1884 till his death, of the Record Society of Lancashire and Cheshire from 1883 to 1895, and of the Library Association in 1889.

Mr. Christie's own library was remarkably choice, containing many rarities, especially of the sixteenth and seventeenth centuries. By the generosity of Mrs. Christie this library, though left to her for her lifetime, will shortly be handed over to the Owens College, where it will be housed in the beautiful buildings due to Mr. Christie's munificence, and where it will be accessible to all serious students.

A. S. W.

DANIEL JOHN LEECH, J.P., M.D., D.Sc., F.R.C.P., was the second son of the late Mr. Thomas Leech, of Manchester, and was born at Urmston in 1840.

His early scientific tastes led him to choose medicine as a profession, and after the usual period of apprenticeship, and a distinguished career at the Chatham Street Medical School, he became a member of the Royal College of Surgeons in 1861, when only 21 years of age. Further periods of clinical study were passed in Paris and London, and in 1862 he was appointed Demonstrator of Anatomy at the Manchester Medical School, then removed to Pine Street.

After two years' work at anatomy, Dr. Leech settled down in general practice in Stretford Road, Manchester, first as partner, then as successor, to the late Mr. Richmond. In 1869 he married the eldest daughter of the late Mr. James Maclaren, of Whalley Range. While immersed in the cares of a large general practice Dr. Leech found time and energy to engage successfully in further study, and in 1868 he obtained the degree of M.B. of the London University, with first-class honours. In 1876 he took the degree of M.D. ; in 1875 he was admitted a member, and in 1882 elected a Fellow, of the Royal College of Physicians of London.

Dr. Leech was an active worker in connection with local medical institutions, and took a leading part in such societies as

the Manchester and Salford Sanitary Association. He produced several very able and valuable reports upon the health of Manchester and Salford, more especially in relation to the pollution of the rivers, the contamination of the air by smoke, the adulteration of food, and the housing of the working classes.

In medical societies Dr. Leech took an active part, and especially in the British Medical Association and its Lancashire and Cheshire Branch. In 1877 he was one of the general secretaries for the annual meeting of the Association in Manchester, and was afterwards President of the Lancashire and Cheshire Branch. In later years his interest was chiefly in the Pharmacological and Therapeutical Section, of which he was Vice-President in 1887, and President in 1897 at the annual meeting in Montreal, and for some years he was Chairman of the Therapeutic Committee.

In 1884 he became a member of the Manchester Literary and Philosophical Society; he was also a member of the Royal Medical and Chirurgical Society, of the London and Manchester Pathological Societies, and an Honorary Member of the Pharmaceutical Society.

In 1897 Dr. Leech was appointed a justice of the peace for the city of Manchester.

Much of Dr. Leech's time and energy was devoted to the Owens College and the Victoria University. Appointed at first Joint Lecturer in the Owens College in 1876, he became the first Professor of *Materia Medica* and Therapeutics in 1881, and rapidly organised one of the finest Museums of *Materia Medica* in this country, and introduced experimental Pharmacology into his teaching at a time when the importance of that subject was but little recognised in our English Medical Schools. In the development of all departments of the Owens College he took a deep and often generous interest, as a member of the Senate, Council, or Court of Governors.

In the formation of the Victoria University he bore a leading part, and especially in the organisation of the Medical Faculty. For many years a member of the Council and the Court, a

chairman of Convocation, Pro-Vice-Chancellor and the representative of the University on the General Medical Council, he has had an influential voice in guiding the policy of the growing University and instituting a high standard for its degrees. In recognition of his services he received, in 1895, the degree of D.Sc. of the Victoria University, *honoris causa*.

As a member of the General Medical Council, his special knowledge was of the greatest value upon the Pharmacopœia Committee, and he devoted much time and work to the revision of the "British Pharmacopœia," the new edition of which, issued in 1898, owes much of its excellence to his care and judgment. The value of his work was soon recognised by his colleagues, by his appointment to the chairmanship of the Committee in succession to the late Sir Richard Quain.

Dr. Leech contributed a large number of papers to medical literature, the most important being a series of papers upon the medicinal action and uses of the various Nitrites; upon this subject he delivered the Croonian Lectures, in 1893, before the Royal College of Physicians of London.

His death took place on July 2nd, 1900.

R.B.W.

SIR JOHN WILLIAM MACLURE was born on April 22nd, 1835. From an early age he took part in the public life of Manchester, being a sidesman of the Cathedral at eighteen, and a member of the governing body of the Royal Infirmary at twenty-two. He acted as Secretary to the Relief Committee at the time of the Cotton Famine in Lancashire, due to the American Civil War, and, as is well-known, displayed conspicuous ability in that position. In later years he was concerned with numerous important business undertakings at home and abroad. He represented the Stretford division of Lancashire in the House of Commons from 1886 till his death, which occurred on January 28th, 1901. He assisted in the formation of the Manchester Natural History Society, since dissolved, and had been a member of the Literary and Philosophical Society from January 25th, 1859. The distinction of a baronetcy was conferred upon him in 1897.

MANCHESTER LITERARY AND

J. J. Ashworth, Treasurer, in Account with the

Dr.

	£	s.	d.	£	s.	d.
To Cash in hand, April 1st, 1900				28	15	3
To Members' Subscriptions:—						
Half Subscriptions, 1899-1900, 4 at £1. 1s. od.			4	4	0	
" 1900-01, 6 " "			6	6	0	
Subscriptions:— 1894-95, 1 at £2. 2s. od.			2	2	0	
" 1895-96, 1 " "			2	2	0	
" 1896-97, 1 " "			2	2	0	
" 1897-98, 2 " "			4	4	0	
" 1898-99, 4 " "			8	8	0	
" 1899-1900, 10 " "			21	0	0	
" 1900-01, 113 " "			237	6	0	
" 1901-02, 1 " "			2	2	0	
To Transfers from the Wilde Endowment Fund						289 16 0
To Sale of Publications						78 7 0
To Sale of Field's Card Catalogue of Zoological Literature, 1896-8						15 16 8
To Dividends:—						5 1 3
Natural History Fund			58	8	10	
Joule Memorial Fund			7	7	2	
To Income Tax Refunded:—						65 16 0
Natural History Fund			2	5	11	
Joule Memorial Fund			0	6	4	
						2 12 3

£486 4 5

1901.—April 1. To Cash in Williams Deacon's Bank, and in hand £34 5 1

WILDE ENDOWMENT

	£	s.	d.
To Balance from 1899-1900			124 5 11
To Dividends on £7,500 Gas Light and Coke Company's Ordinary Stock			314 17 6
To Remission of Income Tax, 1900			13 0 0
To Bank Interest			1 19 11

£454 3 4

1901.—April 1. To Cash in Manchester and Liverpool District Bank £85 1 8

NATURAL HISTORY

	£	s.	d.
To Dividends on £1,225 Great Western Railway Company's Stock			58 8 10
To Remission of Income Tax, 1900			2 5 11
To Balance against this Fund, April 1st, 1901			58 2 9

£118 17 6

JOULE MEMORIAL

	£	s.	d.
To Balance, April 1st, 1900			31 2 8
To Dividends on £258 Loan to Manchester Corporation			7 7 2
To Remission of Income Tax, 1900			0 6 4

£38 16 2

DALTON TOME

	£	s.	d.
To Balance, April 1st, 1900			30 0 0
To Donations			1 2 1
To Bank Interest			0 6 5

£31 8 6

Treasurer's Accounts.

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PHILOSOPHICAL SOCIETY.

Society, from 1st April, 1900, to 31st March, 1901.

Gr.

	£	s.	d.		£	s.	d.
By Charges on Property :—							
Chief Rent (Income Tax deducted)	12	6	5				
Income Tax on Chief Rent	0	12	11				
Insurance against Fire	13	17	6				
Repairs to Building, &c.	4	18	7				
By House Expenditure :—					31	15	5
Coals, Gas, Electric Light, Water, Wood, &c.	24	10	3				
Tea, Coffee, &c., at Meetings	14	10	3				
Cleaning, Sweeping Chimneys, &c.	3	18	8½				
By Administrative Charges :—					42	19	2½
Housekeeper	53	6	0				
Postages, and Carriage of Parcels and of "Memoirs"	35	15	2				
Stationery, Cheques, Receipts, and Engrossing	6	14	9½				
Printing Circulars, Reports, &c.	18	3	9				
Miscellaneous Expenses	2	0	10				
By Publishing :—					116	0	6½
Honorarium for Editing the "Memoirs" (and moiety for 1899-1900)	25	0	0				
Printing "Memoirs and Proceedings" (less amount charged to Joule Fund)	142	0	0				
Illustrations for "Memoirs and Proceedings"	11	19	0				
Binding "Memoirs"	2	0	0				
By Library :—					180	19	0
Books and Periodicals (except on Natural History)	38	0	7				
Library Appliances (Catalogue Cards)	1	0	0				
By Natural History Fund :—					39	0	7
(Item shown in the Balance Sheet of this Fund)					36	5	7
By Joule Memorial Fund :—					4	19	0
(Item shown in the Balance Sheet of this Fund)							
By Balance at Bank	24	5	1				
„ „ in Treasurer's hands	10	0	0				
					31	5	1
					<u>£486</u>	<u>4</u>	<u>5</u>

FUND, 1900—1901.

	£	s.	d.		£	s.	d.
By Assistant Secretary's Salary, April, 1900, to March, 1901					138	0	0
By Maintenance of Society's Library :—							
Binding and Repairing Books	71	17	0				
Periodicals to complete sets	0	7	6				
By Decorating and Repairs to Society's Premises					72	4	6
By Gold Medal and Engraving same					30	1	2
By Wilde Premium for Selected Memoir					18	19	0
By Honorarium to Lecturer					15	15	0
By Transfers to Society's Funds					15	15	0
By Balance at Bank, April 1st, 1901					78	7	0
					85	1	8
					<u>£454</u>	<u>3</u>	<u>4</u>

FUND, 1900—1901.

	£	s.	d.		£	s.	d.
By Balance against, April 1st, 1900					82	11	11
By Natural History Books and Periodicals					36	5	7
					<u>£118</u>	<u>17</u>	<u>6</u>

FUND, 1900—1901.

	£	s.	d.		£	s.	d.
By Printing J. H. Grindley's paper on "The Thermodynamical Properties of Superheated Steam, and the Dryness of Saturated Steam"					4	19	0
By Balance, April 1st, 1901					33	17	2
					<u>£38</u>	<u>16</u>	<u>2</u>

FUND, 1900—1901.

	£	s.	d.		£	s.	d.
By Printing and Postages	0	4	10				
By Balance at Bank	31	3	8				
					<u>£31</u>	<u>8</u>	<u>6</u>

NOTE.—The Treasurer's Accounts of the Session 1900-1901 of which the foregoing pages are summaries, have been endorsed as follows :

April 17th, 1901.

Audited and found correct.

We have also seen, at this date, the certificates of the following Stocks held in the name of the Society :—£1,225 Great Western Railway Company 5% Consolidated Preference Stock, Nos. 12,293, 12,294, and 12,323; £258 Twenty years' loan to the Manchester Corporation, redeemable 25th March, 1914 (No. 1564); £7,500 Gas Light and Coke Company Ordinary Stock (No. 6389); and the deeds of the Natural History Fund, of the Wilde Endowment Fund, those conveying the land on which the Society's premises stand, and the Declaration of Trust.

(Signed) { CHARLES H. LEES.
 { THOMAS THORP.

THE COUNCIL
AND MEMBERS
OF THE
MANCHESTER
LITERARY AND PHILOSOPHICAL SOCIETY.

(Corrected to July 31st, 1901.)

President.

CHARLES BAILEY, F.L.S.

Vice-Presidents.

OSBORNE REYNOLDS, M.A., LL.D., F.R.S.
HORACE LAMB, M.A., LL.D., F.R.S.
J. E. KING, M.A.
C. E. STROMEYER, M.Inst.C.E.

Secretaries.

FRANCIS JONES, F.R.S.E., F.C.S.
A. W. FLUX, M.A.

Treasurer.

J. J. ASHWORTH.

Librarian.

W. E. HOYLE, M.A., M.Sc., F.R.S.E.

Of the Council.

J. COSMO MELVILL, M.A., F.L.S.
HAROLD B. DIXON, M.A., F.R.S.
FRANCIS NICHOLSON, F.Z.S.
R. L. TAYLOR, F.C.S.
F. J. FARADAY, F.L.S.
CHARLES H. LEES, D.Sc.

ORDINARY MEMBERS.

Date of Election.

- 1870, Dec. 13. Angell, John, F.C.S., F.I.C. 6, *Beaconsfield, Derby Road, Withington, Manchester.*
- 1896, Jan. 31. Armstrong, Frank. *The Rowans, Harboro' Grove, Harboro' Road, Ashton-on-Mersey, Cheshire.*
- 1895, Jan. 8. Armstrong, George B. *Clarendon, Sale, Cheshire.*
- 1887, Nov. 16. Ashworth, J. J. 47, *Faulkner Street, Manchester.*
- 1865, Nov. 14. Bailey, Charles, F.L.S. *Ashfield, College Road, Whalley Range, Manchester.*
- 1888, Feb. 7. Bailey, Alderman Sir W. H. *Sale Hall, Sale, Cheshire.*
- 1895, Jan. 8. Barnes, Charles L., M.A. 10, *Nelson Street, Chorlton-on-Medlock, Manchester.*
- 1894, Jan. 9. Beckett, J. Hampden, B.Sc., F.C.S. *Corbar Hall, Buxton.*
- 1896, April 14. Behrens, George B. *The Acorns, 4, Oak Drive, Fallowfield, Manchester.*
- 1895, Mar. 5. Behrens, Gustav. *Holly Royde, Withington, Manchester.*
- 1898, Nov. 29. Behrens, Walter L. 22, *Oxford Street, Manchester.*
- 1868, Dec. 15. Bickham, Spencer H., F.L.S. *Underdown, Ledbury.*
- 1896, April 14. Bindloss, James B. *Elm Bank, Eccles, Lancs.*
- 1896, April 28. Bolton, Herbert, F.R.S.E. *The Museum, Bristol.*
- 1861, Jan. 22. Bottomley, James, D.Sc., B.A., F.C.S. 220, *Lower Broughton Road, Manchester.*
- 1896, Oct. 6. Bowman, F. H., D.Sc., F.R.S.E. *Mayfield, Knutsford, Cheshire.*
- 1896, Feb. 18. Bowman, George, M.D. 594, *Stretford Road, Old Trafford, Manchester.*
- 1875, Nov. 16. Boyd, John. *Barton House, Didsbury Park, Didsbury, Manchester.*
- 1889, Oct. 15. Bradley, Nathaniel, F.C.S. *Sunnyside, Whalley Range, Manchester.*
- 1894, Mar. 6. Broadbent, G. H., M.R.C.S. 8, *Ardwick Green, Manchester.*
- 1896, Nov. 17. Broderick, Lonsdale, F.C.A. *Somerby, Wilmslow, Cheshire.*
- 1861, April 2. Brogden, Henry, F.G.S., M.I.Mech.E. *Hale Lodge, Altrincham, Cheshire.*
- 1889, April 16. Brooks, Samuel Herbert. *Slade House, Levenshulme, Manchester.*
- 1860, Jan. 24. Brothers, Alfred. 117, *Summerfield Crescent, Edgbaston, Birmingham.*

Ordinary Members.

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Date of Election.

- 1886, April 6. Brown, Alfred, M.A., M.D. *Sandycroft, Higher Broughton, Manchester.*
- 1846, Jan. 27. Browne, Henry, M.A. (Glas.), M.D. (Lond.), M.R.C.S. (Lond.), *The Gables, Victoria Park, Manchester.*
- 1889, Jan. 8. Brownell, T. W., F.R.A.S. 64, *Upper Brook Street, Manchester.*
- 1889, Oct. 15. Budenberg, C. F., M.Sc., M.I.Mech.E. *Bowdon Lane, Marple, Cheshire.*
- 1872, Nov. 12. Burghardt, Charles Anthony, Ph.D. 35, *Fountain Street, Manchester.*
- 1894, Nov. 13. Burton, William, F.C.S. *The Hollies, Clifton Junction, near Manchester.*
-
- 1899, Feb. 7. Chapman, D. L., B.A. *Owens College, Manchester.*
- 1895, April 30. Collett, Edward Pyemont. 7, *Wilbraham Road, Chorlton-cum-Hardy, Manchester.*
- 1884, Nov. 4. Corbett, Joseph. *Town Hall, Salford.*
- 1895, April 30. Cornish, James Edward. *Stone House, Alderley Edge, Cheshire.*
- 1859, Jan. 25. Coward, Edward, Assoc.Inst.C.E., M.I.Mech.E. *Heatherlea, Bowdon, Cheshire.*
- 1899, Mar. 7. Crombie, Charles H., B.A. *West Gate, Burford Road, Whalley Range, Manchester.*
- 1895, Nov. 12. Crossley, W. J., M.I.Mech.E. *Openshaw, Manchester.*
- 1876, April 18. Cunliffe, Robert Ellis. *Croft, Ambleside.*
-
- 1853, April 19. Darbshire, Robert Dukinfield, B.A., F.S.A., 1, *St James' Square, Manchester.*
- 1895, April 9. Dawkins, W. Boyd, M.A., D.Sc., F.R.S., Professor of Geology. *Owens College, Manchester.*
- 1894, Mar. 6. Delépine, A. Sheridan, M.B., B.Sc., Professor of Pathology. *Owens College, Manchester.*
- 1887, Feb. 8. Dixon, Harold Bailey, M.A., F.R.S., Professor of Chemistry. *Owens College, Manchester.*
- 1898, Oct. 18. Donovan, E. W., M.I.Mech.E. *Hilton House, Prestwich, Lancs.*
-
- 1899, April 11. Earle, Hardman A. 40, *Oughton Road, Birkdale, Lancs.*
-
- 1883, Oct. 2. Faraday, F. J., F.L.S., F.S.S. *Ramsay Lodge, Slade Lane, Levenshulme, Manchester.*

*Ordinary Members.**Date of Election.*

- 1900, April 24. Faraday, Miss Lucy Winifred, M.A. *Ramsay Lodge, Slade Lane, Levenshulme, Manchester.*
- 1897, Oct. 19. Faraday, W. Barnard, LL.B. *Ramsay Lodge, Slade Lane, Levenshulme, Manchester.*
- 1900, Feb. 20. Flintoff, R. J. *Haxby, Crumpsall Lane, Crumpsall, Manchester.*
- 1895, April 30. Flux, A. W., M.A., Professor of Political Economy. *Owens College, Manchester.*
- 1897, Nov. 30. Freston, H. W. 6, *St. Paul's Road, Kersal, Manchester.*
- 1898, Nov. 29. Gamble, F. W., D.Sc. *Owens College, Manchester.*
- 1900, Feb. 6. Goldthorpe, William. *Brook House, Burnage Lane, Levenshulme, Manchester.*
- 1896, Nov. 17. Gordon, Rev. Alexander, M.A. *Memorial Hall, Albert Square, Manchester.*
- 1900, Oct. 16. Grindley, J. H., M.Sc. *Owens College, Manchester.*
- 1897, Jan. 26. Grossmann, J., Ph.D. *Harpurhey Chemical Works, Harpurhey, Manchester.*
- 1875, Feb. 9. Gwyther, Reginald F., M.A., Fielden Lecturer in Mathematics. *Owens College, Manchester.*
- 1890, Feb. 18. Harker, Thomas. *Brook House, Fallowfield, Manchester.*
- 1895, Nov. 12. Hartog, Philippe Joseph, B.Sc., F.C.S., Demonstrator in Chemistry. *Owens College, Manchester.*
- 1890, Mar. 4. Henderson, H. A. *Eastbourne House, Chorlton Road, Manchester.*
- 1889, Jan. 8. Heywood, Charles J. *Chaseley, Pendleton, Manchester.*
- 1895, Mar. 5. Hickson, Sydney J., M.A., D.Sc., F.R.S., Professor of Zoology. *Owens College, Manchester.*
- 1884, Jan. 8. Hodgkinson, Alexander, M.B., B.Sc. 18, *St. John Street, Manchester.*
- 1898, Nov. 29. Hopkinson, Alfred, K.C., M.A., LL.D., Principal of Owens College. *Fairfield, Victoria Park, Manchester.*
- 1896, Nov. 3. Hopkinson, Edward, D.Sc., M.Inst.C.E. *Oakleigh, Timperley, Cheshire.*
- 1889, Oct. 15. Hoyle, William Evans, M.A., F.R.S.E., Director of the Manchester Museum. *Owens College, Manchester.*
- 1900, Oct. 16. Hutton, R. S., M.Sc. *Owens College, Manchester.*
- 1899, Oct. 17. Huxley, George, M.I.Mech.E. 20, *Mount Street, Manchester.*
- 1899, Oct. 17. Ingleby, Joseph, M.I.Mech.E. *Ingleside, Marple Bridge, near Stockport.*

Ordinary Members.

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Date of Election.

- 1870, Nov. 1. Johnson, William H., B.Sc. 26, *Lever Street, Manchester.*
1896, Oct. 20. Jones, A. Emrys, M.D. 10, *St. John Street, Manchester.*
1878, Nov. 26. Jones, Francis, F.R.S.E., F.C.S. *Manchester Grammar School.*
- 1886, Jan. 12. Kay, Thomas. *Moorfield, Stockport, Cheshire.*
1891, Dec. 1. King, John Edward, M.A., High Master, *Manchester Grammar School.*
1895, Nov. 12. Kirkman, W. W. *The Grange, Timperley, Cheshire.*
- 1893, Nov. 14. Lamb, Horace, M.A., LL.D., F.R.S., Professor of Mathematics. 6, *Wilbraham Road, Fallowfield, Manchester.*
1899, Feb. 7. Lawrence, W. T., B.A., Ph.D. *Owens College, Manchester.*
1895, Nov. 12. Lees, Charles Herbert, D.Sc. Demonstrator in Physics. *Owens College, Manchester.*
1895, Mar. 5. Levinstein, Ivan. *Hawkesmoor, Wilbraham Road, Fallowfield, Manchester.*
1857, Jan. 27. Longridge, Robert Bewick, M.I.Mech.E. *Yew Tree House, Tabley, Knutsford, Cheshire.*
1896, Nov. 3. Lynde, James Henry, M.Inst.C.E. *Buckland, Ashton-on-Mersey, Cheshire.*
- 1898, Nov. 29. McConnel, J. W., M.A. *Wellbank, Prestwich, Lancs.*
1866, Nov. 13. McDougall, Arthur, B.Sc., *Fallowfield House, Fallowfield, Manchester.*
1875, Jan. 26. Mann, J. Dixon, M.D., F.R.C.P. (Lond.), Professor of Medical Jurisprudence at Owens College. 16, *St. John Street, Manchester.*
1896, Oct. 20. Massey, Leonard F. *Openshaw, Manchester.*
1864, Nov. 1. Mather, William, M.P., M.Inst.C.E., M.I.Mech.E. *Iron Works, Salford.*
1873, Mar. 18. Melvill, James Cosmo, M.A., F.L.S. *Brook House, Prestwich, Lancs.*
1896, Nov. 3. Milligan, William, M.D. *Westbourne, Wilmslow Road, Rusholme, Manchester.*
1881, Oct. 18. Mond, Ludwig, Ph.D., F.R.S., F.C.S. *Winnington Hall, Northwich, Cheshire.*
1894, Feb. 6. Mond, Robert Ludwig, M.A., F.R.S.E., F.C.S. *Winnington Hall, Northwich, Cheshire.*
1899, Mar. 7. Morris, Edgar F., M.A., F.C.S. *Grey House, Barrington Road, Altrincham, Cheshire.*

Date of Election.

- 1873, Mar. 4. Nicholson, Francis, F.Z.S. 84, *Major Street, Manchester.*
- 1900, April 3. Nicolson, John T., D.Sc. 7, *Athol Road, Alexandra Park, Manchester.*
- 1889, April 16. Norbury, George. *Hillside, Prestwich Park, Prestwich, Lancs.*
- 1884, April 15. Okell, Samuel, F.R.A.S. *Coverley, Langham Road, Bowdon, Cheshire.*
- 1895, Nov. 12. Pennington, James Dixon, B.A., M.Sc., 254, *Oxford Road, Manchester.*
- 1892, Nov. 15. Perkin, W. H., jun., Ph.D., F.R.S., Professor of Organic Chemistry. *Owens College, Manchester.*
- 1885, Nov. 17. Phillips, Henry Harcourt, F.C.S. 9, *Crawford Avenue, Bolton, Lancs.*
- 1900, Feb. 20. Ragdale, J. R. *The Beeches, Whitefield, near Manchester.*
- 1888, Feb. 21. Réé, Alfred, Ph.D., F.C.S. 15, *Mauldeth Road, Withington, Manchester.*
- 1869, Nov. 16. Reynolds, Osborne, M.A., LL.D., F.R.S., M.Inst.C.E., Professor of Engineering, Owens College. 19, *Ladybarn Road, Failowfield, Manchester.*
- 1880, Mar. 23. Roberts, D. Lloyd, M.D., F.R.S.E., F.R.C.P. (Lond.) *Ravenswood, Broughton Park, Manchester.*
- 1864, Dec. 27. Robinson, John, M.Inst.C.E., M.I.Mech.E. *Westwood Hall, Leek, Staffs.*
- 1897, Oct. 19. Rothwell, William Thomas. *Heath Brewery, Newton Heath, near Manchester.*
- 1893, Mar. 21. Schill C. H. 117, *Portland Street, Manchester.*
- 1896, Nov. 17. Schmitz, Hermann Emil, B.A., B.Sc. *Manchester Grammar School.*
- 1842, Jan. 25. Schunck, Edward, D.Sc., Ph.D., F.R.S., F.C.S. *Kersal, Manchester.*
- 1873, Nov. 18. Schuster, Arthur, Ph.D., F.R.S., F.R.A.S., Professor of Physics. *Kent House, Victoria Park, Manchester.*
- 1898, Jan. 25. Schwabe, Louis. *Hart Hill, Eccles Old Road, Peulleton, Manchester.*
- 1895, Nov. 12. Shearer, Arthur. 36, *Demesne Road, Alexandra Park, Manchester.*
- 1890, Nov. 4. Sidebotham, Edward John, M.A., M.B., M.R.C.S. *Erlesdene, Bowdon, Cheshire.*
- 1890, Jan. 21. Sidebotham, James Nasmyth, Assoc.M.Inst.C.E. *Parkfield, Groby Place, Altrincham, Cheshire.*

Ordinary Members.

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Date of Election.

- 1895, Nov. 12. Southern, Frank, B.Sc. 6, *Park Avenue, Timperley, Cheshire.*
- 1896, Feb. 18. Spence, David *Pine Ridge, Buxton.*
- 1896, April 14. Stanton, Thomas E., M.Sc., Professor of Engineering. *University College, Bristol.*
- 1894, Jan. 9. Stevens, Marshall, F.S.S. 18, *Exchange Street, Manchester.*
- 1894, Nov. 13. Stirrup, Mark, F.G.S. *High Thorn, Stamford Road, Bowdon, Cheshire.*
- 1897, Nov. 30. Stromeyer, C. E., M.Inst.C.E. *Steam Users' Association, 9, Mount Street, Albert Square, Manchester.*
-
- 1895, April 9. Tatton, Reginald A., M.Inst.C.E., Engineer to the Mersey and Irwell Joint Committee. 44, *Mosley Street, Manchester.*
- 1893, Nov. 14. Taylor, R. L., F.C.S., F.I.C. *Central School, Whitworth Street, Manchester.*
- 1873, April 15. Thomson, William, F.R.S.E., F.C.S., F.I.C. *Royal Institution, Manchester.*
- 1896, Jan. 21. Thorburn, William, M.D., B.Sc. 2, *St. Peter's Square, Manchester.*
- 1896, Jan. 21. Thorp, Thomas. *Moss Bank, Whitefield, near Manchester.*
- 1899, Oct. 31. Thorpe, Jocelyn F., Ph.D., Demonstrator in Organic Chemistry. *Owens College, Manchester.*
- 1899, Oct. 17. Todd, W. H. *Greenfield, Flixton, near Manchester.*
-
- 1873, Nov. 18. Waters, Arthur William, F.L.S., F.G.S. *Sunny Lea, Davos Dorf, Switzerland.*
- 1892, Nov. 15. Weiss, F. Ernest, B.Sc., F.L.S., Professor of Botany, Owens College. 4, *Clifton Avenue, Fallowfield, Manchester.*
- 1895, April 9. Whitehead, James. *Lindfield, Fulshaw Park, Wilmslow, Cheshire.*
- 1859, Jan. 25. Wilde, Henry, D.Sc., F.R.S. *The Hurst, Alderley Edge, Cheshire.*
- 1859, April 19. Wilkinson, Thomas Read. *Vale Bank, Knutsford, Cheshire.*
- 1888, April 17. Williams, Sir E. Leader, M.Inst.C.E., M.I. Mech.E., *Spring Gardens, Manchester.*
- 1896, Dec. 1. Wilson, George, D.Sc. *Owens College, Manchester.*
- 1889, April 16. Wilson, Thomas B. *Holly Vale House, Mellor, near Marple, Cheshire.*
- 1860, April 17. Woolley, George Stephen. *Victoria Bridge, Salford.*

Date of Election.

- 1863, Nov. 17. Worthington, Samuel Barton, M.Inst.C.E., M.I.Mech.E.
Mill Bank, Bowdon, and 37, Princess Street, Manchester.
- 1865, Feb. 21. Worthington, Thomas, F.R.I.B.A., 46, *Brown Street,*
Manchester.
- 1895, Jan. 8. Worthington, Wm. Barton, B.Sc.. M.Inst.C.E. 2, *Wilton*
Polygon, Cheetham Hill, Manchester.
- 1897, Oct. 19. Wyatt, Charles H. *Chelford, Cheshire.*
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N.B.—Of the above list the following have compounded for their subscriptions, and are therefore life members :—

Bailey, Charles, F.L.S.
Bradley, Nathaniel, F.C.S.
Brogden, Henry, F.G.S.
Johnson, William H., B.Sc.
Worthington, Wm. Barton, B.Sc.

HONORARY MEMBERS.

Date of Election.

- 1892, April 26. Abney, Sir W. de W., K.C.B., D.Sc., F.R.S. *Rathmore Lodge, Bolton Gardens South, South Kensington, London, S.W.*
- 1892, April 26. Amagat, E. H., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Honorary Professor, Faculté des Sciences, Lyon. *34, Rue St. Lambert, Paris.*
- 1894, April 17. Appell, Paul, Membre de l'Institut, Professor of Theoretical Mechanics. *Faculté des Sciences, Paris.*
- 1892, April 26. Ascherson, Paul F. Aug., Professor of Botany. *Universität, Berlin.*
- 1889, April 30. Avebury, John Lubbock, Lord, D.C.L. LL.D. F.R.S. *High Elms, Down, Kent.*
- 1892, April 26. Baeyer, Adolf von, For. Mem. R.S., Professor of Chemistry. *1, Arcisstrasse, Munich.*
- 1896, Feb. 9. Baker, Sir Benjamin, K.C.M.G., LL.D., F.R.S. *2, Queen Square Place, Westminster, London, S.W.*
- 1886, Feb. 9. Baker, John Gilbert, F.R.S., F.L.S. *3, Cumberland Road, Kew.*
- 1895, April 30. Beilstein, F., Ph.D., Professor of Chemistry. *8th Line, N. 17, St. Petersburg, W.O.*
- 1886, Feb. 9. Berthelot, Marcellin, For. Mem. R.S., Membre de l'Institut, Professor of Chemistry, Secrétaire perpétuel de l'Académie des Sciences. *Paris.*
- 1892, April 26. Boltzmann, Ludwig, For. Mem. R.S., Professor of Physics. *K. K. Universität, Vienna.*
- 1886, Feb. 9. Buchan, Alexander, M.A., LL.D., F.R.S., F.R.S.E. *42, Heriot Row, Edinburgh.*
- 1888, April 17. Cannizzaro, Stanislao, For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Chemistry. *Reale Università, Rome.*
- 1889, April 30. Carruthers, William, F.R.S., F.L.S. *14, Vermont Road, Norwood, London, S.E.*

Date of Election.

- 1866, Oct. 30. Clifton, Robert Bellamy, M.A., F.R.S., F.R.A.S., Professor of Natural Philosophy. 3, *Bardwell Road, Banbury Road, Oxford.*
- 1887, April 19. Cornu, Marie Alfred, For. Mem. R.S., Membre de l'Institut, Professor of Physics. *École Polytechnique, Paris.*
- 1892, April 26. Curtius, Theodor, Professor of Chemistry. *Universität, Kiel.*
- 1892, April 26. Darboux, Gaston, Membre de l'Institut, Professor of Geometry, Faculté des Sciences, Secrétaire perpétuel de l'Académie des Sciences. 36, *Rue Gay Lussac, Paris.*
- 1894, April 17. Debus, H., Ph.D., F.R.S. 4, *Schlangenweg, Cassel, Hessen, Germany.*
- 1888, April 17. Dewalque, Gustave, Professor of Geology. *Université, Liège.*
- 1900, April 24. Dewar James, M.A., LL.D., D.Sc., F.R.S., Fullerian Professor of Chemistry. *Royal Institution, Albemarle Street, London, W.*
- 1892, April 26. Dohrn, Dr. Anton, For. Mem. R.S. *Zoologische Station, Naples.*
- 1892, April 26. Dyer, Sir W. T. Thistelton, K.C.M.G., C.I.E., M.A., F.R.S., Director of the Royal Botanic Gardens. *Kew.*
- 1892, April 26. Edison, Thomas Alva. *Orange, N.J., U.S.A.*
- 1895, April 30. Elster, Julius, Ph.D. 6, *Lessingstrasse, Wolfenbüttel.*
- 1900, April 24. Ewing, James Alfred, M.A., F.R.S., Professor of Mechanism and Applied Mechanics. *Langdale Lodge, Cambridge.*
- 1889, April 30. Farlow, W. G., Professor of Botany. *Harvard College, Cambridge, Mass., U.S.A.*
- 1900, April 24. Forsyth, Andrew Russell, M.A., Sc.D., F.R.S., Sadlerian Professor of Pure Mathematics. *Trinity College, Cambridge.*
- 1889, April 30. Foster, Sir Michael, K.C.B., M.P., M.A., M.D., LL.D., Sec. R.S., Professor of Physiology *Trinity College, Cambridge.*
- 1892, April 26. Fürbringer, Max, Professor of Anatomy. *Grossherz. Universität, Jena.*
- 1892, April 26. Gegenbaur, Carl, For. Mem. R.S., Professor of Anatomy. 57, *Leopoldstrasse, Heidelberg.*
- 1900, April 24. Geikie, James, D.C.L., LL.D., F.R.S., Murchison Professor of Geology and Mineralogy. *Kilmorie, Colinton Road, Edinburgh.*

Honorary Members.

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Date of Election.

- 1895, April 30. Geitel, Hans. 6, *Lessingstrasse, Wolfenbüttel.*
- 1892, April 26. Gibbs, J. Willard, For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Mathematical Physics. *Yale University, New Haven, U.S.A.*
- 1894, April 17. Glaisher, J. W. L., Sc.D., F.R.S., Lecturer in Mathematics. *Trinity College, Cambridge.*
- 1894, April 17. Gouy, A., Professor of Physics. *Faculté des Sciences, Lyons.*
- 1894, April 17. Guldberg, Cato M., Professor of Applied Mathematics. *Christiania, Norway.*
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- 1900, April 24. Haeckel, Ernst, Ph.D., Professor of Zoology. *Zoologisches Institut, Jena.*
- 1894, April 17. Harcourt, A. G. Vernon, M.A., D.C.L., F.R.S., V.P.C.S., Lee's Reader in Chemistry, Christ Church. *Cowley Grange, Oxford.*
- 1894, April 17. Heaviside, Oliver, F.R.S. *Bradley View, Newton Abbot, Devon.*
- 1892, April 26. Hill, G. W. *West Nyack, N. Y., U.S.A.*
- 1888, April 17. Hittorf, Johann Wilhelm, Professor of Physics. *Polytechnicum, Münster.*
- 1892, April 26. Hoff, J. van't, Ph.D., For. Mem. R.S., Professor of Chemistry. 2, *Uhlandstrasse, Charlottenburg, Berlin.*
- 1892, April 26. Hooker, Sir Joseph Dalton, G.C.S.I., C.B., D.C.L., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *The Camp, Sunningdale, Berks.*
- 1869, Jan. 12. Huggins, Sir William, K.C.B., LL.D., D.C.L., F.R.S., F.R.A.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 90, *Upper Tulse Hill, Brixton, London, S.W.*
- 1851, April 29. Kelvin, William Thomson, Lord, G.C.V.O., M.A., D.C.L., LL.D., F.R.S., F.R.S.E., For. Assoc. Inst. Fr. (Acad. Sci.). *Netherhall, Largs, Ayrshire.*
- 1892, April 26. Klein, Felix, Ph.D., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Mathematics. 3, *Wilhelm Weber Strasse, Göttingen.*
- 1894, April 17. Königsberger, Leo, Professor of Mathematics. *Universität, Heidelberg.*
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- 1895, April 30. Lacaze-Duthiers, F. J. Henri de, For. Mem. R.S., Membre de l'Institut, Professor of Zoology and Comparative Anatomy. 7, *Rue de l'Estrapade, Paris.*
- 1892, April 26. Ladenburg, A., Ph.D., Professor of Chemistry. 3, *Kaiser Wilhelm Strasse, Breslau.*

Date of Election.

- 1887, April 19. Langley, S. P., For. Mem. R.S. *Smithsonian Institution, Washington, U.S.A.*
- 1892, April 26. Liebermann, C., Professor of Chemistry. 29, *Matthäi-Kirch Strasse, Berlin.*
- 1887, April 19. Lockyer, Sir J. Norman, K.C.B., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *Science School, Kensington, London, S.W.*
- 1900, April 24. Lorentz, Henrik Anton, Professor of Physics. *Hooigracht, 48, Leyden.*
- 1892, April 26. Marshall, Alfred, M.A., Professor of Political Economy. *Balliol Croft, Madingley Road, Cambridge.*
- 1892, April 26. Mascart, E. E. N., For. Mem. R.S., Membre de l'Institut, Professor at the Collège de France. 176, *Rue de l'Université, Paris.*
- 1889, April 30. Mendeléeff, D., Ph.D., For. Mem. R.S., *Université, St. Petersburg.*
- 1895, April 30. Mittag-Leffler, Gösta, D.C.L. (Oxon.), For. Mem. R.S., Professor of Mathematics. *Djursholm, Stockholm.*
- 1892, April 26. Moissan, H., Membre de l'Institut, Professor of the Faculté des Sciences à la Sorbonne. 7, *Rue Vauquelin, Paris.*
- 1894, April 17. Murray, Sir John, K.C.B., LL.D., D.Sc., F.R.S. *Challenger Lodge, Wardie, Edinburgh.*
- 1894, April 17. Neumayer, Professor G., For. Mem. R.S., Director of the Seewarte. *Hamburg.*
- 1887, April 19. Newcomb, Simon, For. Mem. R.S., For. Assoc. Inst. Fr. (Acad. Sci.), Professor of Mathematics and Astronomy. *Johns Hopkins University, Baltimore, U.S.A.*
- 1894, April 17. Ostwald, W., Professor of Chemistry. 2/3, *Linnéstrasse, Leipsic.*
- 1899, April 25. Palgrave, R. H. Inglis, F.R.S., F.S.S. *Belton, Great Yarmouth.*
- 1892, April 26. Perkin, W. H., LL.D., Ph.D., F.R.S., V.P.C.S. *The Chestnuts, Sudbury, Harrow.*
- 1894, April 17. Pfeffer, Wilhelm, For. Mem. R.S., Professor of Botany. *Botanisches Institut, Leipsic.*
- 1892, April 26. Poincaré, H., For. Mem. R.S., Membre de l'Institut, Professor of Astronomy. 63, *Rue Claude Bernard, Paris.*

Honorary Members.

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Date of Election.

- 1892, April 26. Quincke, G. H., For. Mem. R.S., Professor of Physics.
Universität, Heidelberg.
- 1899, April 25. Ramsay, William, Ph.D., F.R.S., Professor of Chemistry.
12, Arundel Gardens, Notting Hill, London, W.
- 1849, Jan. 23. Rawson, Robert, F.R.A.S. *Havant, Hants.*
- 1886, Feb. 9. Rayleigh, John William Strutt, Lord, M.A., D.C.L. (Oxon.),
LL.D. (Univ. McGill), F.R.S., F.R.A.S., Corr. Memb.
Inst. Fr. (Acad. Sci.). *Terling Place, Witham, Essex.*
- 1900, April 24. Ridgway, Robert, Curator of the Department of Birds, U.S.
National Museum. *Brookland, District of Columbia,
U.S.A.*
- 1897, April 27. Roscoe, Sir Henry Enfield, B.A., LL.D., D.C.L., F.R.S.,
V.P.C.S., Corr. Memb. Inst. Fr. (Acad. Sci.). 10,
Bramham Gardens, Earls Court, London, S.W.
- 1889, April 30. Routh, Edward John, D.Sc., F.R.S. *Newnham Cottage,
Queen's Road, Cambridge.*
- 1889, April 30. Salmon, Rev. George, D.D., D.C.L., LL.D., F.R.S.,
Corr. Memb. Inst. Fr. (Acad. Sci.). *Provost's House,
Trinity College, Dublin.*
- 1894, April 17. Sanderson, Sir J. S. Burdon, Bart., M.A., M.D., F.R.S.,
Corr. Memb. Inst. Fr. (Acad. Sci.), Regius Professor of
Medicine. *University, Oxford.*
- 1892, April 26. Sharpe, R. Bowdler, LL.D., F.L.S., F.Z.S. *British
Museum (Natural History), Cromwell Road, London,
S.W.*
- 1892, April 26. Solms, H. Graf zu, Professor of Botany. *Universität,
Strassburg.*
- 1869, Dec. 14. Sorby, Henry Clifton, LL.D., F.R.S., F.L.S., F.G.S.,
Broomfield, Sheffield.
- 1851, April 29. Stokes, Sir George Gabriel, Bart., M.A., LL.D.,
D.C.L., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.),
Lucasian Professor of Mathematics. *Lensfield Cottage,
Cambridge.*
- 1886, Feb. 9. Strasburger, Eduard, D.C.L., For. Mem. R.S., Professor
of Botany. *Universität, Bonn.*
- 1895, April 30. Suess, Eduard, Ph.D., For. Mem. R.S., For. Assoc. Inst.
Fr. (Acad. Sci.), Professor of Geology. 9, *Africanergasse,
Vienna.*
- 1895, April 30. Thomson, Joseph John, M.A., Sc.D., F.R.S., Professor of
Experimental Physics. 6, *Scrope Terrace, Cambridge.*

Date of Election.

- 1894, April 17. Thorpe, T. E., C.B., Ph.D., D.Sc., LL.D., F.R.S., P.C.S.,
*Government Laboratory, Clements Inn Passage, Strand,
London, W.C.*
- 1900, April 24. Tower, Beauchamp, M.Inst.C.E. *Warley Mount, Brent-
wood, Essex.*
- 1894, April 17. Turner, Sir William, K.C.B., M.B., D.C.L., F.R.S.,
F.R.S.E., Professor of Anatomy. 6, *Eton Terrace,
Edinburgh.*
- 1886, Feb. 9. Tylor, Edward Burnett, D.C.L. (Oxon.), LL.D. (St. And.
and McGill Colls.), F.R.S., Professor of Anthropology,
Museum House, Oxford.
- 1894, April 17. Vines, Sidney Howard, M.A., D.Sc. F.R.S., Sherardian
Professor of Botany. *Headington Hill, Oxford.*
- 1894, April 17. Warburg, Emil, Professor of Physics. *Physikalisches
Institut, Neue Wilhelmstrasse, Berlin.*
- 1894, April 17. Ward, H. Marshall, D.Sc., F.R.S., Professor of Botany.
Botanical Laboratory, New Museums, Cambridge.
- 1894, April 17. Weismann, August, Professor of Zoology. *Universität,
Freiburg i. Br.*
- 1889, April 30. Williamson, Alexander William, Ph.D., LL.D., F.R.S.,
V.P.C.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *High
Pitfold, Shottermill, Haslemere, Surrey.*
- 1886, Feb. 9. Young, Charles Augustus, Professor of Astronomy,
Princeton College, N.J., U.S.A.
- 1888, April 17. Zirkel, Ferdinand, For. Mem. R.S., Professor of Mineralogy.
Thralstrasse, 33, Leipsic.
- 1895, April 20. Zittel, Carl Alfred von, Professor of Palæontology and
Geology. *Universität, Munich.*
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CORRESPONDING MEMBERS.

Date of Election.

- 1850, April 30. Harley, Rev. Robert, Hon. M. A. (Oxon), F. R. S., F. R. A. S.,
Hon. Memb. R. S., Queensland. *Rossllyn, Westbourne
Road, Forest Hill, London, S. E., and The Athenæum
Club, London, S. W.*
- 1882, Nov. 14. Herford, Rev. Brooke, D. D. 91, *Fitzjohn's Avenue,
Hampstead, London, N. W.*
- 1859, Jan. 25. Le Jolis, Auguste François, Ph. D., Archiviste-perpétuel,
of the Soc. Nat. Sci. Cherbourg. *Cherbourg.*