E. M'C.

My Essays
Scientific miscellaneous

J MacCulloch

MacCulloch, John
[Papers]

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Mac Culloch

HINTS

ON THE

PROCESSES OF WINE-MAKING.

By Dr MUCCULLOCH, Woolwich.

In a Letter to Mr NEILL,
Secretary of the Caledonian Horticultural Society.

HINTS, &c.

In compliance with the wishes of some of the members of the Caledonian Horticultural Society, I have attempted to sketch the general principles and practices used in the manufacture of wine, with a view of assisting the efforts of those whom the Society, by its annual premiums, has encouraged to cultivate the art of making this liquor from fruits of domestic growth.

In laying down these rules, and in describing these usages, I have been chiefly careful in selecting, and solicitous in inforcing, those which could most readily be brought to bear on our domestic manufacture; being desirous rather to point out such analogies as were applicable to the practices which the Society has so laudably patronized, than to enter either into the chemical history of this most interesting process, or to give a detailed account of the art, as it is practised in those more favoured climates, where the grape is the sole fruit in use for this purpose. The magnitude of the subject, would have otherwise led me into discussions, of a length incompatible with the limits of the Society's publications. In condensing and abridging the materials originally collected for this purpose, I have perhaps reason to fear that I have omitted matters essential to the perfect understanding of this subject. Yet I hope that I have not neglected any thing which will prove a material want, in reducing to practice the views which I have held out, and that some light, however feeble, will be afforded to those, who have hitherto been guided by rules of a dogmatical and positive nature.

It is evident that, in the complicated process of fermentation, some rules should be laid down as the foundation of our proceedings, and the test to which we must have recourse in examining the accuracy of our manipulations. I cannot too strongly enforce the necessity of familiarizing ourselves with *general principles*, which alone can assist us through the obscure paths, which this, as well as every art connected with chemistry, is obliged to pursue. And it is the address displayed by the artist in converting these general principles to his changing processes, that will give him a certain pre-eminence over those who are governed by invariable rules. In fact, however these rules may appear fixed, they cannot be generally applied, because, under the mutable circumstances in which the application is made, they must frequently be rendered futile, and sometimes even injurious.

The constituent parts of the fruits used in the experiments now under consideration, are malic acid, either in a state of purity, or one of combination with potash, (a circumstance not yet perfectly ascertained); vegetable mucilage, or extractive matter; supertartrite of potash; sugar; water; the sweet principle; the colouring principle; tannin; super-oxalate of potash; and the principle of flavour. The proportions of these, vary much in different fruits, and it sometimes happens that one or more of them is entirely absent. In the white currant for instance, the colouring substance is often deficient, whilst it abounds in the elder-berry and red grape. So the super-oxalate of potash is rarely found; and, on the contrary, those salts to which the tartarous, or malic acid appertain, are more frequent. So likewise, the sugar is much less abundant than the sweet principle, which is indeed the general cause of the sweetness of the greater number of our fruits. The vegetable mucilage is, if any, the only principle whose presence is invariable; and this principle is one of the most essential in the fabrication of a vinous liquor, as we shall see hereafter. The main diversities of character, in the products of the various fruits, is owing to the varying proportions of the several ingredients which they contain. It is true, that difference of management may produce different effects; but no contrivance can give to the gooseberry the constituent elements of the grape, nor can any mode of procedure extract the flavour of champaigne from the juice of gooseberries, although many, who have not been much accustomed to the flavour of the foreign wine, have been deceived by that made from our humble fruit.

Among the principles enumerated, tartar, water, sugar, the sweet principle, and the vegetable extract or mucilage, are the most essential in the conversion of fruits into wine. Colour and flavour may be considered as adventitious; and the principles which yield them, are in nowise essential to the process of wine-making. The effect produced by the super-oxalate of potash is unknown, as it has not been the subject of experiment.

Tartar, however, seems essential to the formation of a genuine vinous liquor; and an addition of it where it is naturally wanting, is found, not only to ameliorate the produce, but even to increase the quantity of alcohol, which a given proportion of sugar and the vegetable extract is capable of producing. Fermentation is more easily induced where this salt is present; and the experiments of some of the French Chemists, seem to shew that it is decomposed during this process. Their opinion, that it is converted into the malic acid is questionable. The presence of tartar is the circumstance which most strongly distinguishes the grape from all the fruits which have been applied to the making of wine. In this fruit, it exists in the greatest quantity before ripening, and a portion of it disappears during this process. From this peculiarity of the grape, the practice has been introduced of mixing tartar with those washes, which makers of *sweets* intend for the basis of their wines; and from it I have also derived the practice of mixing tartar with those native fruits which are deficient in this substance; a practice which has been attended with the best results. The details of this practice will be treated of hereafter in their proper place.

The effect of the *malic acid*, another of the enumerated ingredients in fruits, is very different from that of tartar, inasmuch as it has been found injurious to the fabrication of wine. It is remarked, that all wines which abound in malic acid are of a bad quality, although in many cases it has not been determined, whether this acid was an original ingredient in the fruit, or whether it was not generated during the process of fermentation.

In either case, since its existence in wine is found to be injurious, it is important to attend to this fact, as our native fruits seem all to be characterized by an excess of malic acid. This is perhaps one of the most fundamental and least corrigible defects in our domestic wines. To render the nature of this defect more obvious, it must be remarked, that the essential distinction between cider and wine, consists in the quantity of malic acid which enters into the composition of the former. From this cause our native wines are more apt to partake of the nature of cider than wine, although these are often rather disguised than changed by the predominance of undecomposed sugar, of brandy, and other foreign matters which enter into their composition.

It is a question, worthy of consideration, whether some chemical means might not be adopted for destroying a portion of this acid, either before or after the process of fermentation. In the manufacture of sherry wine, lime is added to the grapes before this process is commenced. However empirical this practice may be among the manufacturers, it probably acts by neutralizing this acid, as well as a portion of the tartarous acid, and to this is probably owing the peculiarly dry quality of that wine. A hint may probably be borrowed from this practice towards the amelioration of our domestic wines; and I may here venture to point it out as a practice worthy of imitation,—worthy at least of a careful trial. It is only from the results of such, and similar experiments, that we can hope ever to place our domestic manufacture on a sound and rational basis.

Of all the substances which are called into action, during the process of wine-making, *Sugar* must be considered the most essential, being that on which the strength of the wine depends. Those fruits which contain the greatest proportion of sugar, furnish the strongest wine; the alcohol generated in the act of fermentation, being always found to bear a proportion to the pre-existing sugar. The principal defect in our domestic fruits is the small proportion of sugar which they contain; but it is at the same time that which we are most easily able to remedy; and it is on this basis indeed that the whole system of our domestic wine manufacture is founded. But even in this part of the process, difficulties occur, and lead to the imperfect fermentation of these wines, and the consequent sweetness by which they are too often characterized. The saccharine matter has indeed been considered as existing in two distinct states in vegetables, that of pure sugar and that of the sweet principle; but it is perhaps more correct to consider sugar as an artificial substance formed by chemistry from the sweet principle, the only state in which sugar truly exists in vegetables. The sweet principle is characterized by its want of tendency to crystallize, and by the facility with which, on the addition of water, it runs into fermentation. Sugar, on the contrary, is crystallizable, and has no tendency to ferment, except in as far as it contains a portion of the sweet principle, or of that peculiar substance by which this principle is distinguished from sugar. If a solution of pure sugar in water be allowed to repose, it crystallizes without fermenting; nor does even the residuary syrup, or mother water as it may be called, undergo this process. But if it has been imperfectly refined, the remaining syrup, will, after the deposition of the crystals, contain so large a proportion of the sweet principle, that it will readily run into fermentation; an accident well known to confectioners. The juice of the sugar-cane readily allows of the separation of the sugar from the sweet principle, and has hence become the almost exclusive subject of this manufacture. The residuary matter, known by the name of Molasses, is the sweet principle of the French Chemists, and is a peculiar compound of sugar, with vegetable extractive matter, similar to that which exists in the generality of sweet fruits. In considering this substance, therefore, it will be most consistent with the accuracy of chemical language, to speak of it as a peculiar compound of sugar and vegetable matter, and not to consider it, with Deyeux, Proust, and Seguin, as a simple substance. Hence we should not say with these chemists, that in some fruits, and in some varieties of the grape, sugar predominates, and in others, the sweet principle; but that the sugar of the fruit is in some cases combined with more, and in others with less of the vegetable extract. These varying proportions of the two substances under consideration, are the cause of the various effects, which are observed in the results of fermentation in different fruits. If the sugar predominates, the wine will be sweet, unless expedients are used to complete the fermentation of the sugar, and convert the whole into wine. If the sweet principle is most abundant, or, to speak more correctly, if there is much vegetable extract combined with the sugar, the fermentation will be complete, and the wine dry, unless artificial means, hereafter to be described, are used to prevent this effect. The distinction which I have here drawn, though appearing to partake of unnecessary refinement, will be found to lead to practical utility.

Among the enumerated ingredients of fruits, the *vegetable extract* naturally falls next under consideration. Although this substance has not been analyzed, we know that it differs from mere vegetable mucilage, by containing azote, or a substance which on decomposition produces it, since azotic gas has been detected in the produce of fermentation, both in an uncombined state, and in one of its most frequent combinations, forming ammonia. These substances are known to exist in yeast, which is a modification of the vegetable extract. In many vegetables, and conspicuously in the gluten of wheat, it exists in great proportion. It is for this reason that wheat as well as rye, act powerfully as ferments. It is also found in many flowers, in that of the elder for example,—in the leaves of the vine,—in the grape,—in the gooseberry, and in many other fruits as well as leaves. It is observed to abound in those vegetable juices which gelatinise on boiling. This substance, then, is the true natural leaven of fruits, or that by which the sugar which they contain, is rendered capable of undergoing fermentation: And in the artificial process of vinification, which is the subject of this paper, it is to this substance that we must look for the conversion into wine of that sugar which may enter into the compound. But I shall have occasion to enlarge on this subject, when I consider the process of fermentation.

Water, enumerated among the principles of fruits, simple as it may appear, is a substance requiring consideration. If the proportion of water be too small in the liquor subjected to fermentation, that process is difficultly either established or maintained. This is a matter of constant occurrence in those countries, where the juice of the grape is boiled to a certain consistence, or where the fruit before pressing, is allowed to undergo a partial desiccation. From these practices, result sweet and half-fermented wines, those of Cyprus and other places, as well as that class of wines known in Italy by the name of *Vino cotto*. The *vina cocta* of the antients, appear to have been of a similar quality from the same cause. The wines of Tokay and San Lucar, are known to derive additional richness and strength, from a moderate use of this practice. This process can be of no use in the manufacture of our domestic wines, nor does the nature of our fruits admit of it. An excessive addition of sugar may produce a similar effect; but I know not that any of the receipts in use, approximate to that excess. That sweetness which is the prevalent fault of our wines, arises from other causes, which I shall consider hereafter.

The fruits of this country possess so little of the three remaining substances, which were enumerated as constituents, that it is unnecessary to dwell much on them.

Scarcely any *colour* is contained in our fruits, if we except the black cherry and the elder-berry, and as colour may be considered in the light of an ornament, and is easily procured by colouring ingredients, its want is not to be regretted; the essential parts of wine-making in nowise depend on it.

The *tanning principle*, which is the cause of astringency, is contained in the husks and stems of some grapes, and communicates at the pleasure of the operator, that roughness known in Port wines. The sloe and damson possess it, but as it can readily be communicated by kino or catechu, and is not a very desirable quality, it is sufficient to have noticed it, considering, as we may, the imitation of foreign wines by circuitous means, as a fruitless attempt.

The last principle, that of *flavour*, is so uncertain and fugacious, that it is difficult to establish any general rules respecting it. In many grapes, as those of Frontignan, the flavour of the fruit is absolutely identified with the wine which they yield; but in all such cases the wine is sweet and half fermented. The finer flavours of the superior wines, those of claret, hermitage and burgundy, bear no resemblance to that of the fruit, but are the result of the vinous process. In the manufacture of many wines, recourse is had to flavouring ingredients, such as orris-root, grape-flowers, almonds, mignonette,—a process which is imitated in this country in the making of elder and cowslip wines. If the flavour of fruits could be transmitted with certainty to the wines, we might expect similar results from the strawberry and raspberry; but the effect of fermentation is generally such as to volatilize or destroy this delicate principle. Hereafter I shall point out a probable method of attaining this object.

If a knowledge of the circumstances which attend and modify the intricate process of *fermentation*, be necessary in the making of wine from the grape, it is still more requisite to investigate the various accidents and causes which may affect it, when the substances exposed to its action, are, like those used in our domestic manufacture, artificially compounded. It is thus only that we can hope to establish such general rules, as may be applicable to those ever-varying cases, where particular rules of practice would be unattainable. A general notion has already been given of the substances, to whose mixture the process of fermentation is owing, and the essential ones will be found to consist of sugar, vegetable extract, tartarous and malic acid, and water. These are indispensable, and to their varieties in proportion, some of the most remarkable differences in the results of fermentation will be found owing. Among these, sugar is the most essential, since the alcohol of wine is more particularly derived from the decomposition of this substance. The strength of the wine is proportioned to the quantity of sugar fermented, and the most saccharine juices, therefore, afford the strongest wine, or in the artificial process, if so it may be termed, that compound to which the greatest proportion of sugar has been added, will be capable of giving the strongest, if duly managed. But we have already seen, that sugar and water alone do not ferment, if the sugar be pure, and that this process only takes place in clayed sugars, or in those which contain a portion of that vegetable extract which characterizes the sweet principle. In the juices of fruits, the sugar and extract exist in a state of combination, to which, as I before remarked, the term of Sweet Principle has been applied. If the juice of the grape, for example, be exposed to heat and rest, a coagulable substance is separated. The juice then ceases to ferment with the same facility, but may again be induced to undergo that change, by a re-addition of a matter similar to that which was separated from it. This matter is found in all vegetables, in some, as in wheat, conspicuously; and it appears to constitute the greater proportion of yeast, as well as of the lees of wine and beer, or other fermented fluids. Here, then, we have the theory of this process, as it is applied to artificial compounds. It consists of mixing with a solution of pure sugar in water, a certain proportion of this unknown substance, which, to distinguish it from common yeast, I shall hereafter call by the name of *leaven*. It is on the proportion, quality and management of the leaven, that the most important consequences in vinification depend. I must therefore describe at more length, the various modes under which it appears.

The natural leaven of fruit, is coagulable, and partially separable by heat, but it is not entirely rendered inert. From this cause, as well as from the partial dissipation of the water and concentration of the sugar, boiled juices produce a sweet wine, the process of fermentation being rendered incomplete by a partial separation of the leaven. When the process of fermentation is suffered to proceed in any of the natural compounds formed in the grape or other fruits, a portion of the leaven is separated from the wine, and is exhibited in two forms of yeast and lee, part rising to the surface in froth, and the remainder subsiding to the bottom of the vessel. It is essential to attend to this distinction, and to understand the true nature of these substances, as some of the most important practices in wine-making depend on it. I must add, that it still remains uncertain, whether any portion of the leaven enters into combination with the vinous produce, or whether it acts solely by exciting the requisite changes in the sugar, and is then finally and entirely separated. The yeast and lee form the artificial leaven, which, in some important particulars, differs from the natural. It is soluble in hot water, whereas the natural is not. But it is insoluble in cold, and it is thus separated by the act of fermentation. I may add, that, notwithstanding the numerous experiments to which yeast has been subjected, its composition, like that of many other vegetable matters, remains obscure. It is important, however, to recollect, that it contains ammonia, or at least the principles of this substance, as Proust has shown. Those who have been engaged in the manufacture of domestic wines, must know, that one of the most frequent defects of these wines, is an ammoniacal taste; and there is little reason to doubt, that it arises from some mismanagement in the process of fermentation, or an improper introduction of artificial leaven. Although I cannot point out a precise remedy for this evil, these remarks may perhaps turn the attention of wine-makers to search for one.

It will from these considerations be evident, that if certain proportions of sugar and of leaven, whether natural or artificial be taken, and the process of fermentation be suffered to proceed to its natural termination, the result will be a fluid perfectly vinous, containing neither sugar nor acid, and analogous either to beer or to wine, according to other circumstances hereafter to be considered. If the proportion of leaven be deficient, the produce will contain unchanged sugar; and the same effect will take place, if the fermentation be prematurely stopped by artificial means. If, on the contrary, the leaven is in excess, or the fermentation has been designedly protracted by artificial means, a new product will be formed, and the whole, or a portion of the alcohol, will disappear, and acetic acid will be found in its place. Sweet wine, therefore, is an imperfect wine, or one in which the leaven has borne so small a proportion to the sugar, as to have been incapable of converting the whole into a vinous liquor. This is the case with our domestic wines, when a large quantity of sugar is added to so small a proportion of fruit, that the compound does not contain natural leaven enough to convert the whole into wine. This evil may be corrected by the use of the artificial leaven *yeast*, but the quantity added is generally inadequate to this object. It is from this cause, that the makers of domestic wines so often attempt in vain to produce dry ones. When this is attempted by diminishing the sugar, the result is a liquor both feeble as a wine, and at the same time, tending strongly to the acetous fermentation. If, on the contrary, recourse is had to an increase of the yeast, the consequence is an increase of the bad flavour, which this substance almost invariably communicates. The true remedy, is so to balance the vegetable juice and the sugar, as to produce a fluid analogous to the juice of the grape, or one in which there shall be a proportion of natural leaven, sufficient to convert the whole of the sugar into wine. Where a sweet wine is desired, this caution is not necessary. I shall hereafter shew how wines even of this quality can be procured from such a fluid, by an artificial suspension of the fermentation. I cannot too strongly caution the artist against the use of the common and pernicious practice of exciting the fermentation, by the yeast of beer. I have already made it appear, that when a due proportion exists between the leaven and sugar, either in a natural or artificial fluid, a regular fermentation takes place, and a perfect conversion of the whole into wine. It is therefore unnecessary to add yeast to a fluid properly compounded; and it is further injurious, since the use of this substance not only communicates the bitter flavour which it derives from the hop, but a peculiar and nauseous taste, apparently derived from its ammoniacal quality. It is well known to brewers, that a single spoonful of putrid yeast, will spread its contagion through many tuns of beer. If an artificial yeast is ever wanted, it may be found in the lees of wine, in which it is mixed with tartar, or else it may be reserved from the fermentation of former parcels of domestic wines. But a proper management of the fermentation itself, may be made to supply the want of natural leaven. I have already shown, that this leaven is rendered insoluble by the act of fermentation, and that it partly rises to the surface, and partly falls to the bottom of the fermenting fluid. By restoring this separated matter, the process may be protracted at pleasure, till the wine has acquired the degree of dryness that may be desired. It is only necessary for this purpose to break the *head*, and disperse it through the fermenting fluid, or to agitate the whole in such a way, as to mix the lees and scum with it, until the desired effect is produced. The apparently obscure process of rolling wine, or of returning it on the lees to *feed*, as it is technically called, is founded on this principle; it renders the wine stronger and better, by re-exciting the languid fermentation. The converse of this practice will be equally intelligible. If a sweet wine is desired, the fermenting process may be at any time artificially suspended, by separating the wine already produced from the ferment with which it is mixed. The operations in use for this end, consist in decanting, in clarifying by means of glue or albumen, or in the use of certain chemical substances which decompose the leaven; processes which I must consider more at length hereafter. From this view, it will be easily deduced, that sweet wines cannot turn sour, because their leaven has been expended. Another remark of equal importance may also be deduced, that all wines will have this tendency, if the whole of the sugar of the fluid has been converted, and if at the same time care has not been taken to separate completely the leaven which may remain in them. Hence the necessity of fining wines for their preservation, as well as their beauty. It will also be apparent, that if any fluid to be fermented, is of such quality, that the leaven predominates over the sugar, it will be necessary to stop the process by chemical means, to prevent the occurrence of the acetous stage, which would otherwise take place.

I have already stated, that both the malic and the tartarous acids take a share in the process of fermentation. Where the former naturally predominates, as in apples and pears, the produce is cider or perry; where it abounds in the juice of the grape, it is supposed to lead to bad qualities in the wine. The practice of liming wine vats, and that in use with sherry wines, seem to have been founded on some views of this nature.

It appears from the experiments of the Marquis de Bouillon, that tartar contributes to the formation of alcohol, and that it is partially decomposed during this process, a portion of it being converted into malic acid. But even sugar and tartar require the presence of vegetable extract, before they can be induced to ferment, although the addition of tartar materially increases the facility with which a compound of sugar and extract only is brought into fermentation. Hence we are enabled to explain the reason why moderately acid grapes run much more readily into fermentation than sweet ones.

From this view of the presence of tartar in the grape, and its utility, we may now deduce rules applicable to the art of domestic wine-making.

The juices of our fruits are known to be deficient in saccharine matter, and experience has long established the well known remedy,—that mixture of common sugar on which the whole art depends. But it has not generally entered into the views of makers of wine, to supply this other important defect, although the means are equally easy. The makers of *sweets* are indeed acquainted with it, although, from the defective nature of their process in general, it has not produced in their hands the effects which might have been expected. Their principal error consists in the use of yeast and molasses,—articles, whose vicious nature is incorrigible; but in the experiments which I have directed to be made on this subject, ample reason has appeared to consider the addition of tartar to the juices of our fruits, as a valuable improvement in the art of making domestic wines. In the use of this ingredient, no very accurate limit seems necessary, since the wine of the grape may generally be considered as a saturated solution of tartar; and I may add, that by using crude tartar instead of the purified salt, we derive other advantages from the leaven contained in the lees attached to it.

From the preceding remarks, we shall be at no loss in understanding the true theory of this art. The formation of a liquor truly vinous, is the first object, and the adventitious circumstances of colour and flavour will be considered hereafter. It is almost superfluous to say, that the wine of the grape is superior to every other vinous liquor, and we have, in the foregoing remarks, a detail of the circumstances on which the formation of wine from that fruit depends. These are sugar, the extractive matter, and tartar. If now we compare our common fruits with the grape, we shall find, that, in common with it, they possess the extractive matter or natural leaven, but that they are deficient both in sugar and in tartar. Our first object, therefore, should be to assimilate them as nearly as possible to the grape, by the addition of the requisite proportions of those two substances. The whole process is, therefore, from its commencement, artificial, and capable of considerable precision. It is only required so to proportion the adventitious ingredients to the natural juice, as to form a fluid resembling the juice of the grape. To the peculiarities of the several fruits employed, we must afterwards look for the flavour or other accidental properties which they may be capable of giving. It is necessary also to consider, that as the several fruits may differ in their quantity of leaven, as well as in their proportions of sugar and acid, some attention to their various compositions will be required, before any accurate rules of practice can be established. We can also see, that we are limited in the application of our own fruits, and that we cannot avail ourselves of all the use which we might derive from their natural sugar, nor in some cases from their leaven, lest we should introduce too large a portion of their malic acid; that acid in which they are too apt to abound, and which I have already stated to be ill adapted to the formation of genuine wine. They who shall attempt to make wine from the juice of the currant or gooseberry alone, will feel practically the force of this statement. We also may see from these general principles, that we are not necessarily limited to the use of fruits; since, being indebted to the fresh vegetable for very little more than the extractive and fermenting matter, we are permitted to seek it, even among leaves and roots.

But to return to the agents engaged in fermentation; water is one of these, and we have seen, that a certain degree of fluidity is essential to this process. If a mixed solution of sugar and leaven is concentrated to a certain degree, it refuses to undergo the act of fermentation, or enters into it with difficulty. For the same reasons, its progress is so slow, that the result is generally a sweet wine; since the operator, accustomed to regulate his processes by time, rather than by the changes which the liquor experiences, is apt to conceive it finished before it is well established, and thus to suspend it, by the operations of decanting and clarifying, before the liquor has suffered all the changes of which, in due time, it is capable.

When the juice to be fermented, contains, on the contrary, too large a proportion of water, the fermentation is equally slow and difficult, but the produce is weak, and runs readily into the acetous stage. Thus, weak currant juice exposed to fermentation, is converted into vinegar, by a gradation so regular, that it can scarcely be said to form wine, during any part of its progress. In wine countries, these opposite evils are remedied, either by dilution or concentration. The artificial composition of the fluid used in the domestic manufacture, admits of more ready remedies, already sufficiently obvious from the preceding remarks.

Having examined the nature and re-actions of the ingredients to which the process of fermentation is owing, it is now proper to attend to the external circumstances which affect and regulate it, before any rational processes can be adopted for its conduct.

Temperature is one of the external circumstances which has the greatest share in influencing the act of fermentation, and that of 54° has been considered the most favourable. Some latitude is however to be allowed; but in a temperature either very high or very low, this process does not go on at all. Attending to this circumstance, we are enabled to regulate the process when it does not proceed regularly, either by cooling the fluid to check its too rapid progress, or by warming it when it proceeds in too languid a manner. By this we can also explain a phenomenon of common occurrence in wine-making, a renewal of the fermentation which takes place in spring, after it has been partially or entirely suspended by the cold of winter. This is a subject worthy of attention, as some important practices in the art depend on it. Thus, if we are desirous of making a wine to imitate *Champagne*, it is necessary to watch for the period when the fermentation is re-excited by the arrival of spring. By bottling in this stage, we insure a brisk wine, which, if bottled, either in the cold of winter, or after the second fermentation has been exhausted by the heats of summer, would be dead or still. This renewal of fermentation, or *fretting*, as it is sometimes called, is also a favourable time for the addition of flavouring matters, as they then give out their flavours and combine with the wine. It is at this time also, that spirits should be added to the wine, if it is ever allowable to make this addition. It is the only time at which alcohol can safely be added without destroying its vinosity, as it then enters into a kind of chemical combination with the wine.

It is necessary likewise to consider the effects which the *air* produces in fermentation, although its presence may rather be considered as favourable than essential. If the liquor is shut up in close vessels, it does not readily ferment, although it still slowly undergoes this process, and is at length converted into perfect wine. It is ascertained, that no air is absorbed during the vinous fermentation, although this happens in the acetous, but that the free and ready disengagement of the carbonic acid, is the principal circumstance in which fermentation in open vessels differs from that in close ones. One important fact, however, is established,—that the wine is stronger when the fermentation has been either partially or totally carried on in close vessels, and that the flavour is also better preserved; and it appears that a great part of the alcohol produced is dissipated by the carbonic acid, which holds it in solution, and which produces a well known effect, both on the organ of smell, and on the nervous system in general, when this disengagement is made in the stomach. It is not yet well explained, how the carbonic acid is disposed of when produced in close vessels. Many of the practices followed in making particular wines, depend on a consideration of these two modes of conducting the fermentation; but it rarely happens that an exclusive fermentation in close vessels is used. This is generally reserved for the last and most tranquil stage. A consideration of the effects produced by these different methods, and of the product which we wish to obtain, will be necessary to guide us in our choice of either of these two processes, or of a certain admixture of both. If the wine is meant to be still, and if it is not desirable to husband the strength and flavour, the whole fermentation may be carried on openly. This will be the case with strong and sweet wines. If, on the contrary, a wine of the character of Champagne is intended, which must retain its briskness, flavour and strength, we must be guided in our practices by rules similar to those in use in that, and other districts of France, and adopt a partially close mode of fermenting. In all cases, it appears to be a useful practice, even if the first fermentation is carried on in an open vat, to exclude the free access of air, by covering the vessel with boards and blankets. If the first fermentation is carried on in the vessel in which the liquor is meant to continue,—a case which can only occur when no solid matter is fermented with the fluid,—a slight covering will be sufficient. Whatever process has been adopted in the first instance, the bung may after a time be lightly put down, and ultimately tightened, a spill-hole being added, to give an opportunity of relieving the vessel from time to time, of the elastic fluid which might endanger its safety.

The *volume* or quantity of the fluid, is the last circumstance which requires notice, as influencing the act of fermentation. This process is more rapid and more perfect in large, than in small vessels, and is often entirely completed in the course of a few days in a large vat, while, in smaller vessels, it may require weeks or months for its perfection. This question, interesting to manufacturers of *sweets* on a large scale, is of little moment to domestic makers of wine, among whom the quantity made at any one operation is generally small. But it is not quite uninteresting even to them, as it explains some of the difficulties with which they have to contend, and serves to direct and guide their operations. The same materials, for example, will not experience the same changes in equal times, if they are exposed to fermentation in the quantity of two or ten gallons; and time will therefore be allowed by the operator, in a ratio the inverse of the bulk of the fluid on which he is operating. I may also remark, that if there be a flavour to preserve, it will more readily be secured when the fermentation is slow, and the mass of fluid small; and that the sweeter and thicker juices, require to be treated on a larger scale than the thinner ones. It is easy to make lemon wines in a cask of two gallons, but it is a very difficult task to operate on so small a quantity of thick and sweet raisin wine. This is one of those general principles which, together with the quality of the liquid, the temperature, the proportion of leaven, and the other circumstances which I have inculcated, ought always to be present to the maker of wines, since it is only by conforming to the complicated actions of these various causes, that he can hope to secure certainty or uniformity of result.

I may pass lightly over the phenomena which occur during the process of fermentation, which, however important to a general view of this subject, are, from their minor share of practical interest, more easily dispensed with, than those details which are necessary to the unphilosophical practitioner.

The act of fermentation is marked by the extrication of air-bubbles, and by the agitation and turbid appearance of the liquor. The turbid matter is shortly separated into two portions, which, in part, rise to the surface in scum, and, in part, subside in the form of lees. Both of these, as I have before shewn, have the power of continuing the act of fermentation; and it has also been shewn, that their separation, by decanting and clarifying, serves to check this process. For the same purpose, the cask is kept always filled to the bung-hole, so as to admit of the disengagement of the scum or yeast as fast as it is formed. The bulk of the liquor is increased during fermentation, partly in consequence of the heat excited, and partly from the extrication of the carbonic acid gas which is separated. It will be obvious, how the practices required in regulating the qualities of all wines, must be deduced from this general fact respecting the management of the yeast during its production, and that the manipulations must be different when either a sweet or brisk, or a still and dry, wine is desired. In the former two, the fermentation will be checked, by filling to the bung-hole; in the latter, the yeast will be allowed to subside.

The *carbonic acid* is not necessarily separated and disengaged from the wine, since the brisk wines of Champagne owe their sparkling quality to a portion of it which is retained by them, either in consequence of the period of bottling being duly chosen, or to a portion of leaven allowed to remain in the bottled wine, and which has a tendency to renew the fermentation under confinement. This quality is sought after in many wines, and it is often, in the worst class of Champagne wines, the only valuable one which they possess. It is owing to the necessity of having a superfluous quantity of leaven for producing this effect, that a brisk wine is with difficulty made, unless a portion of unripe fruit enter into the composition. This is the case with the wines of Champagne, and equally so with the produce of our gooseberry, which has been conceived to resemble them.

I have already mentioned, that the carbonic acid of fermentation is supposed to contain alcohol, and thus, by fermenting in closed vessels, a great part of the spirit of the wine which would be dissipated, is retained and preserved.

Heat is also generated during fermentation, and to such a degree, as often to require tempering; but as this can only occur in manufactories on a large scale, I need not dwell on it.

The *colouring matter* of the fruit is extracted during this process, since the darkest grapes yield but a white wine, if their skins are not fermented in the liquor; and by attending to this fact, we can regulate the colouring of our wines at pleasure, if the fruit possesses this principle.

The last and most important effect of fermentation, is the *formation* of *alcohol* or *spirit*, and this depends collectively on the proportion of sugar in the entire fluid, on the due proportion of the leaven to that sugar, and on the perfection of the fermentation. The whole of the sugar is seldom decomposed during the first process of fermentation; but a proportion is generally attached even to the wines considered dry, long after they are tunned or bottled. It is only by a slow continuation of the same actions in casks and bottles,—a process often requiring many years for its completion,—that the sugar entirely vanishes, and the liquor is found to consist of alcohol, combined with the other matters which join it to form wine. It is important to consider the effects produced on wine by a portion of undecomposed sugar remaining in it. As long as this exists, the acetic fermentation cannot take place, and it therefore offers a test of security against this result, in our ill made domestic wines. In the natural wines, the balance of principles appears to prevent this occurrence, even when all the sugar has disappeared, and thus Hock, Claret and Madeira, seem to be possessed of the power of endless duration.

All care will be unavailing, if the process of fermentation, and its application to practice, be not thoroughly understood; and I shall therefore deduce from the general doctrines laid down above, some further rules which have been cursorily passed over. If all the favourable circumstances already described are present, the act of fermentation goes on without any assistance, by the action of natural causes. The circumstances which are capable of impeding these natural actions, exist either in the quality of the liquor, or in the temperature to which it is exposed. When the liquor is a natural *must*, like the juice of the grape, it rarely labours under any other defect than the want of saccharine matter,—a defect which the experience of wine countries has found the means of correcting by the addition of sugar of honey, or of *must* evaporated by boiling, until it has become a thick saccharine fluid. The same defect is also sometimes remedied, by partially drying the grapes, or by adding burnt gypsum, or plaster of Paris, to the *must*, so as to absorb the superfluous water. It is evident, that as the maker of domestic wines has always an artificial fluid on which to operate, he need never be subject to any inconvenience from this cause, as it is in his power at all times so to compound his *must*, as to render it answerable to the requisite conditions. The management of the fermentation, when it has actually commenced, must also be regulated by the views of the artist, respecting the wine which he wishes to obtain. If sweet, the proportion of the water as well as that of the leaven to the sugar, must be reduced in compounding the *must*, or his *working receipt* must be modified to this end; and the management of the fermentation will then be such, as to discharge the yeast as fast as it is generated, by keeping the cask full to the bung-hole, and by a careful repetition of decanting and clarifying. If, on the contrary, the wine is to be dry and strong, the proportion of the leaven will be increased, and the yeast will be agitated with the liquor, by rolling and stirring, so as to protract the fermentation. If the wine is to be brisk, the proportion both of leaven and water will be increased, and the fermentation will not only be conducted in vessels partially closed, but the liquor will be bottled and secured, before the fermentation is finished. The management of the temperature is easily deduced from the general doctrines. When the fermentation languishes from defect of heat, it is necessary to introduce a stove into the apartment where the process is carried on, or, by heating a portion of the liquor, and mixing it with the mass, the temperature may be elevated to the most favourable point. Injurious changes, arising from variations of the external temperature, may be warded off, by a covering of straw or blankets. These attentions, trifling as they may appear, are by no means unimportant, since they are sufficient to cause the whole difference between good and bad wine. It is owing more to varieties in management, than to radical differences in the qualities of the grape, that the wines of different countries differ so widely from each other, and that the wines of France, for example, possess a superiority so decided over all others.

The limited nature of this little essay, prevents me from entering on the chemical theory of Fermentation, a subject still very obscure; and I shall therefore proceed to consider the management of wines after fermentation, a subject of more practical interest.

Many popular practices in the after-treatment, and in the suspension of fermentation, are founded on positive precepts respecting the time which the process has occupied. But time is but one out of the many elements which should enter into this calculation; since it has already been seen, that it is modified by the varying quality of the fluid subjected to that process, by the temperature, by the mass, and by many circumstances which it would be superfluous to repeat. Other rules, which are apparently better founded, since they are deduced from the appearances after fermentation, may yet deceive us, if they are too implicitly followed, without a due regard to the ultimate intentions of the operator, respecting the quality of his wine. Neither the smell, taste, or colour of the fluid, nor the activity or cessation of the fermentation, are positive guides. As the prime object is to convert the sugar into spirit, it is evident that the fermentation must continue longer, if the produce is to be a dry wine, and the reverse if a sweet one. If, on the contrary, it is the wish of the operator to preserve the flavour or *bouquet* of the wine, the period must be shortened. The case will be the same if a brisk wine is wanted, as the carbonic acid on which this property depends, would be irrecoverably dissipated, by an undue protraction of the fermenting process. As all wines are reducible to the four general divisions, of dry and strong, sweet, light and flavoured, or brisk; it is plain, that a regard to this ultimate object, their quality must determine the mode of proceeding. If it is intended, for example, to make that kind of dry wine which is made in this country from raisins and sugar, the same practices will be necessary which are followed in the countries where wines are made from the grape for distillation. In this case, the wine is suffered to remain in the vat for three, four or more days, until it ceases to have a saccharine taste, and till the whole of the sugar is converted into spirit. If it is intended to make a strong and sweet wine, the fermentation must be discouraged, by speedily removing it from the vat to the cask, and by the further use of processes hereafter to be described, which suspend and ultimately destroy the fermenting process. If it is desired to produce a light and flavoured wine, like those of Burgundy, for example, the practices should resemble those followed in that country. There, the *must* is allowed to remain but a few hours in the vat, the time varying according to the quality of the *must*, the temperature, and other accompanying circumstances. The period is, *cæteris paribus*, always shortened, when flavour or perfume is expected from the wine; a precaution, however, which the maker of domestic wines may dispense with, as the little flavour he has to expect from the fruits of his own growth, is generally better avoided. Further, if it is proposed to make wines brisk, and resembling those of Champagne, the juice must remain in the vat but a few hours; and indeed when small quantities only are operated on, it is often prudent to conduct the whole process in the cask, even from the commencement.

I cannot conclude these general directions, without inculcating the necessity of cleanliness in the use, and care in the selection of the casks, since results otherwise promising, are often destroyed by this minor sort of negligence.

In removing the wine from the vat to the cask, it is necessary to get rid of all the insoluble and superfluous matter which it may contain. This removal, is in fact the first stage of decanting,—an operation of which the careful conduct is of prime importance in this manufacture. By tapping the vat at a due distance above the lee, and by stopping the flowing liquor before the scum has descended too low, this separation is in general, easily effected. In some cases, straining may be required; but in all, the scum should be carefully removed, as it is from exposure apt to acquire either a musty taste, or acid property, easily communicated to the liquor. In the wine countries, the solid matter is exposed to the wine press. Here it would not be an object worthy of the labour required.

The wine thus far advanced, still undergoes a fermentation in the casks, more languid, yet necessary to its completion. If this process be suffered to go on indefinitely in those wines of which the saccharine matter has been entirely decomposed, it will proceed to the acetous stage, and vinegar instead of wine will be the result; the natural tendency of fermentation being a progress from the vinous to the acetous stage, which, if not counteracted by circumstances in the wine itself, must be prevented by artificial expedients. The natural circumstances which prevent this change, consist in that state of proportion between the leaven and sugar, which allows part of this last to remain undecomposed after the process is completed, or a balance of principles so nice, as to terminate in a perfect neutralization of the two elements which conspired to produce it. This accuracy is perhaps seldom obtained, since the palate is unable to detect the last portion of sugar, masked as it is by the predominant taste of the wine, on the qualities of which it nevertheless produces an advantageous effect. Knowing that the acetous process cannot take place while sugar remains unchanged in the fluid, we can regulate our conduct in the use of the artificial means of checking fermentation above alluded to, since any anxiety on this head is unnecessary while the wine continues sweet. We can also see from the same consideration, how the addition of sugar to a wine whose durability is suspected, may prevent the acetous process from taking place, although, when this process is once established, it would be, according to circumstances, either unavailing, or the cause of a speedier conversion into vinegar.

I must now describe the artificial means by which fermentation may be checked or stopped, in those cases where a natural termination would not occur. Those most generally used, are racking and fining, of which the object and effects must already be intelligible to those who have read the preceding remarks. Turbid wine is in an unfinished state, as well as in a precarious one, and its brightness and purity is not merely an ornament, but a property necessary to its permanence. It is from being left in this state, that wine frequently becomes *pricked*, this disease being the first stage of the acetous fermentation, but one which may also originate in other causes already explained. But although racking and fining may disengage the wine from all precipitated leaven, it will not separate that which is held in solution, and of which the tendency is equally to destroy the wine at some distant period. For this purpose, chemical means are required, and the process in common use, is known by the name of *sulphuring*. Many unnecessary and complicated methods are resorted to for this end; the most simple is equally effectual, and consists in filling the empty cask with the vapour of sulphur, from burning matches placed in the bung-hole. The wine is then introduced into the cask, and if this first operation is found insufficient, it may be repeated as often as is necessary. When the *leaven* is so abundant, that a very large quantity of sulphureous acid is required, as in many of the wines of Bourdeaux, a portion of wine, impregnated with the gas, by a process similar to that of the silk-bleachers, is used for mixing with the wine in the cask. The sulphite of potash, offers itself as a convenient substitute for this operation; and in the quantity of a drachm or two, it is sufficient in general for a large cask of liquor. Other chemical agents, capable of accomplishing this end, might be enumerated; but the operation of the whole is similar, and consists in precipitating, and rendering insoluble the leaven which was contained in the wine. It is obvious, that this process must be followed by that of racking and fining. The substances used for fining, are most commonly isinglass, or the white of eggs, and the mode of applying them is universally known. Sand, gypsum, starch, rice, milk, blood, and the shavings of beechwood, have been found to answer the same purpose.

In the general practice of making wine from grapes, many expedients are in use, to remedy particular defects of colour, sweetness, flavour, sharpness or dullness. As few of these are applicable to wines of domestic manufacture, I shall pass them over slightly. The causes and remedies of excessive sweetness, must already be obvious from what has been said. The causes of offensive sharpness, are either the excessive fermentation of a weak and watry *must*, or an undue portion of malic acid. In the former case, the wine is tending to vinegar, and although the evil may be palliated, it can scarcely be remedied, nor is it perhaps, in the case of our domestic wines, worth the remedy. The use of lead, chalk, and other expedients, must be left to manufacturers. The mode of prevention, is more worthy of our attention, and it is obviously that of using a better *must*, or attending more carefully to the fermentation. That sharpness which arises from excess of malic acid, is well exemplified in hard cider. It is not a fit object of remedy, but may be prevented by a better choice of materials, or by the expedients alluded to in the beginning of this paper.

A disagreeable quality opposed to the former, is flatness, or a mawkish flat taste, which, though sensible to the acuter palates of those who are habituated to good wine, is scarcely perceived by those who are accustomed to the strong dull wines, so generally used in England. The light and quick flavour, so preceptible in the wines of France, disappears under the treatment by which the more fiery wines of Spain and Portugal, are made marketable in this country. At times, flatness may arise from age, or from the complete annihilation of the fermenting process; but the most common cause is the admixture of brandy or spirit. This addition, when used in excess, is not only injurious to the liquor, but to the constitution, as it introduces an additional quantity of ardent spirits, into a beverage already perhaps too strong. Its use is also in some measure founded on a mistaken principle, as it is resorted to, at least in this country, among the makers of domestic wines, for the imaginary purpose of checking fermentation, and preventing the occurrence of the acetous state. It has been shown by recent trials, that alcohol does not check the acetous process, unless added in a much greater quantity, than it is ever used for wines; and I have already pointed out the true principles on which the tendency to vinegar may be prevented. An idle notion is prevalent among makers of domestic wines, that they are deficient in durability. The unfounded nature of this belief, must appear from every thing which has been stated respecting the true theory of wine; and I may here add, that the durability of these wines, is in fact shortened by the admixture of brandy, since it ultimately decomposes them, driving off their carbonic acid, destroying their brisk and sprightly taste, and rendering them vapid and flat, while at the same time, their salubrity is diminished, and their price increased.

If, notwithstanding this view, makers of wine are still determined to have recourse to the practice of adding spirit; I will now point out the least injurious manner in which it may be effected. It may be added to the liquor before fermentation,—a method in use in the manufacture of sherry. It may also be added, during the subsequent renewals of the fermentation, which have a sort of periodical recurrence in the cask; the operation being founded on the practice known to wine-coopers, by the term *fretting in*. When for any purpose it is found convenient to mix two varieties of wine, that time of spring is selected, when a slight fermentation is renewed, or this process is brought on by rolling or heating. A perfect union of the wines mixed at this period then takes place, a slight fermentation being induced, which serves to unite the whole into one homogeneous fluid. It is under similar circumstances, that brandy may be added, and it then enters into a combination with the wine, more nearly resembling that natural union in which alcohol exists in this fluid; while at the same time it produces less injury, either to the flavour of the liquor, or to the health of the consumer.

The sketch which I have now given of the general principles of wine-making, may possibly suffice for the purpose of practice, and enable the the practitioner to guide himself by rules, both more correct and more generally applicable, than the positive ones on which he has hitherto proceeded. I shall now proceed to a cursory examination of the several practices in use in our domestic manufacture. The receipt books abound with details, which it is unnecessary for me to examine, as it would be a waste of time to comment on manipulations, which have been guided by no principles, of which a great number is manifestly absurd, and of which many others appear incapable of giving results at all resembling wine. I shall content myself with noticing the most prominent errors, and with pointing out those general practices in which the most rational receipts can be made to agree.

When we read in many of those books of receipts, directions for sulphuring the casks before fermentation; we must be convinced, that such directions have arisen from an utter confusion of ideas on the subject. The same remark may be made on another rule, of which the object is equally misapprehended; the mixing of white of egg with the fluid about to be subjected to fermentation. The proportions of sugar seem to have been allotted with equal want of consideration; and it seldom appears to have entered into the minds of the inventors, that the strength of the wine was to depend on this ingredient. The proportions of the fruits to the total compound, seem to have been dictated by similar caprices; their natural properties, whether of sugar, acid or flavour, not having been considered in the views of the artist.

Those ingredients which are added for the avowed purposes of flavour, have been managed with similar want of judgment, and they have indeed often been supposed capable of communicating the strength, or vinous quality, to the liquor. Instead of being introduced at the decline of the fermentation, they have been exposed to all its effects; in consequence of which, their flavour has often been volatilized or destroyed. This is the case with cowslip wine, where an enormous quantity of flowers is used, to obtain an effect which might be procured with a much smaller allowance. Such also is the practice with raspberries,—a practice worth noticing, since it affords an opportunity of stating the more correct and useful mode of proceeding. If an attempt is made to form wine from raspberries and sugar, a liquor will be produced with little or no flavour of the fruit; but a small quantity of syrup or juice of raspberries added at the decline of the fermentation, or a little fresh fruit suspended in the cask at the same period, will be sufficient to communicate a taste, more likely to prove excessive than defective.

But the most striking defects of the common proceedings are visible in the vacillation and uncertainty, with which both the fermentation and the subsequent processes are conducted. By using the yeast of beer,—a practice founded on ignorance of the nature and causes of fermentation,—a false and bad flavour is introduced, which is often sufficient to render the produce tainted and even nauseous. By want of attention to the process itself, and the circumstances by which it is affected, the artist is unable to advance or retard it, to alter or amend it; while, guided solely by rules founded on fixed periods, inattentive to his subject or its concomitancy, and undecided respecting the future character of his wine, it is not surprising if he meets with perpetual disappointment, producing still wine when he wished for brisk, or sweet when he intended to form dry. The same want of principles prevent him from taking advantage of the practices of sulphuring, racking and bottling, as will be obvious to those who shall compare the practices in daily use, with the more correct ones which have been laid down.

I must now proceed to give a view of the methods in common use, as far as they offer differences worthy of notice, confining myself to those varieties of domestic wines, which are either in themselves good, or capable, under proper management, of being rendered so. I shall take no notice of the projects to make wines from esculent roots, as I believe that they are misplaced ; but limit myself to fruits, from different kinds of which, the several wines take their names. I shall also omit the grape at present, because, considering it as almost exclusively worthy of attention, I wish to treat of it in a separate paragraph.

The fruits chiefly in use are the quince, cherry, strawberry, sloe, elder-berry, damson, mulberry, black or bramble berry, raspberry, orange, lemon, gooseberry, and the three varieties of currant. Dried raisins, although not ranking among our fruits, are extensively used, and require also to be noticed.

A wantonness of experiment seems to have, in some measure, led to this great and superfluous number of articles as the nominal bases of wines, although the practices have also been in a great degree, founded on false views of the real nature and objects of this manufacture. It is evident, on the principles already laid down, that when no peculiar and agreeable flavour follows the adoption of any individual fruit, it can have no legitimate claim for use, beyond that which is founded on its several proportions of sugar, leaven, acid, colour or astringency. As the two last of these can be communicated with the greatest certainty by adventitious ingredients, it is bad policy to have recourse to weak expedients for the same, and particularly, if, for the sake of these minor objects, we must sacrifice others of greater importance.

Since also the sugar is, confessedly, and in all cases, an adventitious ingredient, capable of being proportioned with the greatest nicety, completely in our power, and of a moderate price, it is unnecessary to consider that ingredient in fruits, as the one which is to guide our choice. It is to the due admixture of acid, and of leaven (the fermenting principle), that we are chiefly to look for the causes which are to determine us in our selection. If a good flavour can be obtained from any fruit of our own growth, we have then the whole data which should rule our determinations. The object of price, is a consideration which will naturally be added to these more important ones.

The Quince appears to have usurped a place in the foregoing list, to which it properly has no title. Its similarity in principles to the apple and pear, is sufficient to assure us, that its produce can only be a species of cider, characterised, according to circumstances, by the astringency and flavour which distinguish it from these two fruits. Its price and rarity also increase the objections to its use.

Vinous liquors, of no very particular character, may be made from the several varieties of Cherry; but the operator should be cautioned against the the common practice of pressing the kernels in quantity, as, however agreeable a slight flavour of the bitter may be, a taste amounting to bitterness, is always unassimilating and injurious to the wine.

From the Strawberry, wines of agreeable quality, both dry and sweet may be produced; but the peculiar flavour of the fruit is generally dissipated in the process. The cautions which I have given respecting flavour, will suffice to point out in what way that is most likely to be obtained.

I make the same remark on the Raspberry, with this additional hint, that as very little in point of flavour or produce is gained by the use of these fruits, which are in most places of a high price, it behoves the operator to balance the advantages against the disadvantages, before he enters on the undertaking. A simple infusion of this fruit, as before noticed, in any flavourless currant wine, will, with greater cheapness and certainty, produce the desired taste.

Having no experience in the Brambleberry or Mulberry, I am unable to say, whether any flavour can be communicated by their use. The cheapness of the former is a recommendation; and there is no doubt that they both contain the substances, leaven and acid, most essential for this purpose. They also afford what so few fruits do to the same degree, the colouring principle. In managing them, so as to derive the greatest advantages from their colour, it is necessary, that the fermentation be allowed to go on with the skins, until the colour is extracted, which will also be accompanied by the slight degree of astringency, which, at a certain period of ripeness, accompanies both these fruits.

The Sloe and Damson are so associated in qualities, that nearly the same results are produced from both,—a bitterish and astringent liquor, capable of being converted into rough wine of a good character, care being taken duly to proportion the quantity of fruit to the sugar, or to modify that liquor by the addition of other fruits of less decided properties. This is a case, in which it is necessary to protract the fermentation, so as to make a dry wine, as the peculiar astringency of these fruits, forms a very discordant association with sweet wines. By a due admixture of currants or elder-berries, with sloes or damsons, and with proper care, wines not much unlike the inferior kinds of Port are often produced. Since receipts are in the hands of every one, I need not detail the proportions, which ought, in fact, to vary, both according to the ripeness of the different fruits, and the particular views of the artist.

In naming the Elder-berry, I have mentioned a fruit whose cheapness and abundance have long recommended it to notice; and from which, with attention, excellent red wine can really be made. It seems to possess in great perfection, that portion of the extractive principle, which is required to produce a free and full fermentation; and its admirable colour, communicates to the wine a tint as rich as can be desired. It appears to be deficient in acid; and its produce is consequently much improved, by the addition of tartar as an ingredient in the artificial *must*. Its natural sugar is so small in quantity, that it requires an ample addition of this fundamental ingredient. If it has no good flavour, it is at least free of any bad one,—a virtue which does not appertain to many of the fruits of current application in wine-making.

In apportioning the two several ingredients of tartar and sugar, the following rules may be of use.

Considerable differences in the dose of tartar may be allowed without producing any correspondent changes in the result, and the proportion of this ingredient has consequently been made to vary from one to four, and even six *per cent.* The causes of this admissible laxity will appear, when it is considered that the greater part of the tartar is deposited in the lees. I may also remark, that from two to four *per cent.* will be found a sufficient dose, and that in proportion to the greater or less sweetness of the fruit, the sweetest requiring the largest quantity of tartar, and *vice versâ*. The dose of tartar ought also to vary in proportion to the added sugar, increasing as this increases. Although pure tartar, or cream of tartar, may answer the intended purpose, the crude salt is to be preferred, because it already contains a portion of yeast conducive to the more perfect fermentation of the artificial *must*.

In proportioning the sugar, the following general rule may also be taken as a guide. Two pounds of sugar, added to a gallon of a compound, containing all the other ingredients requisite to a perfect fermentation, produce a liquor equal in strength to the lightest class of Bourdeaux white-wines. Three pounds produce one equal in strength to the wine known by the name of White Hermitage: and from four, if fermented till dry, a wine resembling in strength the stronger Sicilian wines, that of Marsala, for example, or the Cape Madeira, is produced, supposing these wines to be free of brandy. Where a fruit already contains sugar, it is obvious that the quantity of added sugar must be diminished in proportion to that which the natural juice may be estimated to contain, if we are desirous of accurate results. If in any case wine is to be left sweet, it is clear that this general rule cannot be applied, since sweetness and strength are, in the same wine, and from the same quantities of sugar, incompatible. The rules thus laid down, render any formal detail of proportions unnecessary, since they are readily deduced from the general view; and the circumstances which ought to regulate the fermentation and after-management, have already been so fully investigated in the first part of this essay, that it would be superfluous to repeat them.

But, while on the subject of the juicy fruits, I may as well notice a part of the current practice which appears ill founded, and often attended with bad consequences. This is the large proportion of water, and consequently small proportion of fruit, which is generally used, an usage apparently originating in a misplaced economy. If we attend to the common practice of making wine from grapes, that which ought to be the model for all our imitative operations, we shall see that no water is used, but that the whole fluid is composed of the juice of the fruit itself. If we now attend to the current practice, as recommended in our own domestic receipts, we shall find that the juice of the fruit rarely forms more than one-fourth of the whole liquor, and often much less, the proportion of fruit being seldom more than four pounds, including the solid matter it may contain, to eight pounds of water, and three or four pounds of sugar; and this proportion is fixed with no regard to the ripeness of the fruit, a circumstance of considerable importance. The consequences resulting from this sparing use of the fruit are highly injurious. It is plain, that the artificial *must*, thus compounded of water, sugar and juice, must contain a much less quantity of the vegetable extractive matter, and of the native acid, than that which I have formerly shewn to be absolutely essential to a perfect and efficient fermentation. To put this case in a stronger light, let this proportion of juice be still further gradually diminished, and the *must* will soon consist of little else than sugar and water, a compound incapable of forming wine. Let it, on the contrary, be increased, and a vigorous and perfect fermentation, with a produce perfectly vinous, will be the result.

If green fruit is used, in which little or nothing exists but acid and extract, of which the former is in this case always in much greater proportion, bulk for bulk, than in ripe fruits, the acid would be too predominent were the juice of the fruit used in undue quantity. There dilution is absolutely necessary, and of this practice I shall take occasion to point out examples hereafter. But if the fruit be ripe, the acid is diminished in quantity, and cannot therefore bear to be still further diminished by excessive dilution. It will accordingly be found, as I shall again have cause to shew, that a much more perfect wine is produced by diminishing the water, or increasing the proportion of fruit.

As the *orange* and *lemon*, although not native fruits, are familiar to us, and scarcely differ in their chemical composition, I may safely consider them in one view. So little difference exists between the citric acid which is found in these fruits, and the tartarous which characterizes the grape, that it is natural to expect their produce to be of a good quality. They are, however, deficient in extractive matter or leaven, and for this reason are incapable of being converted into wine, even with the aid of sugar, unless yeast or some other leaven be added. As it is impossible to add the yeast of beer in sufficient quantity for the perfect fermentation of the fluid, without spoiling the flavour, these wines are generally imperfect and sweet. They are likewise almost always corrupted in their flavour by the infusion of the peel, giving a taste, which, however grateful abstractedly, does by no means coalesce with the taste of wine. It would tend to the improvement of these wines, if the peel were to be omitted, and if any vegetable matter could be added capable of inducing the complete fermentation, without communicating a bad flavour. I have attempted it by means of gum, and with partial success. The principles I have already pointed out, will lead experimentalists to the search of proper substitutes for the natural leaven. It is not unlikely that they would be found in wheat; either in the flour or gluten.

The *gooseberry* is one of the fruits most commonly used, and is in particular well known as an ingredient in brisk wines, which are made to resemble, in appearance at least, the wines of Champagne. For this purpose, it is used in an unripe state. It is well known in the wine countries that, independently of those causes of briskness in wines which consist in the management formerly described, this property always results from the use of unripe fruit, and is readily produced by mixing unripe grapes with the ripe ones. The case is the same with the gooseberry. The fault of this wine, however, if it be considered as an imitation of Champagne, is a bad flavour, which is almost invariably communicated by the fruit, and that in proportion to its ripeness. To avoid this evil, so generally injurious to the brisk gooseberry wines, the fruit can scarcely be taken in a state too crude, as at this period the flavouring substance has not been developed. At the same time the expressed juice alone should be used, care being taken to exclude the skins from the fermentation, as being the part in which the flavour principally resides. With these precautions, the noxious flavour may generally be prevented. It is true, that the produce is then without flavour, or nearly so, but this is by much the most tolerable fault in domestic wines, whose leading defect is almost invariably a disagreeable taste. Various proportions of fruit and sugar are used by different persons; but the most common consist of three pounds sugar and four of fruit, to eight pounds of water. Here the proportion of fruit is too small compared to that of the sugar, and the fermentation is consequently in general so imperfect, as to leave the wine disagreeably sweet. At the same time, the proportion of sugar is such, as to render the wine stronger than the strongest wines of Champagne. If, therefore, this wine is to be amended in composition, it is either by reducing the sugar, if we are contented with a weaker wine, or by increasing the fruit, if we are desirous of retaining the greater strength. In managing the fermentation to a constant and successful result, the rules laid down as practised for Champagne wine are strictly applicable in the present case; and with these precautions and practices carefully attended to, the produce of the gooseberry will be invariably successful. I may also add, that it is perfectly durable; as much so as Champagne wines of corresponding quality, provided equal care be taken in the bottling, the cellarage, and other management; all of them, circumstances in which our domestic fabricators are too apt to fail, thinking that when they have mixed together a portion of sugar and fruit, their labour is finished, and that the rest may be trusted to chance. They should consider, on the contrary, that it has but then commenced.

From the gooseberry in a ripe state, wines may also be made, for which no rules are required, as they are precisely conformable to those before laid down. But the produce of the ripe fruit is commonly ill flavoured, and, whether sweet or dry, is scarcely to be rendered palatable, unless perhaps, by a most careful exclusion of the husks.

The three varieties of the *currant*, are perhaps even better known, and more in use as ingredients in wine-making than the gooseberry; and as the produce of each is attended with some difference, I shall notice them separately. Both from the *white* and *red* sort, wines are made, which differ principally in colour, but also vary slightly in flavour, though the flavour of neither is very characteristic. I have ascertained by repeated trials, that a principal defect in these wines, as commonly fabricated, arises from the sparing proportion in which the fruit is used, which otherwise contains a sufficient quantity of natural acid, as well as extractive matter, to ensure a perfect fermentation, if properly managed. Partly from this cause, as well as from the imperfect management of the fermentation, these wines are usually made sweet. They are also, not uncommonly, nauseous, as well from the combination of a natural bad flavour with this mawkish sweetness, as from the other improprieties of management before noticed. By increasing the quantity of fruit, (which is generally proportioned like that for gooseberry wine,) and by avoiding the use of the husks, the flavour is materially improved, and the quality of the wine further ameliorated, the fabricator at the same time acquiring the power of making his wine sweet or dry; whereas, according to the present mode, he is generally unable to produce the latter variety. The natural tendency of this fruit is to form a wine analogous to the lighter white wines of the grape, and it is a rational object to follow the tendency which is pointed out by the nature of the fruit. I have also reason to think that much advantage would result from the use of tartar in this case, by which, among other defects, the ammoniacal taste so common in this wine seems to be prevented. The proportion of tartar need not be specified, as it has been mentioned before, and that of sugar is to be regulated by the principles already laid down. With careful management, wines are thus produced from currants not easily to be distinguished from the Colares of Portugal, which, although not in the first class of wines, is certainly superior to most of our domestic manufactures. A considerable improvement may be made in the fabric of all those wines produced from fruits of which the flavour is either bad, or which possess no flavour at all; and this is by boiling the fruit previously to fermentation, —a practice which I have caused to be adopted in currant wines with decided success. From this treatment many tastless fruits acquire a flavour, as is well known, and many bad flavours are converted into agreeable ones. In no case, perhaps, is this more remarkable, than in the *black currant*, which, harsh, and comparatively insipid in its natural state, acquires by boiling a powerful, and to most persons a highly agreeable flavour.

In making wine from this variety of currant, the effects of this process are very remarkable; the produce of the raw fruit being scarcely distinguished by any particular property from the herd of domestic wines, while that of the boiled fruit may with careful management be brought to resemble some of the best of the sweet Cape wines. In the white and red currant, the same precaution has been attended with results equally successful, though not marked by a contrast so decided. The same varieties of proportion are admissible in this case, as in the others lately mentioned, and I need not therefore detail receipts which are to be found in the hands of every one. To what extent the practice of boiling may be tried with advantage, I do not know; but I may venture to point it out as an improvement worthy of further investigation.

Although the dried *raisin* cannot be considered as a domestic fruit, yet as, like the orange and lemon, it is largely used in the manufacture of domestic wines, I may here take notice of it. The history of the art of wine-making, in the countries where the vine is an object of common cultivation, has already shown, that the grape is in many places used for this purpose in a state, if not actually that of raisins, yet approaching towards it. Thus, the wines of Cyprus and Tokay, among many others, are produced from grapes which have undergone a partial desiccation. Analogy, therefore, would lead us to expect, that wines of good quality, might, in this country, also be produced, by using the dried grapes for that purpose, as they are imported in the state of raisins. Yet the success which has followed the innumerable attempts to make raisin wine, has by no means justified that expectation, although the expensive scale on which the manufacture has been, and is still carried on by the makers of *sweets*, should long ere this have brought it to perfection. It is not apparent to what causes this failure is owing, nor is it possible, without repeated and expensive experiments, to investigate the process in such a way, as to lay the foundation of a more successful practice. But an examination of the processes in common use, may perhaps suggest some hints conducive to a more rational and improved mode of proceeding.

In manufacturing this wine on the large scale, whether for the purpose of open sale as *sweets*, or for the fraudulent imitation and adulteration of foreign wines, a quantity of raisins varying from two as far as seven pounds to the gallon of water is used, together with a proportion of common clayed sugar or molasses, reaching from half a pound to three or four pounds. In many cases from four to six pounds of crude tartar per cwt. is added. Yeast is not in general employed to assist the fermentation, nor should it ever be used, for the reasons already assigned. It is asserted, that the product of this process is a pure and flavourless vinous fluid, capable of receiving any flavour which may be required, and thus, of imitating many wines of foreign growth. Whatever the case may be when such fluids are used for the fraudulent purposes above-mentioned, the wines themselves, which are common in the market, and which are confessedly made in this way, are almost always nauseous, whether sweet or dry, and however they may be called by the various names of Lunel, Teneriffe, Sherry, or Canary, they have all the same disagreeable and overpowering flavour. It is probable, that a great part of this peculiarity is owing to the quality of the sugar employed; but it is also to be suspected, that the complete drying of the grape developes in that fruit, some obnoxious taste which is communicated to the produce. I cannot pretend to throw any more particular light on the subject; but should recommend to those who are inclined to make trial of raisins, a nice attention to all the circumstances in the mode of fermentation and management, which have already been detailed. If these fail to produce the desired effect of purity in the wine, we shall then be entitled to consider the manufacture of raisin wine as incapable of further improvement.

I have thus given such a brief general view of the several varieties of wines which may be made in this country, as will be sufficient to render more intelligible, the principles and practices on which they are founded, without which, all attempts must either be futile, or must at least be regulated by chance, giving results, which will seldom obey the previous intentions of the manufacturer. The reader, who shall be at the pains of comparing what has now been said on our domestic fruits, with the more detailed theoretical and practical views laid down in the first part of this essay, will easily form for himself a correct set of rules of practice. It is in vain to say, that correct rules can be laid down in an abstract form, and capable of easy application, or that the practice may be rendered perfect, independently of the theory. Circumstances of a most evanescent nature, and, although important, often unheeded, necessarily interfere with all positive rules, and new cases are continually occurring, for which no previous rules can be given. He who is acquainted with the theory of the art, is always in possession of that light which will alone guide him through the intricacy of new cases, and of unexpected results. With the small apparatus of a theory, he has it in his power to do that without difficulty, and without labour, which he, who is destitute of theory, can seldom execute, even with the cumbrous and generally unintelligible apparatus of a set of fixed canons.

In making wines, as it is to be supposed that the fabricator has previously adopted some general views regarding the species of wine he proposes to make, and does not intend to trust the result to chance, he should consider of what kind he wishes his wine to be, or which of the several modifications of foreign wines he means it to resemble. By these considerations, he must be guided in his practice; and to assist his views, I will briefly enumerate the several varieties which it is in his power to imitate, in their general and fundamental qualities.

The first and simple class, are the *sweet wines*, of which the fermentation is incomplete. This incompleteness may arise from two sources, either the disproportion of sugar in the *must*, or the artificial means adopted for suspending the fermentation, and which have been already described. It is to this class that our native wines bear the greatest resemblance; a resemblance indeed so general, that few makers of this article appear to possess sufficient knowledge of the art, to enable themselves to steer clear of that which may be fairly called the radical defect of domestic wines. But a consideration of the causes of sweetness in wines, already amply laid down, and of the modes in which it may be avoided; will, I trust, enable the manufacturer to choose, whether his wine shall be sweet or not,—a choice, which in the present mode of management, is rarely left to him.

The next leading description of wines, is that to which, either in a state of sweetness, or comparative dryness, is super-added the effervescence on uncorking, which produces *briskness* or *sparkling*. The causes of this phenomenon, and the mode of ensuring, preserving and regulating it, have been also fully detailed ; and it has been seen how it is compatible, either with a very considerable sweetness, or with a limited degree of the same property. As this modification is also esteemed among the made wines, it is desirable that an accurate knowledge of the method of producing it should be attained, since it is frequently missed, in consequence of negligence or ignorance in the conduct of the process. It is from gooseberries almost solely, that this variety has in this country been made ; but it is by no means limited to that fruit, since, with due attention to the period of maturity, and with careful management, it may be equally well made from any other fruit. I must not, however, quit this subject, without cautioning the operator against a bad expedient, to which recourse has been had for producing the effect of sparkling. It is the introduction of a small portion of carbonate of potash or soda, into the bottle immediately before corking it. The consequence of this, is doubtless, a disengagement of gas at the moment of pouring out. But the gas speedily flies off, almost before the wine can be drunk, since it exists but in a loose state of combination, and in but small quantity. Nor does it communicate to the palate, that agreeable and lively sensation, which follows from the disengagement of that carbonic gas, which is in a real state of combination with the wine. Moreover, the neutral salt formed by the alkali, with the natural acid of the wine, is always sensible to the taste; while at the same time the native acid of the wine, so essential to the composition of this fluid, is destroyed; not to mention the danger of this acid taste being replaced by an alkaline one, from an over-dose of that ingredient.

The third variety of wine, is that, of which Hock, Grave and Rhenish, may be taken as examples. In these, the saccharine principle is entirely overcome by a complete fermentation, while their after-change is prevented by a careful application of those processes laid down for the preservation of the wines of this class. Makers of domestic wines have rarely succeeded in imitating these wines. The reasons are obviously two-fold, the great disproportion of the sugar to the subsequent fermentation in the first instance, and that want of the after-management, the neglect of which soon consigns these wines to the vinegar cask, if chance should even at first have produced success. I may venture to point out the imitation of these wines, from my own experience, not only as readily attainable, but as among the very best of those which can be made from domestic fruits. It is evident from what has been already said, that the relative proportions of the fruit and sugar in most common use, must be materially altered, and that the fermentation must be conducted in a much more perfect manner, before we can hope to produce wines of this character. It is equally evident, that the processes of racking, sulphuring and fining, must be practised with great assiduity, to preserve these wines after we have succeeded in making them.

The last class of wines, are those which are both dry in their quality, and strong in their nature. Such are Madeira, Sherry, and the stronger wines. The theory of these, is equally apparent; and it is certain, that with due attention to the the fermentation, wines of this strength and quality may be made without the addition of brandy. Yet the operator has it in his power by means of this ingredient, under the restrictions already laid down, to produce wines of any required degree of strength; and I trust, that with the light which I have thus endeavoured to derive from the legitimate processes of wine-making, I have established a beacon to guide him through the trackless route of his hitherto conjectural art.

British Grape Wine.

I have chosen to throw into a separate section of this essay, the remarks which I had to offer on the art of making wine from *Grapes* of British growth, on account of the greater importance of this part of the subject, and also on account of the neglect which seems to have attended that branch of domestic wine-making. I hope to make it appear that wines, not to be distinguished from those of foreign growth, can, in this country, be made from Grapes, and at a moderate expence; and that the success of this process is not at all affected by the uncertainty which attends the ripening of the grape in our climate. It is not too strong an expression to say, that the use of this fruit is calculated to supersede that of all others, and that it is, in fact, almost the only species of domestic wine which is worthy of serious attention.

The essays of Mr Pegge in the Archæologia, with the subsequent controversies which originated in the opposition of Mr Daines Barrington, have established beyond doubt the fact, that vineyards were cultivated in the monasteries of Britain, for the purpose of making wine. It appears, however, by the records of Ely, that the grapes did not ripen every year, but that the vineyards, as might be expected in this climate, were subject to occasional failures. We have therefore no reason to conclude, from the establishment of this fact, that our climate has undergone any material and steady alteration,—a supposition which is often hazarded by discontented horticulturists without sufficient grounds, and apparently from no other cause, than that ill humour which delights, as it has at all times delighted, in praising the past at the expence of the present.

The physical history of Europe, indeed, shews, that its climate has, for many centuries, been in a state of amelioration. Whether this amelioration may not now have attained its *maximum*, is another consideration. If it has so done, it is certainly within a period comparatively very recent. As far as we are capable of judging, no material variation in the success of our horticultural speculations has occurred for the worse, provided we choose periods of sufficient length to admit of an average result. Occasional seasons of peculiar severity, or unusual irregularity, can afford no ground for judgment. The suppression of the monasteries, the great and splendid changes which our whole system of agriculture has undergone since those days, the increase of trade, the more economical division and application of capital to objects of commerce, and to those of domestic manufacture, the multiplied demands which wealth and prosperity have made on the consumption of wine, and the increased discrimination and taste which this has produced, have combined together to change materially both the objects of commerce and cultivation, and have jointly operated in producing the decay of this art, if (as is by no means proved,) it was ever actually practised to any great extent. But this question does not concern our present purpose. It is sufficient to prove, what in fact there is no reason whatever to doubt, that the grape, as it is or may be cultivated in England, is capable of making wine; whether with advantage, considered in an agricultural view, and with what advantage, must depend on other considerations into which I need not now enter. However diminished this practice is in modern times, it is by no means extinct. The cottagers in Sussex are in the habit of making wine almost annually from the produce of vines trained on the walls of their houses. Many individuals through various parts of the southern counties, and even as far north as Derbyshire, practise the same with success. But the experiment is well known to have been made for many years on a large scale, and with complete results, at Pain's Hill, by the Honourable Charles Hamilton, in a situation, with respect to soil and exposure, of which parallel instances are to be found almost every where throughout the country, and produced from land of no value whatever for the ordinary purposes of agriculture.

It is true, that the uncertainty of this climate will sometimes prevent the grapes from ripening: But this case is not without remedy.

Of the numerous varieties of grapes, it is well known to gardeners, that some are much more forward than others, and ripen their fruit at least a month earlier. It is obviously necessary to select for our purposes those which are the most early, if it is our desire to produce in every season a ripe crop. Of these, the Auvernat, the Miller, the White Muscadine, the White and Black Chasselas, the Black Sweet-water, and the Black Hamburgh, are among those which ripen earliest, and with the greatest certainty. But I need not enter on this part of the subject, since it is fully known to gardeners.

It is more important to consider, what improvements may yet be made in the naturalization of this foreign plant, and whether care and attention may not, in time, produce new varieties, still more hardy and capable of ripening, with the same certainty as the currant or gooseberry. In a paper read before the Caledonian Horticultural Society,* I slightly alluded to this subject, and pointed out the methods to be followed in naturalizing exotic plants in general *. The observations of all gardeners have long since shown, that a tender exotic, rarely, if ever, becomes habituated to a climate, if it be propagated by layers, grafts, or cuttings; since the new plant is always perfectly identical in all its habits and properties with the parent, of which indeed it forms a part. But a material change in the constitution of plants is produced by sowing the seeds, and the seedlings are invariably more hardy than the plant from which they were derived. I quoted in that paper some observations made by Sir Joseph Banks, on the naturalization of *Zizania aquatica*, and related an instance still more remarkable of a similar effect produced on *Canna indica*, a native of the West India islands, by successive sowing of the seeds in Guernsey. From these two remarkable facts, and perfect examples of success, as well as from innumerable more imperfect trials, it seems clearly established, that any plant may be naturalized to this climate, provided its seeds can be made to grow in succession. This, however theoretically true, is obviously attended with much practical trouble, in consequence of the difficulty of descending equally, and for a given length of time, through a given range of temperature; a difficulty which would, in fact, in most cases, be insuperable. But no such obstacle prevents the further naturali-

* Published in vol. i. p. 284. of the Memoirs of the Society.

zation of those which produce seeds already in our summer temperature, and which are not destroyed by our winter frosts. Among these, the vine may be enumerated. To a certain extent it may indeed be considered as already naturalized, since it flowers every summer, and the winter frosts do not destroy it. So may the common laurel be looked upon as naturalized; yet a severe winter will kill this shrub, as a cold summer will prevent the vine from bringing its fruit to maturity. It is by a sedulous culture of seedling vines alone, that we can hope to overcome this obstacle, and to produce varieties which shall ripen in all summers. For this purpose it is not sufficient to make trial of one or two successions of seedlings. Experience has shown, that numerous generations in a direct descent from the parent are required for the production of this effect. What that number is, has scarcely yet been ascertained, except in the cases of the Zizania, and the Canna above quoted; but it probably varies according to the previous tenderness of the parent. In the vine, already considerably hardy, the object would probably be attained in a few generations. As I consider this object as one of prime importance, I venture to point it out to the serious attention of horticulturists, and as one which is likely to reward their labours. The production of new varieties will naturally follow these attempts, and by combining with them, the process of impregnating the flowers with the *pollen* of different grapes, new and valuable ones may ultimately be produced. By the choice, therefore, originally, of proper varieties of the vine, and by such naturalization on these principles as we may be capable of producing, we shall have gained one great step in the art of making wine, from grapes of British growth.

The next step is the choice of that soil, exposure, and method of treatment, which is adapted, not only to the habits of the vine, but to that particular climate in which the cultivation is attempted. Our guide here must be the practice of those countries, whose climate most resembles our own; of certain parts of Germany and Hungary. An elevated situation, a southern exposure, shelter to the north and north-west, rocky and southern precipices, are peculiarly adapted to the situation of a vineyard: so are gravelly and rocky soils; a circumstance in another view advantageous, since these soils are of very little value for common agricultural purposes. But I forbear to enter into details, which are to be found in many essays on gardening, and in others which have been written expressly on this subject.

It is the more direct object of this essay to show that the making of good wine from grapes of British growth, does by no means depend on their maturation, and that this is not a necessary circumstance. The process of making wine from grapes will be reduced to a much narrower question, if we can succeed in making it at all times, unchecked by seasons or accidents. A vineyard may thus be conducted with almost as little care as a gooseberry garden, with the certainty of a constant produce applicable to the purposes in view; and it will be in every one's power, in almost any situation. However precarious the ripening of the grape may be, its produce is not so. We are sure of an annual crop of grapes, but not of an annual crop of ripe ones.

It has been fully proved, by the facts and principles laid down in the first part of this essay, that a compound and artificial *must* can be fabricated from due mixtures of sugar, with the extractive matter and saline substances of fruits, capable of undergoing a regular fermentation, and of forming good and perfect wine. The case is as applicable to the grape as to the gooseberry. Long ago, experiments were made in France, by several chemists, with green grapes and sugar, and with complete success. I have repeated these experiments, and varied them with the best effects. The produce has varied with the management, and the results of the trials have been wines resembling Champagne, Grave, Rhenish, and Moselle, and of qualities so perfect, that the best judges and wine-tasters have not been able to distinguish them from foreign wines. The grapes may be used in any state, however immature. When even but half grown, and perfectly hard, they succeed completely. It is evident that wines made on this principle, will be more expensive than when made from ripe grapes, as a sufficient quantity of sugar must be used, to compensate for the deficiency of the natural sugar of the grape. But even then, they are no more costly than currant or gooseberry wines, while, at the same time, their superiority is beyond all comparison. The hardest grapes will produce a wine of the strength of white Hermitage, with a proportion of three pounds of sugar to the gallon; and the expence will be trifling compared to the value of the produce.

It might be supposed that these wines would necessarily be devoid of flavour. But this is by no means the case, since all the specimens which were made under my direction, were characterized by flavours, as genuine and decided, as those of the foreign wines to which they approximated. I have little doubt, that under due management, on a large scale, and with sufficient age, wines of the Hock quality, could equally well be produced here in the same way.

Many trials must yet be made before we can hope to appretiate the extent of our resources in this manufacture. It is more than probable, that different grapes, even in this immature state, would produce different wines; but these trials must be left to the efforts of individuals, and to the necessarily slow progress of experiment.

With regard to the management, it must be founded on the operations followed in the wine countries, and of which a sufficiently full account for all the purposes of practice has already been given. It is in the first place obvious, that the grapes should be suffered (from motives of economy) to remain on the vines, while there is any hope of gaining an accession either of strength or sweetness. They should then be carefully separated from the stems; those which are mouldy or rotten, being at the same time rejected. Some judgment will be required in proportioning the fruit to the water in the first instance, and to the sugar in the second. I have before said, that the grape, when ripe, consists of sugar, combined with vegetable extractive matter, or the fermenting principle, and certain salts, besides the astringent and flavouring matter. As the colour is not developed in the immature grape, it need not be noticed here. But the proportions of these ingredients vary materially, according to the state of maturity of the fruit. As a great part of the saline and other constituents of the grape, appear to be converted into sugar, during the process of maturation; it is plain, that, weight for weight, there will be more of the principles contained in the immature, than in the mature fruit. To form, therefore, a *must* of such a quality as shall resemble the natural *must* of ripe fruit, it is necessary that water should be added to the immature juice, for the purpose of diluting, and thus diminishing the proportions of those saline matters, which would otherwise confer on the wine a degree of harshness, difficult to overcome.

As it is impossible to give positive rules to meet the infinitely varying and undefinable degree of maturity, in which the grape must often be used, and as such rules would in fact but tend to mislead, I shall content myself with laying down some general principles, as I have done on former occasions, leaving the application to the ingenuity and observation of the operator.

If the object be to produce a wine which shall resemble Champagne, or the white wines of Bourdeux, a small proportion of crude grape, will be required. Grapes barely half grown, require, for the production of wines of this class, to be used in the proportion of equality to water. If they are more grown, the proportion may be increased; if less, it may be diminished. If the intention be to make a wine resembling Hock, the proportion of grapes must be materially increased, and the wine at first harsh, austere, and not drinkable when new, will, by a few years residence in the cask, undergo that amelioration which time alone can give. To the proportions which I have described, varying quantities of sugar may be applied. A proportion of two pounds in the gallon of mixture, will yield a very light wine, of no great durability, resembling (under the proper treatment), the inferior classes of Champagne wines, and under a different mode, a wine resembling Barsac, and the lighter of the Bourdeaux wines. An increase of the sugar to three pounds, will yield a wine equal in strength to the best sorts of Champagne, or if fermented to dryness, to the strongest of the white wines of Bourdeaux. Larger doses of sugar, will doubtless yield wines of different qualities, but of such proportions I cannot speak from experience. I may only caution the operator who shall undertake these trials, that larger quantities of sugar require larger proportions of fruit, if it be his intention to work the wine to dryness, as the quantity of fruit above-mentioned, is but barely sufficient to convert the proportion of three pounds above named. With regard to the durability of these wines, I may add, that I have kept them for seven years, and during all that time with evident improvement. I should consider them to be as little liable to destruction, as foreign wines of the very best *fabrique.*

While, on the subject of sugar, I may also say, that the general cause of failure in those wines which are made in this country from ripe grapes, is the deficiency of sugar, and that even these would be much improved by an addition of it. It is owing to this deficiency that these wines are perishable, and easily converted into vinegar, the natural *must* being too aqueous to produce a durable wine. The proportion of sugar need not be larger in these cases; but, as before remarked, no positive rules can be given for it, since it must vary with the maturity and saccharine quality of the fruit,—circumstances which differ in almost every season.

Two modes of management may be adopted with regard to the fruit, either subjecting the skins to the fermentation, or not. In the first case, a greater degree of austerity will be the consequence; and the wine will consequently vary in its qualities. If the object be to make a wine resembling Champagne, the skins may be separated previously to the fermentation. If this manufacture be conducted on a large scale, the result of the second pressing may be reserved to make a distinct wine. If, on a small one, it may either be mixed with the first, or rejected altogether.

The methods of conducting the fermentation, as well as all the after management, need not be repeated here, as they are to be found in the beginning of this essay. From these, the operator will be directed to the several sorts of wine he may wish to make. It is equally unnecessary to repeat, that wines produced in this way, may be modified either in flavour or colour, by the several expedients already detailed. But let me again inculcate, that the wine is not made when the ingredients have been introduced into the vessel. It is then that the labour begins, and nothing but care and attention to every part and every minute circumstance of the subsequent processes, can ensure satisfaction, and produce valuable results.

To such uses may the immature fruit of the vine be converted; but the capacities of that plant are not even yet exhausted. Situations may be found in this country where the vine may not produce even immature fruit; yet still it can be directed to the end of wine-making. Chemical examination has proved, that the *young shoots* the *tendrils*, and the *leaves* of the vine, possess properties, and contain substances exactly similar to the crude fruit. It was no unnatural conclusion, that they might equally be used for the purposes of making wine. Experiments were accordingly instituted in France with this view, and they have been repeated here with success. From vine-leaves, water, and sugar, wines have thus been produced in no respect differing from the produce of the immature fruit, and consequently resembling wines of foreign growth. The few experiments which I have tried have been eminently successful. No further rules can be given respecting the management of the leaves, in addition to those I have laid down for the treatment of the unripe fruit. Similar proportions and similar management will, in both cases, produce similar effects. The leaves, however, scarcely yielding any thing to the press, require to be infused in the water for some days before they are subjected to fermentation, and they seem to yield their soluble parts most readily to boiling water, without any material alteration in the result. The leaves of the Claret vine thus treated, produce wine of a delicate red colour. Tartar appears also to be a useful addition in this case; and it may be added in the proportion of half a pound, or even one pound, to ten gallons of the *must*. One advantage results from the use of the leaves. This is the facility with which they are reproduced during the growth of the vine; and thus, the produce of a small vineyard in leaves alone will be abundant; and that even of a single vine will be as great as is required for the use of most families, should they make this wine for their sole consumption. Let it always be remembered, that in all these cases, the price of the sugar is the price of the wine. The expence of utensils and labour is comparatively trifling, and, when the manufacture is upon a small scale, scarcely worthy of regard.

I have thus brought to a conclusion the remarks which I purposed to make on the art of fabricating wines in Britain. That I have offered so little from my own experience, will be pardoned by those who consider that each experiment must extend to a period of one or two years, and that the labour of a life would be insufficient to reduce every one of these suggestions to practice. It will be enough, that they are all readily deducible from the labours of others, or from fair analogies taken from established rules of practice in the wine countries. The co-operation of many, to which I may hope that this essay will afford additional facilities, will in time improve this practice to that degree of perfection of which it is capable, and establish it on a sure and solid basis.

WOOLWICH,
May 1815.

NOTE.

THE Council of the Caledonian Horticultural Society strongly recommend the foregoing essay to the attention of all who wish to promote improvement in the manufacture of domestic wines. They suspect, that to many, who are in the habit of making such wines, the general *principles* on which the process depends are nearly unknown, and that others, though in some measure acquainted with these principles, still trust too much to chance.

As the Society will continue to give every encouragement in their power to the improvement of the manufacture of domestic wines, they have earnestly to request every one who may be engaged in it, to keep a memorandum of the whole process which was followed, even the most minute manipulations. It is intended, when a very superior wine is produced in competition, to bestow a distinguished honorary reward, provided it shall appear that the maker has fully understood, and carefully acted upon, the scientific principles, the only certain guides to success.

The Council may remark, that some individuals in this place have already made considerable progress in naturalizing the vine from the seeds of plants kept in the open air; and, as there is no difficulty in sowing seeds, (which will vegetate though the grape be unripe,) and in watching when the plants thus produced yield a few grapes in the open air, the seeds of which are again to be sown, proceeding in this way to several generations; hopes may be entertained of some varieties of the grape being obtained, which will never fail to give abundant crops of tolerably ripe fruit; and *that* in no long time, since, under proper management, the vine may be expected to shew fruit in three or four years. In the mean time, the *leaves* (as suggested by Dr Macculloch) may be tried; but it ought to be observed, that some shoots, from which fruit may be expected, should not be stript of a single leaf. Indeed, for the purpose of making wine from the leaves, it would be better to plant vines of any sort, and to preserve the seedlings with the greatest care. To give a pleasant colour to wines, the Claret grape may be cultivated for its leaves.—Premiums will be given for Scottish grape wine, and a Gold Medal for the first good Scottish grape raised from seeds produced in the open air in Scotland.

XX.

A method of Cultivating Asparagus practised in France.

Communicated by Dr MACCULLOCH.

(Read 11th January 1816.)

THAT part of the garden which is longest exposed to the sun, and least shaded by shrubs and trees, is to be chosen for the situation of the asparagus quarter. A pit is then to be dug five feet in depth, and the mould which is taken from it, must be sifted, taking care to reject all stones, even as low in size as a filberd nut. The best parts of the mould must then be laid aside for making up the beds.

The materials of the bed, are then to be laid in the following proportions and order:

6 inches of common dunghil manure.
8 inches of turf.
6 inches of dung as before.
6 inches of sifted earth.
8 inches of turf.
6 inches of very rotten dung.
8 inches of the best earth.

The last layer of earth, must then be well mixed with the last of dung.

The quarter must now be divided into beds five feet wide, by paths constructed of turf, two feet in breadth, and one foot in thickness. The asparagus must be planted about the end of March, eighteen inches asunder. In planting them, the bud, or top of the shoot, is to be placed at the depth of an inch and a half in the ground, while the roots must be spread out as wide as possible, in the form of an umbrella. A small bit of stick must be placed as a mark at each plant, as it is laid in the ground. As soon as the earth is settled and dry, a spadeful of fine sand is to be thrown on each plant, in the form of a molehill. If the asparagus plants should have begun to shoot before their transplantation, the young shoots should be cut off, and the planting will, with these precautions, be equally successful, though it should be performed in this country even as late as July. Should any of the plants originally inserted have died, they also may be replaced at this season.

The plants ought to be two years old when they are transplanted; they will even take at three; but at four they are apt to fail.

If it be necessary to buy asparagus plants for these beds, it will be proper to procure twice as many as are required. The best must then be selected for planting, and the remainder placed in some remote portion of the prepared bed, or into a similar situation, but without separating the plants. Here they must first be covered with four inches of sand during the summer, and as soon as the frost sets in, with six inches of dung over that.

The stems of the planted asparagus must be cut down as soon as the frost commences, and close to the ground. The beds are then to be covered with six inches of dung, and four of sand. In March, the bed must be stirred with a fork, taking care not to approach so near to the plants as to derange them. Towards the end of April, the plants which have died, may be replaced with the reserved ones lately described.

In three years, the largest plants will be fit to cut for use. If the beds be sufficiently large to furnish a supply in this manner, the asparagus shoots should be cut as fast as they appear, otherwise they must be left till the quantity required has pushed forth, in which case, the variety in colour and size prevents them from having so agreeable an appearance. An iron knife, of the shape here represented, is used for this purpose.

In cutting, this knife is to be slipped along the stem, till it reaches the bottom of the shoot, where the cut is to be made. At the end of four years, the great and small ones may be taken indiscriminately. The cutting should cease about the end of June.

At the beginning of winter, the stems are all to be cut away, and the beds covered with dung and sand, in the manner above described. If muddy sand from the sea-shore can be procured for the several purposes above described, it is the best; otherwise, river sand may be used; and if that cannot be procured, fine earth must be substituted.

The asparagus bed now described, will generally last thirty years; but if they be planted in such abundance, as to require cutting only once in two years, half the bed being always in a state of reservation, it will last a century or more. The turf used in making the beds, should be very free from stones.

Care must be taken not to tread on the beds, so as to condense the earth in planting the asparagus; and to prevent such an accident happening on any other occasion, a plank should be used to tread on. It must be remembered, that the division of the beds, which is formed by thick turf, is intended to prevent the condensation of the earth below, in consequence of the necessary walking among the beds. As in the course of time, this condensation will gradually take place, the turf ought to be renewed every three years, for the purpose of stirring the ground below; and in applying the winter coat of manure, it must be remembered, that even these walks are to be covered. If these circumstances are not attended to, or if the earth below the walks has not originally been constructed in the way described above, the asparagus plants which grow near the walks, will be much less fine than those in the middle of the beds.

N. B.—I understand that this plan has been put in practice by Mr Allan of Tweedside, with success.

XXI.

Horticultural Gleanings.

Communicated by Sir G. S. Mackenzie,

To the Secretary.

Sir,

It has occurred to me, that it would be of use to many gardeners who purchase our cheap volumes, to possess abstracts of useful hints thrown out in other, but more expensive works; such as the Transactions of the London Horticultural Society, in which much valuable information is contained. With such a view, I now send to you some Gleanings from the work just mentioned, and from other sources; and if the Council shall deem them of sufficient importance, I shall be glad to see them occupy a portion of the Memoirs. I am, &c.

G. S. Mackenzie.

flue at different places, retard the heated air in the higher parts, the advantage of which is very obvious. The rest of the flue is low, as marked in fig. 1. at K. It may be managed, however, in different ways.

I can, from experience, assure the Society, that I have had as good fruit on the vertical cross trellisses, as under the glass, or on the back wall; and had I not succeeded to my utmost wishes, I should never have brought the plan into notice. It is my intention, some time hence, to construct a house, with partitions of brick instead of trellises, which last, however, look best. But when use, and not appearance is studied, I should be inclined to give brick a decided preference, for many reasons; and among others, on account of the facility with which the temperature could be regulated. In fig. 2. P is a small porch, the outer door of which is always shut, before that of the house is opened, to prevent, when necessary, the rushing in of the external air. Q is the furnace.

II.

On the Cultivation of the Guernsey Lily, as practised in the Island of Guernsey.

By Dr Macculloch, Woolwich.

(Read 14th June 1814.)

In a short notice relating to the cultivation of exotics in the Island of Guernsey, read before the Society last year, I took occasion to remark, that the *Amaryllis Sarniensis* or Guernsey Lily, might possibly be induced, under proper treatment, to flower in our own island.

It is certain that this plant is not a native of Guernsey, since it is always in danger of perishing during winters of extraordinary severity, such as was that of 1794, which destroyed nearly the whole of the roots in the island. It is known to be a native of Japan; and it is a popular tradition in Guernsey, that the roots were there introduced by the accidental wreck of a ship from some part of the East Indies. I observed in the paper to which I now refer, that many delicate bulbous roots were, equally with this one, successfully cultivated in that island. A popular notion, the consequence of preconceived opinions and limited trials, has prevented the experiment on the *Amaryllis Sarniensis* from being pursued in Britain, on such a scale, and with such perseverance, as can alone, in cases of this kind, afford a probability of success. If we revert merely to the circumstances of climate under which these differences are experienced, it does not appear that there are any sufficiently striking to preclude it in our own; since the only remarkable distinction, and that which seems alone to affect the results, severity of frost, may, with regard to bulbous roots, be tolerably well obviated by the methods in common use with gardeners. As the mode of managing the plant in this island is perfectly simple, and may be practised any where, I shall have done all that is requisite as a preliminary to this object, if I describe it for the guidance of those who may be inclined to appropriate a few square yards of ground to this object. In the department of the flower-garden, it is assuredly worthy of attention, since the beauty of the flower itself, its durability while flowering, and the advanced season to which the blossom endures, render it peculiarly desirable, when the sweetness and splendour of all the productions which this elegant branch of horticulture includes are fast expiring.

Like most other bulbous roots, this plant requires a light and rich soil. It produces offsets in abundance. Once in three or four years, and in the month of July, when (in this island) the leaves are dead, the roots are taken up, for the purpose of removing the offsets. The largest roots are then separated, and planted in beds, at a distance of nine inches from each other. These beds are reserved for flowering, while the smaller offsets are planted in separate beds, and treated in a similar manner at the end of an additional period of three or four years. They are found to flower most certainly and most successfully, when they are planted in open beds exposed to the sun. In the hands of the little farmers, almost every one of whom has a spot appropriated to this favourite object, they are both separated with less care, and treated with less attention; since they are commonly planted in the orchards, under the shade of apple-trees. Among them the produce in flowers is consequently neither so vigorous nor so abundant.

It is necessary, even in this mild climate, where the frost seldom penetrates half an inch below the surface, to protect the bulbs from its action. This is in general easily effected, by a covering of sand of the depth of an inch or less. It is evident, that a greater degree of protection against this enemy to tender exotics, would be required in our own more severe climate; but as the means of giving this protection are simple and practicable, there is no difficulty in effecting it. In the milder climates of the western side of our island, it might probably be effected by means as simple as those used in Guernsey.

These are the only practices by which the cultivation of this root is distinguished. But I must again repeat, that its tendency to flower is not great; in technical language it is shy of flowering, even in Guersney,—a circumstance which appears to be common to it, with many other plants well known to gardeners, and which I need not enumerate, plants, whose delicacy of sensation appears to suffer from irregularities of temperature so minute, that we are unable to appretiate them by any other test: Scarcely five flowers are produced annually from a hundred healthy roots. It is for those horticulturists to whom the beauty of the flower-garden is an object of attention, to calculate the relative value of the toil and the reward. Let them at any rate be assured, that he who sows not, shall not reap.

III.

On Wire-Grates, as a means of preventing Wasps from entering Hot-houses.

By Mr John Machray, Errol.

(Read 13th December 1814.)

There are few avocations in life which require more attention to a diversity of objects than that of a gardener.

After having, with the greatest care and attention, brought his trees to a bearing-state, he is obliged to maintain a perpetual contest with ignoble enemies: the feeble efforts of puny insects are often to him the source of many painful sensations. Taken singly, they may appear contemptible; but numbers render them formidable. Even the elements sometimes conspire to blast his expectations. On the one hand, he sees aphides in numberless myriads roll up the tender foliage of the peach; the coccus preys upon the bark;

LXVI.

On the cultivation of the Parsnip, as it is practised in Guernsey.

By Dr Macculoch, Woolwich.

(Read 13th September 1814.)

The great superiority of this root, as cultivated in Guernsey and the neighbouring islands, to its produce in Britain,—the high reputation which it bears among the farmers in those islands, and the very little knowledge of it, which those of Britain seem to possess,—have induced me to lay before the Society, a short account of the methods practised in its culture in Guernsey.

I am inclined to think, that it will be found much more worthy the attention of agriculturists, than has been hitherto supposed, and that it will form a material and valuable addition to the system of green crops, when it shall become better known.

But it is chiefly on account of the power which it possesses of resisting the injuries of frost, that I have ventured to point it out as an object of attention to the Caledonian Horticultural Society. The injury which the green crops, commonly cultivated in the northern parts of our island, suffer from this enemy, is such as to render it highly desirable to find one which shall be exempt from the effects of winter.

It has been hitherto, but generally and carelessly said, and as if the fact was not well ascertained, that this root did not suffer from frost. The unusually severe winter of 1813—14, has enabled me to decide this question most positively; and to name the parsnip, as perhaps the only cultivated root which appears to defy all cold. In the garden of my friend Mr Mathews at Waltham Abbey, a crop of parsnips was suffered to continue in the ground throughout the winter. That land is well known to be wet meadow-land, and was frozen in a solid mass, to the depth of a foot or more. The roots remained unhurt; and while I write, in the beginning of April 1814, they are all putting out their new shoots. This hardiness, which would render the parsnip a desirable object of cultivation in the coldest parts of Scotland, would still more recommend its use to the unfortunate Greenlanders, among whom the esculent vegetables have hitherto been limited to two or three, and where the parsnip has not as yet been introduced. If other circumstances (the method of culture, the deep ploughing required, and the nature of the soil necessary for this root) do not prevent its introduction into the Highlands, it may eventually be found a valuable substitute for the potato, in many situations where the early frosts often destroy that plant long before the tubers have arrived at maturity. It is no small additional merit, that it is nearly exempt from the attacks of insects; and from the diseases incident to all our esculent roots, as well as from the effects of cold. In wet springs only, it is remarked, that the plants in Guernsey are sometimes destroyed by slugs, and that extremes of dryness or moisture protracted through the season, are injurious to them.

The superior quality and size of the root in Guernsey, appears to be the result of the long continued care and attention bestowed on it, since there is nothing in the soil of that island, to account for this difference; and since that soil itself is by no means of a very superior quality. The greater part of the island consists of a large foliated gneiss, impregnated with a considerable proportion of iron, and subject to decomposition in the mass, by a process of rotting or gangrene similar to that which occurs in many varieties of the trap family, and among other places very remarkably in Sky. The result is consequently a gravelly loam. It is remarked by Mr Young, that the parsnip requires a rich putrid dry sandy loam; and he discourages its cultivation where the soil is not of this desirable quality. This is assuredly not the character of the soil of Guernsey, where the cultivation is successfully carried on, even in situations where the land is stiff, cold and wet. An open and loose soil is obviously necessary, to allow of the growth and descent of the long-rooted variety; but it will be observed by and bye, that two varieties are in use, of which the one is much shorter than the other; and consequently better adapted to soils of no great depth.

These two principal varieties cultivated in Guernsey, are known by the names of the *Coquaine* and the *Lisbonaise.*

The first of these roots is the finest, and sometimes runs four feet deep. It is rarely so small in circumference as six inches, and has been known to reach sixteen. The leaves of this variety grow to a considerable height, and proceed from the whole crown of the root.

The Lisbonaise does not extend to so great a depth as the Coquaine; but the root is as good, and is preferred by many farmers, since that which is lost in length is gained in thickness, and it does not require so deep a soil. Though the crown is equally large in this variety, the leaves are small and short, and only proceed from its centre, in which there is a hollow or cup. The root terminates rather abruptly, in small fibrous radicles.

There is yet a third variety, known by the name of *Fourquée*, (forked,) which appears to be only a modification of the last, and which, although still cultivated, is less esteemed.

On comparing the dimensions of these roots with those of the variety cultivated in Britain, it will be seen, that the former are much superior; and it is supposed, that their qualities in Guernsey are also superior to those of our varieties. It will likewise be seen, that they can produce a heavier crop in that island on the same extent of ground.

From these considerations, it would be advisable to cultivate the Guernsey varieties in this country, by procuring the seeds from that place, and to abandon those whose produce seems in every respect inferior.

Although this root is cultivated in almost all the soils of that island, that is esteemed the best which consists of a good light loam, the deeper the better. If the loamy soil is not deep, the under soil at least should be open, to allow of the free penetration of the roots.

If the land is not perfectly clear from couch-grass and other weeds, it is pared with the paring-plough in October, and harrowed, to remove the weeds. About the middle of February, the land is prepared for sowing by means of two ploughs. A small plough precedes, and opens the furrow to the depth of four inches, and is followed by a larger plough, drawn by four or six oxen and as many horses, which deepens the furrow to ten or fourteen inches. This plough is called the *Grande Charrue*, and as the small farms into which Guernsey is divided, do not admit of such an army of cattle in the possession of any one farmer, this work is performed by a contribution of the neighbours, who are repaid by the like joint-stock assistance, the whole being attended with a holiday-like bustle, that cannot fail to surprise a stranger. I need not remark, that a more accurate system of husbandry could accomplish the subsequent trenching and turning up of the first furrow with much less force. The spade is used for this purpose in some parts of France as well as in Jersey, but is less expeditious and economical than a judicious use of the trenching-plough. As soon as the clods are capable of being broken, the harrowing commences, and is repeated till the soil is pulverized, and reduced nearly to the state of garden mould. The whole of these processes are intended to loosen the soil to as great a depth as possible.

The seed should not be more than a year old, as it is uncertain when of a greater age. It is sown broadcast, and in a day just so windy as to insure its regular spreading over the surface. The seed is then covered by the harrow. The quantity sown is from half a *denerel** to one *denerel* per *vergée*. The half *denerel* is judged sufficient, but many farmers sow the whole, to enable them to harrow the land before the first weeding, by which means, they destroy so many weeds as to save much of the after hand-weeding. As soon as the plants are sufficiently strong, they are hand-weeded and thinned; and this operation must be repeated at least three times during the summer. The distance between the plants is ultimately about nine inches; and, to save a portion of the labour, a harrowing is sometimes given between the first and second weedings. The expence of weeding a *vergée* three times, is 30s. I believe that the practice of drilling and horse-hoeing, by which much labour might probably be saved, has never been attempted in Guernsey, where agriculture has not arrived at that perfection which it has attained in this country, and where, from the infinitely small division of property, and consequent size of the farms, with the almost unavoidable attachment to antient practices which accompanies

* The *denerel* is four quarts; the *vergée* 17,640 square feet; 2.46 *vergées* are equal to an English acre, which consequently gives about ten quarts to the acre. The price of parsnip seed while I write, is 2s. 6d. the *denerel*, making the whole expence per acre nearly 7s. 6d.

these circumstances, its operations are in general antiquated. It is indeed said, that in other countries, where this method has been tried, it has not been found to answer so well as the system of broadcast culture.

The first weeding is performed about the middle of May, or it may be earlier or later according to the state of the plants; it is repeated when necessary, till the beginning of July. The distance at which the plants are allowed to remain, is greater in Guernsey than in England, where they are suffered to stand at six inches asunder.

Although the general practice is that which I have now described, the seed is sometimes sown at the latter end of September or beginning of October, and the plants are found to pass the winter well, and produce a good crop. It is supposed that they may thus become strong before they can be injured by weeds. There is also some variation in the time of the spring sowing. Where the soil is a rich sandy and dry loam, the seed is sown early in January; but the general period of sowing over the whole island, is from the middle of February to the beginning of March, except in stiff and wet lands, where it is deferred for a fortnight.

The produce per acre, is considerably greater than that of the carrot. A good crop in Guernsey is considered 17,600 lb. per *vergée*, or about

44,000 lb. per English acre. This is a less heavy crop than turnip, but it is much more considerable than that either of the carrot or potato. If we consider, at the same time, that the quantity of saccharine, mucilaginous, and, generally speaking, of nutritious matter in the parsnip, bears a far larger proportion to the water, than it does in the turnip, its superiority in point of produce, will appear in this case also to be greater.

The roots are dug up about the middle of August, when they are thought to be most nutritious, and to fatten animals better than after the leaves are decayed. I do not understand that the green tops are used in Guernsey, although in England they have been found as useful for live stock, as other green food, either consumed in the field, or cut off when the roots are taken up. The quantity dug up at this season, is not more than is required for two or three days consumption. It is only in October that the root is fully ripe, when it may be dug up with forks, and preserved dry in sheds during the winter, but it is usually left in the ground in Guernsey, where frost is rare, and taken up as it is wanted.

The parsnip is considered by the farmers of Guernsey, as the best fallow crop known, and as in the greatest degree influencing the subsequent crop of grain. In Jersey, it is the usual practice to follow it by wheat. As it draws its nourishment from the deeper parts of the soil, it is evident, that it is particularly calculated to succeed the generality of fibrous-rooted vegetables. If sown, therefore, after a hay or barley crop, it seldom needs any manure, and yields a very good produce without it. In England, where manure is required, farm-yard dung is preferred, and it is turned into the soil by a light plough, immediately before sowing the seed. But in Guernsey, sea-weed is universally adopted when it can be obtained,—a species of manure, in which many districts of the Highlands abound, although its use is by no means so extensive as it deserves to be. The recent and apparently steady diminution in the price of kelp now going on, will doubtless introduce this valuable manure into much greater use in the Highlands, than has hitherto been the case.

The parsnip is considered by the Guernsey farmers, to be the most nutritious root known, superior even to the carrot and the potato. When small, it is given to the animals whole; but when large, it is sliced longitudinally. As no farmer in Guernsey feeds his horses or cattle on parsnips alone, it is not possible to determine its exact value from their practice, with the accuracy which the more scientific agriculturists of this country would desire. The art has not yet attained in that island the same precision, nor been subjected to the same laws of rigid calculation, which it has undergone in Britain. But a tolerable conclusion may be drawn of the efficiency of this root, even from the examination of the testimony of Guernsey farmers.

Cows fed with parsnips, are said not to yield so great a quantity of milk, as when fed with turnips; but the milk is richer, and the butter is better, as well as in far greater proportion, and both are also free from the disagreeable flavour which they acquire from turnips;—a circumstance highly deserving the attention of those dairy farmers, who supply the population of great towns, with these indispensable articles of consumption. They are in fact equal to those which are produced by feeding in the best pastures. These animals, when intended for the butcher, are observed to fatten faster and better on parsnips, than on any other food. The only precaution used, is to interpose hay, to prevent them from being surfeited with the root. It is also found necessary to begin with a smaller proportion, as they are apt to be satiated with this food in the first week, if given to excess. After that period, it is remarked that it may be used in any quantity.

The farmers are of opinion, that cabbages are the best substance to interpose for this purpose, although turnips or hay may also be given with the parsnip. The allowance for fattening an ox, who will weigh 1100 lb. is 120 lb. per day, exclusive of hay. As far as any experiments have been made in England, the results tally with those here reported. The cattle were found to fatten quicker and become more bulky, than when fed with any other root; and the meat has also turned out more sweet and delicate. In some experiments, recorded as having been made by an experienced farmer in Surrey, an ox was fattened from the plough on parsnips alone in thirteen weeks. I may add, that in many parts of France, and among the rest in Brittany, where this root is extensively cultivated, the same results have been obtained. Beef fattened with parsnips fetches a halfpenny per pound more in Jersey than under any other system of fattening.

Hogs prefer this root to all others, and make excellent pork, but it is fancied in Guernsey, that the boiling of the root renders the bacon flabby. It has, however, been found, in the trials of the Surrey farmer above mentioned, that the hogs became satiated with the raw parsnips before they were fattened, upon which he caused them to be boiled, with good effect. The animal can be fattened in six weeks by this food.

Horses are equally fond of the parsnip, although, from eating it with too much avidity, it is said sometimes to stick in the throat, and to choke them. But this may be easily prevented, by cutting the roots into pieces before they are given. The use of parsnips is said to affect the eyes of this animal, but we may safely consider this assertion as somewhat apocryphal. They are found to supersede the necessity of corn, except when the work is excessive; and in Brittany, they are even used for this purpose, to the exclusion of corn.

I may add, that it is a popular opinion among the Jersey farmers, that all animals intended for the butcher may be fattened on parsnips in nearly half the time, and with half the quantity, which is required in feeding them with potatoes. This must, however, be taken rather as a general opinion, with regard to the superiority of the one root over the other, than as the result of any accurate set of experiments, since the practices of agriculture in that island as well as in Guernsey, are by no means reduced to that nicety of calculation, which they have hitherto experienced in Britain.

In Brittany, they also form a principal article of the food of the people, and are still used largely, notwithstanding the introduction of the potato; but I need scarcely add, that, as in the case of most other roots, the potato has, to a great degree, also diminished the consumption of parsnips as an article of human food. The peculiarity of their flavour is such, as perhaps for ever to prevent them from entering into competition with that most valuable plant; although, in situations similar to the highland districts to which I have above alluded, the cultivation of the parsnip, to a certain extent, might probably be found a useful resource, at least as an auxiliary article of food, in case of the failure of the potato.

Before terminating this paper, I may remark, that a species of wine has been often manufactured from the fermented juice of parsnips, and that report speaks in its favour. I have no experience of it, and, for obvious reasons, there has never been any temptation in Guernsey or its neighbour islands, to discover substitutes for the untaxed and superior produce of the vine. Nor do I know that the parsnip wash has been subjected to distillation. It would be worthy the attention of the Society to inquire, whether the spirit produced from it might not become a substitute for whisky, since the produce per acre would unquestionably be much greater.

I may also add, that parsnips are cultivated to great extent in Jersey, as well as in Guernsey, and with the same favourable results, though with some little variation in the process.

The preparation of the land there, and the other previous arrangements, are similar to those already described. After the harrow, the ground is dibbled with beans in rows at five feet distance. The parsnip seed is then sowed over the whole broadcast. In May, the handweeding commences, and the parsnips are thinned to the requisite distance. The beans are pulled up by hand in September, and the parsnip crop is then disposed of as in Guernsey. I have not been able to procure any accurate estimate of the comparative value of the two processes, nor to learn how far the bulk of the parsnip crop is diminished by the additional incumbrance imposed on the land by the beans.

LXVII.

Extract of a Letter from Dr JOHN COAKLEY LETTSOM, *Physician, London, to Dr* DUNCAN *senior, Edinburgh, respecting the Beta Cicla, Mangold-Wurzel, or Root of Scarcity, as it has been called.*

(Read 14th December 1813.)

I HAVE directed to you a box, containing, among other trivial articles, a few pounds of Mangold-Wurzel seeds from different sources and correspondents.

When I introduced the knowledge and cultivation of this seed about forty years ago, I met with some approbation, and much ridicule. Even Peter Pindar was pleased to devote a few lines to me, as well as to Sir Joseph Banks, in his Emperor of Morocco. But time and experiment have now established it as the most productive vegetable in Europe. On my request to Sir Mordaunt Martin of Burnham, Norfolk, by whose steady perseverance this root was pre-

COMMUNICATION

TO THE

Caledonian Horticultural Society:

ON THE

CULTIVATION OF THE PARSNIP

AS IT IS PRACTISED IN

GUERNSEY.

By Dr. MACCULLOCH, Woolwich.

(Read 13th September 1814.)

The Notes, with the exception of the Third, have been added from subsequent information.

COMMUNICATION, &c.

THE great superiority of this root, as cultivated in Guernsey and the neighbouring islands, to its produce in Britain,—the high reputation which it bears among the farmers in those islands, and the very little knowledge of it, which those of Britain seem to possess,—have induced me to lay before the Society, a short account of the methods practised in its culture in Guernsey.

I am inclined to think, that it will be found much more worthy the attention of agriculturists, than has been hitherto supposed, and that it will form a material and valuable addition to the system of green crops, when it shall become better known.

But it is chiefly on account of the power which it possesses of resisting the injuries of frost, that I have ventured to point it out as an object of attention to the Caledonian Horticultural Society. The injury which the green crops, commonly cultivated in the northern parts of our island, suffer from this enemy, is such as to render it highly desirable to find one which shall be exempt from the effects of winter.

It has been hitherto, but generally and carelessly said, and as if the fact was not well ascertained, that this root did not suffer from frost. The unusually severe winter of

1813—14, has enabled me to decide this question most positively; and to name the parsnip, as perhaps the only cultivated root which appears to defy all cold. In the garden of my friend Mr. Mathews, at Waltham Abbey, a crop of parsnips was suffered to continue in the ground throughout the winter. That land is well known to be wet meadow-land, and was frozen in a solid mass, to the depth of a foot or more. The roots remained unhurt; and while I write, in the beginning of April 1814, they are all putting out their new shoots. This hardiness, which would render the parsnip a desirable object of cultivation in the coldest parts of Scotland, would still more recommend its use to the unfortunate Greenlanders, among whom the esculent vegetables have hitherto been limited to two or three, and where the parsnip has not as yet been introduced. If other circumstances (the method of culture, the deep ploughing required, and the nature of the soil necessary for this root) do not prevent its introduction into the Highlands, it may eventually be found a valuable substitute for the potato, in many situations where the early frosts often destroy that plant long before the tubers have arrived at maturity. It is no small additional merit, that it is nearly exempt from the attacks of insects; and from the diseases incident to all our esculent roots, as well as from the effects of cold. In wet springs only, it is remarked, that the plants in Guernsey are sometimes destroyed by slugs, and that extremes of dryness or moisture, protracted through the season, are injurious to them.

The superior quality and size of the root in Guernsey, appears to be the result of the long continued care and attention bestowed on it, since there is nothing in the soil of that island, to account for this difference ; and since that soil itself is by no means of a very superior quality. The greater part of the island consists of a large foliated gneiss, impregnated with a considerable proportion of iron, and subject to decomposition in mass, by a process of rotting or gangrene similar to that which occurs in many varieties of the trap family, and among other places very remarkably in Sky. The result is consequently a gravelly loam. It is remarked by Mr. Young, that the parsnip requires a rich putried dry sandy loam ; and he discourages its cultivation where the soil is not of this desirable quality. This is assuredly not the character of the soil of Guernsey, where the cultivation is successfully carried on, even in situations where the land is stiff, cold and wet. An open and loose soil is obviously necessary, to allow of the growth and descent of the long-rooted variety ; but it will be observed by and bye, that two varieties are in use, of which the one is much shorter than the other; and consequently better adapted to soils of no great depth.

These two principal varieties cultivated in Guernsey, are known by the names of the *Coquaine* and the *Lisbonaise*.

The first of these roots is the finest, and sometimes runs four feet deep. It is rarely so small in circumference as six inches, and has been known to reach sixteen. The leaves of this variety grow to a considerable height, and proceed from the whole crown of the root.

The Lisbonaise does not extend to so great a depth as the Coquaine but the root is as good, and is preferred by many farmers, since that which is lost in length is gained in thickness, and it does not require so deep a soil. Though the crown is equally large in this variety, the leaves are small and short, and only proceed from its centre, in which there is a hollow or cup. The root terminates rather abruptly, in small fibrous radicles.

There is yet a variety, known by the name of *Fourquée* (1) (forked,) which appears to be only a modification of the last, and which, although still cultivated, is less esteemed.

On comparing the dimensions of these roots with those of the variety cultivated in Britain, it will be seen, that the former are much superior; and it is supposed, that their qualities in Guernsey are also superior to those of our varieties. It will likewise be seen, that they can produce a heavier crop in that island on the same extent of ground.

From these considerations, it would be advisable to cultivate the Guernsey varieties in this country, by procuring the seeds from that place, and to abandon those whose produce seems in every respect inferior.

Although this root is cultivated in almost all the soils of that island, that is esteemed the best which consists of a good light loam, the deeper the better. If the loamy soil is not deep, the under soil at least should be open, to allow of the free penetration of the roots.

If the land is not perfectly clear from couch-grass and other weeds, it is pared with the paring-plough in October, and harrowed, to remove the weeds. About the middle of February, the land is prepared for sowing by means of two ploughs. A small plough precedes, and opens the furrow to the depth of four inches, and is followed by a larger plough, drawn by four or six oxen and as many horses,

(1) This variety is only accidental, seeds are not saved from it, and it is never cultivated.

which deepens the furrow to ten or fourteen inches. This plough is called the *Grande Charrue*, and as the small farms into which Guernsey is divided, do not admit of such an army of cattle in the possessiou of any one farmer, this work is performed by a contribution of the neighbours, who are repaid by the like joint-stock assistance, the whole being attended with a holiday-like bustle, that cannot fail to surprise a stanger. I need not remark, that a more accurate system of husbandry could accomplish the subsequent trenching and turning up of the first furrow with much less force: The spade is used for this purpose in some parts of France as well as in Jersey, (2) but is less expeditious and economical than a judicious use of the trenching-plough. As soon as the clods are capable of being broken the harrowing commences, and is repeated till the soil is pulverized, and reduced nearly to the state of garden mould. The whole of these processes are intended to loosen the soil to as great a depth as possible.

The seed should not be more than a year old, as it is uncertain when of a greater age. It is sown broadcast, and in a day just so windy as to insure its regular spreading over the surface. The seed is then covered by the harrow. The quantity sown is from half a *denerel* (3) to one *denerel* per *vergée*. The half *denerel* is judged sufficient, but many farmers sow the whole, to enable them to harrow the land before the first weeding, by which means, they

(2) Sometimes also in Guernsey in limited farms, or in very small enclosures.

(3) The *denerel* is four quarts; the *vergée* 17,640 square feet; 2,46 *vergées* are equal to an English acre, which consequently gives about ten quarts to the acre. The price of parsnip seed while I write, is 2s. 6d. the *denerel*, making the whole expence per acre nearly 7s. 6d

destroy so many weeds as to save much of the after hand-weeding. As soon as the plants are sufficiently strong, they are hand-weeded and thinned; (4) and this operation must be repeated at least three times during the summer. The distance between the plants is ultimately about nine inches; and, to save a portion of the labour, a harrowing is sometimes given between the first and second weedings. The expence of weeding a *vergée* three times, is 30s. I believe that the practice of drilling and horse-hoeing, by which much labour might probably be saved, has never been attempted in Guernsey, where agriculture has not arrived at that perfection which it has attained in this country, and where, from the infinitely small division of property, and consequent size of the farms, with the almost unavoidable attachment to antient practices which accompanies these circumstances, its operations are in general antiquated. It is indeed said, that in other countries, where this method has been tried, it has not been found to answer so well as the system of broadcast culture.

The first weeding is performed about the middle of May, or it may be earlier or later according to the state of the plants; it is repeated when necessary, till the beginning of July. (5) The distance at which the plants are allowed to remain, is greater in Guernsey than in England, where they are suffered to stand at six inches asunder.

Although the general practice is that which I have now

(4) Before this is done, it is now the general practice to roll the ground with a wooden roller not too heavy. They do not roll after the first weeding.

(5) Sometimes even till August.

described, the seed is sometimes sown at the latter end of September or beginning of October, and the plants are found to pass the winter well, and produce a good crop. It is supposed that they may thus become strong before they can be injured by weeds. There is also some variation in the time of spring sowing. Where the soil is a rich sandy and dry loam, the seed is sown early in January; but the general period of sowing over the whole island, is from the middle of February to the beginning of March, except in stiff and wet lands, where it is deferred for a fortnight.

The produce per acre, is considerably greater than that of the carrot. A good crop in Guernsey is considered 17,600 lb. per *vergée*, or about 44,000 lb. per English acre. This is a less heavy crop than turnip, but it is much more considerable than that either of the carrot or potato. If we consider, at the same time, that the quantity of saccharine, mucilaginous and, generally speaking, of nutritious matter in the parsnip, bears a far larger proportion to the water, than it does in the turnip, its superiority in point of produce, will appear in this case also to be greater.

The roots are dug up about the middle of August, when they are thought to be most nutritious, and to fatten animals better than after the leaves are decayed. I do not understand that the green tops (6) are used in Guernsey, although in England they have been found as useful for live stock,

(6) They are always given to horned cattle, except when the roots are left in the ground till the tops decay, for they are seldom eat off.

Some farmers do not dig up the parsnips with a spade or fork, but draw them off the ground with an instrument adapted to that purpose; they pretend that the succeeding crop of wheat proves better.

as other green food, either consumed in the field, or cut off when the roots are taken up. The quantity dug up at this season, is not more than is required for two or three days consumption. It is only in October that the root is fully ripe, when it may be dug up with forks, and preserved dry in sheds during the winter, but it is usually left in the ground in Guernsey, where frost is rare, and taken up as it is wanted.

The parsnip is considered by the farmers of Guernsey, as the best fallow crop known, and as in the greatest degree influencing the subsequent crop of grain. In Jersey (7) it is the usual practice to follow it by wheat. As it draws its nourishment from the deeper parts of the soil, it is evident that it is particularly calculated to succeed the generality of fibrous-rooted vegetables. If sown, therefore, after a hay or barley crop, it seldom needs any manure, and yields a very good produce without it. In England, where manure is required, farm-yard dung is preferred, and it is turned into the soil by a light plough, immediately before sowing the seed. But in Guernsey, sea-weed is universally adopted when it can be obtained,—a species of manure, in which many districts of the Highlands abound, although its use is by no means so extensive as it deserves to be. The recent and apparently steady diminution in the price of kelp now going on, will doubtless introduce this valuable manure into much greater use in the Highlands, than has hitherto been the case.

The parsnip is considered by the Guernsey farmers, to be the most nutritious root known, superior even to the

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carrot and the potato. When small, it is given to the animals whole; but when large, it is sliced longitudinally. As no farmer in Guernsey feeds his horses or cattle on parsnips alone, it is not possible to determine its exact value from their practice, with the accuracy which the more scientific agriculturists of this country would desire. The art has not yet attained in that island the same precision, nor been subjected to the same laws of rigid calculation, which it has undergone in Britain. But a tolerable conclusion may be drawn of the efficiency of this root, even from the examination of the testimony of Guernsey farmers.

Cows fed with parsnips, are said not to yield so great a quantity of milk, as when fed with turnips; but the milk is richer, and the butter is better, as well as in far greater proportion, and both are also free from the disagreeable flavour which they acquire from turnips;—a circumstance highly deserving the attention of those dairy farmers, who supply the population of great towns, with these indispensable articles of consumption. They are in fact equal to those which are produced by feeding in the best pastures. These animals, when intended for the butcher, are observed to fatten faster and better on parsnips, than on any other food. The only precaution used, is to interpose hay, to prevent them from being surfeited with the root. It is also found necessary to begin with a smaller proportion, as they are apt to be satiated with this food in the first week, if given to excess. After that period, it is remarked that it may be used in any quantity.

The farmers are of opinion, that cabbages are the best substance to interpose for this purpose, although turnips or hay may also be given with the parsnip. The allowance for fattening an ox, who will weigh 1100 lb. is 120 lb. per day, exclusive of hay. As far as any experiments have been made in England, the results tally with those here reported. The cattle were found to fatten quicker and become more bulky, than when fed with any other root; and the meat has also turned out more sweet and delicate. In some experiments, recorded as having been made by an experienced farmer in Surrey, an ox was fattened from the plough on parsnips alone in thirteen weeks. I may add, that in many parts of France, and among the rest in Brittany, where this root is extensively cultivated, the same results have been obtained. Beef fattened with parsnips fetches a halfpenny per pound more in Jersey than under any other system of fattening.

Hogs prefer this root to all others, and make excellent pork, but the boiling of the root renders the bacon flabby. (8) It has, however, been found, in the trials of the Surrey farmer above mentioned, that the hogs became satiated with the raw parsnips before they were fattened, upon which he caused them to be boiled, with good effect. The animal can be fattened in six weeks by this food.

Horses are equally fond of the parsnip, although, from eating it with too much avidity, it is said sometimes to stick in the throat, and to choke them. But this may be easily prevented, by cutting the roots into pieces longitudinally before they are given. The use of parsnips is said to affect the eyes of this animal, but we may safely consider this assertion as somewhat apocryphal (9) They are found

(8) I since learn on the most respectable authority, that it is really the case.

(9) It blinds geese, but they recover on leaving them off.

to supersede the necessity of corn, except when the work is excessive; and in Brittany, they are even used for this purpose, to the exclusion of corn.

I may add, that it is a popular opinion among the Jersey farmers, that all animals intended for the butcher may be fattened on parsnips in nearly half the time, and with half the quantity, which is required in feeding them with potatoes. This must, however, be taken rather as a general opinion, with regard to the superiority of the one root over the other, than as the result of any accurate set of experiments, since the practices of agriculture in that island as well as in Guernsey, are by no means reduced to that nicety of calculation, which they have hitherto experienced in Britain.

In Brittany, they also form a principle article of the food of the people, and are still used largely, notwithstanding the introduction of the potato; but I need scarcely add, that, as in the case of most other roots, the potato has, to a great degree, also diminished the consumption of parsnips as an article of human food. The peculiarity of their flavour is such, as perhaps for ever to prevent them from entering into competition with that most valuable plant; although, in situations similar to the highland districts to which I have above alluded, the cultivation of the parsnip, to a certain extent, might probably be found a useful resource, at least as an auxiliary article of food, in case of the failure of the potato.

Before terminating this paper, I may remark, that a species of wine has been often manufactured from the fermented juice of parsnips, and that report speaks in its favour. I have no experience of it, and, for obvious reasons, there has never been any temptation in Guernsey or its neighbour islands, to discover substitutes for the untaxed and superior produce of the vine. (10) Nor do I know that the parsnip wash has been subjected to distillation. It would be worthy the attention of the Society to inquire, whether the spirit produced from it might not become a substitute for whisky, since the produce per acre would unquestionably be much greater.

I may also add, that parsnips are cultivated to great extent in Jersey, as well as in Guernsey, and with the same favourable results though with some little variation in the process.

The Jersey farmer cultivates the parsnip in a very inferior manner. He weeds them badly, and the beans and potatoes with which he loads the crop always injure it.

The preparation of the land there, and the other previous arrangements, are similar to those already described. After the harrow, the ground is dibbled with beans in rows at five feet distance. The parsnip seed is then sowed over the whole broadcast. In May, the handweeding commences, and the parsnips are thinned to the requisite distance. The beans are pulled up by hand in September, and the parsnip crop is then disposed of as in Guernsey. I have not been able to procure any accurate estimate of the comparative value of the two processes, nor to learn how far the bulk of the parsnip crop is diminished by the additional incumbrance imposed on the land by the beans. (11.)

(10) The note writer has tasted it, and found it superior to most fabricated sweet wines, and of great strength without any spirit.

(11) It is much diminished.

NOTE.—The practice in Brittany, is to divide the field into large ridges and throw up the earth from the furrows to increase the depth of the soil, and on the edges they plant cabbages for the market or consumption. On the top of the ridge at the distance of from five to six feet, they plant three or four beans of a small size which forms a row along the ridge, and serves for their soup both green and dry.

An account of some delicate Plants cultivated in the open air, in the Island of Guernsey; with Hints on the means of naturalizing tender Exotics.

By Dr Macculloch of Woolwich.

In a letter to Mr Neill, Secretary.

Sir,

Having visited the Island of Guernsey some years ago, I was much struck with the peculiar luxuriance exhibited by many plants, which either grow with reluctance, or refuse to grow at all, even in the mildest counties of England. The variety and splendor of these productions, give a character to its horticulture, which is very impressive to an English visitor, and which excites surprise, when compared with the very slight advantages of climate this island appears, from its geographical difference of position, to possess. As some of these facts seem capable of leading to useful results in this valuable art, I have turned to the notes I then made, with the hope that they might afford you a few minutes amusement. Among those productions, its Amaryllis * is almost too well known to be enumerated. It is said to have been brought from Japan, a country possessing such a variety of climate, that it might well afford plants suited to any latitude. I think, however, it is yet a point to be ascertained, whether there is any thing in the climate of Guernsey, peculiarly favourable to the growth and flowering of this plant. This is a fact which cannot be determined till the cultivation of it is carried on in England to the same extent in which it is practised in Guernsey. The gardeners of Britain are satisfied with returning to the earth the few roots they receive in flower, but are scarcely content to wait till the period of flowering of the exhausted individual shall again return. From such impatient and narrow trials, no conclusion can be drawn against its possibility. In Guernsey, every gardener, and almost every petty farmer who has a bit of garden-ground, appropriates a patch to this favoured root; and the few hundreds of flowers which are brought to England in their season, or which are kept for ornament on the island, are the produce of thousands of roots which are there planted. The average rate of flowering is not more than

* Amaryllis Sarniensis.

fifteen or eighteen in a hundred. The soil in which they are raised is light, and the beds are covered with sand; in other respects, there is no particular care taken of them, except keeping them very clean. What portion of this success depends on climate, cannot, as I have already said, be known, till experiments on a similar scale are tried in England. It is, however, true, that the bulbs are frequently injured in the winter, by a frost which has no effect on the hardy geraniums; so that it would be requisite in this country to guard against this danger, at least by matting or occasionally covering the beds. I may add, that some of its congeners, the Amaryllis belladonna, vittata, undulata and formosissima, also flower in Guernsey without care, and with great certainty and vigour.

A shrub of great beauty, the Magnolia grandiflora, is well known to be shy of flowering in England, if we except the mild climate of Cornwall, to which that of Guernsey bears a near resemblance. In this little island, however, its flowering is as certain as its growth is luxuriant. Among the more hardy of the tender plants which also grow freely in Guernsey, and which Cornwall but barely preserves through the rigour of winter, are the Hydrangea hortensis, Fuchsia coccinea, Geranium zonale, inquinans, radula, glutinosum, and some others, which pass the winter without difficulty, and emulate in the summer the luxuriance they possess in their native climates. Many tender and transient varieties of flowers, and among those the varieties of the pink tribe, are remarkable for the facility and certainty with which they are propagated, and for the constancy of their characters. Every rustic cottage is covered with geraniums, and ornamented with numerous pinks, rarely seen in this country but among careful florists. Even the greenhouse is influenced by the climate. It is well known, that the Heliotropium Peruvianum, a plant otherwise of sufficiently easy cultivation, is in England much limited in its growth, becoming woody and feeble after it has attained a certain height. Here, on the contrary, if placed on the bed of earth in the house, although no artificial heat be applied, it soon fills the whole space, running over the bed, and striking fresh roots from its branches as it advances. But of all those shrubs which require the protection of the greenhouse in England, the Verbena triphylla, is that of which the luxuriance is here the most remarkable. Its miserable stature and bare woody stem are familiar to us. In Guernsey, it flourishes perfectly exposed, and attains the size of a tree of twenty feet and upwards, spreading in a circle of a diameter equal to its height, and its long branches reaching down to the ground on all sides. Its growth is indeed so luxuriant, that it is necessary to keep it from becoming troublesome, by perpetually cutting it almost to the root; from which fresh shoots fourteen feet in length, resembling those of the osier willow, are annually produced. I may also enumerate a few other plants of tender constitution in Britain, which appear equally hardy in this more uniform climate. The Celtis micrantha, which ranks among our stove-plants, grows with very little care out of doors. So do both the double and single varieties of Camellia Japonica, the latter often attaining the height of twenty feet. Some species of Olea are also hardy, as well as many of the Proteas, the whole of which require in our own island the shelter of the greenhouse. Such is the case also with many species of the genus Cistus, and among them I may name crispifolius and formosus. I may add to this enumeration, Yucca aloifolia, Dracocephalum Canariense, Jasminum Azoricum, Nerium oleander, Clethra arborea, Daphne odorata, Mimulus glutinosus, Correa alba, Melaleuca hypericifolia, Gorteria rigens, together with a very large number of the genera Ixia and Erica, all equally requiring the protection of the greenhouse, during the severer winter of our island, and many of them subject to perish at that season, notwithstanding this care. I need scarcely add, that the Myrtle defies the utmost rigour of a Guernsey winter, and flourishes in the greatest luxuriance.

In the production of many fruits, the gardens of this island are no less remarkable. The superiority of its Chaumontelle pear is well known, a superiority which the grafts imported into England do not retain. Yet in this respect it yields to its neighbour, Jersey; and I may add, for the consolation of English gardeners, that this pear, even in these islands, is reared under the warmest walls, succeeding but indifferently in any other situation. The purple and green fig grow readily as standard trees, and produce perfect fruit every year. Many varieties of the melon ripen without glasses. The Romana is even raised in Jersey, without the assistance of the hand glass, and is cultivated there in large quantities. The usual method of proceeding with it, is to dig a hole in the earth, into which is thrown a small quantity of hot dung, and above that ten or twelve inches of earth. The seeds are then sown, and the young plants, although sometimes covered with hand glasses for a time, are often left entirely to nature.

The attempts to raise Oranges have not been numerous, but in different gardens there are trees of the Seville and sweet orange, both standing under the shelter of a wall, and producing fruit in abundance every year. They require, however, to be protected by mats in the winter. In a lower, but not less useful department of this art, the Parsnip, the favoured root of the island, is remarkable for its bulk and goodness.

But the circumstance to which I would chiefly call your attention, is the naturalization of a native of very warm climates, the Canna Indica; a circumstance which confirms and illustrates the remarks made by Sir Joseph Banks, on the naturalization of Zizania aquatica. This very tender plant has become thoroughly habituated to the climate, scattering its seeds every year, so as to prove a weed in the gardens which it has occupied. I attempted to introduce it here also, from seeds which I brought from Guernsey; but my experiment was interrupted by an accident, and I have never since attempted to repeat it. I think it is not only desirable that it should be repeated, but that similar attempts should be made to naturalize other ornamental or useful plants, which have as yet foiled us, chiefly perhaps because the trials have been ill conducted. Abundant experience has shown, that the propagation of a plant, by cuttings or offsets, has little or no effect in changing its constitution, and the instances above cited, equally show us, that the seed will produce a hardier progeny, a progeny which in time may possibly be habituated to bear all the range of temperature which the globe affords. To carry this speculation into practice, it is evident, that in most cases the attempt will be unavailing, if the transition is violent; and that we should often fail in our endeavours to naturalize the inhabitants of Bengal or Jamaica, to the climate of England or that of Newfoundland. It is probable, however, that in the immense number of untried plants, many might be found, which, like the Canna Indica, would even bear a change as great as that now mentioned: but to pursue this system of naturalization with any great hopes of success, it would be necessary that the transition should be more gradual, and that the transplantation should be carried from a hot climate, through some intermediate one, to our own more ungenial shores. The very peculiarity of the climate of Guernsey, arising chiefly from the uniformity of its temperature, would afford us ground to hope, that it possesses many of the requisite properties, and that it would form the step required in this experiment. It is certain, that neither the thermometric state of a given country, nor any meteorological condition which we have yet been able to observe, are competent to explain the peculiar affection of plants for particular regions of the earth. The observations of Monsieur Ramond, in the "Annales du Museum," which have been translated by Mr Salisbury, show this in a striking point of view. From these we see the persevering regularity with which certain plants affect peculiar elevations, apparently unconnected with the nature of the soil, but bearing a relation alone to particular states of the atmosphere, which we have no means of appretiating. Similar facts are familiar to botanists in our own country, in the very limited zones of elevation, affected by our alpine plants. But perhaps of individual instances, the strongest and best known, is that of the Caper, Capparis spinosa, whose delicacy of sensation has, I believe, hitherto precluded its cultivation in any other climate than its native one. Whatever this obscure condition of a climate may be, it appears that the island of which I have been speaking, posesses requisites appertaining to it which are not common, and which, to us at least, in the present state of things, are elsewhere inaccessible. These considerations, therefore, should stimulate us to make trials, which, in their results, may possibly prove useful as well as ornamental. Many of the fruits which are now too tender to bear our climate, might be taught to produce seeds, which would give us products equal in goodness to the original, and of hardier character. It is not unlikely, for example, that a variety of the Melon, from seeds produced in Guernsey, might be made to grow without the aid of glass in England. Perhaps, even the Caper or the Orange might be naturalized through the same medium. That process which has naturalized the Canna Indica, might go far to put us in possession of many other desirable objects, at least in cases where, like the melon, the generations can be rapidly repeated, and where the produce goes hand in hand with each successive generation. Thus, possibly, even the elegant Pine of Norfolk Island, might become a British tree, although the toil of many years would be requisite for effecting such a purpose.

An economical object which depends on this property of plants, remains yet to be noticed. This, which is still more in our power, is probably of more consequence than either of those above mentioned; I mean the perfect naturalization of the Vine. It is well known, that from many of the ordinary varieties cultivated in this country, we can always insure a crop of grapes, but not always a crop of ripe ones. From two or three of these, the chance of ripening out of doors is considerable; from many others it is hopeless. It is not improbable, that by successive sowing of seeds, other varieties might be produced, still more certain of ripening than those which succeed best with us, the Miller and Sweetwater. We should thus acquire possession of an article of cultivation of great importance, by which a useful addition would be made to the agricultural proceeds of land in particular situations, and by which we should be enabled to fabricate wines of quality sufficiently good to compete with those of foreign growth.

A more important object is the perfect naturalization of the Potato, an effect as yet but very partially obtained, notwithstanding the length of time during which this valuable root has been a subject of cultivation. It is certain, that this imperfect naturalization has been the result of the common practice of propagating by the tubers, to the almost total neglect of the seeds. It is true, that seeds have been occasionally sown, and new varieties thus produced; but the experiment has stopped in the first stage, having been always undertaken for the mere purpose of producing these varieties, without any regard to that much more important object, the production of a plant sufficiently hardy to bear at least the first frosts of winter. In the southern parts of our island, it is not a desideratum of much importance, as the tubers are in general fully formed before the plant is killed by frost; but in the northern parts it is an object of great consequence, the plant being frequently killed long before the roots have attained maturity. In the Highlands of Scotland, in particular, where a frost will frequently occur early in September, the crop is often prematurely destroyed, and the uses of this vegetable are in consequence materially limited. It is plain, that it would be necessary to sow the seeds of successive generations many times, before the requisite degree of hardiness could be expected, and that the process would demand both patience and time. Yet, if it requires more of these than we can expect from the ordinary culivator, it is an experiment which we may at least recommend to those public bodies, who so laudiby exert themselves in ameliorating the agriculture and horticulture of this country. The difficulty of procuring seeds from seedling plants, could doubtless be obviated in some measure, by depriving the young plant of its tubers, and thus compelling it to direct its energies to the other and more common mode of propagation, with which nature has provided all plants.

I cannot, however, conclude this speculation, without noticing a formidable objection which stands in the way of our attempts to naturalize particular plants. In every case where the useful varieties have been the result of cultivation in a warmer climate from a base and useless parent, it is to be feared that the process followed in naturalization, would again throw the plant back to its original state. This objection applies chiefly to those fruits, such as the peach, the apple, and grape, which, in their present cultivated state, are almost entirely the produce of art. For this reason, it is not improbable, that all attempts to naturalize the grape to a cold climate may fail; yet the trial deserves to be made. The case does not apply equally to the potato. The original plant appears to be valuable, independent of any artificial character, and would consequently admit of a change, tending even to some degree of deterioration, before it was materially injured in its properties.

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Art. II.—*On the Naturalization of Plants, with Remarks on the Horticulture of Guernsey.* *By* J. Mac Culloch, M.D., F.R.S., *&c.*

[Communicated by the Author.]

Those who have interested themselves in horticulture have been long aware of the belief that those plants, not belonging to our own climate, which have been propagated by cuttings, retained the tenderness or delicacy of the original parent, while that, if produced from seeds, they became comparatively hardy, and might, in a certain number of successive generations, become perhaps as hardy as our native vegetables. The observation of Sir Joseph Banks, by which this opinion was chiefly confirmed, was, I need scarcely say, the propagation, in this manner, of the Zizania aquatica: my own, by which it seemed to be still further confirmed, related to the Canna indica principally, but to some other herbaceous plants and shrubs also, which, after having been long confined to the greenhouse, had been placed out of doors in Guernsey.

I have now to remark that the same opinion seems to have been still further confirmed since that date, by more trials of the same nature; and the object of this paper is to relate the several facts or to name the plants in question, accompanying them by any remarks that may possess an interest on this subject. But I must not here conceal that the opinion in question, as to our power over plants in this manner, is not by any means so demonstrated that it must be erected into a law. There are some cases in which no such results have taken place, others in which the gain in point of hardiness is doubtful; while, I believe, I may safely add here the opinion of Mr. Sabine, that, if I mistake not, the whole is a fallacy (I hope I do not misrepresent his opinion): lamenting, at the same time, that there should be such high authority for a belief so little consolatory, for what, if really true, will deprive us of many expected sources of pleasure.

However, till the demonstration of the fallacy of this opinion is completed, it would be bad policy not to persist in the same trials, when we consider the advantages that would be derived from them, should they be true, even in a small number of cases. If it should happen, as may yet turn out the fact, that there are plants in which this succeeds, though there are others in which it fails, from circumstances in their several constitutions yet unknown to us, the effect of admitting the general or universal fallacy of the opinion would be to paralyze all future efforts, and with this also, perhaps, to limit our general attempts as to that natural hardiness in which some plants differ from others, although natives of the same climate.

This last fact seems unquestionable, in whatever way it is to be explained: and it is chiefly from want of attention to it, that so many plants were so long, and so many yet are, imprisoned in our greenhouses and stoves, when capable of bearing the free climate, and thriving, in fact, far better in the open air. The mere knowledge of all these, which can only be the result of trial, would be a considerable gain, not merely as a question of economy with respect to buildings and fire, but from the additions they would make to our gardens and shrubberies.

And it is partly for the purpose of increasing those trials that the present paper is drawn up; as, should it even prove that the progeny from seed is not, in the majority of cases, really hardier than the parent, there will still perhaps be pointed out to English gardeners some plants, out of the whole list, which are still treated with unnecessary suspicion and tenderness.

I am aware, however, that the rules which hold in Guernsey will not hold universally in England, however they may suit the southern coasts in general, from Penzance even to Southampton, and perhaps still further east. Yet in some of the cases formerly enumerated (in the transactions of the Caledonian Horticultural Society), the result was, a considerable success, in some parts of Scotland, as to the exclusion of many plants from the greenhouse, respecting the *necessary* tenderness of which no gardener had ever doubted. Should but a few plants more be thus gained for the shrubbery, the labour will not be lost.

Whatever be the peculiarities of the climate of Guernsey, it remains to be proved much more clearly than yet has been done, what it is precisely by which the hardiness of plants is regulated, or how it is influenced. It is easy to make use of general terms, but they will not satisfy a philosophical mind. The effect of frost can unquestionably be understood in a general way; yet the tender greenhouse plants of England, which are hardy in Guernsey, are not killed by the frosts, in which that island is not wanting, nor by the cold easterly winds, which prevail there with considerable duration and severity. They have always survived those attacks; and sometimes, with the usual shelter from long east winds, have passed through even those very severe winters, so well remembered, in which this island proportionally participated.

Could it serve any purpose, I might here give the meteorological register of Guernsey for a considerable period; but it would not deserve the space it would occupy, as, in truth, very little useful information has yet been derived from the accumulation and parade of those records. To say that the climates of Guernsey and Penzance are very coincident, will be information enough on this head; with this exception however in favour of the latter, that in all this group of islands, the easterly winds are more frequent, more durable, and I think more severe.

I must therefore leave this question of the cause of the beneficial influence of this peculiar climate as to the plants which it encourages, to future inquiry and other hands; yet not without remarking that this is not a very sunny climate, either as to light or heat. I believe that in a great many matters appertaining to vegetation, whether in horticulture or agriculture, the question of light is often of much more importance than that of heat, however much it has been overlooked by agricultural as well as philosophical writers. It is of most material importance as to the perfection of flowers, whether in vigour, colour, or odour; and not less so, as is very well known, as to the ripening of fruits. Nor does it appear to me less so as to ordinary agriculture, whether as it relates to the perfection of certain herbaceous plants, or the ripening of grain. I think this is peculiarly visible in certain parts of Scotland, where the most serious differences in this respect occur; where no other circumstance of difference than that of the annual quantity of light can be discovered, and when indeed the condition as to temperature, and soil both, is highly in favour of those climates where the produce is worst. This is remarkably true in comparing the eastern and western sides of Scotland generally, and in noting the singular limitation of the region of wheat thus produced; and, unless I mistake, a difference in the vigour, and especially in the vigour of flowering, in clover, not to be accounted for by differences in the soil, method of cultivation, or quantity of manure. And while the power of producing wheat, or what, for the present purpose, is analogous in principle, the early ripening, as well as the superior quality of barley, diminishes in proceeding westward on a parallel of latitude, till we arrive at the cloudy region, it reappears on passing this again to the westward; insomuch, indeed, that much more northern latitudes, if the lands are insular and flat, are superior in these respects to the southern ones, while there are no differences as to soil, cultivation, or aught else, capable of explaining the facts. It is not a difference in rain merely, nor is it a difference in the mean or the summer temperature; since it would be abundantly easy to produce geographical proofs of this, could I here enter on a subject of such detail. Nor is there any solution to be given but that of the differences of light: an explanation indeed which ought not to be questioned, since the effects of this in ordinary horticulture, as to fruits, are acknowledged, whether for benefit or injury, as it shall exceed or fall off. That a register of light ought to form an essential ground of judgment on agricultural questions, relating to territorial or geographical position, is a conclusion naturally following from this view.

The deficiency of light in Guernsey is not such as to interfere with its flowers, as the season of flowers is its purest summer: but the want is decidedly marked in autumn, and especially in respect to the difficulty of ripening grapes out of doors, in which it is inferior to the English central counties, which produce grapes in this manner. It is usual to attribute this to defect of heat; but the heat of Guernsey, by the register is, at that late period, equal to the heat of the English counties in question, though the cloudy atmosphere renders the light inferior. And if the effect of greenhouses does, as is unquestionable, depend, in a great measure, on the heat which they concentrate, it is not to be forgotten that one of these effects is to bring forward the fruit, so that its period of maturity shall approach nearer to that season in which light is most abundant. This conclusion is indeed amply confirmed by the effect of cloudy summers, even on the grapes of the greenhouse.

Thus much it was necessary to say respecting this climate, as concerned with the peculiar appearances of its horticulture, and I must proceed to describe the few facts, as to individual plants, which may be in any way interesting. One of the objects is here to show, that certain plants of hot climates differ materially in hardiness from others, as a temptation to try more widely the extent of this law. Another is, to demonstrate the injury which many plants, perhaps all, receive from confinement, as an inducement to further trials on plants which have hitherto disappointed us by their unwilling growth. And, in addition, I should wish to prove, if indeed it can be proved, that a process of naturalization can really be carried on by sowing native seeds ; or at least, that this is so far true respecting certain plants, though it may not be a general law, as to render a continuation of the same experiments advisable. Any other miscellaneous remarks that may arise, must defend themselves on the claims of their utility.

On the question of naturalization by sowing, I formerly remarked, that the Canna indica had here become an absolute weed, propagating itself perpetually. One of two useful conclusions follows. It has either been naturalized by this process, as the Zizania is supposed to have been, or else this West Indian plant, a native of a hot and moist region, was originally a hardy plant for this climate. If this last only be the conclusion, it is a temptation to try an endless number of other annuals or biennials, or of plants generally, whose roots remain in the ground to spring up afresh in summer. It is possible that the successful list may prove a long and a valuable one.

Supposing this to be the real fact as to the Canna, it is confirmed by another plant, which proved to be hardy in Guernsey, and sprung at once in the open air from imported seeds, producing also its own seeds. This is a species of Panicum, the Guinea grass. We might indeed expect hardiness in this tribe, if in any, from our general knowledge of their peculiarities, and from the wide geography, artificial in so many cases, of the common Cerealia. Should this prove true, even our agriculture might gain widely by the introduction of many of the grasses of hot climates : a result that might often be profitable, even when the seeding was uncertain, in the case of these being durable, or perennial, or propagating by roots. It would be singular if this Panicum should be the only hardy grass of a hot climate.

This capriciousness, as to hardiness, is also evinced by the Pine-apple, which, it is now known, can be cultivated and ripened without fire ; although, from the usual obstinacy shewn as to all improvements, the practice has not spread. The fruit thus grown in Guernsey, and probably elsewhere, is fully equal in bulk and flavour to that produced by fire: it had even struck me that the flavour was superior; but, as must be expected, it is not produced so early in the summer as under the forcing frame.

I might here, under this head, and for the same purpose, produce other examples; but they are unnecessary in proof of the fact itself, which is even thus sufficiently established as an inducement to more extensive trials. I may now quote another plant, which seems to aid in confirming the opinion, that a seedling from native seeds is really more hardy than the imported parent, or than its portions propagated in the usual methods of slipping or laying; or that there is a certain power thus possessed over the naturalization of plants.

This is the Psidium Catleianum. In Guernsey, or elsewhere, there were plants of this shrub produced by this process, and which yet never bore fruit; which even now, after many years, and in the very same houses, have not produced any, while the seedlings from the English seeds are annually covered with a profusion of ripe fruit, the plants becoming fruitful after the second year. The seed in question was produced by the Horticultural Society; and its generations, as far as they have gone, are all equally fruitful, while the original slips remain as barren as at first. This then seems a fair case of naturalization, and appears to confirm the conclusions formerly drawn as to the Canna indica and the Zizania. Whatever others may be conceived to bear on this point, will be found in the appended list; but I am unwilling to place them here in confirmation, while any doubt remains, that I may not appear to prejudge the question.

The last question of a general nature here noticed, is that which relates to the advantages gained by removing plants from the greenhouse to the open air. It has happened to a great number in Guernsey, some of which will be found in the appended list, that after many years of care, and following the usual fashion, the growth continued stunted, or the plants even threatened to die; many of them actually dying, and no possibility of producing a seed having occurred. From weariness rather than system, these were turned out to their fates, and the consequence was immediate vigour, and a liberal and constant production of fruit or ripe seeds; while the plants have now become the common tenants of the borders or shrubberies. This then is a fact, which though well known to many English gardeners as to certain plants, has not been acted on so widely as it might, and which deserves a more extended trial, however difficult it may be to explain what is the peculiar suffering which plants undergo from the confinement of the greenhouse. If many points, as to the effects of stoves and houses, are explained, whether as to heat, moist air, as in the case of West India plants in particular, and shelter from winds, there are others, both for good and evil, which yet stand in need of examination; nor will these investigations be successful till we shall become much better acquainted with the physiology, I might almost say the metaphysics, of plants than we yet are. I need not here say to whom we are indebted for much valuable knowledge on this subject, since a record like this could add nothing to his reputation; but it may fairly be said, that while the botanists assume the exclusive honours of science to themselves, it is to the horticulturists, too often affectedly contemned, that our greater debts are due on more points than that of mere utility; that utility which system and nomenclature pretend to undervalue. In the case in question, for example, it remains, among other things, to explain why it is by cramping the roots of one plant that it is induced to produce fruit; while, in another, the same effect is attained by giving to the roots the full liberty of the surrounding soil.

But these are subjects not within the present inquiry; and as to the following list, I shall only remark, that in as far as any plant may be found in it which is equally hardy about London, for example, as in this island, I must apologize for the ignorance, by saying that this list was collected when horticulture was far other than it is now in England, and that many years of interruption have prevented me from keeping my own knowledge of this subject at the level of the surrounding experience.

I cannot however draw up this document, without noticing the extreme vigour and beauty of almost all the flowering plants in this favoured climate, favoured at least in this respect; a vigour which seems to show that the heat of a climate is not its most essential part, as the upward range of the thermometer in this island is very narrow compared to England; seldom or never equalling it, at the extreme, by ten degrees. The term mildness is sufficiently unmeaning as a solution of the difficulty; and I know of no advantage to be derived from indefinite language. One fact however does deserve notice, and that is, the soil; which is, for want of more definite terms, a yellow loam, deep, and produced by the decomposition of gneiss. This is perhaps one of the most extensively advantageous soils for the cultivation of flowers; while it is certain that many gardeners are still in error on this subject, in preferring dark agricultural soils for that purpose. But I must pass on, lest I should trespass on my narrow limits; yet not without an example or two of this singular vigour and beauty in the common flowering plants and shrubs.

This is very remarkable in the Verbena triphylla, among others, assuming the size of a small tree; and not less so in the Hydrangea, which grows to an enormous bush, and is covered with flowers during a very long season. It will convey a more accurate idea of this vigour, to say that there were cut, in one case, from one plant, at the same time, a thousand and fifty-four flowers, and each of them of a very large size. In general also the flowers are blue, and of an intensity and splendour of colour which never occurs in England; while among the other mysteries which attend the production of this particular colour in this strange plant, it is observed that those which produce pink flowers on the low grounds, or near the sea, are invariably blue in the higher lands, although the soil is the same. That the sweet, as well as the bitter orange, are annually covered with large crops of ripe fruit out of doors, are proofs that this mysterious mildness, whatever it is, is of more importance than a very hot or a very sunny climate.

Yet it is worth remarking here, that vigour of growth or splendour of colour are circumstances depending on different causes from that vigour of action in other respects, which it requires a hotter, and perhaps also a more luminous climate, to bring forth: and the fact, as relating to vegetable physiology, may perhaps hereafter be of some moment when this subject shall be better understood. At so small a distance as that of the neighbouring shore of France, the same plants, in the same summer, possess an odour, which, if odours could be measured, might be pronounced twenty or fifty times greater than in Guernsey. In a certain sense, this can be decided on; inasmuch as the smell of the common jasmine in that part of France can scarcely be endured, from its power, while a single flower appears to possess more of the quantity or matter of odour, than a hundred grown in Guernsey, as well as in England. And it is the same as to the Rose and others; proving, as it would seem, that, as to this result, light and heat are more essential than in the case of general vigour, or even colour. The broad fact, as to the flowers of the south of France and Italy, is sufficiently familiar; and hence the comparative futility of the attempts to extract perfume from most English flowers, and the infinite superiority of those made about Hyeres and Frejus.

I have not thought it worth while, in the following list, to distinguish the plants exclusively hardy in Guernsey, from those which have also recently been rendered so in England; because those acquainted with our present horticulture can readily distinguish them. Some of them are introduced, not because of this, but for the sake of their peculiar vigour or other circumstances, as I know very well that they are, as far as mere hardiness goes, hardy also with ourselves; while where others, equally hardy with us, are here named, it is because they are common weeds, even in the gardens of the cottagers, when, with us, though hardy, they are still considered somewhat delicate, or are rare out of doors.

The Physalis alkekengi, the Solanum pseudo capsicum, and most others of the genus generally found in our gardens, are hardy, even to neglect. The Peonia arborea is as much so as the common peony; and the Yucca aloifolia, somewhat rare in our gardens, is there common, and covered with a constant profusion of flowers, growing also to a very large stature. I need scarcely perhaps say that the Laurus nobilis is as hardy as the myrtle;

since it is equally so where the myrtle is hardy in England. In Guernsey the three common species of myrtle seem to be equally hardy; though the cross-leaved one is less ready in flowering than the other two. The Fuchsia, like the Verbena triphylla, is remarkable for the extraordinary vigour of its growth; and if there is no period of the year in which the China rose does not flower, it is an example of that mildness in the winter, to which, possibly, so much of the general success may be owing. Thus, the Erica mediterranea becomes a large tree; while the baccans, and a few more, kept in our greenhouses, grow also to a great size, and are the ornaments of the shrubbery.

Among the tenderer Hypericums, the crispum, the ericæfolium, and a broad-leaved one common in our greenhouses, whose specific name has escaped me, are perfectly hardy; as is the Veronica decussata, the Thea viridis, the Correa speciosa and alba, and all the Melaleucas which we cultivate. The Magnolias, including the grandiflora, tetraptera, glauca (of course,) conspicua, purpurea, and others, are here remarkable for the vigour of their growth and the profusion of their flowers; far excelling, at least in the more refractory ones, the plants of our own shrubberies; while the Dahlia, now so common, is almost a nuisance, from the enormous bulk and stature of the bushes which it forms.

Thus the Camellia japonica does not only produce large shrubs out of doors, attaining to the height of twenty feet, but is covered with flowers, double as well as single, white and red, even to contempt; as the Leptospermums, including the lanigerum, pubescens, myrtifolium, acutifolium, and another whose specific name I have forgotten, are almost trees, in the shrubberies where they are cultivated; accompanied by every Diosma which we possess, attaining a similarly powerful growth, compared to those of the greenhouses. I ought formerly to have remarked that the lemon grows together with the orange, protected only by a wall from the violence of the west winds; and when I named the Verbena, I might have said that I had measured the stems twenty inches and more in circumference, with an altitude and spread of twenty feet and upwards.

The Mimosa paradoxa is also a powerful shrub; sowing its own seeds annually, and possessing a profusion of flowers, which renders it one of the greatest ornaments of the shrubbery; while it is here remarkable, as proving one of the general facts already stated, that, in no instance, could this plant be induced to produce its seeds in the greenhouse. That all the shrubby natives of New South Wales known to us will probably prove hardy, here at least, and improve accordingly in vigour, there is no reason to doubt. Many other Mimosas, formerly treated as tender, are equally found hardy, and equally to improve under exclusion. I may add an Argophyllum to this number; together with three Sophoras, the tetraptera being common with ourselves; the double as well as the single Nerium oleander, growing to almost a tree in the shrubbery, a number of Proteas, the Jasminum azoricum and odoratum, the common olive, producing fruit, with some other species of Olea, the Cistus, in many species, which with us are confined to the greenhouse, the Clethra arborea, the Daphne odorata, and others, of various degrees of reputed tenderness, which might swell this part of the list to too great a length. But I may still add the Bignonia capreolata and Pandora, on account of their vigour and beauty, two Punicas, the Hibbertia volubilis, and a Metrosideros, of which I have here missed the specific name, the Colutea coccinea, sowing itself annually, the Celtis micrantha, and the common Heliotrope; chiefly, because they include, with some of the former, examples of the great accession of strength which the confined plants gain by being turned loose to nature, and partly because of some of them thus producing seeds with freedom, even from the very same plant, when they had refused to do so in confinement. The Heliotrope now not only sows its own seeds in the open ground, but produces plants of uncommon strength and luxuriance; but whether this is a process of naturalization or not, is a question which, after the doubt already recorded, I feel no inclination to ask.

If I have passed over some of the shrubby plants that I might have noticed, such as the Gnidia pinifolia, odorata, simplex, and many others, it is of no moment, as the list is long enough for the intended purpose; and if it shall be objected that some are already hardy in England, it must be remembered that part of the object was to show the great increase of vigour gained by exclusion and climate together, as in the case, for example, of the Veronica decussata, which grows about the little gardens of the cottagers, to the size and appearance of a common gooseberry-bush.

As to the effect of exclusion, and in a sort of herbaceous plant, if I named the Yucca before, I might have remarked that the filamentosa and the aloides are equally vigorous, and that, on the first plant of the tenderer of these species the effect of exclusion was to cause it to flower in the first year, after having been many years in the greenhouse without showing the least inclination to blossom. If the American aloe does not choose to flower very often, it does nevertheless flower out of doors, and propagates itself with great vigour, even in stone walls.

Among herbaceous plants reputed tender in various degrees, but here flowering vigorously and freely out of doors, I may enumerate the following, without any anxiety to distinguish such as have been occasionally treated as hardy by gardeners in England. Like the shrubs already enumerated, they may lead to further trials among ourselves.

Every Mesembryanthemum, without exception, having been found hardy, I need not name the species: and the same has been found true of a great number of the Cactus, of which, however, I need only name the hexangularis, the formosissima, the common caterpillar, and the prickly pear. Of allied plants, the Crassula coccinea has also proved hardy. An Echium sent from a London hothouse, whose specific name I could not at the moment discover, and long kept in the house, proved perfectly hardy: offering one proof, among a thousand others that might be adduced, of the mistakes committed on this subject, which have so long contributed to rob us of ornaments that ought to have been now flourishing in our gardens. This, in fact, is a leading error among all gardeners. Regulated merely by habit, or else by geography as to new plants, it is not sufficiently often inquired what the real climate of the plant is, since this is a fact not always regulated by the geography, still less what natural differences, as to physiology or constitution, different plants may possess; even where the climate is absolutely the same for all. That the pine-apple plant should actually pass a Guernsey winter out of doors, is a proof that we have much yet to learn on this subject.

Of the half-tender plants, I must remark here, that the Cobea scandeus, which should have stood in the former list, is quite hardy in this climate; as the Phormium tenax, sufficiently hardy I believe, with ourselves, is so vigorous as to tempt us to try it as an object of economy. The Ipomeas are, similarly, no otherwise remarkable than for their vigour. The common Gnaphaliums of the greenhouse prove also to be perfectly hardy; while the Lobelia cardinalis, hardy with us, is noted, like the Fuchsia and others, for its magnitude and beauty.

I am not aware of the relative tenderness of the several liliaceous and analogous plants which, in Guernsey, are remarkable, not only for their magnitude and the profusion of their flowers, but for their absolute vulgarity; and shall therefore give the catalogue of those which struck me, without a comment. Polhos cordifolia—not exactly in this division—Agapanthus umbellatus, Antholyza spicata, and another whose specific name I forget; Tritonea uvaria, Gladiolus cardinalis, Ferraria undulata, Polyanthes tuberosa, Amaryllis vittata, undulata, formosissima belladonna, and Sarniensis, of course; the latter of which, so long supposed to have arrived from Japan, is at last known to be a native of Buenos Ayres. I should add here, that every one of the Ixias propagates in the ground, without care, so as to become perfect weeds. The Mimulus glutinosus, Gorteria ringens, Dracocephalum canariense, might, with many more, have been added to this list, for various purposes not now worth repeating; but it has already swelled to such a length, that it is time to conclude it. Yet not without adding that while every Geranium has been found hardy, there are singular differences in their apparent relative resistance, and consequent luxuriance, even where they are, as far as we know, all natives of the same exact spot and climate.

Thus I may terminate this subject as it regards Guernsey, and the conclusions which may be drawn from the peculiar character of its vegetation. But on the probable or possible subject of naturalization, it must yet be added, that the experiments on seedling vines seem also to prove that such an effect does really take place; as, in many instances, the fruit of those has been found to ripen with greater facility and certainty than that of the ordinary plants from cuttings. The whole question must, however, remain for further examination. Did it only concern this question,—the increased facility of producing grapes out of doors,—it would be amply deserving of much fuller trials than have yet been made; while, when it is recollected how much it interests the far more important question of the potatoe, particularly as this relates to its cultivation in the wretched climates of Scotland, there is nothing in the whole range of horticulture that is more truly deserving of a serious course of experiments; a course which should be indeed undertaken as to many other plants before we reject the belief altogether.

It is certain, as a general principle, that different plants vary very much as to their sensibility respecting cold; even when we can discover no reasons in their constitution, their structure, or their general physiology, why it should be so; and, similarly, where these natural affinities, or family connexions, and not less their native climates, afford no ground for any *priori* judgment as to this. The examples would be as endless to quote as they are familiar. Is this a case, sometimes, of mere sensibility, of the action on a nervous power, if I may use such a term, a power of which the existence seems proved by their sufferings from various poisons? And if so, is it possible to change that constitution, as it appears to be susceptible of being changed in animals—by habit? In animals, the organization remains the same, but the sensibility is diminished, while probably, possibly, the heat-generating power is augmented. Here perhaps one difficulty may lie, as it certainly does, in the extreme case, as to vegetables. It is more than doubtful whether they do generate heat; and if this were necessary, we should be disappointed. But if not, and if the effect be an effect on their sensibility or nervous system, and if this can, within certain limits, be diminished by habit, as in animals, naturalization within these limits, is not impossible.

If this be plausible, the road is obvious, for vegetables as for animals; it is gradation of climate and a succession of generations. Thus it has been widely effected for animals, and thus it may perhaps be effected for vegetables; if less widely, from the want of powers productive of heat to resist the excess of a new and destructive influence. Let us not decide on this impossibility *à priori;* not, philosophically, till we are better acquainted with vegetable physiology, and, in no case, till we have conducted a much wider series of experiments than the few controvertible ones already made.

There is a plausibility respecting this view of the sensibilities of plants. The Nasturtium, in the full vigour of flower and fruit, is killed in an instant by frost, vigorous to the very moment of freezing. Our own herbaceous plants, of structures as similar as the eye can ascertain, go on resisting, many of them, throughout a severe winter. The difference is not in the vessels, in the circulating system, in the fluids. In both they would equally be frozen; but, to one, this condition is death, while the other heeds it not. Where then is the difference, if there be not a nervous system? that system the seat of life, the system whose action is destroyed by poisons, destroyed even by the narcotic poisons. Plants are poisoned as animals are; not by an action on their fluids, not under a system of humoral pathology (to use old medical language), since their primary circulating fluid is water, not to be decomposed by the poisons which kill them; as the blood of animals might be, and has been, supposed to suffer. But I must reserve this subject for another occasion. It is sufficient to have thrown it out as a hint on this particular question; and should it prove a fact, as it cannot fail to prove, should the various sensibilities of plants prove analogous to those of animals, we shall be enabled to explain many more phenomena than the tenderness of the Caper, the affections of plants for peculiar situations, climates, elevations, what not, phenomena which have long been a stumbling-block in the way of botanical philosophy.

CONJECTURES RESPECTING THE GREEK FIRE OF THE MIDDLE AGES.

By J. MAC CULLOCH, M.D. F.R.S., &c.

THERE are few of the inventions of former times that have excited more inquiry, and given rise to more discussions, than the celebrated Greek fire, so often used in the middle ages, in the wars of the Christians and Saracens. The subject is, in itself, sufficiently obscure; but it appears to have been rendered much more so, by many collateral causes, and most of all by that love of the marvellous in which the people loves to indulge. It seems pretty clear, that even grave historians are not exempt from this charge; and, in tracing their narratives and descriptions, the marks of exaggeration are not much less apparent than the confusion in which they have contrived to envelop this subject.

Among these historians, there are some who were witnesses to its effects, and some who even pretend to describe its composition. Yet to them we may turn in vain for distinctness, or truth. The actual terrors of some, the traditional ones of others, the exaggerated style of the times, and the general ignorance of science, have led to perplexities which it seems almost hopeless to try to disentangle. Succeeding antiquaries and historians, the analysts of all these barbarous histories, have had little better success; and after much vain toiling, the more prudent seem to have abandoned the inquiry in despair. Even Gibbon's gigantic hand, that seems to have wielded all subjects alike, whose mastery of the most abstruse, and the most perplexed parts of history appears perfectly marvellous, seems to have been compelled, like the rest, to yield.

Him we can excuse; while we may regret the want of that only knowledge, chemistry, which could have assisted him in the investigation, and which had he possessed it, would have left nothing for his successors to do. The same excuse will hold good for Du Cange, Des Brosses, and others; perhaps for Dutens also. Grose might have done more than he has, for he knew much of what was required for its illustration. Watson, better fitted still for the inquiry, has shunned it entirely, after leading us to hope that he was about to enter on it.

It would be presumptuous to expect to render that clear which so many great names have thus attempted in vain, or abandoned as hopeless. Yet by comparing the narratives and descriptions of the ancient writers with each other, and with some collateral information, that can be brought to bear on the same point, it will not be very difficult to make some steps at least on firm ground. It will turn out, unless I am much mistaken, that different inventions have been described by the same name, and that the main source of the confusion can be traced to this cause. It may perhaps even appear, that though we cannot in this way reconcile all the accounts, yet that we shall discover what some kinds of the Greek fire really were, if we should still remain at a loss about others. Something too will be gained by divesting these accounts of the marvellous, which has in no small degree aided their confusion in obscuring this provoking subject.

In examining this question, it will, I think, appear that some of the inventions which we consider modern, are of a very distant date; and that if we have so long remained ignorant of that, it is because there is scarcely a scientific writer of those ages to which alone we must look for this kind of information. It will also be seen, that there is an intimate connexion between the history of the Greek fire and that of gunpowder. But it is here intended to avoid touching on that subject as much as is possible, and to reserve it for a future communication.

The common opinion is, that the Greek fire was invented during the reign of Constantine Pogonatus, in the year 668, by Callinicus, an architect of Heliopolis. Gibbon has collected another tale, which says that it was revealed to Constantine the Great by an angel, with a sacred injunction that this gift of heaven and peculiar blessing of the Romans, should never be communicated to any foreign nation. The impious attempt, it was said, would provoke the sudden and supernatural vengeance of the God of the Christians.

Thus, he goes on to say, it was confined for four hundred years to the eastern Romans; adding, that at the end of the eleventh century, the Pisans suffered from it without knowing its composition. He concludes with saying, that it was at length either discovered or stolen by the Mahometans; and that in the holy wars of Syria and Egypt they retorted an invention, contrived against themselves, on the heads of the Christians. I think it will appear presently, that Gibbon has not examined this subject with his usual acuteness, and that he is here decidedly wrong as to the history of the invention and its true progress.

We know not, indeed, why this great historian should have formed the judgment which he has done on the invention of gunpowder; since his reading must, if any person's could, have led him to a different conclusion. He says, "Vanity or envy has tempted some moderns to carry gunpowder up to a period beyond the fourteenth, and Greek fire before the seventh century." What the motives of the writers with whom he thus disagrees might have been, it is unnecessary to ask. Dutens has experienced some harder blows than this; yet that the historian is himself in the wrong here, it will not, I believe, be very difficult to show. I must defer the question of gunpowder, as long as possible, and be content with inquiring what probability there is that the Greek fire was a Greek invention at all; and whether it is not much more probable, that the Greeks, or eastern Romans, borrowed it from the oriental nations, instead of teaching it to them.

We may safely begin by putting aside the history of the angel and Constantine the Great, though willing to believe that it might have been known before the time of Constantine Pogonatus. It will be better to take up the story from Callinicus, as it carries with it more of the appearance of circumstantiality and truth.

The communication between Heliopolis and the eastern nations, renders it, in the first place, suspicious, that the Greek architect borrowed the invention from the orientals. That they possessed it at least before the Greeks, whether they communicated it or not, appears to me as capable of proof as can be expected under similar circumstances. When Gibbon says that the Mahometans borrowed the invention from the Christians during the wars of the crusades, he forgets that the Arabians learned their chemistry from the Egyptians, by whom that art was practised three hundred years at least before the time of Mahomet. That they also borrowed from a still more distant oriental source, appears equally certain.

But to return to the supposed invention of Callinicus: naphtha is said to have been one of the chief ingredients in this composition. This substance is well known to be very common in many parts of the ancient Persian kingdom and in India; near the Caspian sea it occurs over an extensive tract of country. It arises out of the ground in the form of vapour or otherwise, in such abundance as to be commonly used for domestic purposes; it was also an object of religious attention to the worshippers of fire. It is noticed, among other authors, by Judas Maccabæus, or rather by the compiler of that history.

Now it is much more probable, that a burning compound in which this was an ingredient, should have been invented where the substance abounded, than where it was unknown. The latter is barely possible, but far from likely; and if it can be proved, that the use of inflammable compositions in war or otherwise, was known to the eastern nations before the time of Callinicus, his claim to this invention falls to the ground.

The Arabian claims of a more modern date are already excluded; nor can these people, at any former period, have a title to the discovery, if it can be shewn that its source lies further to the eastward. There seems little reason to doubt that all the Arabian learning, as well as their algebra, had its origin in India; the parent it is probable of Egypt itself, and the great ancient source of all art and science.

The true nature of this composition, or rather of these inventions, (for it will be seen that there are more than one,) will be examined hereafter. In the mean time it is necessary to remark, that the same effects have been attributed to different contrivances, before asking what claims India has on any of them. It is not surprising, if, when these burning compositions, whatever they may have been, were new and little known, they should have given rise to so many tales, and as is more than probable, to much exaggeration. Had the Mexicans given the history of the Spanish arms, and had no other history of guns and gunpowder come down to us, it is easy to understand what the consequences must have been.

It is not here however meant to be denied, that this invention might have spread among the later Arabians from the Greeks. Notwithstanding the attempts at secrecy, the consequence of an order of Constantine Pogonatus, it is certain that it did spread among the surrounding nations, as is fully recorded in the histories of those days. It became common, and probably from this very source, in the wars of the crusades. But it is also possible, that this, or one of the different inventions known by the same name, might have been discovered by the Arabians themselves, who were then much addicted to chemical pursuits. This confusion arises from that just noticed, which includes more inventions than one under the common term Greek fire.

We shall hereafter see that one at least of the Greek fires of the crusades was a composition into which nitre entered, and therefore depending on the same principle as gunpowder. Thus the two inventions are connected; although it will appear that gunpowder, used as a projectile force for shot, is the more modern of the two. Pyrotechny, or the art of making fireworks, appears to be the original invention, and to have been the true parent of gunpowder, ancient as well as modern. It will be soon shewn, how the Greek fire described by Joinville as used at the siege of Acre, agrees with the most ancient record we have of the use of a similar invention in India.

Like printing, the loadstone, and much more of our knowledge that is little suspected, there seems abundant reason to suppose that the cradle of pyrotechny was in the east. In China, the use of fire-works for amusement has been known from a period beyond all record; and, in India, the use of rockets for military purposes is of an antiquity equally obscure. As all pyrotechny depends on the property which nitre possesses of accelerating or determining the combustion of inflammable substances, even when these are excluded from the air, and as all the compositions used in this art bear an analogy to gunpowder, it is plain, that the antiquity of gunpowder is implied in that of pyrotechny. Yet it is probable, as before suggested, that the art of making fire-works by means of nitre and inflammable substances, is of more ancient date than that of making gunpowder as we now know it. The one can, in fact, be done in a certain way, by almost any mixture of combustible substances into which nitre enters in a sufficient proportion; whereas duly to select the proper combustibles, to proportion the ingredients, to mix and to granulate them, requires a degree of contrivance, attention and practice, which was not likely to have occurred till long after. It is even probable, that ordnance was derived from some kind of fire-works; it was much more likely at least to have originated in this manner, than from Barthold Schwartz's mortar; a fable so often repeated as to have become a matter of general belief.

Without therefore thinking it necessary to examine the question of gunpowder particularly, which is in itself but a branch of pyrotechny, I may attempt to trace backwards to the oldest records that have come down to us respecting any compositions of this nature. These, as already observed, lead us to India; and if any hesitation is felt in allowing to the oriental nations, from a time so remote, an art which only reached us long after, we must recollect, that astronomy and algebra were known in India equally long before they had found their way into Europe. The latter, in particular, is of very recent introduction. In the same manner were printing and the mariner's compass known to the Chinese, long before they had been introduced among the western nations, although both of them were inventions fully as likely to have spread. If we are inclined to ask why the messengers of Justinian, who brought silk from that remote empire into the west, did not also bring gunpowder and fire-works, we must also explain why they did not bring the art of printing; an invention far more likely to have attracted and excited the attention of a literary people.

In Grey's *Gunnery*, printed in London in 1731, the following passage is found, deduced from the life of Apollonius Tyanæus, by Philostratus. "These truly wise men dwell between the Hyphasis and the Ganges; their country Alexander never entered; deterred, not by fear of the inhabitants, but, as I suppose, by religious considerations: for had he passed the Hyphasis, he might doubtless have made himself master of the country all round; but these cities he never could have taken, though he had led a thousand as brave as Achilles, or three thousand such as Ajax, to the assault; for they come not out to the field to fight those who attack them; but these holy men, beloved by the gods, overthrow their enemies with tempests and thunderbolts shot from their walls. It is said, that the Egyptian Hercules and Bacchus, when they over-ran India, invaded this people also, and having prepared warlike engines, attempted to conquer them; they, in the mean time, made no shew of resistance, appearing perfectly quiet and secure; but upon the enemy's near approach, they were repulsed with lightning and thunderbolts hurled on them from above." These people were the Oxydracæ, and the period of Alexander is 355 years before the Christian era.

Here then is a record of the very early use of some kind of fire-work; whether of ordnance, is more doubtful. It is more probable that this story alludes to some kind of rocket, the very rocket of modern India, perhaps, which would fulfil the condition both of lightning and thunderbolts.

This strange history of the Oxydracæ will render more easy of belief that which is related of the use of gunpowder, and even of ordnance in China, at a very early period; a time no less distant than 85 years after the birth of Christ; and an invention which, if admitted, would, as already suggested, prove the much earlier knowledge of the less difficult kinds of pyrotechny.

If there is somewhat of the air of fable in this story of the Oxydracæ, its probability is confirmed by the very early knowledge of explosive compounds in the east. Even gunpowder is mentioned in the code of Hindoo laws; and that code is, by oriental antiquaries, supposed to reach back to the time of Moses. It may also be added, that there is a passage in Quintus Curtius, where a compound possessed of these qualities is mentioned, strongly confirming these testimonies.

If this is thus far right, the claims of the early orientals to the Greek fire is established. The Greeks might have received it from the Arabians, or from a more direct source; but it seems likely that Western Europe, at least, is indebted to this people for its knowledge of pyrotechny. It will be useful to shew that this art is of more ancient date among us than is commonly imagined.

I quote through Hallam. An Arabian writer in the Escurial Collection, about the year 1249, as translated by Casiri, has the following passage: " Serpunt susurrantque scorpiones circumligati ac pulvere nitrato incensi, unde explosi fulgurant atque incendunt. Jam videre erat manganum excussum veluti nubem per aëra extendi, ac tonitrus instar horrendum edere fragorem, ignemque undequaque vomens, omnia dirumpere, incendere, in cineres redigere." This appears to be the description of a rocket, and does not much disagree with Joinville's account of the Greek fire at Acre.

We may puzzle ourselves, indeed, somewhat between a rocket and a shell, or carcass; yet this would make no difference as far as relates to the question of the Greek fire. The " serpunt," the " susurrant," and the " circumligati," apply best to the description of the former. But the use of the " manganum," from which our early engine, the mangonel, derives its name, bespeaks a mechanical force which could not have been required for a rocket, and which is moreover not very easy of application. We might almost also conclude that this was a shell, from the effects: " omnia dirumpere, incendere, in cineres redigere," applies rather to this machine than to a rocket, unless indeed these were contrived, like the Congreve rockets, to carry a shell with them. There is exactly the same difficulty in Joinville's account of his Greek fire, as will appear hereafter.

The next authority is decisive, respecting the rocket, and it is found in a manuscript quoted by Dutens, from which Roger Bacon is supposed to have derived his knowledge of fireworks. The author's name is Marcus Græcus, and, by the title, the work appears to be a general essay on military pyrotechny.

"Incipit liber ignium a Marco Græco perscriptus, cujus virtus et efficacia est ad comburendum hostes, tam in mare quam in terrâ." The directions for making a rocket are as follows: "Secundus modus, ignis volatilis hoc modo conficitur. R. libras duas sulphuris vivi, libras duas carbonis salicis, salis petrosi libras sex: quæ tria subtilissime tereantur in lapide marmoria; postea pulvis ad libitum in tunica reponatur volatili vel tonitrum facientia. Nota, quod tunica ad volandum debet esse gracilis et longa, et prædicto pulvere optime calcato repleta: tunica vel tonitrum faciens debet esse brevis, grossa, et prædicto pulvere semiplena et ab utraque parte filo fortissimo bene ligata. Nota, quod in qualibet tunica primum foramen faciendum est, ut tenta imposita accendatur; quæ tenta in extremitatibus fit gracilis, in medio vero lata, et prædicto pulvere repleta. Nota, quæ ad volandum tunica plicaturas ad libitum habere potest, tonitrum vero faciens quàm plurimas plicaturas. Nota, quod duplex poteris facere tonitrum, ac duplex volatile instrumentum, vel tunicam subtiliter in tunica includendo."

There is here no direction, it is true, for boring a rocket, without which it cannot fly by its own recoil; so that it is possible this firework may be a kind of squib, intended to be rendered "volatile" by mechanical means, and not by its own unassisted energy. It is not unlikely that this is the very fire of Joinville; and the distinction into two parts, the "tunica volatilis," and the "tonitrum faciens," confirms the opinion that these ancient projectiles combined the nature of a shell and a rocket together.

It is unnecessary to trace this invention further down. Bacon is the mere copyist of Marcus Græcus, or more probably the recorder of a composition in common use. But the extent of his claims, and of the still worse founded ones of Schwartz, may be suffered to remain for a future notice on gunpowder.

Having thus traced the origin and progress of pyrotechny as far as the evidence admits, it is time to return to the more particular consideration of the Greek fire, and to try to ascertain, from the narratives of authors, if possible, what its nature and effects really were.

It seems clear that no single invention, or composition, of a combustible nature, will fulfil all the conditions of this celebrated military firework. It is easy enough to conceive how those who felt the alarm and the effects, and knew not the means, should have confounded all these annoying contrivances under one term; or it is possible enough that they might have given this as a generic name to all offensive fireworks, while their readers, ignorant of the subject, have imagined that the composition was as single as the name. It will presently be seen, by the description of a few of the effects recorded by writers and eye-witnesses, what probability there is in this supposition.

Having traced generally the origin of pyrotechny from the East, it will however first be proper to see if some of the particular inflammable compounds, known by the name of the Greek fire, cannot be traced thither also. It is reported by the author of the *Esprit des Croissades,* to have been known in China in the year 917. This, it is true, is 250 years after the time of Constantine Pogonatus; yet as the Chinese have never been known to borrow arts from the Europeans, it is far more likely that it was known to them long before. This is a supposition, indeed, that can scarcely be rejected, if, as already shewn, the eastern nations, and the Chinese among the rest, were acquainted with the properly explosive compounds, or with gunpowder. The same reporter says, that it was there known by the name of the Oil of the Cruel Fire, and that it had been introduced by the Kitan Tartars, who had learnt the composition from the king of Ou. Thus the oily or resinous Greek fire, which forms one of the kinds immediately to be described, seems to claim an oriental origin as well as the explosive and combustible nitrous compounds.

With respect to the names, composition, and effects of the Greek fire, the Byzantine writers are our earliest European authorities; and, unfortunately, these personages are all very prone to the marvellous.

The Greeks called it the liquid, or maritime fire, probably from its application in naval engagements, as it is certain that they were acquainted with the use of fireships. Procopius, in his history of the Goths, uses the same term as the Chinese, calling it an oil, Media's oil, as if it had been some infernal composition of that noted sorceress. But the historian seems to have borrowed this term from Pliny, who calls naphtha ελαιον Μηδειας, a sort of proof, by the way, that naphtha entered into its composition. Cinnamus also calls the Greek fire πυρ Μηδυκον. All these names bespeak some resinous or oily inflammable compound, such as might be used in fire-ships, or for other purposes, without the intervention or help of nitre. But Leo uses a different mode of expression, when he calls it πυρ μετα βροντης και καπνȣ. We must conclude that he is speaking of some explosive substance into which nitre entered as an ingredient, and that there were consequently more Greek fires than one. Of the terms used by others, I need only notice that of the author of the *Gesta Dei per Francos*, who calls naphtha *oleum incendarium*, making it further probable that this ingredient entered into some of these compounds.

With respect to its composition, the information is very scanty; but the descriptions seem all to refer to resinous and oily substances, confirming the opinion to be derived from the greater number of the names above recited. By some it is said to have been unctuous and viscid, while others again describe it as a solid substance. Quintus Curtius considers it as made of turpentine. Anna Comnena says that it was composed of sulphur, bitumen and naphtha. In another place she says that it was a mixture of pitch and other similar resins, and that it was thrown from balistæ, and attached to arrows.

Other authors also describe the modes in which it was used. In fire-ships it was blown through tubes over the sides. This is not very intelligible, unless it refers to ordnance of some kind, which we can scarcely admit. Fire-ships of this kind were used by the Arabs, at the second siege of Constantinople, in 716 and 718. In other cases it was poured from the ramparts in large boilers; a description which agrees very well with a merely inflammable resinous composition. Tow was dipped in it, and wrapped round arrows, a mode of use that will apply to the same class of compositions. But it was also launched in red hot balls of stone or iron. There we are at a loss again. This could be no mode of using a resinous composition, and it is more likely that these balls were some kind of carcasses, or hollow bodies, projected by means of balistæ, or other machinery. In this case the composition must have contained nitre, as without that no resinous compound could have burnt in such confinement, without access of air.

This leads to the conclusion formerly made, that there was more than one kind of Greek fire, or that different kinds of military fire-works were described under a common name. It proves, perhaps, still more; namely, that the reporters were ignorant of its nature, and that they named by guess those substances with the inflammable properties of which they happened to be acquainted.

It is now time to try to reconcile the more particular reports 'f its effects, and of the manner in which it was used, to any f the compositions above-named, or to any single invention. 'he description in the *Speculum Regale*, from a manuscript of .ie thirteenth century, is amongst the least intelligible. After numerating several military engines, it says, "Omnium autem]uæ enumeravimus armorum et machinarum, præstantissimus st incurvus clypeorum gigas, flammas venenatas eructans." Of this I must fairly confess that I can make nothing.

The next account that I may select is from a French Chronicle of 1190, by which it would appear that it was a liquid, enclosed in vessels of some kind, "phioles." Here is the passage itself: "Ainsi qu'il alloit par mer il rencontre un nef de Saracens que le Soudan Saladin envoioit en Acre pour le secours faire à ceux, qui étoient en la cité, et cette nef avoit grande plant de phioles de voire pleines de feu Gregois."

This was then the liquid fire that is said to have been used by hand at sea, or in close action, and which is also said to have been thrown by means of military engines, in sieges. It is evident that this is not Anna Comnena's fire, as that could not well be thrown from balistæ, or attached to arrows; unless we imagine that it was always used with tow, as before mentioned. Hers appears rather to have been a solid composition. It disagrees still more with that of Leo and Joinville.

It is not very easy to conjecture what it really was. Supposing it to be naphtha, or petroleum, or any similar liquid, it is certain that it could not have been thrown from any machinery in a stream to any distance, as it must have been extinguished in its passage through the air. As little could it have been used by hand to produce any serious effect, or not at least without the risk of equally injuring both parties. On the other hand, it could not have been thrown in an inflamed state in these "phioles," or in any other close vessels, as it could not have burnt without the contact of air.

It is idle to say that the Arabs or Greeks of that day had chemical substances unknown to us; and as it is impossible to reconcile this description to any imaginable composition or effects, the point must fairly be given up as unintelligible. We cannot suppose the liquid in the "phioles" to have contained nitre, because that salt will not mix with any liquid of this nature in such a manner as to aid its combustion.

Whatever this was, it has at any rate been shewn that it was but one of many military fires, and that it must not be taken as the standard of the "feu Gregois."

It is worth while, however, to quote the opinions of the times respecting it, as it seems to have inspired an unreasonable degree of terror. We cannot suppose that it ever was in very common use, as many authors who have described the military operations of these times, and among the rest, William of Tyre, take no notice of it, though in his account of the sieges and actions which he relates, assaults and defences by ordinary fire are frequently mentioned. The romancers of these ages, the abstracts and brief chronicles of the times, are equally silent respecting it. The pagans have all the credit of it, at least in the following verses :

> **Ignis hic conficitur tantum per Paganos**
> **Ignis hic exterminat tantum Christianos**
> **Incantatus namque est per illos prophanos**
> **Ab hoc perpetuò, Christe, libera nos.**

The good monk seems to have held it in great horror.

The descriptions which represent it as unctuous and viscid, and as adhering to the objects which it reached, may be perhaps reconciled to the former, since a viscid substance, as well as a liquid one, might have been kept in "phioles." But as these viscid and unctuous substances only present the same kind of difficulties as the former, I need not dwell on them. They might easily have been all formed of the same resinous ingredients in various proportions.

There is a much greater difficulty coming. The opinion of the Greek fire being inextinguishable by water, could not justly have been entertained of any compositions of this nature, not even of Anna Comnena's sulphureous compound. No burning substance could have resisted an application of this nature, provided it were employed in sufficient quantity, unless under the protection of a carcass or tube of some kind, in which case it must also have contained nitre. It is plain that there is either a good deal of imagination or of ignorance in these reports; such, indeed, as to throw serious doubts upon much more of the history of this substance. The Florentine monk, who describes the siege of Acre, says,

> **Pereat ô utinam ignis hujus vena**
> **Non enim extinguitur aqua sed arena**
> **Vixque vinum acidum arctat ejus fræna**
> **Et urina stringitur ejus vix habena.**

That sand should have extinguished some of these fires, we can understand; but that it should have been put out by vinegar and urine, and not by water, is impossible, as these were not likely to have been procured in sufficient quantity, surely not in such abundance as water; and on no other principle could the one have acted better than the other.

I do not see that any further light can be thrown on these varieties of the Greek fire. The accounts seem to be confused, and unintelligible, as far as they are so, partly by the ignorance, and partly by the exaggeration, of the reporters. Abstracting these, it is probable that they were truly enough, as has been said, resinous inflammable compounds, solid, tenacious, or liquid, without nitre, and exactly similar to the fires of our own ancient fire-ships, before chemistry had taught us to proceed on better principles. Fire arrows have been used by nations who never heard of Saracens or Greek fires. If there is any thing further to be explained, it appears to have arisen from applying generally to all these military fire-works the effects of some of them, an error easily produced by the use of a general term. Joinville's fire will probably help to explain the mystery, such as it is.

His description will be found much more intelligible, and will, I think, fully prove the supposition that there were different things known by one name, and that the Greek fire used against Louis at Acre was neither the Chinese oil, nor any oil, nor any viscid substance, nor even the composition described by our celebrated female historian. As this writer was an eyewitness, having been himself present at this famous siege, his account is as worthy of credit as it is clear and descriptive. We shall also have reason to see that it implies a knowledge of gunpowder, and possibly even of ordnance, and that the former invention is thus carried back to a period which supports the account of the Arabian author of 1249, who has been quoted from Casiri.

According to Joinville, the Greek fire was thrown from the walls of Acre by a machine called a petrary, occasioning such terrors among the commanders of St. Louis's army, that Gaultier de Cariel, an experienced and valiant knight, advised his men, as often as it was thrown, to fall prostrate on their elbows and knees, and pray to God, as he alone could deliver them from the danger. And as the king lay in bed, whenever he was informed that this fire was thrown, he used to raise himself, and, lifting his hands, exclaimed, " Good Lord, preserve my people!" This petrary only threw it three times in the night, but it was also thrown four times from a cross-bow.

Here we have apparently two kinds of artillery; since, as it is described to have come from "the bottom of the petrary," that machine can scarcely have been any thing but a piece of ordnance; a mortar, perhaps, of largc bore. The cross-bow, or balista, might have been used for the same purpose for a smaller projectile of the same nature, or possibly for some other kind of fire.

To confirm the opinion already given of the nature of the fire which thus annoyed St. Louis, it must be remarked, that it came forward as large as a barrel of verjuice, with a tail issuing from it as big as a great sword; making a noise in its passage like thunder, and seeming like a dragon flying through the air; while, from the great quantity of fire which it threw out, it gave such a light that one might see in the camp as if it had been day.

Now we are here still left to our conjectures as to the exact nature of this fire; as we have no other account of it than that of Geoffrey de Vinesauf, who attended Richard to the crusade, and who describes it as consuming even flint and iron, and as being unextinguishable by water, while it was also attended by a pernicious stench and a livid flame.

It is apparent, on considering this evidence, that the fire now under review bore no relation to those which were first described, and that we have to choose between a rocket and a carcass. There are difficulties both ways. The fact of its having been projected from a petrary, is in favour of a carcass; as a rocket would not have borne the explosion of a piece of ordnance, and which indeed could not have been necessary, since it is capable of flying by its own energy. As little could a cross-bow be required for a rocket; while small carcasses, or inflamed balls, like our modern light-balls, of a firm texture, might easily have been projected in this manner.

On the other hand, though the fuse of a carcass would produce a tail of light, that would not have been equal to a long sword, nor could it have illuminated the whole camp. This is more like the description of the stream of fire from a rocket; while the noise like thunder, which attended its passage, agrees well with the latter machine, but not at all with a carcass, which only makes a gentle whistling as it passes through the air. Thus it may be supposed that it must have been a rocket; an opinion, perhaps, supported by the early knowledge, formerly discussed, of this projectile, in India, whence, as I have already attempted to shew, the Arabians derived this invention, among much more of their knowledge.

The only objection to this notion, is the fact of its having been projected from some machine, as just mentioned. But this may be obviated by supposing that it was a firework of this nature, without a bore, and therefore incapable of flying by its own recoil: in short, a huge squib. Such a firework as this would produce all the appearances described; the long tail of fire, the noise, and the light; and it would require a projectile force, which might have been given both by mechanical and chemical artillery, by the balista, and by the petrary or mortar. This opinion is further confirmed by the description of the rocket in Marcus Græcus, which seems also to have been a military firework. There are no directions for boring it: whereas, had that been practised, it was scarcely possible he should have omitted to mention it, minute as he is in all his description of the composition, and of the two cases, the "volatile" one and the "tonitrum faciens." Indeed, he positively directs the rocket-case to be completely filled and well rammed. It is scarcely necessary to say, that an unbored rocket cannot fly without a foreign projectile impulse.

If I am thus right in supposing the Greek fire of Joinville to have been a rocket of this imperfect kind, it is easy to explain the resistance which it offered to any attempts to extinguish it. Water has no effect, because the blast from the orifice prevents it from entering; for the vinegar and urine, the good monk must be held responsible. It is pretty clear that his account of this property in the Greek fire has been derived from these very fireworks, and has, by the usual mistake, been assigned to the whole race.

Whatever this formidable fire was, it seems to have caused more alarm than injury, as we cannot discover in the narration, that any mischief of moment was produced by it. This is pretty much the case with rockets at the present day.

I may yet remark on Joinville's history of this siege, that, while it confirms the opinion before held out of the differences in kind among the Greek fires, and of the real nature of this particular one, it also corroborates that which has already considered the Arabians as acquainted, even at that distant time, with the explosive compounds that derive their properties from nitre.

If it was a rocket or a squib, that admits of no doubt; if it was any kind of carcass, or fire-ball, the same is true; as no resinous compound, without nitre, could have burnt enclosed in a case, as this appears most evidently to have been; and as indeed no such compound at liberty could have resisted water. Nitre is absolutely necessary for every kind of carcass, and that in considerable proportion: and it is only indeed by compounding the charge of carcasses on the same general principles as gunpowder, that they can be made effectual.

As no further light can be thrown on this subject from the ancient authors, it is unnecessary to prolong this inquiry. The subject seems to be cleared, at least, of much of its mystery; and that this mystery has in a great measure arisen from mistakes and exaggerations, must be very apparent. We may remain at our ease on this head, and be satisfied that we have lost nothing by our imaginary loss of the Greek fire. We may still safely boast, that in whatever arts either the Greeks or Arabs may have excelled us, in that of destroying each other we could have taught them much, and could have learnt nothing from them. Divested of the mist which wonder and ignorance have drawn round it, the boasted Greek fire seems to have been a contemptible weapon enough. Had the rhyming monk or St. Louis been at the sieges of Copenhagen or Algiers, it would be difficult to conjecture where they would have found words to express what must have been, to their fires, like the thunders and lightnings of heaven to those of the theatre.

It will not be misplaced to bestow a few words more in bringing down the use of this engine of war to a later period. We already hinted that, about the end of the eleventh century, the eastern Romans used it against the Pisans, at which period the secret of its composition was unknown, not only to the sufferers themselves, but to western Europe. But we are informed by Père Daniel, that Philip Augustus brought some from Acre, and used it against the English vessels at the siege of Dieppe. Lastly, when Ypres was besieged by the Bishop of Norwich in 1383, the garrison defended itself with Greek fire. At this time gunpowder and ordnance had become common, and from that period the very term Greek fire fell into disuse.

Since that, however, there have not been wanting inventors who have laboured to discover what required no discovery; dazzled by the visionary character of this exaggerated and mysterious substance. Neither have there been wanting quacks and impostors, who have pretended to a knowledge of the imaginary secret from interested views. Grose informs us that a chemist in this country, whose name, however, appears to have been forgotten, pretended to this piece of knowledge, and enjoyed an annual pension on condition of keeping it secret, because our government was unwilling to increase the destruction and cruelty of war. The same attempts were frequently made by this fruitful race during the late war, but not with the same success. In France also, many years ago, a certain Dupré received a pension on the same grounds. But the world has grown wiser of late; and we are in little danger now of being misled by any modern empiric, however we may still choose to dream over the tales of the careless and credulous Byzantine writers.

ON THE

CHART OF SHETLAND.

BY J. M'CULLOCH, M.D., F.R.S.

HAVING been lately engaged in a geological survey of the Shetland islands, I had occasion to lament the deficiency which British Geography labours under in the want of a map of this district; a want which was productive of considerable labour and much uncertainty, and which eventually rendered it impossible to deduce any satisfactory conclusions respecting the general direction of the strata, or the dependency and connexion of those of a similar nature which were separated by wide intervals. Had even the maritime outline been tolerably correct, these difficulties would have been easily overcome, as the interior country is so little distant from the sea in any part, that a map capable of answering the ends in view could have been constructed with very little labour. The sea-chart of Shetland is, on the contrary, not only grossly incorrect in its general geological details, but, with a very few exceptions, utterly unfit for the purposes of navigation. It would be better, indeed, if no such chart existed; as, except in the very few instances which I shall presently point out, a reliance on it is in danger of tempting a vessel to its destruction. It has not therefore even the negative quality of being useless.

The deficiency of the chart is not so generally known as it ought to be. The name of Captain Preston, which is attached to it, is no less likely to mislead those who are unacquainted with its incorrectness, than the apparent decision with which the rocks, soundings, and anchorage, are laid down; and it is too late to ascertain the position of a rock when a vessel is on it, or the badness of an anchorage when she is embayed on a lee shore. In this respect, indeed, there is a striking constrast between the chart of Orkney and that of Shetland; while the excellence of the former may also have the bad effect of tempting those who have navigated by it, to place the same reliance on the latter; unaware that the survey of Orkney was conducted by M'Kenzie with the greatest care and anxiety, and that the chart of Shetland is little better than a map-seller's compilation, supplying the want of documents with conjectures.

To render these deficiencies better known through the medium of this Journal, is an act of justice which public benefit claims; criticism is not always employed in so pure and good a cause, nor can our defects be remedied till they are pointed out; and it is by no means generally known that this part of British hydrography is in so imperfect a state. If it were known, it is certain that the department of our government which takes charge of these matters, would have long ago found a remedy; as is proved by the laudable anxiety it has always shown to improve the art of navigation. The recent establishment of a light-house on Sumburgh-head is, indeed, an earnest of a desire to render the navigation of Shetland more safe than it has yet been; and it is to be hoped that it will, ere long, be followed by a nautical survey of all these islands *.

The present chart is stated to have been drawn up from the observations of Captain Preston, and the latitudes and longitudes of Admiral Lowenorn. A recent addition has been made to it, of a very accurate survey of Brassa Sound by Captain Ramage, who has also published a correct chart of Balta Sound, which, however, is not appended to the general chart. Some alterations have also been made in the original chart, down to 1820, which are said, in the work, to be "considerable improvements." These alterations are, however, trifling, and relate to little else than some of the latitudes, and to a correction of the longitude of Brassa; a new scale having been fitted on the old plates, and a rock added, conjecturally, to the east of Fetlar, as the cause of the loss of the Hound sloop, of which the place is, nevertheless, at this moment unknown.

It is, however, not possible to discover from what authorities the chart has actually been drawn up. It is understood in Shetland that Captain Preston did not survey the eastern coast, having been drowned while engaged on the west side of the island. It is certain, from internal evidence, that he could not have examined the west side throughout, as the coast from Papa Stour toward the north is exceedingly incorrect. His

* The Commissioners under whom this elegant building has been erected have doubtless proceeded on the best evidence in choosing this place, but the situation is unfortunately too high. In the thick weather so common in Shetland, particularly with easterly winds, this lighthouse must always be involved in mists and fogs; and, even in the ordinary westerly winds, it arrests the flight of the clouds. It is to be feared that the light will frequently be invisible, and particularly when it is most wanted; and that it will thus become an additional source of danger rather than of security. There is unfortunately no lower point at the southern extremity of these islands where it could have been built, so as to serve the purposes of ships coming from the eastward as well as the westward; but many seamen give a preference to Moussa Island, as the chief want is that of a night-mark for vessels intending to make Lerwick. Such a light-house, together with a small light on the Nab, would render that harbour accessible even in the darkest night.

labours were probably limited to Valley Sound and the Voes as far as Scalloway; although, even these are so incorrectly surveyed, that it is probable the compiler had no access to his documents in a complete state. Neither has the compiler taken advantage of Collins's survey; which, limited as it is, is far more accurate than the present chart is in the same places; as any one may see who will take the trouble of comparing his chart of the two Burras with that which is given, and with the actual form of these islands*.

It is not my intention to go through all the details of this chart; nor would it indeed serve any purpose, unless I could have accompanied it by a large copy, which the dimensions of this Journal do not admit. I shall therefore limit myself to a few observations on some of the most remarkable points, for the purpose of establishing the justice of this general censure; those who may be possessed of a copy, may follow these observations without difficulty. The enumeration of even the few particulars which I have selected for remark, will amply justify this general criticism; and it is hoped that it will have the effect which is intended, of exciting the attention of some individual, or that of the government, to the subject; the object being, not to censure error or neglect, but to instigate to a remedy. Having entered almost every harbour under an excellent pilot, I am the more easily enabled to point out where the defects lie, but shall limit myself to the most prominent†.

One of the most important circumstances in the navigation of all the groups of islands which beset the coast of Shetland, is

* Although not an advocate for monopoly, the publication of maps, or at least of sea-charts, on the correctness of which so many lives, and so much property depend, ought to be restrained to the hands of government. The temptation arising from a little profit, is too often an inducement to publishers to construct these charts from imperfect and imaginary documents, careless of the consequences which must result from their incorrectness, and, it is to be hoped, not aware of the fatal results which are so often produced by their inaccuracy.

† The accurate and universal knowledge of this pilot, whose name is Peter Anderson, would afford great facility to any one intending to construct a chart of these islands: and it is an opportunity which, once lost,

the nature of the tides: their strength, or velocity, their direction, the times of change, their interference, and the currents which are formed among them. Without an accurate knowledge of this nature, the best geographical survey would be utterly useless. If a vessel is not acquainted with the time of change in all these intricate channels, it will often be found impossible to reach the destined harbour, or to effect the intended passage; as the periods of ebb and flood are so materially influenced by the forms of the land in many places, by the collisions of two floods or ebbs from different quarters, or by the interference, perhaps, of the flood of one channel with the ebb of another. Not unfrequently also, it becomes necessary, in shifting from one harbour to another, so to time matters as to secure a portion both of ebb and flood; since, in consequence of the currents, or depths of water in such harbours, or the existence of bars and shoals, the object may as effectually be defeated by taking too large or too little a portion of the one, as by miscalculating the the time required to effect the passage. With a leading wind, or a favourable breeze, it is true, an accurate attention to the tides is often of little consequence; but cases are constantly occurring, in which, if the passage is not effected by the tide, it will not be effected at all; or the vessel may be caught at sea in a dark night, an event which is always a source of great peril on coasts of this nature, or else be embayed on a lee shore subject to any casual change of adverse wind, which, in these regions, often rise with great violence and incredible rapidity. Very often, security is to be obtained by taking shelter in an eddy, or in the still water which is often found to the lee of the current that sets on some island; but it is unnecessary to detail all the cases, too well known to seamen, and particularly to those acquainted with the Scottish islands, in which an accurate knowledge of the tides is as indispensable as that of the coasts and harbours themselves.

is not easily replaced; as he is the only person in the islands who is acquainted with every rock and harbour in them. I need not point out to surveyors how much time is saved in investigations of this nature by such a coadjutor.

In this important part of every sea-chart, that of Shetland is lamentably deficient; and it affords a strong contrast with that of Orkney, where all these particulars are recorded with the greatest fidelity and accuracy. There is, in fact, in the chart of Shetland, not the slightest indication even of the direction of the flood, except on the west coast, far from land, and for a small space on the eastern; in both of which it is little better than conjectural, and serves no useful purpose. This most essential circumstance is not only entirely omitted in the channels and near the shores, where a knowledge of it is most wanted, but it is not even noticed on the northern extremity of these islands, where the violence of the tide is such as materially to affect the plan of a vessel attempting that passage, and is extremely dangerous to boats. I shall content myself with enumerating a few of the channels where the tides are most troublesome, or where the defect of this part of the chart is most likely to be felt. In all these cases, it must be presupposed that there is not a leading wind, or a sufficient breeze; and when it is stated that the velocity of these tides often reaches to five or six knots an hour, or even much more, it will easily be understood that such a wind may often be wanting, particularly to deep and slow vessels.

Passing over the navigation of Brassa Sound, since a pilot may always be obtained there, I shall first remark, that neither the anchorage of Simbister Bay in Whalsey, nor that of the Out-skerries, can be taken without an accurate knowledge of the time and nature of the tides; owing to the shallowness and intricacy of the channels leading to them. The same remark may be made on the sound of Uyea and that of Balta; particularly if a vessel attempts to take the latter harbour by the northern passage. In shifting from the former harbour to the latter, it is necessary to make use of the latter part of the flood and the first of the ebb; since, without the first of these, it is difficult to beat out of the harbour of Uyea; and, without the last, equally inconvenient to beat into that of Balta. If a vessel, again, is desirous of going from Balta Sound to Cloup Voe, or the western parts of Yell, or from Uyea harbour to the same places, the chart does not indicate that the pasage round the Scaw in the former case, or that of Blumel Sound in the latter, are inexpedient, or even, in certain circumstances, dangerous; and that it is far preferable to take the southern passage through Yell Sound. The strength of the current through Colgrave Sound, though far less than that of the stream which runs with such velocity through Blumel Sound, renders it also necessary to be well acquainted with the times of ebb and flow through that passage; no less in merely sailing through it, than in attempting to make the harbour of Basta Voe. As, in leaving a harbour, every vessel has an opportunity of ascertaining the state of the tide, it is unnecessary to point out the peculiar situations in any of these islands, in which it is necessary to possess this knowledge for that purpose; but I may remark, generally, that with respect to the making a great proportion of them, a vessel may often fail in its object unless that circumstance is previously well known, and thus be compelled to stand out to sea again.

In passing round the Skaw, or Papel-ness in Yell or Fedaland Point in North Maven, it is equally necessary to be accurately acquainted with the times of change; as the strength of the current is considerable in all these situations, and it is requisite to take advantage of the ebb and flood both, for doubling these headlands; but on this subject the chart gives no information. The whole of the flood or ebb is equally required for making the passage from Fedaland to Hillswick, or through Swarbuck's Min; or from Papa Stour to the southern harbours of Æthsting, or the reverse; and, in all these cases, a miscalculation of the time or velocity of the current, if there is a short wind or a head sea, or both, may be productive of the most serious inconveniences. The same remarks might be extended to all the remainder of the western shore; but it is unnecessary to enter into minute details of cases which have occurred in my own experience, and which must occur to all vessels attempting this navigation without a well-informed pilot.

To a stranger, attempting to make any harbour, it is essentially necessary to have some physical marks, or picturesque appearances, if that term may be used, by which the spot can be recognised under different positions, or under that position, at least, in which it is most likely to be seen. The picturesque representations of coasts and headlands in sea charts are not often accurately or characteristically given; and the necessity that every surveyor should have a facility in drawing landscape, is but too obvious in many better charts than that of Shetland.

A great aid to the judgment is afforded, in all these cases, by the mode of expressing the shores on the geographic outline; whether it be low and sandy, or skirted with low rocks, or consisting of cliffs of different degrees of elevation. In the chart of Shetland these circumstances seem often to have been placed at random; while equal value is often given to rocky shores of a few feet in elevation, and to cliffs reaching to many hundreds. To quote examples is but too easy. The west and east sides of Foula are laid down as if they were of the same elevation; whereas, on the former side, the cliffs exceed a thousand feet in height, and the latter is almost uniformly low, and, in some places, indeed, quite level with the sea. The same error is found in many parts of Yell, Unst, and Fetlar; where low shores, and even sandy bays, are laid down as if they consisted of lofty cliffs. Trestra Bay in Fetlar, and Uyea Sound in Unst, are remarkable examples of this error. The island of Balta is another; in which the high cliffs of the eastern shore, and the low and often sandy outline of the western, are represented by the same hieroglyphic. I need not enumerate other striking instances of the same inaccuracy; as, to go over them in detail, would be to give an analysis of the whole lengthened outline of this intricate and indented coast.

To the mere geographer, the most gross inaccuracy of the chart of Shetland, consists, not only in the displacement, but in the absolute omission, of many of the smaller islands ; some of which are far from being of trifling dimensions. I shall content myself, as before, in pointing out some of the most remarkable of these; as the want of an accompanying chart on a large scale would render the detail of trifling particulars as unintelligible as it would be tiresome. It will be easily understood, that, independently of the mere geographical defects, these errors are of important consequence in this chart, as far as it is intended for a guide to navigators; not only tending to mislead them respecting their position with regard to any given point of the coast, but further endangering their safety, in thick weather, by the unexpected occurrence of land where they expected to find sea.

An island which lies off Scant Ness is entirely omitted; and this is the more unpardonable, as it is the southernmost point of all Shetland, and therefore sufficiently remarkable. Two small islands to the north of Rovie Head, near Grumister, have also been forgotten. The same occurs at the entrance of Catfirth Voe; where one of the two Glitness Islands is left out of the chart. The How Stack, near them, which is a green island, is also laid down as a naked rock. In Oure Voe there is also an island omitted; and another has been forgotten near Hog Island, not far off from its entrance. At the north end of Whalsey are two islands, only one of which is noticed; but the confusion of small islands on the eastern coast of this spot is utterly unaccountable. There are four islands where only one is marked: three of them called the Holms of Ibister, and another, detached, of which I have lost the name. The Rumble and the Grief Skerry are also utterly misplaced; the former being a mile or more out of its true position, to the southward, and the latter appearing to have been transposed from the north to the south side of East Linga, over a space of more than three miles.

The Out Skerries are represented in nearly as incorrect a manner; the three larger islands being either displaced or omitted, so as to produce the most inextricable confusion. In consequence of this confusion, it would be quite impossible for any vessel to recognise these islands, or to attempt to make the anchorage. The geologist is equally puzzled in attempting to reconcile the physical geography of the stratification which he is examining, with the political geography which the map-maker has thought fit to assign to the remote tenants of this melancholy and stormy spot.

To compensate for the loss of an island in one quarter, the same artist has conferred on Unst one which has no existence;

namely, that of Houna, near Norwick Bay; treating as a rock the real Houna, which lies at the entrance of Balta Sound. It would be equally difficult to account for the assigned place of Hascosea, an island more than two miles in length, lying in a much frequented passage, and forming the very important breakwater to Basta Voe; it is moved more than a mile to the southward, so as no longer to perform that office.

In Yell Sound, the proportions, or relative positions of nearly all the islands are entirely perverted, so as to render it difficult, in navigating them, to know which is meant by any one of those laid down in the chart. This misplacement is most remarkable in the Brother Holm; while one of considerable size to the northward, called Little Holm, is omitted. Similar irregularities occur in the position of the Ramna Stacks, and in that of Greenholm, off Fedaland Point, while one of the former is also omitted. As the passage round this Point of North Maven, which forms the northernmost point of the mainland, lies between Greenholm and the land, this error is the more inconvenient and censurable.

To pass over errors of less consequence in the position of Little Wya and Ossa Skerry, in the dimensions and position of that Linga which lies at the mouth of Olna Firth Voe, and in the omission of a small island at the end of Selie Ness, I may remark, that in Wisdale Voe, an island containing not less than a square mile, is converted into a rock. The position assigned to the rocks and islands which crowd the bay, intercepted between Skelda Ness and Burra, are also incorrect; but the inconvenience that might arise from this is, in a great measure, obviated by the channels which lead into Scalloway having been laid down. It is for this part of the chart that the compiler appears to have been indebted to Captain Preston's survey; and it is certainly the least exceptionable part of the work; though I must in justice remark, that an appended chart of Valley Sound and Grueting Voe, on a larger scale, is also very correctly laid down.

Where such errors exist in the positions of islands of such dimensions, and where so many are omitted, it cannot be expected that there is more accuracy in the places of rocks, whether visible or sunk, in which so many parts of the coasts of Shetland abound. It is not too much to say, that, with very trifling exceptions, the whole of them are incorrect; either by reason of omissions, misplacement, or characters wrongly expressed. It will suffice here to mention a very few of the most remarkable cases, as some of them will again come under notice in pointing out the errors in laying down the harbours. How important it is to be accurate in this part of every nautical chart, it is quite unnecessary to remark. If there is one circumstance more than another which is a source of perpetual anxiety and distrust to a vessel attempting to make a harbour, or navigate a channel, it is a doubt respecting the place, existence, and character of rocks; and, more particularly, of those which are not always visible. It does not, indeed, fall to the lot of many mariners to experience the anxiety that is felt by him whose fate it is to navigate coasts of this nature; but those whose business it is to be often engaged among islands and channels like these, know well the hourly risk to which they are subject, where the space of one day alone exposes them to greater hazard than could be crowded into a whole life spent in navigating the ocean. It is not too much to say, that the circumnavigation of the Shetland Islands is attended with more hazard than that of the globe. A correct chart would reduce that hazard to little or nothing; yet that is not only wanting, but the seaman is exposed to the additional risk which must ever arise from the necessity of placing confidence in one which is grossly erroneous.

A number of sunk rocks are marked in this chart as lying near to the Noull of Eswick; whereas there is deep water here close in shore, with a safe passage for ships of any draught between the How Stack and the land.

Respecting the very intricate and dangerous navigation between Whalsey and the main land, or that on the east side of this island, it is only necessary to say, that not a single rock is rightly indicated; the whole being such a scene of confusion in the chart, that it is vain to attempt to specify the errors in words. That which was remarked respecting the islands at the Out Skerries, may also be observed of the rocks, which are equally incorrect in their positions.

In entering Oure Voe, it is not indicated that there is a rocky shoal between Ballasetter Holm and the southern shore, respecting which I had the disagreeable experience of having struck on it in nine feet water.

A rock is laid down off Fetlar, on which the Hound sloop, as formerly remarked, was said to have been lost in 1800. Now the true place of this rock is not ascertained, important as it is; nor did our pilot believe that the place indicated was at all near to that in which that vessel was wrecked; certainly, at least, none of the fishermen, who are perpetually on this coast, were acquainted with the spot. Hence no vessel can approach Fetlar from the east with any confidence, and those steering north or south must either keep a very wide offing, or sail close in shore.

There is an utter confusion respecting the rocks which lie to the southward of Yell, of which the knowledge is exceedingly important, as they lie in the way of vessels intending to pass from the north through Yell Sound. As to the Ramna Stacks, which were already noticed in mentioning the misplacement of islands, the omissions are of less consequence, as the principal are sufficiently conspicuous to form marks for themselves.

There is a passage between Papa Stour and the main land, which would often be very convenient, as enabling ships to save a tide in going for St. Magnus's Bay; but it is so ill laid down that no vessel can venture to take it. Not to prolong a part of the subject, however, on which it would be useless to insist further, I shall lastly remark, that there are great doubts in the minds of the pilots and fishermen, respecting the true place of the Have de Grind rocks, which lie to the eastward of Foula. Such a want of confidence, indeed, was felt by our pilot, experienced as he was, that he declined taking charge of the vessel, and those who have been in similar situations may judge of the uneasiness experienced in standing off and on, in a heavy sea, during a whole night on this coast, with a view of making Foula in the morning.

The profusion of excellent harbours in Shetland is such, that every seaman who has experienced the want of similar refuge in the channels of England, is inclined to express a childish regret at the waste of a commodity, as he is inclined to view it, which, if properly distributed, might almost supply the whole of Europe with anchorages. Even in this profusion, however, is the bounty of nature shewn, as, without the refuge which they afford at almost every point, it would be impossible, at least in the short days of winter, to navigate these coasts at all. It is not possible for those who have not experienced this kind of navigation, to conceive the anxiety which the coming on of darkness or thick weather produces in such intricate channels, amid rocks and on lee-shores, and among currents and tides, which prevent the pilot from forming any estimate of the vessel's place. In such cases even all the harbours of Shetland are not too many; and yet of these there is a large proportion in which the compiler of the chart has placed no anchor, while in others he has marked stocked anchorages, where no vessel would even venture to stop a tide, unless in fine and summer weather. I shall enumerate these errors and omissions in somewhat greater detail, as it is a species of information which can more advantageously be communicated by mere words, than that which was attempted in most of the preceding remarks.

The anchorage at West Voe, near Sumburgh Head, may often be very convenient with an east wind, or with a wind from the west, when Quendal Bay would be too open. The ground is clean and good, and there is no difficulty in beating out, unless the wind were to shift to the southward. It is far more spacious than is represented in the chart, owing to the western promontory having been laid down of more than double its actual breadth, and from the omission of the island off Scant Ness.

The harbours immediately north of Sumburgh Head, namely East Voe and the Pool, are both exposed and shoal, nor are they safe, even for the smallest class of fishing vessels, although in the chart a stocked anchor is laid down in each. Levenwick, Sandiwick, and Æth's Voe, are almost equally bad; but any incorrectness in these is of less moment, as no vessel would incline to stop in them when equally able to reach Brassa Sound. On the subject of that sound, the minute survey of Captain Ramage, lately appended to the general chart, leaves nothing to be desired. There is nothing to object to the several anchorages laid down in Catfirth, Wadbester, Laxfirth, and Dale's Voes, nor to those in Oune Voe, since an anchor may be let go in almost any part of these inlets.

But in Whalsey the chart of the harbour is so incorrect, that the real anchorage could not be discovered by it without the aid of a pilot; so that in this respect the chart is, to say the least of it, useless. If the anchorage at the Out Skerries, which may often be very convenient, had been properly laid down, there would have been no difficulty whatever in taking it, by attending to the tides. For want of any direction respecting these, from the absence of marked soundings, and from the extremely incorrect position given to these islands and the intermediate channels, no vessel would now dare to enter them; although, so far from the harbour being fit for small vessels only, as the chart says, ships drawing twelve feet water and upwards may lie in it with the greatest safety, and may quit it with any wind, as there are two entrances.

The entrance to Vidlon Voe is perfectly simple; and here the chart has very properly laid down anchors, as it has, with much less propriety, in Burra Voe, at the southern point of Yell, since that harbour is superseded by the much better and neighbouring one of Hamna Voe, although in neither have any soundings been laid down. From this part of Yell to Refirth Voe there is no anchorage, and, although there is fortunately no difficulty in entering this harbour, excepting that arising from its narrowness, it is extremely ill delineated in the chart, nor are any soundings placed in it, so that it cannot be entered without the lead. Basta Voe forms one of the finest harbours in Shetland, or perhaps in the world; but no indication of its nature is given in the chart, and, as usual, it is deficient in the essential circumstance of soundings; so that in thick weather, in which it was my fate to enter it, it is necessary to keep the lead always going. In speaking formerly of the incorrectness of the islands, I remarked that this harbour was principally formed by the island of Hascosea, which covers it, while, according to the chart, no vessel would venture to run for it in a south-east wind, to which, according to the draught, it appears to be open.

Fetlar contains no harbour, yet, for want of soundings in the chart, vessels might be inclined to take Trestra Bay, where the shoal water of this very bad place ought to have been noticed. Uyea Sound is properly marked as an anchorage, but the anchor is laid down too near to the shore of Unst.

Captain Ramage's chart of the important harbour of Balta Sound has supplied the deficiency of the general chart in this place, but a reduced copy ought to have been added to it, as it is impossible otherwise to venture on this harbour, particularly by the northern passage, where the relative position of Balta and Unst is extremely erroneous. It has been long enough before the public to leave the proprietors of the Shetland chart no excuse for not having appended it to the editions sold in 1820.

There is no other harbour in Unst, and although an anchor is laid down in Cloup Voe, at the north end of Yell, it is not frequented. The difficulty of beating out of Whalfirth Voe, against the western swell, also renders that an inconvenient harbour, a circumstance of which notice ought to have been taken in the chart. To the southward of this, near Sandiwick, are two harbours where vessels may lie securely, but in neither of these is an anchor marked.

It is scarcely necessary to notice the omission of anchorage marks in the voes to the south of Waterholm, as these harbours are not wanted in a channel where so many others are at hand; but it ought to have been remarked that there is a very good and a very convenient anchorage in Urha Voe, for vessels which are either employed in Yell Sound, or have not the good fortune of wind or tide to effect their passage through it. This omission is particularly censurable, as the depth of Hagraster Voe makes it inconvenient, and as there is a scarcity of good harbours, compared with the necessity for them, which may often be felt in this channel, on the east side of North Maven.

In Hagraster Voe no anchor at all is laid down, although, for a space of near eight miles, vessels may anchor almost any where in this very secure and quiet place, in clean and good ground.

Colifirth Voe also forms a very convenient harbour for vessels losing the ebb tide in the channel, yet no anchor is laid in it. The draught of this harbour is indeed so incorrect, that no vessel would be aware of its containing a smaller bay within, where there is always smooth water, and excellent soft holding ground.

No anchorage is marked in Burra Voe, to the northward of this, or, as it is sometimes called in the country, North Ru. Yet it is peculiarly convenient for vessels intending to make the passage round North Maven, as, by taking the end of the ebb from it, they may ensure their passage round Fedaland Point, with a whole flood, to reach any of the harbours in St. Magnus's Bay. Independently of this, it is laid down in such a manner that no vessel would expect to find a harbour in it, while a sunk rock in the entrance, which is not easily seen in the smooth and dark water of a bay, receiving so much fresh water from the hills, is entirely omitted. I may as well add here, that which more properly belongs to the examination of the coast outline, that there is here laid down in the chart a bay called Husater Voe, which has no existence, the whole coast from Colifirth Voe to Bura Voe being nearly straight, instead of being deeply indented.

Although an anchorage is laid down in Sand Voe, on the west side of North Maven, no vessel can possibly take this harbour, unless under extreme distress. From its narrow entrance it is utterly impossible to beat out of it, and, from the prevalence of westerly winds, and the almost unceasing heavy swell from that quarter, a vessel once at anchor here might be detained for months. The same reasoning applies, and almost in the same degree, to Ronas Voe, although the entrance is much wider. The difficulty of getting out of these harbours is much increased, and indeed often rendered extremely formidable, by the squalls which blow from the surrounding high land, and by which a vessel is so often baffled in her attempts to stay, while the want of room to wear renders the missing of stays a very dangerous accident, as I have more than once experienced. To avoid future repetition, I may here remark, that Ronas Voe has a deep inlet nearly at right angles to the entrance, which, in the chart, is entirely omitted. Of Hamna Voe, on this shore, where an anchor is also laid down, it is only necessary to observe that, owing to its breadth, it might be safer for the purpose of stopping a tide in, with a wind from the eastward, but that in a westerly wind it affords no shelter whatever.

Although an anchor is laid down at Hillswick, no vessel, looking at the draught on the chart, would attempt to take it, as the line of the coast is made nearly straight where there is a considerable bay. Thus, as happened to myself on getting into this bay, a seaman is tempted to run for Hamer's Voe; a most secure harbour it is true, but out of which it is scarcely possible to beat against a strong west wind, from the narrowness of the entrance, while that attempt is also attended with a hazard which nearly cost the loss of the vessel in which I sailed. I ought here also to remark, that there is an inlet from Hillswick northwards of two miles in depth, which is forgotten in the chart. This, however, is a mere question of terrestrial geography, as the water is too shoal for vessels. As ships may anchor by the lead almost any where to the west of Muckle Roo, the chart is here sufficiently correct, as are the directions to enter by Swarbucks Min. But there are two serious deficiencies in the sailing directions for St. Magnus's Bay, as well as in the chart of that place, which require notice, more particularly as, for want of proper information, a Russian vessel was lost here not long ago, when she might probably have escaped without much difficulty. The tallow, which formed part of the cargo, is still picked up on the shores, being mistaken by the natives for spermaceti, and having undergone some changes from the action of the sea water, which are not uninteresting to chemists. Vessels caught in St. Magnus's Bay with a westerly wind, are directed to run for Swarbucks Min. Now, if the wind is to the southward of west, a vessel, in attempting to weather Muckle Roo, may fail in this object, and become so deeply embayed as inevitably to go on shore on Eglisha, the Longhead, or Isle-burgh-ness, as that above-mentioned did. The direction in this case should have been, to make for Hillswick or Hamer's Voe, as more to leeward, and where the entrance is attended with no difficulty. If once to leeward of the Longhead, it would be too late, with such a sea as the westerly swell sets in here in a gale of wind, to attempt Hillswick, and equally impossible to weather Muckle Roo. It ought also to have been noticed in the chart, that there is no water, except for boats, in Rose Sound, which is, on the contrary, laid down as a wide channel, and without soundings, since a vessel, despairing of weathering the land, might make for this opening, where she would infallibly be lost.

In Papa Stour no anchor is laid down in House Voe, which is not only a good anchorage for ships of moderate burden, but is absolutely necessary for the purpose of waiting the tide to the southward, supposing a vessel to have left the harbours within Swarbucks Min with the ebb. Two or three anchors, on the contrary, are placed in harbours at the north of Walls, where no vessel enters.

The separate survey of Valley Sound and Grueting Voe are correct, although, in a geographical view, the latter inlet is very improperly contracted in its dimensions. It ought also to have been noticed, that no vessel can beat out of the east sound with a swell from the south-west, and that the attempt is attended with the greatest hazard, from the narrowness of the channel, and from the height of the land, which produces baffling squalls, and from there being no room to wear in the passage, nor ground to let go an anchor if a vessel should miss stays. Of the perilous nature of this attempt I can also speak from experience. There is a stocked anchor laid down in Selie Voe which ought not to be there, as it is almost an open harbour. In Frixeter

Voe one anchor is placed; the whole is, however, one immense harbour, capable of containing all the fleets of Europe, but the chart has neglected to notice the shoal water at the entrance, which renders it nearly as impracticable as it is useless on this coast. In Wisdale Voe no anchor is marked, although there is an excellent anchorage near Sand, with a clean channel. Of both these latter bays I may further remark, that the outline is very incorrect; in Wisdale Voe, in particular, a deep bay being gratuitously placed where the shore forms a straight line. It is from errors of this nature that the opinion was formerly given, that Captain Preston's documents could not have been applied to the construction of even this part of the Shetland chart, as such mistakes could not possibly have existed in any real survey, had it even been executed by the most ordinary fisherman.

No anchorage being marked in Stromness Voe, it is almost superfluous to say that the entrance is too narrow, as well as too shoal, for any vessel; but a singular omission of a geographical nature is here deserving of notice. This is the total omission of the prolongation of this voe, which reaches for nearly three miles into the interior country, being connected with the more open bay by a narrow channel, over which there is a bridge. As a part of the sea outline, this should have been inserted, although other inland lakes and objects were neglected, as appertaining rather to the terrestrial geography. The harbour of Scalloway is sufficiently well laid down, but there is a very singular mistake in representing the two lakes of Tingwall as one, and in connecting them with the sea, as if they were salt lakes, whereas the southernmost is separated from it for more than a mile by a tract of meadow-land, which certainly has not been formed since the chart was constructed. Anchors are laid down in several parts of Cliff Sound, where no seaman would think of anchoring, owing to the depth of water, and the squalls from the high land, and where, in fact, there is no occasion for any vessel to stay. A similar remark may be made on an anchorage marked between the two Burras, which can only be required by the smallest class of fishing vessels, and is safe for no other, while the extremely incorrect way in which these two islands are drawn, renders it nearly impossible for any stranger to conjecture where the channels are, or where his position is.

Near St. Ninian's Isle are laid down three anchors, and it would be difficult to say which of these places is the worst harbour, if indeed they at all deserve the name of harbours. In an east-wind, a vessel might stop a tide under St. Ninian's ; but, with a wind from the west, no seaman in his senses would make such an attempt. I may also here observe, that the bar which connects St. Ninian's Island with the main land, is laid down in a wrong place ; being nearer to the middle of the island.

The last harbour in the circuit is Quendal Bay. Here Collins's chart is more correct than that which is here reviewed ; although deficient with respect to the point that covers the proper anchorage under Quendal house. This is a wide and excellent bay, even in winds from the west ; nor would there be any difficulty in getting to sea, should the wind shift to the southward, unless there was a very heavy swell ; as it is sufficiently wide to enable a vessel to beat out without difficulty.

It would be an endless task to go over the subject of soundings, and I shall therefore be content with remarking, in a general way, their incorrectness and deficiency. Where these were of most importance, they have already been noticed as far as is necessary for the purposes of this criticism, in the preceding remarks on the harbours.

Neither is it necessary to make any detailed remarks on the very few sailing directions which are appended to the chart ; that which relates to St. Magnus's Bay having already been examined. I shall only observe in addition, that the passage through Cliff Sound, either into, or out of, Scalloway, is always inexpedient, owing to the squally nature of this bay and narrow channel, and the nicety required in passing the bar of Trondray, on which there are only twelve feet at high water.

With respect to the general outline of Shetland as given in the chart, I must limit myself to a few cursory remarks on some of the most prominent errors which are to be seen by the eye alone ; as I had no opportunity of making any accurate observations by the aid of instruments. Nor indeed can any correct notion of the heap of errors which it displays, be given in words. In a nautical view, this species of error is certainly of far less importance than those already pointed out; yet it is not the less discreditable, that so large a portion of the British dominions, remote as it may be, should have remained so long neglected as it is, but as it cannot now continue much longer. The interior geography is, in fact, not merely little better, but somewhat worse than a blank; as that which is given is incorrect, and as the record of any one object only tends to mislead, by causing the traveller to suppose, that where nothing is laid down, nothing is therefore present. Near Sumburgh Head, it is not indicated that the connexion between this promontory and the main land is so slight that it is almost insulated by a tract of loose sand scarcely higher than the level of the sea; nor would the near approach of the voes on the east side to Quendal Bay, be supposed, from the outline in the chart. There is no incorrectness of much moment, as far as the objects of the chart are concerned, from this point to the Naull of Eswick, where a small but deep inlet is entirely omitted. I may remark indeed, once for all, to avoid tedious repetitions, that throughout the chart in general, the voes are rarely carried to a sufficient depth within the land, and are often equally contracted in their lateral dimensions.

The incorrectness of the outlines of Whalsey Island, and of the Out Skerries, were already mentioned in speaking of the anchorage in these places; but it is fair to remark, in extenuation of these and other errors, that Oure Voe and Vidlon Voe are, on the whole, very well delineated. In Yell there is a deep bay at Quyon which is very slightly marked in the chart; but as it is not used as an anchorage, on account of some rocks at the entrance, the error is of the less moment. The extraordinary incorrectness of the coast and the harbours immediately to the northward of this, was already mentioned in speaking of these harbours, and of the misplacement of Hascosea Island.

The outline of Balta is extremely faulty, but there is a much less pardonable error here in representing the northern passage into the sound as a wide and clear opening, whereas it is very much narrowed both by the position of Balta, and by a boundary of low rocks.

Of Yell, it is sufficient to say that the general outline is no less incorrect throughout, than are the draughts of the harbours; and, on the whole of Yell Sound, the incorrectness of which was already noticed in speaking of the smaller islands, it is proper to remark, that the want of an indicated tract renders the chart in this place nearly useless.

Having already observed upon the incorrect outline of the east side of North Maven, I need only here add that a singular omission will be found near Fedaland Point, which is indeed quite unaccountable, if ever any survey of this shore was made. The extremity of North Maven here forms a peninsula of considerable dimensions, separated from the main land by a beach of shingle and rocks; the indentation on the east side forming a cove for boats, and containing a very important fishing station. The omission of two fresh-water lakes in this neighbourhood, will perhaps not be considered of any moment; but, where some of these are laid down, it is a natural expectation that the whole should equally be found.

On the west-side of North Maven, the land under Ronas Hill is carried too far to the westward; and the same sort of incorrectness prevades the whole of this shore. Independently of the omissions of the two bays formerly noticed at Hillswick, there is a third sandy inlet on the west side of that peninsula, where a boundary of rocky cliffs is indicated in the chart. In the same manner, there is not due value given, either to the dimensions or form of Hamers Voe, which, as I formerly observed, is a very important object to vessels embayed in St. Magnus's Bay. Respecting the outlines from this part as far as Scalloway, the chief remarks, as far as the use of the chart is concerned, have already been anticipated in speaking of the various anchorages; and it would be superfluous to enter into more details respecting so erroneous a specimen of geography as it exhibits. Yet it may be remarked, that the very incorrect outline of the two Burras is particularly unpardonable; as the survey of Collins, to which the compiler might have had access, gives a far more correct view of them. It is indeed difficult to conceive how any one drawing them at all, could have contrived to do it so incorrectly; as the most superficial examination by the eye, is sufficient to correct the glaring errors which occur in the chart. The bridge which connects the two is not only omitted, but its place is indicated much too far to the southward. A deep bay on the east side of East Burra, which is reduced to almost nothing in the chart, is so situated and of such dimensions in nature, as to tempt a boat into it from Cliff Sound, with the expectation of finding the passage between the two islands. At the southern extremity of each of the islands, there is also a peninsula separated by a low rock, in one case indeed nearly insulated; but these are totally omitted in the chart.

But it is unnecessary to proceed further, and I shall therefore conclude these remarks on the general outlines of the Shetland Chart, by noticing the incorrectness of the draught of Foula, which the most superficial view might have given in a better form, and which it would require no great expense of time to survey with sufficient accuracy for all general purposes.

In terminating this communication, I shall only add, that a set of the most common astronomical observations on the latitudes and longitudes of a few leading points, would materially improve this chart; and that, with the assistance of the pilot before-mentioned, the industry of an active person would, in one or two summers, supply most of the chief desiderata in the present imperfect documents, until a real survey of all the islands can be effected. It is in vain to attempt to construct such a chart by the ordinary operation of boat surveying; as the rapidity and uncertainty of the currents, render it absolutely impossible to determine points in this manner with any tolerable accuracy. I shall therefore trespass no longer on the patience of the readers of this Journal, to most of whom the navigation of Shetland is, perhaps, as little interesting as that of the Celebes or Loo Choo. It is sufficient to have justified, by the details already given, the general censure with which I commenced this communication; and its object will be fully attained if it shall either induce those who may with authority undertake it, to commence this necessary work; or point out to unemployed officers in these times of peace, a subject, from which, if they do not reap profit or fame, they will assuredly acquire the thanks of many who, like myself, have hourly hazarded their lives during a stormy summer in a dangerous and anxious navigation.

Shetland, August, 1821.

Art. XI. *On the Attempts recently made to introduce the Shawl Goat into Britain.* *By* J. Mac Culloch, M.D., F.R.S., *&c.* *In a Letter to the Editor.*

Dear Sir,

As the attempts to introduce the Thibet goat into this country are not generally known, your readers may perhaps be interested by the following brief account of these trials, and of the results which have attended them. It may serve the further purpose, of inducing those, who have the means of procuring this animal, and estates fitted for its habitation, to contribute

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* The calculated mean specific gravity of this alloy is 11.2723 assuming the specific gravity of platinum and steel, as expressed in this Table.

† The calculated mean specific gravity of this alloy is 16.0766.

their efforts towards the accomplishment of this object. Parallel attempts, it is well known, have also been recently made in France; but, with what success, we are not yet thoroughly informed, although there is considerable reason to believe, that similar failures have there taken place, and from the same causes which have hitherto rendered our own efforts unsuccessful.

In relating the history of these experiments, it will therefore be useful to add such information as could be procured, respecting the treatment of these animals, both in this country and in their native mountains; as it may point out some of the errors to be avoided, and some of the means to be pursued, to ensure at least some chance of better success than has yet been experienced with regard to the naturalization of this interesting and valuable creature. It will be a sufficient apology for the defective and unsatisfactory nature of these observations, to recollect, that our own experience is as yet very limited, and that the information which we have procured from India is not much more accurate or full. It is unnecessary to make any remarks on the probable advantages to be derived from the introduction of a new species of produce, applicable to a manufacture much in demand; as, on that subject, your readers are fully competent to form a correct judgment for themselves. If this communication shall serve no other purpose, it will probably induce others to convey to the public, through the same channel, whatever information they may possess on the same subject, and which, for want of knowing where it may exist, is inaccessible to your present correspondent.

Your readers need not be informed, that the original flock of the Thibet goats sent to Bengal, was procured by the exertions of Mr. Moorcroft and Lieutenant Hearsay, in their interesting journey to the source of the Ganges, of which the account was published in the *Asiatic Researches*. A selection from these was sent, in the year 1815, to the Duke of Athol, but, by an oversight, eventually unfortunate, the males were sent by one ship and the females by another. The former were lost at sea, and, of the latter, four only arrived at Blair. One of these proved to be pregnant, but the kid was unfortunately produced dead. All these animals were unhealthy, although feeding freely on an excellent pasture, in a dry and warm summer, with the power of resorting to shelter at night. No particular directions regarding their treatment having been received, nor any knowledge communicated respecting the diseases to which they were subject, either in their native climate or after their transportation to Bengal, no precautions were adopted with respect to them, nor any rational plan of cure attempted. But it must be remarked, that none of this flock were subject to that disorder of the feet, which, in a subsequent one, appeared to be the chief cause of their distress. It is not unlikely that their ill health might have been prevented by the use of certain precautions, which will be mentioned when the mode of managing them in India is described.

Of these four, two began to shew marks of an eruptive disease, resembling the *scab* in sheep, after they had been in the pastures for the space of a month or six weeks; and the usual remedies were employed without success, as the disorder continued to increase till the period of their death. But the other two, which shewed no marks of disease, equally pined away and lost their appetites; and, in the course of the summer, the whole flock sickened and died in succession. No change of food, except that of a free access to hay, was attempted; but, like other goats, they shewed a great desire to eat the leaves of any branches of trees that were presented to them. On inquiring respecting the disease abovementioned, I was unable to discover that it was known in their native country or in Bengal; but as our information respecting their habits is still very limited, it may possibly be one to which they are subject. It is at least certain, that, even in their native mountains, they are in that high state of domestication which produces artificial habits and the diseases of civilization; and it is probable, that with more attention to their treatment, and more knowledge of their habits, some of the failures which have taken place in this country may hereafter be prevented.

No directions had been transmitted respecting the management of the fleeces, or the period or mode of shearing them, and the account of Mr. Moorcroft's journey was not then arrived in this country. They were therefore suffered to shed their wool in the natural manner, and this process took place about the middle of August, continuing for a period of two or three weeks. It did not come off in large entangled flakes, as in the sheep, but in small portions; and to prevent it from being lost, was pulled away by the fingers as fast as it became loose. It may be useful to remark, that few of the long hairs came away with the wool; the rough coat of the animal continuing to appear unchanged during the whole of the process.

In Tartary, where the coat is shorn, the hairs and wool are removed together; and the separation of these, in the mode there adopted, is attended with considerable labour, and, consequently, with an expense which would, in this country, be a serious diminution of the value of the produce. As there were then no specimens of native imported wool to be procured in this country, and perhaps no one competent to judge of its nature, even if comparative samples could have been obtained, since the stapling even of common wool with accuracy requires a degree of experience which confines it to a few hands, it was impossible to know whether it had suffered by this natural process. If that should not be the case, it is obvious that much of the labour required in extracting the hair would be saved; but as, even in their native hills, this mode of obtaining the wool is not adopted, although the animals are tame, and collected daily by the goatherds, it is probable that experience has taught them the necessity of resorting to the process of shearing.

A considerable quantity of fine wool was thus obtained, but, from some of it having been lost by neglect, from the diseased state of the skin in two of the animals, and from the death of the whole occurring about this time, the weight of the produce was not estimated. The colours of this wool were white and pale brown; the variety of goat of which this small flock consisted being white with brown patches, very much resembling those of the common brown and white spaniel, and disposed in a similar manner.

In the summer of 1816, another female, with a male, arrived at Dunkeld in good health, and they were placed in a small paddock; as, from their propensity to browsing, they could not be left at large in the pleasure grounds, and it was not judged safe to suffer them to range among the hills with the sheep. These continued in a general state of good health during the winter, having access to shelter, and in 1817 the female produced a kid. Thus far they appear to have become accustomed to their new mode of life, and to a change, first from the cold and dry climate of their own mountains to that of Calcutta, and finally to the rich pasture and partial confinement of a situation which is remarkably rainy, and, for Scotland, warm. In the progress of time, however, they began to shew marks of ill health, denoted by a loss of appetite, attended by a stupid and melancholy look, which lasted for some days and then subsided. No disease of the skin occurred in these, but the male became frequently stiff in the limbs, so as to move with difficulty. This disorder, however, subsided again as it arose, without any means being tried for its cure, and it probably was the consequence of wet weather, which it is known that these animals cannot endure with impunity, even in their native climate.

Both the male and female, but the former in particular, were also much incommoded by the rapid growth of their hoofs, which, in the male, at length proceeded to such an extremity as to prevent him from grazing except on his knees. At the same time the joints of the knees gradually enlarged, and the whole of the fore limbs became nearly crippled. It is probable that this male was an aged animal, as he bore other marks indicating it, and that his death, which took place shortly afterwards, was accelerated by that natural cause. This incommodious growth of the feet must be attributed to the soft pasture in which they were kept: provision appearing to be made by nature for a rapid growth of horn in all the goat tribe, to enable them to bear the rocky ground which they are destined to occupy. There is no doubt that it would have been obviated by the choice of a better situation, had that been possible; and that, even in that to which they were confined, it might have been prevented by paring; a process, which, it is understood, it has been found necessary to adopt, in certain cases, in India.

Subsequently to the death of the male, the kid also died, having attained its full growth, without any apparent cause of disease; and, to prevent the total loss of the breed, a cross was proposed with a native male goat, which resembled the female in its general form and appearance. This project, however, was abandoned, unfortunately, as it would have been desirable to know whether a hardier breed might not have been produced, possessed at least of a sufficient share of the properties of the pure Thibet goat to have rendered it a valuable acquisition.

In the summer of 1819, the female, which had for some time shewn the same marks of rheumatism and general ill health by which the male was affected, died. Thus the second attempt to naturalize them at Blair and Dunkeld, also failed.

It is probable that both these failures must be attributed, partly to the want of a sufficient variety of food, and, possibly, to the quality of a pasture much richer than that to which they are destined by nature. But it appears also to have arisen, in a great degree, from the rainy nature of the Highland climate; a very large proportion of the days, both of summer and winter, being wet, and the rains often continuing for many weeks without intermission. In Thibet, it appears that the climate is dry, the alternation being that of fair weather with snow, and not with rain. If this should be the cause, and that, by successive breeding, the shawl-goat cannot be inured to bear wet weather, it is probable that all attempts to naturalize it in Scotland will prove unavailing. It is worthy of remark on this subject, that, in some attempts to naturalize the reindeer at Blair, the same consequences followed; the animals sickening in the rainy season, and at length dying, apparently from the effects of protracted wet weather; but in some measure also, it was suspected, from the richness of the pasture.

No attempt was made to shear these animals, more than the preceding, but the wool was collected as it dropped off or hung loose on their sides. On comparing it with specimens imported by the East India Company, no difference could be perceived by an ordinary judge of common wool, either in the length or fineness of the staple. Those who had charge of these goats unfortunately neglected to remark whether the kid of this breed produced the same wool, for quantity or quality, as the original animals, or in what respect, in both ways, it differed; a remark which it would have been very important to make, as, although the imported animals should prove incapable of being habituated to the climate, it would have been desirable to know whether the progeny was capable of perpetuating the qualities of the original stock.

With these two trials, the attempts made to introduce the shawl-goat by the Duke of Athol, have for the present terminated. But some experience has been gained for future trials; and some additional knowledge of their habits, recently procured from India, will, with the assistance of that experience, give an additional chance of success to the next experiments that may be made on this subject.

In 1817, a flock was sent to Mr. Dunlop, of Balnakiel, in Sutherland. Some of these died on the passage, but the remainder, consisting of a male, three females, and a kid produced on board of the ship, arrived at his farm in good health. In the autumn of that year, I found them thriving and free from diseases, and I was afterwards informed that in the following summer they still continued well. Since that period, I have neither had an opportunity of seeing them, nor of learning what their fate has been.

This flock was entirely black; and, in India, it is considered the most valuable variety, as the natural black wool is preferred to that which is dyed, and even to the white. It is of a finer and softer quality, and the shawls manufactured from it fetch a higher price in the market than any others; partly, it is probable, on account of their comparative scarcity.

The situation of Balnakiel is in the parish of Diurness, a few miles to the eastward of Cape Wrath, and the climate is peculiarly mild and rainy. The pasture is exceedingly rich, on a calcareous soil, and will probably be found as ill adapted to them as those of Blair or Dunkeld.

If this flock should have thriven and propagated in this place, it will be a sufficient earnest of the possibility of naturalizing them in other parts of Scotland; but, respecting this, as I already remarked, I have had no means of procuring any information.

The last attempt made in Scotland to introduce and propagate these animals was by Mr. Macpherson Grant, the present member for Sutherland.

A pair was procured from the East India Company, in the autumn of 1816, and they were allowed to feed about the house of Invereshie during that winter in the ordinary pasture; having, at the same time, access to the hay-stack, as the first flock already mentioned had at Blair. In the summer of 1817, they continued in health, and were sent up to the high ridge of mountains which here separates the counties of Inverness and Aberdeen. To this mode of treatment is probably to be attributed the superior health of this pair, and their having escaped, in a considerable degree, that disease of the feet which proved so troublesome to those kept in the soft pastures at Dunkeld.

In October, they were again brought down to the house, and, in February 1818, the female produced twins, which, unfortunately, proved to be both males. The young throve remarkably well, and the female was fed on corn and turnips, without any apparent inconvenience, during the remainder of that winter. They were not sent up to the high hills in this summer, but allowed to feed about the low grounds at Invereshie, where they continued to thrive; having then passed two winters, and one complete summer, with every prospect of being in time thoroughly inured to the climate. But, in the middle of the May of 1818, the female began to droop, and, before the end of that month, she died; without any cause having been assigned for her death by those who, in Mr. Grant's absence, had the charge of her. It is not unlikely, however, that this event may have arisen from too full a diet; the only error which appears to have been committed in the treatment of these animals; this experiment having, on the whole, been far more successful than those carried on at Blair and Dunkeld, and giving hopes of future success whenever the management shall be better understood, and when, by an increase of the numbers subjected to trial, occasional contingencies will be of little moment.

It is a sufficient proof of the general healthiness of this female, that, on being opened, she was found to be again pregnant with twins, a male and female; and, had not the cause above suspected, or some other unknown contingency, destroyed her, it is probable, that a native flock would at length have been raised at Invereshie by these efforts.

The males, which continue to thrive, passed the summer of 1819 in the hills, and the old one was long absent, having wandered away from the others, but was recovered before the winter. As these also remain in health after so long a probation of the oldest, there is little reason to doubt that he has become fully habituated to the climate; and that the two young ones are still more perfectly naturalized from the advantages of their birth in it. Unfortunately, no female has since been procured, so that it yet remains a doubt whether this experiment, so long carried on under favourable auspices, will ultimately succeed so as to establish a naturalized breed.

It is necessary here to remark, that, in the first year, the original pair showed the same disease of the skin which occurred in those at Blair. The wool was injured, in consequence, in the first crop, but the animals afterwards recovered, and continued clean. The feet also became tender while in the lower grounds, but, as already observed, without growing to the inconvenient length which they did in the animals kept at Dunkeld. This disorder however subsided in the summer, when they had access to the rocky hills, and showed the necessity of keeping them on ground of this quality, or, where that is not practicable, of paring their hoofs occasionally as a substitute for the natural process of wear. The necessity of this, it was already remarked, has even been observed in

India, and the knowledge of it will afford a useful hint to those who may undertake to prosecute the same experiment.

It is also important to remark, for the benefit of future cultivators of this goat, that they were partial to clean pasture, and were very unwilling to feed where the sheep had been. Hence the necessity of keeping them, as much as possible, separate, or of putting them on pastures so extensive as to diminish this inconvenience. It was also remarked, that they fed greedily on docks, and, as might be expected, were very destructive to the plantations, whenever they could get access to them.

Such are the results of the attempts hitherto made in Scotland towards the accomplishment of this object; and, at present, there appears no immediate prospect of renewing them. In England, nothing has yet been done on this subject, although I am informed at the India-house, that a male and female, sent to Lord Ranelagh at Fulham, are still alive there. The last arrival in this country was that of a male and female in March last, (1820,) but they both died shortly after landing.

P. S. I shall conclude this letter with an account of those circumstances respecting their habits and treatment, and their produce, which may either be useful or interesting to those who may think this object worthy of their attention. As this information was chiefly procured from the Marchioness of Hastings, who interested herself strongly in the subject, it is to be presumed that it is worthy of all reliance.

This animal is a native of that part of the mountains of Thibet which lies near to the region of perpetual snow, and of which the actual elevation, although very great, has not yet been determined in such a manner as to have satisfied the doubts of all parties. The climate is subject to sudden changes, although it does not appear that the summer temperature is ever high; and as that of winter is below the freezing point, the water which then falls is in the form of snow, not of rain. Hence it is understood to be a dry climate, What the exact state of the summer, however, may be, we are not thoroughly informed; and it is probable, that too much stress has been laid on this circumstance in the fears which have been entertained respecting the naturalization of the animal in Scotland; as Mr. Grant's flock seems to have been thoroughly inured to a district which, both in summer and winter, is subject to frequent rains. There is indeed no reason to fear, from the analogy of many other animals which are in time educated to bear all climates, that this also may become habituated to one so different from that to which it belongs. What effect such a change may have on the wool, is another and an important question, which can however only be determined by experience. Some prospective judgment may perhaps be formed respecting this subject, by the consequences produced by similar alterations in the case of Merino sheep; but I am not aware that a difference in the quantity of rain is supposed to have any effect in altering the quality of their wool.

No accurate account has been yet received of the range of temperature in those regions inhabited by the Thibet goat, nor of the mean annual heat; so that it is impossible to institute any comparison between that important circumstance and the climate of Scotland. It is a natural consequence of transferring a deep-furred animal from a cold to a warm climate, that its fur should be diminished in quantity, as well as in the fineness of its quality. This change has accordingly been found to occur in India to those goats which have been brought down to the plains of Bengal; but the return to a colder region soon restores their wool to its pristine condition. Yet there is so wide a difference between the temperature of Scotland and that of Bengal, that no fears need be entertained of any change to this extent; while the permanence of many of the finer-wooled sheep, under a considerable range of climate, renders it probable, that the loss of quality which the fleeces might experience in Scotland, would not be such as to deprive them of their value, should it even in some degree diminish the quantity and quality of the produce.

It must, however, be evident, from both the preceding considerations, that the eastern parts of Scotland are better adapted for the cultivation of this goat than the western; since, if an irregular line be drawn between Perth and Inverness, it will be found, that the number of rainy days, as well as the quantity of rain, is far greater on the western than on the eastern side of this line. Abstracting some particular spots also, the quantity of rain diminishes in this latter division as we recede from the sea; while both the mean annual temperature will be found the least, and the severity of winter the greatest, in that middle tract which contains the courses of the Garry and the Spey. The district of Badenoch is in fact the coldest, and, in the Highlands, probably the driest part of Scotland; and the rocky mountains of that division, therefore, seem most particularly adapted to this object.

The necessity of rocky and mountainous pasture is more particularly rendered obvious by that disease of the feet which was mentioned in recording the experiment made at Dunkeld, and, it must here be added, that the growth of the hoofs in one of these animals was checked, and the feet restored to a sound state, merely by allowing it a free access to a paved stable. Although it was mentioned in the preceding remarks, that it had been found necessary to pare the hoofs in India, it does not appear that this practice is required in Thibet, where, doubtless, they have a free range over rocky ground during the summer, or on hard ice in winter. Moisture is indeed injurious, as is well known, even to the feet of sheep; and the common goat of the Highlands invariably avoids the low grounds, when in its power, to seek refuge among the dry and stony places.

A fear lest they should become a prey to the fox, which, in the Highland mountains, is a very powerful and comparatively a bold animal, prevented the risking of those which were at Blair and Dunkeld in the hill pastures, and thus probably tended to their destruction. That caution would not be necessary, should they become more numerous. But although these goats were extremely gentle and familiar, partly owing to the mode in which they are reared in Thibet, and partly owing to a long sea voyage, they are courageous; and, as the female as well as the male is provided with powerful horns, it is not likely that the fox would attack them, as he never attempts the horned sheep unless they are reduced by disease.

In their native country, the goats are driven in, in the evening, for the purpose of milking the females; and it appears that they are also provided with sheds, in which they may occasionally be sheltered from the rain. Their habits are, in fact, those of a domestic and not of a wild animal; and to this care is probably owing much of their good qualities, and of the various degrees of excellence which are found in the wool in different situations. It would, therefore, be proper for those who may repeat the experiments on their cultivation in this country, to bear these circumstances in mind, and to provide them with that shelter and attention which they seem to require.

With respect to their pasture, it is found, that they not only shun the rich grasses, but that this food is injurious to their health and to their fleeces. In this respect they resemble the common goat of this country, who invariably avoids these pastures, if he can get access to rocky land, covered with a variety of shrubs and plants. In their native hills, they thus travel for great distances among the dry and scanty pasturages; and this free range and exercise is considered to be conducive to their health. They are found to subsist indiscriminately, like their species elsewhere, on all the plants and shrubs within their reach, and chiefly, it is said, on several aromatic plants, and on a prickly shrub which Mr. Moorcroft calls furze. Of this, no botanical description has been given, and it has been supposed, that it cannot be the *Ulex Europæus*. This, however, does not follow, as many of the common European plants are found to inhabit the high mountains of middle Asia, and as it appears that even our common gooseberry plant is found in the mountains in question. In this country, it has been ascertained that they eat the common furze with avidity; and, like the sheep, they also brouze on the young shoots of the heaths. It is further said that they are particularly fond of rue; and, in India, it is recommended to keep this plant in the enclosures in which they are confined in that country. The whole of the species, indeed, appears attached to all the strong-tasted plants, and even to those poisonous species which other animals refuse; but it is evident that, on a large scale, it would be impossible to pay attention to any cultivation of this nature, while the advantages to be derived from it are probably in a great measure visionary. When the ground is so covered with snow in Thibet that the plants are no longer accessible, they are fed on the bruised tops of the furze above mentioned.

It is found to be a salutary practice to give them salt once in a week; and this is said to be general in their native district, and to be the only particular expense to which the proprietors are subject. From this condiment, indeed, all graminivorous animals appear to derive benefit; and, in the commencement, at least, of their naturalization in this country, it ought to be adopted. Had it been known when the first flocks arrived, it might perhaps have prevented their loss.

It is now well known to naturalists, that the goat of Thibet is merely a variety of the common goat; differing from it only in the nature and quantity of its clothing, as that has been modified, partly by the climate which it inhabits, and partly, it is to be presumed, by careful breeding and cultivation. The individuals vary much in size; but are generally all characterized by a head somewhat large when compared to the breeds of our own country, long horns lying backwards and slightly bent, a straight back and delicate limbs.

The coat consists of a thick covering of long coarse hair externally, concealing the fine wool, which is curled up close to the skin. No material differences could be discovered in the wool of those which arrived in Scotland; but it is well known that they vary materially in this respect; and it is further suspected, that although the most weighty fleeces come from the coldest regions, the finest are produced where most care is bestowed on the animal; as, in the sheep, the wool of yearlings is found to be of the finest quality, and is always distinguished in the market as a superior article. It is also remarked, that the white fleeces are less fine than the coloured, and that the black are the finest of all. They equally vary in quantity; the finest wool also producing the heaviest fleece.

The varieties in respect to colour which arrived in Scotland were white, white and brown intermixed, and black. In their native country it is remarked, that those which inhabit the most elevated valleys are of a bright ochre yellow; that, lower down, they are yellow and white intermixed; and that, still further from the highest tracts, they are pure white, or white stained with black or brown. It is not mentioned whether the black variety is limited to any particular district, but, from the much superior price of its produce, it is probably rare.

In Tartary, the fleeces are shorn with a knife, in a rude manner, about the end of Spring, when the snows have melted; and it is probable that our own period of sheep-shearing would be the proper time for that operation in this country. It was formerly remarked, that the first flock at Blair was shedding the fleeces in August. Those at Dunkeld had entirely lost theirs at the end of July. In August, the flock in Sutherland was also losing the fleeces.

The last circumstance, which now remains to be mentioned respecting the shawl goat, is the treatment of the fleeces.

In Tartary, they first undergo two sortings: one according to their colour, and another according to their quality. With respect to the latter operation, two degrees of fineness only are distinguished. It is probable, that from the rude mode of shearing adopted, the whole fleece is confounded together; and, that the separation of the different qualities is far less perfect than it would be in this country, if the fleece was shorn entire, and then separated, as is done in the sheep. After shearing, the long hairs are all picked by hand from the wool, an operation which is understood to be performed by children, but which must be both tedious and expensive. It is probable, that if ever the animal should be naturalized in this country, some sort of machinery would be applied to diminish this labour, as the hair is not entangled in the wool. In those fleeces which were naturally shed in Scotland, the wool was almost entirely separated from the hair during that act; so that from one goat, I procured nearly a clean fleece in this manner.

After the several operations of picking and sorting, according to the degrees of fineness and colour, the wool is washed in a warm and weak solution of potash, and afterwards in water. It is then bleached on the grass, and, when completed, is carded, and prepared for spinning.

That wool which is intended for dyeing, is dyed once before carding: it is then dyed a second time after spinning, and once more when manufactured into the shawl. Great attention is required in the washing to prevent it from felting.

The spinning in Tartary is all performed by hand with the distaff and spindle; the latter being made of a ball of clay, containing an iron wire, and the finger and thumb being preserved in a smooth state by powdered steatite. Great care is taken not to spin the thread too hard, as the softness of the future shawl depends much on its texture in this respect.

The weight of wool required for a superfine shawl is five pounds, for one of the second quality three, and for the inferior sort two.

I may conclude this subject by mentioning the attempts which have been made to imitate this manufacture in our own country.

Some bales of shawl wool were imported by the East India Company a few years ago; but it was found, on trial, that the Norwich manufacturers could not spin it so as to produce a thread of equal fineness and goodness with that from Merino lamb's wool, although the staple is at least five times as long. It had, therefore, very little sale, as it was only occasionally used to work up with other wools. But a simple method of spinning it by machinery was discovered two years ago by Mr. Main, of Bow Lane, in Cheapside; and, by that, threads have been produced even much finer than is necessary, and indeed superior in texture to the best of Thibet manufacture. It is, therefore, not impossible, that we shall hereafter be in possession, not only of the material, but of the means of manufacturing from it an article of great value, for which the demand has hitherto been limited only by the scantiness of the supply.

I am, Sir, your's, &c.

J. MACCULLOCH.

Art. XII. *Proceedings of the Royal Society.*

The following papers have been read at the Table of the Royal Society, since our last report.

March 23.—On the means of supplying muscles in a state of spasm or paralysis with nervous power, by Mr. J. Hood, communicated by the President.

April 13.—On the milk, tusks, and organs of hearing of the dugong, by Sir Everard Home, Bart., V.P.R.S.

April 20.—On the improvement in the eye-tubes of portable achromatic telescopes, by William Kitchiner, M.D.

On the different qualities of the alburnum of spring and winter-felled oak-trees, by Thomas Andrew Knight, Esq.

April 27.—On the properties of domes and their abutment walls, by Samuel Ware, Esq.

May 4.—On diarrhæa asthenica, by Assistant-Surgeon Hood.

On the mode of formation of the canal for containing the spinal marrow, and on the form of the fins of the proteosaurus, by Sir Everard Home, Bart, V.P.R.S.

May 11.—Some experiments on the fungi which constitute the colouring matter of the red snow discovered in Baffin's Bay, by Francis Bauer, Esq.

May 18.—Some account of the dugong, by Governor Sir T. S. Raffles.

On the Forms of Mineralogical Hammers. By J. MAC CULLOCH, M.D., F.R.S.

[Communicated by the author.]

THOSE who have not been very conversant in countries consisting of primary and trap rocks, will not easily believe how difficult it is to procure specimens from many of these substances by means of any of the hammers in common use. This is more particularly the case with some of the members of the trap family, which are often characterized by an uncommon degree of toughness or tenacity; and it is not uncommon in those granites which are of a fine grain, and which contain a conspicuous proportion of hornblende. In those varieties of gneiss in which compact feldspar predominates, in some of the members of the primary sandstone series, and in the varieties of hornblende schist in which the laminar structure is obscure or wanting, the same difficulty frequently occurs, and to such a degree as absolutely to defy the utmost efforts of the heaviest hammers in common use, whether by stone-masons or mineralogists. Serpentine also very often, and diallage rock almost always, present such a resistance as to deprive the collector of the power of obtaining satisfactory or sufficient specimens; but it is unnecessary to enumerate all the rocks which those who are in the least conversant with this department of mineralogy must occasionally have abandoned in despair.

Independently, however, of the wish to obtain a mere specimen, such as can first be detached, it is often desirable to obtain a deep access to the rock under examination, on account of the changes which the superficial parts undergo from the loss of their water, or from the ordinary effects of exposure. In such cases it is necessary to procure specimens in succession from the same point; an attempt, in which ordinary means will often fail, from the gradual loss of the protuberances or angles on which alone an impression can be made by a moderate or ordinary force. It is also often desirable to obtain a cross fracture of some of the schistose rocks, as in micaceous schist, for the purpose of displaying the contortions. This, from the greater facility with which the laminæ yield to a moderate force according to their direction, can rarely be effected by any ordinary hammer; requiring a greater and more concentrated impulse, and often, indeed, demanding the very sudden effort communicated by gunpowder.

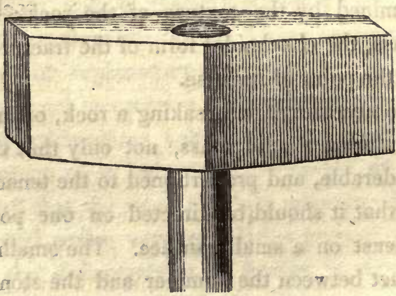
The weight of a hammer required to produce such effects, if of the ordinary construction, is a serious inconvenience to a geologist; who must, in many cases, necessarily examine the ground which he is investigating, on foot, and who is also not unfrequently incumbered with specimens. Nor will mere weight answer the purpose, as a very slight consideration of the laws which regulate the communication of motion will show. Having at first suffered much inconvenience from the use of hammers of the common construction, the geological readers of the *Quarterly Journal* will not be sorry to know the expedients which I adopted to diminish it; and, to render the form which I have used for some years past more intelligible, I have accompanied this communication with explanatory sketches.

That I may not incumber a plain practical question with mathematical considerations, I shall only here remark, that although the momentum of a body is compounded of the weight and velocity, and that the same absolute quantity of motion may be communicated under varying relative proportions of these two elements, the disintegration of bodies is regulated by other rules, and a diminution of velocity cannot be compensated in this case by an addition of weight. It is by an increase of the impulse that the cohesion of bodies is overcome: a great weight causes the body to move in one mass; a great velocity strikes off a fragment, or breaks the whole to atoms. Illustrations of this law must be familiar to every one; the penetration of a musket ball through an open door is well known; and the same is no less true in the case of elastic fluids. Thus the action of fulminating mercury will break, in the gun, that shot which common gunpowder will project; and thus also, in splitting rocks, the greatest effect is produced by the worst gunpowder. An attention to this simple law would have prevented the useless attempts so often made to substitute the stronger detonating compounds in the practice of artillery: but I must not enter, further than is necessary, into this subject, though it will immediately be seen how this doctrine bears on the use of mineralogical hammers.

In striking a fragment from a mass of rock, and equally, indeed, in detaching the smaller superfluous parts from specimens, it is necessary that a vibration should be excited in one place, or lamina; and, by the communication of a limited motion among the particles of this lamina, the parts at rest on each side are separated from it. In the harder and tougher stones, the nature of this process is distinctly to be seen, as it is also in the more brittle and compact, as well as in glass. In the former, it will be found that the point immediately subject to the impulse is bruised, and that the area of vibration extends, in a somewhat concentric manner, along some lamina which is generally determined by the texture of the rock: in common flint, and in glass, the conchoidal form of the fracture is easily seen to respect the point of impulse.

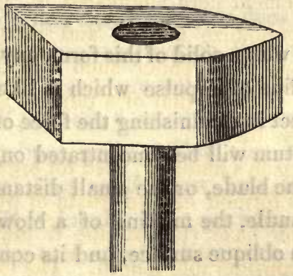
It is therefore necessary, in breaking a rock, or in detaching a large fragment from a solid mass, not only that the impulse should be considerable, and proportioned to the tenacity of the substance, but that it should be directed on one point, or on one line, or at least on a small surface. The smallness of the surface of contact between the hammer and the stone, is, however, not only useful in this way, by causing the vibration of the lamina which is to separate the adjacent parts, but it produces the further effect of concentrating the whole weight, or rather momentum, of the former, on one place, instead of suffering it to be wasted by being directed on many points at once. In the form here adopted, a very small weight will thus be found adequate to produce an effect which would be in vain expected from the same acting on a larger surface, or exposing a broad face of contact. It is true, that, in the ordinary practice of masons and quarrymen, a flat-faced hammer will detach a fragment, by communicating motion to the whole of it, while the mass is comparatively at rest; but it will at the same time be recollected, with how little effort blocks of granite and marble are split into two parts by the comparatively slight blows given on the feather wedges, and how hopeless an attempt it would be to separate such masses by any practicable momentum applied to one half of them. The object of the improvement here suggested is, as in other cases of mechanics, to œconomize power; and though the arm of a practised quarryman may render such expedients of comparatively little value to him, that of a mineralogist is seldom in a condition to despise them.

The ordinary mason's hammer, used for breaking rough stones for rubble work, is formed of two frusta of pyramids on a common parallelogramic base, (to describe it mathematically,) and the blade is of considerable length. The faces, it is true, are thus somewhat narrow in proportion to their length, but yet they present far too large a surface. This hammer is attended

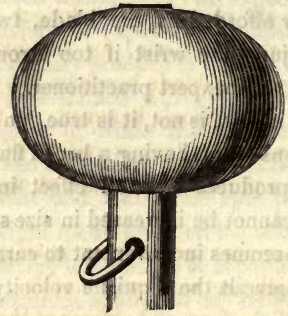


with another serious inconvenience, in consequence of the length of the blade. If the blow is not given in such a manner that the line joining the centre of gravity (or percussion) with the point of impulse, is vertical to the surface of the stone struck, the blow fails; or, at least, a portion of the momentum is lost.

Nor is the missing of a blow attended with impunity; as the length of the lever afforded by the blade, twists the handle in the hand, and injures the wrist if too strongly grasped, as it always will be by an inexpert practitioner. The mineralogical hammer generally in use, is not, it is true, so long or narrow as that used by masons; but, having a broad flat face, it is a feeble instrument, and produces a small effect in proportion to its weight; while it cannot be increased in size so as to compensate this defect, as it becomes inconvenient to carry, and requires too much strength to give it the requisite velocity.



The construction by which these defects are remedied, and the greatest effect produced with the least possible weight and strength of arm, is that where the face of the hammer is round, or spheroidal. Theoretically, an obtuse wedge would, perhaps, be generally preferable; but it is scarcely possible to give the blow in such a manner that the centre of percussion should fall in the true line; and, in such a form, the slightest deviation causes the blow to be wasted. A hammer in the form of a sphere, would, indeed, ensure the effect of every blow, but it is very difficult to steel such a figure all round, and it cannot be made all of steel, since it will not stand without a centre of iron. Besides, with a weight of three and a half or four pounds, the surface of the sphere becomes somewhat less curved than is convenient for making the impulse on one point. I have, therefore, preferred the form of an ellipsoid, and the particular figure will be better understood from the accompanying drawing, than from any description.



It is plain that, with a solid of this form, any deviation from the most favourable line of impulse which is likely to happen, will have but little effect in diminishing the force of the blow; and that the whole momentum will be concentrated on one point. From the shortness of the blade, or the small distance of the face from the axis of the handle, the missing of a blow by the sliding of the hammer on an oblique surface, and its consequent attempt to turn round, communicates no strain to the hand.

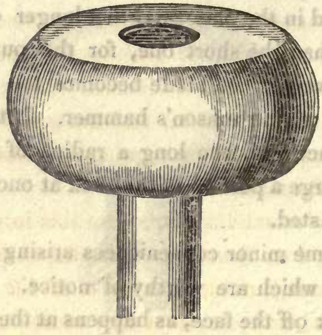
The weight of such a hammer need not be very great, nor is any advantage, indeed, to be gained by increasing it beyond a certain point, proportioned to the strength of the arm which is to use it; as, in such cases, the power of the impulse is diminished. A few trials will convince any one that, with this construction, a given weight will produce as great an effect as the double, or even much more, would do in a flat or broad faced hammer. It is not convenient, however, that it should be less than two pounds, and it need not exceed four. With hammers of these weights so constructed, almost every object of the mineralogist can be obtained. A weight of three pounds forms a convenient general size for most purposes; and, to facilitate the construction, I may add that, allowing the usual general size for the eye, or hole, the relative diameters of $3\frac{1}{4}$ inches by 2, of $3\frac{3}{4}$ by $2\frac{1}{4}$, and of 4 by $2\frac{3}{4}$, will, in the form here represented, give pretty nearly the weights of two, three, and four pounds, respectively.

The artist intrusted with the making of these hammers must be directed to pay attention to the particular form of the ellipsoid represented in the plate. If the longer diameter is made much greater than the short one, for the purpose of securing the necessary weight, the blade becomes too long, and it will have the fault of the mason's hammer. If the face, again, is made of a surface with too long a radius of curvature, it will strike on too large a portion of the rock at once, and part of the blow will be wasted.

There are some minor conveniences arising out of the form of this ellipsoid, which are worthy of notice. The steel cannot easily be struck off the face, as happens at the sides of flat-faced hammers when too much hardened; nor does it yield and turn over as when, in the same construction, they are too soft. The directness of all the blows prevents over-hardened steel from splintering; and, if too soft, a second blow replaces the vacuity which the first may have made. Thus also it retains a degree of smoothness which those will know how to appreciate who have suffered in their hands, their pockets, or their clothes, from the ragged edges of a worn hammer. The durability of such a hammer in practice, is in itself no small convenience; as a mineralogist is not always in a situation to get one replaced or repaired, and of this superior durability, my own experience has afforded ample proof. It is unnecessary for a breaking hammer to be provided with a cutting edge, as the great weight prevents any effectual use being made of it. That which is required is best done by a lighter trimming hammer; and thus also, the breaking hammer, having two faces, has double the durability.

I need scarcely add, that all handles should be made of ash, or vine, if it can be procured, and somewhat of a conoidal form, larger towards the hand, to prevent slipping; and, that to render hammers portable, it is convenient to have a loop of wire near the head, through which a strap may be inserted. This is represented in the sketch.

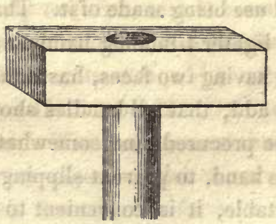
I have added another figure which I have, in practice, found very convenient, where a great weight is required. It is an oblate spheroid, with the polar surfaces cut away, as it is not found easy by the makers to apply the steel to a whole spheroid.



It is unnecessary to dilate further on the advantages of this form; as it is, for all purposes of use, a sphere. From the extent of face, it is almost eternal; and it is not difficult to construct, by welding a ring of bar steel on a nucleus of iron.

The drawings which accompany this communication, represent also the particular form of those hammers for trimming or shaping specimens, which I have found, in practice, to exceed all others.

The ordinary trimming hammer has two cutting edges only, one at each end, and placed in a reverse direction, or like an axe and an adze. Doubtless, this answers its purpose, but not equally well with the construction here represented.



In that there are only two edges, and they soon wear, as these hammers must be made of hard steel. In this there are, at first, four edges; and, as the handle may then be turned, there are thus acquired four more; so that each hammer of this construction is at least as durable as four of the former.

In mineralogical journeys this is particularly convenient, as a trimming hammer soon wears out, and the collector must then carry unnecessary weight, or perhaps fail entirely in procuring convenient and well-shaped specimens. In a collection of rocks, where the number and weight, and the room occupied, form so serious an inconvenience, the regular shape of a specimen is an object of no slight moment.

There is an additional advantage in this form of the trimming hammer, arising from the rectangular shapes of the edges, which renders them more durable than those of the axe-shaped hammer. I need scarcely say that they must be regular prisms, that the eye may see the edge which strikes, and that they must be entirely made of steel.

With respect to the weights of trimming-hammers, they must be proportioned chiefly to the weight of the specimen to be broken or shaped, or to the size of the fragments which it will be requisite to detach. They must also bear some relation to the fragility of the specimen; the most brittle requiring the lightest hammers. It is not possible to give any exact rules on this subject, but the general principle has already been stated sufficiently to show that it is only by the velocity of a small weight, or by the impulse, that fragments can be detached from any desired place without disturbing other parts of the specimen. The mineralogist should be provided with different weights, from a drachm to two ounces, and upwards; and his own experience will very shortly direct him to that which will produce the desired effect on any specimen or substance under trial. To facilitate the labours of the artist, I have thought it better to insert a scale of dimensions than of weights, for a set of such hammers, and they are as follows :—

Length of prism—Inches	Side of base—Inches
$1\frac{1}{2}$	$\frac{1}{2}$
$1\frac{3}{4}$	$\frac{1}{2}$.
$1\frac{3}{4}$	$\frac{5}{8}$
$2\frac{1}{4}$	$\frac{3}{4}$
$2\frac{1}{2}$	1

I may add, lastly, that when worn by use, the hammers of this construction are more easily repaired than the common ones; as, by grinding one face to a small distance downwards, four edges are at once replaced.

In concluding this paper, it will not be improper to suggest that the same principle might be advantageously extended to the ordinary hammers of quarrymen and masons, and more particularly to those of road-makers. The forms of these latter are almost in every instance very faulty, and the consequences are important, as they add double or treble the expense to that which is, in many places, one of the most costly parts of road-making. It is not only indeed in the shape, but in the use of the hammer, that the system of breaking stones for roads is defective. Independently of the fatigue of standing, the same velocity, or impulse, cannot be communicated by two hands as by one, from the crossing, or obliquity of the arms; and, with a single-handed hammer, sitting, one person can easily do the work of two standing, possibly more. This practice has indeed been partially introduced of late, but the prejudices against it are still very general. To render it perfect, the forms of the hammers should also be improved according to the principles already laid down; and the labourer should further be provided with a set of these, of different weights, using them in succession as the size of the materials diminishes under his hands.

Do not take out these leaves

I may add, lastly, that when worn by use, the hammers of the common form are more easily repaired than the common ones, as, by grinding one face to a small distance backwards, the edges are at once replaced.

In concluding this paper, it will not be improper to suggest that the same principle might be advantageously extended to the ordinary hammers of quarrymen and masons, and more particularly to those of road-makers. The forms of these latter are almost in every instance very faulty, and the consequences are important, as they add double or treble the expense to that which is, in many places, one of the most costly parts of road-making. It is not only indeed in the shape, but in the use of the hammer, that the system of breaking stones for roads is defective. Independently of the fatigue of standing, the same velocity, or impulse, cannot be communicated by two hands as by one, from the crossing, or obliquity of the arms; and, with a single-handed hammer, sitting, one person can easily do the work of two standing, possibly more. This practice has indeed been partially introduced of late, but the prejudices against it are still very general. To render it perfect, the forms of the hammers should also be improved according to the principles already laid down; and the labourer should further be provided with a set of these, of different weights, using them in succession as the size of the materials diminishes under his hands.

It may add, lastly, that when stones [illegible], the [illegible] of this construction are more easily repaired than the common ones; as, by grinding one face to a small distance downwards, the edges are at once replaced.

In concluding this paper, it will not be improper to suggest that the same principle might be advantageously extended to the ordinary business of quarrying and masons, and more particularly to those of mill-stones. The forms of these latter are almost in every instance very faulty, and the consequences are important, as they will double or treble the expense of that which is, in many places, one of the most costly parts of machinery. It is not only indeed in the shape, but in the [illegible] of the manner, that the system of working stones for mills is defective. Independently of the [illegible] of [illegible], the same [illegible] be accommodated by one [illegible]

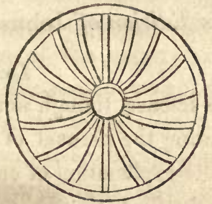
Art VI. *Account of an Optical Deception.*

[In a Letter to the Editor.]

Sir,

The optical phenomenon which I have here attempted to represent, may amuse those of your readers to whom it is new, and will probably serve to exercise the ingenuity of some in attempting its solution.

When a spoked wheel, such as that of a carriage, or the fly of an engine, is viewed in motion, through a series of vertical bars, the spokes assume the peculiar curvatures, respectively, which are represented in the annexed wood-cut



in a general manner. The upper and lower spokes, as they pass the vertical, are seen in their natural form, or perpendicular; but in all the rest a curvature will be observed, directed upwards on each side of the vertical, evanescent towards the upper one in particular, and attaining a maximum, as it appears to me, somewhere about that one on each side which occupies the middle of the two lowest quadrants.

It is indifferent for the production of this effect whether the wheel is running along a plane as it revolves, as in the case of a carriage driving through a street, and viewed through the ordinary iron railing, or whether, as in a fly wheel seen through a similar railing, generally erected in the stair-case of a steam engine, it merely revolves on its own axis. But I must observe that a certain relative distance between the two objects and the eye respectively is convenient; and that the effect is not very perceptible unless the velocity of the wheel exceeds a certain limit. With that velocity, the curvature of the spokes increases to a maximum, which is only limited by the total disappearance of the spokes in consequence of their rapidity

The general principles on which this deception is to be explained will immediately occur to your mathematical readers, but a perfect demonstration will probably prove less easy than it appears at first sight.

I am, Sir, your obedient servant,

J. M.

London, Dec. 1, 1820.

Art. VII. *A Letter to the Editor of the Quarterly Journal, respecting certain Inaccuracies and Omissions in the* Rev. Mr. Todd's *Edition of* Johnson's *Dictionary.*

Sir, *London, Nov.* 9, 1820.

Being attached to science, though not a scientific man, I am frequently obliged during the perusal of your Journal to revert to my dictionary for the explanation of certain terms with which I am not sufficiently familiar, though perhaps acquainted with their general import. Finding the definitions in the old editions of *Johnson* often meagre, and oftener incorrect, I purchased the new edition lately published by the Rev. H. Todd, in which, however, I was much dismayed by discovering very little improvement in the definition of scientific words, and more especially in those relating to chemistry; in too many instances erroneous definitions and meanings have been retained, merely, as it would seem, for want of a little trouble in referring to modern authorities; and on other occasions, the absurdities and jargon of old philosophers, are suffered to pollute and darken those pages which should have been adorned and enlightened by reference to modern discoveries. In the following pages I have in one column put down the word which I looked out, with its definition, as given in *Todd's Johnson;* and in another column the true meaning is given, with which I have been furnished by a scientific friend. From a numerous list I have selected a few specimens only, which, if you approve, and consider them correct and of any use to the possessor of the above Dictionary, I shall be happy to add to on another occasion.

I am, Sir,

Your constant Reader.

C.

Arsenic, a ponderous mineral substance, volatile and uninflammable, &c.	Arsenic, a volatile and highly inflammable metal; called *white arsenic* when in the state of oxide, and highly poisonous in all its combinations.
Chemistry. An art whereby sensible bodies contained in vessels, or capable of being contained therein,	Chemistry is the study of the effects of heat and mixture, with a view of discovering their general and

and views, contain the most important observations upon the geography of plants. On the other hand, however, it is very evident, that this subject, perhaps through the numerous avocations of the author, has received less attention, than from the interesting nature of the inquiry could be wished. It is scarcely necessary for me to add, that I entertain the greatest respect for the worthy author, and fully acknowledge his distinguished services to science in general, and to the geography of plants in particular. Nor have I any reason to think, that if you, Sir, should deem these observations not unworthy a place in your Journal, they will be displeasing to him. On the contrary, I am persuaded, that even the smallest contribution will be well received by one, who is so great an admirer of science; especially when it relates to a science, of which he is regarded as the principal founder.

I am, &c. &c.

Art. IV. *Hints on the Manufacture of Catgut Strings.*

[In a Letter to the Editor.]

Dear Sir, *Killin*, *Sept.* 15, 1820.

As no object connected with the arts is beneath your notice, you will perhaps give room to the following hint, on the subject of musical strings, particularly as it is founded on physiological considerations.

It has long been a subject of complaint, as well as a serious inconvenience to musicians, that catgut strings cannot be made in England of the same goodness and strength as those imported from Italy; an inconvenience which was experienced in a great degree during the late war. These, I need scarcely say, are made of the peritoneal covering of the intestines of the sheep; and, in this country, they are manufactured at Whitechapel, and probably elsewhere, in considerable quantity; the consumption of them for harps, as well as for the instruments of the violin family, being very great. Their chief fault is weakness; whence it is difficult to bring the smaller ones, required for the higher notes, to concert pitch; maintaining at the same time, in their form and construction, that tenuity, or smallness of diameter, which is required to produce a brilliant and clear tone. The inconvenience arising from their breaking when in use, and the expense in the case of harps, where so many are required, are such as to render it highly desirable to improve a manufacture, which, to many of your readers, may however appear sufficiently contemptible.

It is well known to physiologists, that the membranes of lean animals are far more tough than those of animals that are fat or in high condition; and there is no reason to doubt that the superiority of the Italian strings arises from the state of the sheep in that country. In London, where no lean animals are slaughtered, and where, indeed, an extravagant and useless degree of fattening, at least for the purpose of food, is induced on sheep in particular, it is easy to comprehend why their membranes can never afford a material of the requisite tenacity. It is less easy to suggest an adequate remedy; but a knowledge of the general principle, should this notice meet the eyes of those interested in the subject, may at least serve the purpose of diminishing the evil and improving the manufacture, by inducing them to choose in the market the offal of such carcases as appear least overwhelmed with exuberant fat. It is probable that such a manufacture might be advantageously established in those parts of the country where the fashion has not, as in London, led to the use of meat so far over fed; and it is equally likely, that in the choice of sheep for this purpose, advantage would arise from using the Welch, the Highland, or the South-down breeds, in preference to those which, like the Lincoln, are prone to excessive accumulations of fat. It is equally probable, that sheep dying of some of the diseases accompanied by emaciation, would be peculiarly adapted to this purpose.

That these suggestions are not merely speculative is proved by comparing the strength of the membranes in question, or that of the other membranous parts, in the unfattened Highland sheep, with that of those found in the London markets; and although a project for putting them to a practical trial, which was suggested some years ago at this place, has not succeeded, the failure must be attributed to the want of mercantile energy in the person to whom it was recommended. Sufficient proof has been afforded that the general principle is correct; but it would be too much to expect from a Highlander the activity or perseverance, required for the establishment of such a manufacture in his own country.

I am, Sir, your obedient servant,

J. Mac Culloch.

Art. V. *Observations on the Theory which ascribes Secretion and Animal Heat to the Agency of Nerves.* By W. P. Alison, M.D., F.R.S.E., *&c.*

As Dr. Wilson Philip has done me the honour to reply to some of the objections I stated to that part of his physiological doctrines which asserts the dependence of secretion on nervous influence, I must beg permission to say a few words in defence of my former paper, before proceeding to the proper object of this.

1. Dr. Philip speaks of the disadvantage under which I labour in this inquiry, in consequence of not being an experimenter. This consideration might have been urged with perfect justice, if I had taken upon me to put my readers in possession of any *new facts* in regard to the physiology of the nervous system, or of secretion; but as I have assigned myself, in these papers, the humbler office of correcting what appear to me to be unwarrantable inferences, that have been deduced from *facts already recorded*, I thought the fairest way of proceeding was to take the facts exactly as I find them stated by those who have observed them. If I have in any place misunderstood him, or any other author, or omitted any particulars which may be thought important, I shall most willingly take his corrected statements of the facts, as the basis of my reasonings; and I admit, without hesitation, that if these reasonings shall not hold, in reference to those *corrected statements*, they are of no value. My object is merely to determine what inferences in regard to

the connexion of the nervous system with the *organic functions** of the body are warranted by the facts that we possess; and, in particular, to state the doubts that have occurred to me in regard to the doctrine, that a constant agency of nerves is concerned in the performance of these functions. If it shall appear, that opinions have been prevalent on this subject, which are not only not proved, but are rendered exceedingly improbable, by knowledge already in our possession, it must be admitted that it is important, *as a preliminary to farther investigation of the facts*, to have these opinions corrected. And on the other hand, if the objections which I state are founded on erroneous or imperfect notions of the facts that have been observed, these facts may be easily stated in such a way as to obviate the objections, and to shew, beyond doubt, that the conclusions have been fairly deduced from them.

2. Dr. Philip thinks, that in asserting "that in the muscles of involuntary motion, the nervous influence produces an alteration in the vital power or tendency to contraction," I have advanced an opinion altogether new, and untenable.—Now I object to the term *nervous influence* on this as on other occasions, on account of its vagueness, and of its apparently implying a theory, the truth of which I very much doubt. But the statement, which I made, that the vital power, or tendency to contraction of muscular fibres, and particularly of the involuntary muscles, may be altered or even destroyed, by *impressions made on the nervous system*, is one, the correctness of which I apprehend Dr. Philip could not have disputed, if he had not misapprehended my meaning in the above sentence; because my intention was, not to advance a speculative opinion, but to express a general fact, the truth of which is no where better illustrated than in his own works, although his mode of expressing it seems to me objectionable.

Dr. Philip (pp. 243, 244) refers to twelve experiments of his

* By the term organic functions I mean those which take place in the natural state, without the intervention or consciousness of the mind.

Lastly, as to the sources and origin of coal. Upon these subjects geologists, as usual, have amply indulged their inventive faculties. Every thing tends to show the vegetable origin of coal, and a regular succession might be shown, commencing with wood, little changed, and ending with coal, in which all traces of organic texture are lost. Yet even in the most perfect coal we frequently find some relic, some trace of a vegetable, or some remains of fibrous texture that announces its ligneous origin. In the leaves that occur in Bovey coal, Mr. R. found resin and extractive matter; and what is more to the purpose, he found a substance having properties intermediate between resin and bitumen, and therefore partaking partly of vegetable and partly of mineral characters; and more lately the same substance has been found in the principal coal field of Staffordshire. Perhaps, therefore, antediluvian timber and peat bog may have been the parent of our coal strata, but then, how has its immersion been effected; is it merely by the agency of water, a kind of decay and rotting down of the wood; or has fire been called into action, torrefying the vegetable matter, and has the pressure under which this heat has operated prevented the escape of volatile matters, and caused them to assume the form of bitumen; and are those reservoirs of compressed carburetted hydrogen which I have mentioned as causing *blower*, to be ascribed to such mode of formation? The discussion of these subjects might be prolonged, but it would end in nothing satisfactory. The theories that have been invented to account for our coal formations are full of weak and assailable points; the further we pursue them, the less do they satisfy us, and the more discordant do they seem with the phenomena they are intended to explain.

We should almost conclude, from the dogmatical air of some writers upon this subject, that they had seen the agents they speak of in active operation; that they had fathomed the depths of the globe, and measured its central heat; but if we compare our planet to an orange, and remember that we have not as yet penetrated its rind; if we compare it to the pasteboard globe of the instrument-maker, and remember that we have scarcely peeled the paper from its surface; these considerations should alone be sufficient to check the presumption of the theorist, and set bounds to the arrogance of hypothesis.

Art. *On a peculiar Appearance exhibited by Hoar Frost. By* J. Mac Culloch, M.D., F.R.S.E., &c.

It has long been known that dew, as well as hoar frost, has a tendency to attach itself to particular bodies, rather than to others, and to rough surfaces in preference to smooth. Hence also it is found that hoar frost, which, from its permanence, is more easily examined than dew, is frequently deposited on acute edges and points, when the flat surfaces of the same bodies continue bare. I need not notice the speculations which have been entertained respecting the connexion of this phenomenon with electrical agency; but it is also obvious that the attachment of hoar frosts to strings, edges, and points, bears a striking analogy to that which occurs in many cases of the ordinary crystallization of salts from solution in water, where the preference is so often given to bodies of these forms as the first bases of attachment.

The causes which influence this mode of disposition, are as much unknown as is every thing that relates to this mysterious process. It is to little purpose to form conjectures, or to propose hypotheses on this subject; but it is not useless to record any facts, which, by their accumulation and ultimate comparison, may tend to throw light on it; and, with this view, I transmit to you the enclosed sketch of a crystallization, or rather a deposit, of hoar frost, which is remarkable for its singularity, and which has not, as far as I know, been hitherto noticed by those who have paid attention to these subjects. As it will tend to save much explanation in words, and will at the same time render the appearance in question much more intelligible, I send you the sketch precisely as it was made on the iron railing of the door-way where I at first observed it.

Crystallization of Hoar Frost on an Iron Railing.

The temperature was little less than the freezing point, and there was a moderate fog with a high barometer, and an easterly wind; but no other meteorological phenomena were observed, nor had I any opportunity of examining the state of the atmospheric electricity, being far from home and casually visiting in Portland-place, where this sketch was made.

Although the general effect of the distribution of this deposit of ice, is sufficiently visible in the drawing, it will require a few words of explanation. The points did not consist of single crystals, but of pyramidal bodies, formed of crystals so minute and entangled, that their forms could not be discovered by the lens. They were about the sixth of an inch in length, and distant from each other by a space equal to the breadth of their bases; conjecturally, about the 30th of an inch. Where they were attached to the salient angle, or edge of a bar, they were at right angles to its line, and at the same time equidistant at the summits from each of the including planes, so as to form an angle of a 45 degrees, with their surfaces on each hand. This distribution was maintained in the same manner in those parts of the iron-work which consisted of curved or circular parts; so that each group, or pyramid, was invariably placed at right angles to the tangent of the curve at that part, or in the direction of the radius of curvature. Hence it appeared, at first sight, that the effort of each pyramid consisted in an attempt to recede as far as possible on each hand, not only from the planes, but from the edge; and thus to attach itself at right angles to the latter. The same effect also took place in the interior as in the exterior of the curved parts; and thus the whole was ciliated like the leaves of some plants with a regular and beautiful fringed work.

The singularity of this appearance exciting my attention, I was induced to examine it more narrowly for the purpose of seeing how the pyramids would dispose of themselves among the more intricate parts of the iron-work. It was found, in consequence, that where any two edges of a bar met at right angles, the crystals formed at an apex occupied the direction of the diagonal of the cube which was formed by the union of the bars, or maintained a distance equally removed from the edge of the joint on the one hand, and from the plane at right angles to it on the other. But the crystals on the two meeting edges, where nearest to the apex, did not immediately assume a rectangular position towards these edges; diverging gradually in succession from that on the angle till they assumed the regular position which they held on the remainder of the edge.

In the re-entering, or internal angle of the same joints, the crystal of the angle was also prolonged according to the diagonal of the cube; and here the crystals, intermediate between that and those which stood at right angles to the internal edges at a short distance, were so arranged as, in maintaining an equal distance at their bases, not to touch at their summits. Thus they all converged for a short space round the interior diagonal crystal, as, on the exterior, they diverged from it, in the manner represented in the sketch.

Where two planes met at a right angle, similar arrangements took place; the crystals, whether on the external, or within the internal angle, occupying a direction equidistant from the planes on each side.

This arrangement equally occurred when the angles of meeting of approximate edges or planes were greater or less than right angles, the equidistant position being regularly preserved; while, in the case of the interior angle formed by planes, any contact of the summits of the crystals was invariably avoided. Hence in those cases where very acute interior angles happened to exist, the crystals became so shortened, for the purpose of avoiding a contact between those on the neighbouring edges, that, near the extreme point, they at length vanished.

In all other more complicated cases of the meeting of the parts of the iron-work, the same general rules were found to prevail. In every part, in short, however intricate, where the crystals were formed, they seemed endued by a repulsive power, in consequence of which they tended as far as possible to recede equally from all the plane surfaces and edges in their vicinity, and, at the same time, to avoid any contact with each other.

It will be suggested that this repulsive property depended on some electrical condition, as we are not acquainted with any other power by which it can be explained; but it is not easy to assign that modification, or mode of action of this mysterious power, by which the effect could have been produced. I cannot pretend to suggest any solution of this appearance, and am better pleased to leave it thus recorded among the numerous insulated and inexplicable facts in science, of which the explanation will at some future time appear as simple as it now seems difficult.

I need only add that, on the same forenoon, all the iron rail-work, which I examined for this purpose, between Portland-Place and Great George-Street in Westminster, exhibited the

Appearance exhibited by Hoar Frost

same appearance; but that I had never observed it before, and have never seen it since the winter of 1818, when this note was made.

The sketch only pretends to represent the general effect of this appearance to the eye. To have given the true position of the crystallization with respect to the sides of the bars, would have required a more highly finished engraving than was here admissible. A section of a bar is added for that purpose. All these intricate appearances, which it was thought unnecessary to represent, may easily be understood from the description.

Art. VIII. *A Letter from* A. Copland Hutchison, Esq., *to* Sir Everard Home, Bart., *containing an Account of a successful Case of the High Operation for the Stone.*

[Communicated by Sir Everard Home, Bart.]

Dear Sir, *8th August*, 1825.

As your two successful cases of the high operation for the stone, published in the third vol. of *Strictures*, have encouraged me to adopt that mode of operating; and finding, also, that you have since that time operated in the same manner twice at St. George's Hospital; these being the only cases, I believe, that have occurred in England since the days of Cheseldon*, I am induced to send you an account of the following case and operation, with full permission to make any use of it you may think proper.

* In one case upon a man 54 years of age, October 29th, 1824, in which the stone was extracted entire, weighing about 3½ ounces, though its texture was so loose beneath the external crust, that it afterwards broke to pieces in the hands of a gentlemen who was examining its surface. In this case the patient died on the third day after the operation; but upon examination after death, the operation, in itself, was not considered the cause in any other way than the bladder having suffered by disease from the presence of the calculus, as not to admit of his recovery.

The other case was a boy eleven years of age; the operation was performed on the 3d December, 1824, and the patient got well, though the wound, from his bad state of health, did not completely heal for two months. From his

ON

BLACK LEAD FROM CAST-IRON.

In a Letter to Dr Brewster.

By J. MACCULLOCH, M. D. & F. R. S. &c.

From the Edinburgh Philosophical Journal.

Dear Sir,

In compliance with your request, I send you the following statement respecting the Black Lead which is obtained from cast-iron, various detached notices of which has already appeared in your Journal.

It is more than twenty years since I was in the frequent habit of examining the metal of the iron guns delivered by the contractors to the Ordnance, by solution, according to Bergman's suggestion on this subject. No useful results, as far as our particular objects were concerned, were, however, obtained in this way; as it was found that the quantity of plumbago in the iron bore no relation to the strength or goodness of the metal, which, I need not say, is metal of the second fusion, or from the reverberatory. The results were, however, sometimes curious, from the very variable quantity of this substance contained in different specimens of iron.

It has been imagined that the worst, or weakest metal, was that which contained most plumbago; but the trials were far from confirming this opinion. On one occasion, in particular, a gun had been condemned for some fault in the bore, (a screw hole, I believe,) and it was found to be so exceedingly tough, that none of our men were able to break off a trunnion, as is the usual practice in these cases, when three or four blows of the sledge were commonly found sufficient for this purpose. I was particularly induced, therefore, to examine this specimen, and was surprised to find that it not only contained a most unusual proportion of plumbago, but that this was in what I may call a disengaged state, for want of a better term. The plumbago was not only visible on breaking the metal, giving it the appearance of having been rubbed with powdered black lead, but the iron was capable of leaving its trace on paper. I have neither before nor since ever met with another example of this kind. The remaining guns of this lot, which must have been made of the same metal, went on service, and some of them are probably still existing. I have no doubt that they were the best that we received during the war; and it would have been very desirable to have discovered by what means this very uncommon specimen of gun-metal had been procured, as its toughness is a matter of such importance. It was from Mr Walker's foundery.

I do not pretend to account for this singular state of the iron; as, although the presence of plumbago is sufficient to affect the colour of the metal, it is never, bating this instance, distinctly visible, as far as my experience goes. Yet, in gun-metal, it is easy to conjecture its presence and proportion, by the colour of the fracture; which is darkest or most grey, where it is most abundant. The trials which I have made, also go to prove that the greyest metal is the toughest; although I know that many iron-founders consider that gun-metal may be too grey, and act on this principle in the assortment of the pigs for the reverberatory.

I ought to add now, that, on dissolving gun-metal in an acid, the black lead was always obtained in the state of powder, and that it is in very small proportion when compared to that obtained from pig-iron. I am sorry that I cannot now state these proportions, as the records of my experiments are out of reach at present.

It is perhaps unnecessary to say that the inferior proportion of plumbago in gun-metal, arises from its approximation nearer to the malleable state than pig-metal, or from its greater purity. The best malleable iron contains none, and a great part of the process of refining iron consists in the combustion of this substance; whence in some degree the loss of weight.

During these trials I was led to repeat the same experiments on the pig-metal used for shells, which is of various qualities, and is generally distinguished into three kinds, white, grey, and black. All these afforded very large proportions of black lead after solution, but still various in different specimens. The black metal seemed to afford the greatest quantity, as might have been expected from the colour; and yet that is no criterion, as the most brilliant silvery metal also afforded it in abundance, where, if colour had been a necessary indication of its presence, it would not have existed. I think it will appear that the plumbago is present in two different states in iron. It will hereafter be shewn, that it is sometimes in the state of a metal, and this I conceive to be its form in the white pig. At the other extreme it is found in the state of black lead, as in the gun-metal just mentioned. But the experiments hereafter to be described will shew, that there is some intermediate state (or states) between the two; and this appears to be its condition in the grey and black pig.

I must now observe, that, in these experiments on pig-iron, the black lead was always found in the state of powder, or at least in such a state as to fall into powder easily. This must have arisen from using sulphuric acid, as the cheapest, and from using it too strong. Thus the matter rested. In 1807 or 1808, I was requested to go to a London porter brewery, to see an appearance which had very much surprised the people employed in it, and which had certainly a very marvellous sound in the narration. The workmen had taken some iron out of their porter backs in making some repairs, and had found it red hot, as they said, to their infinite astonishment. On closer examination, the red heat was found to be an exaggeration. But, on removing the iron articles in question from the porter, they became so hot on scraping off the surface that it was disagreeable to handle them; while they smoked, from the evaporation of the moisture.

These pieces of iron were cast cones, perforated with holes, and about an inch thick, being used as strainers, to prevent foreign substances from getting into the pipes. They had been immersed in the porter for many years,—no one knew how many. On examining them, they appeared entire and unchanged; but some of them, instead of being iron, were entirely of black lead; and, in others, there was a thick coat of that substance on each side, a little iron only remaining in the middle.

As this was then a new phenomenon in chemistry, I was induced to repeat the experiment in the laboratory, and it was attended with the same results, after some failures. An accident, however, occurring about this time, shewed me that the fact was not so new as I had imagined, and I therefore took no notice of it in public. Since that it has been observed by many persons, who all probably imagined, with as good reason, that they had made the same discovery. As many of these accounts have appeared in your own Journal, I need not refer to them more particularly.

The circumstance to which I allude was the following, which I happened to meet with in one of my journeys in the Western Islands.

After Captain Roe had invented the diving-bell, he joined Sir Archibald Grant, a great speculator of that day in coal-mines and other matters, in an attempt to weigh the Florida, one of the Spanish Armada, which had foundered off the coast of Mull, near the entrance of Tobermory harbour; she having been taken by the natives, assisted by some treachery on the part of the crew, which is said to have hung up the Captain at the yard-arm. There her timbers are still lying.

This attempt, which took place in 1740, was unsuccessful, as far as related to the ship; but some guns both of brass and iron were brought up. The former, whether they belonged to the Spanish vessel or not, had the mark of an English founder, R. and J. Phillips, 1584, with a crown and E. R. on them. The iron guns were deeply corroded, and on scraping them, it was said that they were found so hot that they could not be touched, and that they did not become cool till they had been two or three hours exposed to the air.

The astonishment of the Highlanders on finding guns still hot, after having been more than a century under water, may easily be imagined; and it is not surprising that the story was not believed, and that not being believed, it was forgotten. This may afford us an useful hint on the subject of physical incredulity: since, assuredly a fact thus nakedly stated, without a knowledge of the explanation here given, must have been pronounced impossible by every one, chemist or not. I escaped this, however, as the circumstances above mentioned had put me in possession of the solution before the tale, which proved a very agreeable and unexpected confirmation of my own experiments.

I may now state the general result of the experiments. The blackest pig-metal appears to yield the greatest quantity of black lead, and in the most solid state. When the experiment is complete, the produce equals the iron in bulk, and is a solid mass, capable of being cut by a knife, even into pencils; but, as far as I have ever observed, it is of a much more coarse grain, or scaly granular texture, than any natural black lead that has occurred to me.

To procure it in perfection, the acid should be very weak, and the operation is then necessarily very tedious. Acetous acid appears to be the best, and it is by this that it is produced in porter-backs, in the waste-pipes of breweries, and in calico-printing-houses, where sour paste is employed. The process by water is insufferably tedious. Very dilute mineral acids also succeed; but, with these, one of the results is sometimes not obtained.

If the experiment is perfect, the black lead becomes hot on exposure to air, smoking while there is any moisture to be evaporated, particularly when the surfaces are scraped off in succession, so as to give access to the air. Oxygen is absorbed in this case; yet, as far as I have perceived, the eye cannot detect any difference in the appearance of the black lead before and after this operation. In those instances where the substance does not heat, on being taken out of the fluid, it appears to arise from the whole process of oxygenation having been performed in the solution, and probably from an excess of strength in the acid.

The theory of this experiment appears very plain, and it proves, with tolerable certainty, what has been supposed, but what has not yet been proved in any other way, namely, that plumbago is a metal, and black lead its oxide, if I may be allowed to use that term for the present, instead of carbon.

In white-pig, as already suggested, it is probable that the combination is pure plumbago and iron. In the black, the colour would lead us to imagine, that there was already an approximation to black lead. The operation of the acid, in either case, is to dissolve the iron, and to oxygenate the plumbago, so as to convert it into black lead. Thus, when in small quantity, it is obtained in the form of powder, when very abundant, in a solid state. If the acid is strong, the whole operation is completed in the solvent; otherwise some additional oxygen is required to produce in it a state of rest or permanence in the air; and this takes place by a species of combustion, generating the heat in the experiment, analogous to that which occurs with the alkaline bases.

Thus, black lead is an oxide of plumbago, or of carbon, if we choose to use this term for the presumed element. It is scarcely necessary to say that the metallic nature of the base of charcoal is proved by the same experiment. Nor need I say that iron is not a necessary ingredient in black lead. The best kinds, indeed, are those which contain least.

This experiment, and these conclusions, would be much more satisfactory, if we could produce the metal of black lead in its separate state. No method of doing that has yet occurred to any one; and it will probably be found a very difficult problem, as this is evidently a highly combustible substance. But chemistry does so much every day that once appeared hopeless, that we have no reason to despair.

If the foregoing reasoning respecting the metallic nature of this substance, should be deemed unsatisfactory, the following argument may be added.

The specific gravity of pig-iron is about 7.6, and that of black-lead is 2, or less. Now, the bulk of black-lead procured in this experiment, is equal to that of the original iron exposed to solution. Two such bodies could not co-exist in the same space; or, if that could be imagined, the specific gravity of such iron must be far more different from that of pure iron than it is. If pure iron, indeed, is freed from the effects of condensation by heating, it scarcely differs in specific gravity from pig-metal. Thus, while we conclude that the plumbago combined with the iron is a metal, we may also infer, that the specific gravity of that metal is not very different from that of iron.

A problem has long been held out, namely, that of making black-lead by an artificial process. This may be considered as now solved in a certain way. I attempted to improve its quality by heating, in the usual manner, but with indifferent success. It may be procured, however, so compact, as to cut into pencils, as formerly observed; but I never could free it from the brown colour which it gives to paper, arising from some rust which it retains. Whether this could be effected or not, seems a matter of indifference, as far as economical purposes are concerned; since it could not be produced so cheap in this manner, as to compete in the market with mineral black-lead.

I may conclude this communication with remarking, that the effects of heat on black-lead, as well as on charcoal, are, in some measure, explained by the views here held out. If soft black-lead, which yields a black as well as a soft streak, be heated without burning, it diminishes in bulk and increases in specific gravity, while it becomes hard and gives a pale streak. This is the process used in making hard and pale pencils; and it appears to consist in the loss of a portion of oxygen, or in the reduction of the black-lead, to a state somewhat nearer to that of metallic plumbago. Thus, in drawing, artists harden the points of their soft pencils in the flame of a candle.

Something very similar to this happens in charcoal. After giving out hydrogen it becomes harder and more brilliant; so as, from only scratching the softer metals, to become capable of corroding glass. In this state it loses one at least of its valuable qualities, so as to be no longer fit for making gunpowder. Naturally, some woods produce hard charcoal, and others a soft kind; and the latter alone are fit for this purpose. But the softest may be injured by over heating, or they can be reduced to this hard state; so that the wood of the willow or alder may become as bad as that of the oak. This is an accident far more likely to happen in the method of charring in retorts, than in the common way of making charcoal in pits; although that process is always used in the gunpowder manufactories. It is for the same reason that animal charcoal, or that of coal, will not make gunpowder. Both of these are hard and brilliant; and the former, in particular, has sometimes a pseudo-metallic lustre, equal to that of black-lead. The chain of analogy is thus extended among all these substances:—but it is time to terminate this communication. I am, yours, &c. &c.

J. MacCulloch.

Edinburgh, *July* 1822.

Art. XIX.—*Account of the Method of colouring Agates.* By John MacCulloch, M. D. M. G. S. Lecturer on Chemistry to the Board of Ordnance, &c. In a Letter to Dr Brewster.

In compliance with your request, I here send you the circumstances which I am able to recollect respecting the colouring of

* We have just seen a work in two volumes quarto, published at Rio de Janeiro, in 1817, entitled "Corographica Brazilica," certainly the most important literary production which Brazil has hitherto afforded. It contains a pretty accurate description of the geography of the country, of its various tribes of original inhabitants, and treats fully of its moral and political condition; but the natural history is considered in a superficial and unscientific manner.—Ed.

agates by artificial means. It would be necessary to re-examine a collection of these substances, and to repeat some of the experiments on them, to determine the extent to which this art may be carried, and the exact nature of the varieties which are susceptible of the changes in question. As the discovery of the internal structure of agates is your own, no one is more competent than yourself to make these further inquiries, from which I am at this moment precluded.

It has long been known, that zoned agates, formed of laminæ alternately black and white, were brought from India; but it is only since the peace that the same substances have been imported from Germany in considerable quantity; in consequence of which their value has fallen to little more than the price of cutting. These latter are coloured by an artificial process, which is a kind of secret in the trade, and it is not improbable that the specimens from India are produced in the same manner, as the natives of that country possess the art of staining the same minerals white. As the lapidaries are not acquainted with the theory of their process, they are very subject to failures, which also arise at times from the nature of the stones being unsusceptible of the colouring process.

The common process consists in boiling the cut specimens in sulphuric acid; in consequence of which, a particular lamina, or set of laminæ, is rendered black, while others retain their natural colour, or even become whiter than before, thus producing that powerful contrast which is esteemed valuable in this stone. This process often fails, and will always fail, if tried on specimens which have not previously been cut on the lapidaries' wheel. It is, in fact, produced by the action of the sulphuric acid on the oil which has been absorbed by the stone in cutting, and can therefore very obviously be insured, by previously boiling in oil the specimens which are to be subjected to the blackening process. That this is the fact is proved, if proof were necessary, by the disengagement of sulphurous acid gas, which takes place during the action of the acid. To insure success, therefore, it is evident that either the application of the oil must be continued for a sufficient length of time, or that the stone be cut so thin as to admit of its being penetrated by it before the sulphuric acid is applied. You will easily see, that this absorbent property of agates explains the fact of their being occasionally blackened by sulphuric acid, so as to have led chemists to imagine that they naturally contained some carbonaceous matter; and it was a knowledge of this circumstance which led me to subject to long boiling in a solution of potash, those specimens in which I suspected vegetable remains to be entangled, before applying to them the test of sulphuric acid.

The fact itself is curious in another point of view, as it indicates the porosity of agates, and is nearly connected with your interesting discoveries respecting their internal structure. In examining the specimens which are to be subjected to this treatment, it is in the first place evident, that the future changes are not indicated by the colours, as the red, or otherwise coloured laminæ, sometimes become black, while in others the opaque white, or the transparent, are affected. In the few specimens which I possessed at the time I was engaged on this subject, I had no means of determining in what respect the change was connected with apparent differences in the internal structure, and I can only now suggest it to you as a subject for examination. In most zoned agates, some of the laminæ will be found exempt from any apparent internal structure, while in others the appearance of undulating fibres is evident, the fibres themselves varying materially in size. If any conjecture were to be formed *a priori*, it would be expected that the most distinctly fibrous laminæ were the most porous; but it is unnecessary to offer conjectures on what you may so easily put to the test of experiment.

Having mentioned the Indian practice of colouring agates white, it may be remarked, that this is also a secret in the hands of lapidaries, although apparently not generally known to them, and but little practised. Beads of carnelian are sometimes brought from India, ornamented with reticulations of a white colour, penetrating to a small depth within the stone, and equally hard. The black agates of this kind, which are sometimes coloured with complicated or fine lines of white, are often very singular, and, without a knowledge of the mode in which they are produced, have a very puzzling appearance.

They are thus coloured by applying carbonate of soda, and exposing them to the heat of a furnace or a muffle. An opaque white enamel is thus produced, which appears as refractory to steel as the original stone, and cannot easily be distinguished from a natural lamina of white, when used, as it has sometimes been, for producing flat specimens for cameos. By either of these modes, indeed, stones for engravers' work are easily formed, but in the method of blackening the susceptible lamina by sulphuric acid and oil, the effect is more brilliant, and the contrast of the black and white more decided.

BANFF, *July* 1819.

ART. XX.—*Account of some important discoveries in Magnetism, recently made by* P. BARLOW, Esq. one of the Professors of Mathematics in the Royal Military Academy, Woolwich *.

THE Treatise on the Variation of the Compass, lately published by Mr Bain, and the magnetical observations made by Captain Ross and Captain Sabine, in the Arctic Regions, have turned the attention of men of science to the deviation produced by the action of the ship upon the needle of the compass. That eminent mathematician Dr Thomas Young, has constructed a formula and a table from the experiments made on board the Isabella, by which an approximate measure of the deviation may be obtained. Lieutenant Robertson of the Isabella, has also deduced general rules for the same purpose, and Mr Barlow, in investigating the subject experimentally, has been led to several interesting and important results, which could not have been anticipated from the known laws of the distribution of magnetism.

At the commencement of this inquiry, his intention was to avail himself of the favourable opportunity furnished by the immense masses of iron contained in the Royal Arsenal at Woolwich, to make some experiments, with a view of sub-

* Through the kindness of one of our correspondents, who has seen Mr Barlow's experiments, and from other sources of information, we are enabled to present our readers with this early notice of them. Mr Barlow's paper was read at the Royal Society on the 20th May 1818, and will probably appear in the next part of the Transactions of that distinguished body.—ED.

Effect of Iron at different Degrees of Heat on the Compass.

No. of Exp.	Description of bar. 25 in. long, $1\frac{1}{4}$ in. square.	Height or depth of centre of bar from compass.	Distance of bar from compass.	Position of Compass.	Effect Cold.	Effect White Heat.	Effect Red Heat.	Effect Blood Red Heat.
		Inch.	Inch.	°	° ′	° ′	° ′	° ′
* 1	C. B. No. 1.	0.0	6.0	S. 80. W.	+ 0 0	0 0	— 17 0	0 0
2	M.B. No. 2.	4.5 below.	6.0	ditto.	+ 30 0	ditto.	0 0	+ 45 0
3	C. B. No. 2.	4.5 below.	6.0	ditto.	+ 18 0	ditto.	0 0	+ 49 0
4	M.B. No. 1.	ditto.	6.0	ditto.	+ 29 30	ditto.	— 12 0	+ 44 0
5	ditto.	13 below.	6.0	ditto.	Not obs.	ditto.	0 0	+ 52 0
6	ditto.	4.5 below.	6.0	N. 80 W.	ditto.	ditto.	— 12 30	+ 70 0
7	ditto.	4.5 above.	6.0	S. 80 W.	ditto.	ditto.	— 12 30	+ 30 0
8	ditto.	ditto.	6.0	ditto.	ditto.	ditto.	0 0	+ 25 0
9	ditto.	ditto.	6.0	ditto.	ditto.	ditto.	— 19 0	+ 30 0
10	ditto.	1.0 above.	6.0	ditto.	ditto.	ditto.	— 15 0	+ 4 0
11	M.B. No. 2.	12.5 below.	8.5	N. 80 W.	+ 29 30	ditto.	0 0	+ 37 30
12	ditto	ditto.	8.5	N. 80 E.	+ 30 0	ditto.	0 0	+ 41 0
13	C. B. No. 1.	12.5 below.	8.5	N. 80 W.	+ 16 0	ditto.	0 0	+ 42 30
14	ditto.	ditto.	8.5	N. 80 E.	+ 15 30	ditto.	0 0	+ 47 30
15	M.B. No. 2.	9.0 below.	8.5	N. 80 W.	+ 28 30	ditto.	— 1 0	+ 39 30
16	ditto.	ditto.	8.5	N. 80 E.	+ 29 30	ditto.	— 1 30	+ 42 0
17	C. B. No. 1.	9.0 below.	8.5	N. 80 W.	+ 15 45	ditto.	— 1 30	+ 45 0
18	ditto.	ditto.	8.5	N. 80 E.	+ 16 0	ditto.	— 1 30	49 0
19	M.B. No. 2.	6.0 below.	8.5	N. 80 W.	+ 25 0	ditto.	— 3 0	+ 32 30
20	ditto.	ditto.	8.5	N. 80 E.	+ 26 0	ditto.	— 3 30	+ 33 0
21	C. B. No. 1.	6.0 below.	8.5	N. 80 W.	+ 11 30	ditto.	— 3 30	+ 36 30
22	ditto.	ditto.	8.5	N. 80 E.	+ 13 0	ditto.	Not obs.	+ 36 30
23	M.B. No. 2.	3.0 below.	6.0	N. 80 E.	+ 8 0	ditto.	— 21 30	Not obs.
24	ditto.	ditto.	6.0	N. 45 W.	Not obs.	ditto.	— 25 30	+ 25 30
25	M.B. No. 1.	0.0	6.0	ditto.	0 0	ditto.	— 40 0	0 0
26	M.B. No. 2.	1.0 above.	5.3	N. 60 W.	+ 2 0	ditto.	— 4 30	+ 5 30
27	M.B. No. 1.	ditto.	5.3	ditto.	Not obs.	ditto.	— 12 30	+ 5 30
28	M.B. No. 2.	9.0 above.	6.0	N. 85 E.	+ 47 30	ditto.	— 2 30	+ 60 0
29	M.B. No. 1.	ditto.	6.0	ditto.	+ 47 30	ditto.	— 2 30	+ 60 0
30	M.B. No. 2.	1.0 below.	5.5	N. 45 W.	Not obs.	ditto.	— 55 0	+ 5 45
31	M.B. No. 1.	4.5 above.	7.0	N. 75 E.	ditto.	ditto.	— 2 30	+ 33 30
32	M.B. No. 2	1.7 below.	5.5	N. 45 W.	ditto.	ditto.	+ 100 0	+ 13 30
33	M.B. No. 1.	1.7 above.	5.5	ditto.	ditto.	ditto.	— 26 0	+ 13 30
34	M.B. No. 2.	1.7 above.	5.5	ditto.	ditto.	ditto.	+ 30 0	+ 13 30
35	M.B. No. 1.	4.5 above.	6.0	N. 55 E.	ditto.	ditto.	— 5 30	+ 35 30
36	M.B. No. 2.	ditto.	6.0	ditto.	ditto.	ditto.	— 0 0	+ 35 30
37	M.B. No. 1.	0.0	4.7	West.	+ 3 30	ditto.	— 50 0	+ 8 0
38	M.B. No. 2.	0.0	4.7	North.	0 0	ditto.	0 0	0 0

* No. 1. South end drawn to the bar at red heat.
No. 6. This bar being left standing, it attracted the same three days after.
No. 8. The needle suspected to touch the box.
Nos. 11. to 24. Observed at the same time with two compasses.
No. 25. N. end drawn to the bar at red heat. No. 26. Attractions very gradual.
No. 27. Passed suddenly to $12\frac{1}{2}$°, but returned immediately.
Nos. 28. and 29. Attractions gradual.
No. 30. Negative attraction rather sudden. No. 31. Motion of needle very slow.
No. 32. 100° very sudden, returned immediately. No. 33. Both attractions gradual.
No. 34. The same as No. 32; both anomalous. No. 35. Attractions very gradual.
No. 37. Motion regular, but quick. No. 38. No motion in the needle.

Art. X.—*On preserving Fish by Sugar.* In a Letter to Dr Brewster from J. MacCulloch, M. D. and F. R. S., &c. Communicated by the Author.

Dear Sir,

As you have not scorned to give your readers a useful notice respecting the preservation of meat by the use of vinegar, you may possibly not refuse to add to it some remarks on the curing of fish by means of sugar. This is a very antiseptic substance, as is well known; and though partially employed in hams, it is scarcely considered, as what it really is, one of the most active substances in their preservation, being rather employed blindly, and with the notion of giving flavour. It is highly deserving of a much more extended trial, particularly in the curing of meat for the Navy; as it does not, like salt, destroy the provisions, and as it is in itself nutritious.

But to return to the subject of this notice: Fish may be preserved in a dry state, and perfectly fresh, by means of sugar alone, and even with a very small quantity of it. I have thus kept salmon, whitings, and cod, for an indefinite time, and with the best effect; an experiment which I was led to try in voyaging among the Western Islands, where matters of this nature are often of considerable moment.

Fresh fish may thus be kept in that state for some days, (but I know not how long), so as to be as good when boiled as if just caught. If dried and kept free from mouldiness, there seems no limit to their preservation; and they are much better in this way than when salted. The sugar gives no disagreeable taste.

This process is particularly valuable in making what is called Kippered Salmon; and the fish preserved in this manner are far superior in quality and flavour to those which are salted or smoked. If desired, as much salt may be used as to give the taste that may be required; but this substance does not conduce to their preservation.

In the preparation, it is barely necessary to open the fish, and to apply the sugar to the muscular part, placing it in a horizontal position for two or three days, that this substance may penetrate. After this it may be dried; and it is only further necessary to wipe and ventilate it occasionally, to prevent mouldiness.

A table spoonful of brown sugar is sufficient in this manner, for a salmon of five or six pounds weight; and if salt is desired, a tea spoonful or more may be added. Saltpetre may be used instead, in the same proportion, if it is desired to make the kipper hard.

Trusting that I have taught you how to improve a Highland breakfast, I am, &c. J. MacCulloch.

Edinburgh, *July* 1822.

Art. XI.—*Account of the* Mémoires de la Société de Physique et d'Histoire Naturelle de Geneve.

THIS is the first part of a volume of natural and physical science, published by a society of "Savants" of Geneva. The society itself was constituted so far back as the year 1790, and many of the communications made to it, have, from time to time, been given to the public in different scientific journals, or in the particular works of their respective authors. By the present publication, it aspires to a more permanent character, and seems destined to take no mean station among the various philosophical societies and scientific institutions of Europe. Among its members we recognise many names already highly distinguished in the scientific world, and others which, though at present less known, will, we have no doubt, sustain the high reputation which their predecessors have acquired. Having already exhibited to our readers a list of the memoirs which form this portion of the *first* volume of the society's labours *, we shall proceed to notice a few of the principal papers.

In his "Memoir on the Fall of Leaves," M. Vaucher objects to the hypothesis that attributes the fall of the old leaf to the growth of the new bud; to that also which ascribes it to an alleged superabundance of juice in the plant, and defective transpiration; or to the inequality of growth between the circumference of the stem and the petiole of the leaf. The true cause,

* See this Volume, p. 193.

he supposes to consist in a peculiar structure that obtains at the insertion of the petiole with the stem. The fibres of the petiole, instead of being a simple prolongation of those of the stem, are, according to him, distinct from them. At the point where the separation of the leaf occurs, there is only a sort of approximation, or soldering, and not a real continuity of vessels. This soldering is supposed to be produced by the interposition of parenchyme between the two systems of vessels. As long as this parenchyme is supplied with juices, and retains its vegetative power, the adherence of the petiole is maintained; but when it begins to dry, the connection fails, and the leaf falls.

As this hypothesis is made to rest on *anatomical* grounds, we could have wished that M. Vaucher had exhibited something like a *demonstration* of the structure of these parts. He mentions, indeed, the existence of a circular ring or rising, visible exteriorly, at the place of junction of the petiole with the branch; but that this is caused by the interposition of cellular tissue between the vessels of the stem and petiole, or by any sort of soldering of the extremities of these vessels with one another, we have no evidence. We incline rather to the old opinion, that these vessels are truly continuous; and consequently, that whatever be the cause of the fall, it is accompanied by a rupture of vessels. That a diminution or cessation of vegetative power in the part precedes this event, has been generally deemed probable; though others, as M. Vrolick and Sir J. Smith, consider the fall of leaves in autumn as a sloughing of worn out parts, effected by the vital energy of the parts in contact with them.

In his memoir "sur les Charagnes," a species of *chara* that grows abundantly in the Lake of Geneva, and, from the use to which it is applied, called by the inhabitants "herbé à ecurer," M. Vaucher applies himself to discover its *fructification*, and correct the erroneous opinions of Linnæus, Schmidel, Hedwig, and Martin, with relation to it. To accomplish this object, he observed with care the germination of its seeds, which none of his predecessors had done. After many unsuccessful attempts, he was fortunate in collecting, in the month of November, what he deemed the true seeds. These he preserved through the winter, and in the month of April following, had the satisfaction, *On an Indelible Ink, and on Bistre.* By JOHN MACCULLOCH, M.D. F.R.S. F.L.S. and M.G. Communicated by the Author.

DEAR SIR, *Edinburgh, July* 20, 1822.

THE perishable nature of our common ink is, as you well know, a frequent source of serious inconveniencies, particularly in the case of records, which it is important to preserve, if possible, for ever. The cause is too well known to chemists to require mention; and they also know the processes that have been recommended for the restoration of manuscripts which time has rendered illegible or obscure. In a minor way, we are often teased with the obliteration of our labels or memorandums of experiments, in our laboratories, where acid vapours are often let loose so as to affect the atmosphere of these places. Mere damp, I need scarcely say, has the same effects of rendering writing, made in common ink, brown and indistinct; and the same effect sometimes arises from using a bad kind of this most indispensable substance.

Numerous projects for an indelible ink have been brought forward at different times; but none of these are effectual except where they contain powders that are exempt from the operation of the destroying causes. The ancients used charcoal in some form, as we have attempted to use lamp black, whether in that of Chinese ink or in some other shape. This is indelible, as is the ink of the cuttle fish, formerly used by the ancients, and still employed as a paint by modern artists, under the name of sepia.

But there are two objections to these powders, of whatever kind, which has hitherto prevented them from coming into general use. It is necessary that they should be mixed with glue or gum, without which they will not adhere to the paper. These substances, as well as the powders themselves, prevent inks of this nature from flowing freely through the pen, particularly in warm rooms, or hot weather; and hence the process of writing becomes tedious and irritating. They have another fault, of no small weight, namely, that in damp situations, they become mouldy, and are at length destroyed, so as to permit the powders to get loose, and the writing to be obscured or obliterated.

The substance which I have sent you is free from all these faults at least; although it still labours under some defects, which may perhaps prevent it from being generally introduced as an ink. Yet, as it is absolutely indelible, by acids as well as by time, it is worthy of attention, particularly in the cases

Please return this as soon as possible

above alluded to, where a little imperfection will be compensated by the advantages it holds out.

It is prepared from the substance called Bistre, the nature of which I formerly investigated in a paper published in the Transactions of the Geological Society.

This substance is a compound of carbon, or charcoal, and hydrogen, principally; very analogous to the bitumens, but differing from them in some particulars, which I need not here detail. It is most conveniently procured from the destructive distillation of wood, and can now be obtained, at no price, and in any quantities, from the distillers of charcoal for the gunpowder manufactories, and from the manufacturers of new vinegar.

When thus obtained, it is a liquid resembling common tar in consistence; and it is this substance which forms the beautiful brown varnish that covers the inside of a Highland cottage; being deposited from the smoke of the peat. On being subjected to evaporation or distillation, it gives out an essential oil, either colourless or brown, according as the process is managed, analogous to naptha and to petroleum, together with acetic acid. Being thus treated, it becomes first tenacious, like soft pitch, then hard or brittle, like asphaltum, with a bright, clean, conchoidal fracture. The longer the heat is continued, the more brittle it becomes, till at length it falls to powder.

The chemical change which here takes place is that of gradually diminishing the hydrogen in the compound; and, if the process be pushed to an extremity, charcoal alone at length remains. At the same time, the colour, which was at first a yellow brown, becomes gradually darker, till it settles into one that is nearly black.

In a hard state, this is the bistre of artists, although that substance is ignorantly obtained from the soot of wood, particularly beech, if possible; being generally furnished to the colourmen by the chimney-sweepers, who collect it from those places where wood is burnt. For this reason it is a very uncertain colour as to its tone; while artists also know well that it is often glutinous and disagreeable in use; adhering and returning to the pencil, so as to render it difficult to put on clear and repeated washes.

This fault consists in the evaporation not having been carried far enough; and, from the foregoing sketch of its nature, it will also be seen that the yellowish varieties will be the most disagreeable in working. The obvious remedy for these oils is to evaporate the oil and the acid; and that evaporation may be regulated to the greatest nicety, by adopting the liquid tar of the charcoal and vinegar distilleries. Thus it may be procured of the colour of sepia; which indeed it may be made to rival in use, as it is the same substance, considered as a chemical compound.

There is one other objection to the use of bistre, in water-colour painting, and that is its powdery nature; as it is, like other colours, merely suspended in gum. This evil is remedied by the same process which converts it into an ink.

It is soluble in the pure alkalies, both potash and soda; with which it forms a compound analogous to soap, and which is in fact the same, very nearly, as that which common rosin forms with these in that mixture of this substance with tallow which produces what is called brown soap.

But it must be remarked, that the combination with potash remains liquid, if not too far evaporated, while that with soda gelatinizes, even when much water is present. The process itself is extremely simple, as it consists merely in boiling the bistre in the alkaline solutions, taking care that they are fully saturated. The degree of dilution may be regulated at any time, according to the uses for which the colour is intended.

It is not easy to give precise directions for the state in which the bistre ought to be used, for want of a scale of reference. But it cannot well be too brittle and too dark in the colour, provided it has not been so far evaporated as to destroy its solubility. To bring it to the condition of asphaltum, is perhaps a good general rule.

In a fluid state, this is the indelible ink in question. There is no powder here, as the bistre is in a state of solution, and it requires neither gum nor any other addition. It remains unchanged in a bottle, never depositing its colour, like common ink. It flows freely through the pen, and can be used to write as rapidly as ordinary ink. It is so incapable of change as to resist even oxymuriatic gas; nor is it affected by any exposure to damp. I may add, that I have kept a manuscript for ten years, and more, exposed to the vapours of a large laboratory, where acid was always present, and where the paper was constantly damp, but without the slightest alteration.

Its defects are the following: It acts on the quill so as to blunt it rapidly, and to prevent the pens from giving fine hair strokes; no great evil compared to its advantages; and one which is obviated by the use of a metallic or a reed pen. It is more easily washed out by water than common ink; although it is difficult to discharge it entirely in this way, as it penetrates into the substance of the paper. This is a defect, however, to which all the powder inks are completely exposed, nor is it a trial to which manuscripts are likely to be subjected. Lastly, the colour is brown, and not black. If that is a defect to the eye, it is one that arises merely from habit. It is, notwithstanding that, more visible than ordinary ink; as artists well know that brown is a more powerful colour than black, and forms a much *forward* colour, or offers a stronger contrast with white.

more

Such are its advantages and disadvantages; and I still think that the balance is so much in its favour, that it ought to be adopted for all public and legal documents, which it is so essential to preserve from obliteration.

This solution is also better adapted to water-colour painting than common ground bistre. It makes a clear wash, which is not disturbed by fresh application, and which does not deposit powder, that vice of Chinese ink which almost renders it useless in drawing. It has also the advantage of giving a degree of *forwardness*, or intensity, in the foreground, which cannot be obtained by common bistre; and, for this purpose, the solution in soda may conveniently be used, on account of the facility with which the paper may be loaded with it.

In terminating these remarks, I may add, that, in the use of common ink, it is an error to write with that which is blackest, although most agreeable to the eye at first. When rendered thus black, which it is by keeping, a portion of the tanno-gallot of iron has been deposited in the bottle, in consequence of the process of oxydation; so that the fluid, though darker, contains less of this salt than the pale ink which is fresh made. The more that can be applied to the paper, the longer it is likely to last; and thus, when the faint-coloured new ink is used, the greatest possible quantity is attached to it; while, in a few days, it becomes as black as if it had been used in that state from previous standing.

I am, yours truly,

J. Macculloch.

of which these waters held the greater part of carbonate of lime in solution. It results from this, that the deposits of the marshes are rather geological formations than the others; and, in fact, the mineralogical characters which they present, bring them much nearer in nature to various mineral beds of the tertiary formations than any of the former tufas, even of those which are the most solid and most ancient.

It is these waters, charged with calcareous particles in solution, and at the same time with mud simply suspended, which often agglutinate on the declivity of mountains the small fragments of all kinds detached from the neighbouring rocks. There result kinds of breccia or puddingstone, having very little solidity, which are pretty commonly found in the high mountains, and of which Hungary also presents many examples, especially in the counties of Zolyom and Lömör. But no where do these modern deposits form in considerable masses, which may perhaps be owing to this, that, being always rather soft, they crumble down after they have arrived at a certain height. We are so much the more induced to form this idea, that we often find pretty large detached blocks, more or less broken, on the declivity of the mountains, or in the bottom of valleys, and that it is rare to find, *in situ*, masses of greater size. One of the best points which I know in Hungary for verifying these observations, is the route from Neusohe to Henengrund, keeping along the declivity of the mountain.

Art. VI.—*On the Use of Perfumes in preventing the Formation of Mouldiness.* By John MacCulloch, M. D. and F. R. S. &c. Communicated by the Author.

There are many cases of daily occurrence, in which the growth of those minute vegetables that constitute mouldiness, is a very troublesome inconvenience. As your Journal does not despise the useful, I need make no apology for a communication that has no other quality to recommend it.

I do not pretend to account for the mode in which perfumes act in producing this effect; nor do I know the limitations with respect to these: but I have found it hold good with all the essential oils that I have tried, and that even when used in a very minute quantity.

Ink, paste, leather, and seeds, are among the common articles which suffer from this cause, and to which the remedy is easily applicable. With respect to articles of food, such as bread, cold meats, or dried fish, it is less easy to apply a remedy, on account of the taste. Cloves, however, and other spices whose flavours are grateful, may sometimes be used for this end ; and that they act in consequence of this principle, and not by any particular antiseptic virtue, seems plain, by their preventing equally the growth of those minute cryptogamous plants on ink, and other substances not of an animal nature.

The effect of cloves in preventing the mouldiness in Ink, is indeed generally known ; and it is obtained in the same way by oil of lavender, in a very minute quantity, or by any other of the perfumed oils.

To preserve Leather in the same manner from this effect, is a matter of great importance, particularly in military store-houses, where the labour employed in cleaning harness and shoes is a cause of considerable expence, and where much injury is occasionally sustained from this cause. The same essential oils answer the purpose, as far as I have had an opportunity of trying effectually. The cheapest, of course, should be selected ; and it would be necessary to try oil of turpentine, for this reason. The total interruption of all my pursuits has hitherto prevented me from carrying these trials as far as I intended.

It is a remarkable confirmation of this circumstance, that Russian leather, which is perfumed with the tar of the birch-tree, is not subject to mouldiness, as must be well known to all who possess books thus bound. They even prevent it from taking place in those books bound in calf near to which they happen to lie. This fact is particularly well known to Russia merchants, as they suffer bales of this article to lie in the London docks in the most careless manner, for a great length of time, knowing well that they can sustain no injury of this nature from dampness, whereas common curried leather requires to be opened, cleaned, and ventilated. Collectors of books will not be sorry to learn, that a few drops of any perfumed oil will ensure their libraries from this pest.

I had commenced some trials on Wood on the same principle, with the view of preserving it from what is called the dry-rot, and, as it seemed to me, with effect. But as I have now no hopes of pursuing this subject, I am glad to have an opportunity, by your means, of putting it into better hands. A cheap oil, of course, would be required for operations so extensive as this.

The next substance that I shall point out is Paste, which is a very perishable article. Alum, which is used by the book-binders, although it preserves that most necessary substance longer than it would remain useful without it, is not very effectual. Rosin, sometimes used by shoemakers, answers the purpose better, and appears to act entirely on this principle. It is, however, less effectual than even oil of turpentine. Lavender, and the other strong perfumes, such as peppermint, anise, and bergamot, are perfectly effectual, even in a very small quantity; and paste may thus be preserved for any length of time.

Your mineralogical readers in particular, who have frequent occasion to use paste for their labels in very small quantities, and where the trouble of thus making it on every fresh occasion is inconvenient, will be glad to know that this useful article may be made to keep, even for years, always ready for use, and subject to no change.

That which I have long used in this manner is made of flour in the usual way, but rather thick, with a proportion of brown sugar, and a small quantity of corrosive sublimate. The use of the sugar is to keep it flexible, so as to prevent its scaling off from smooth surfaces; and that of the corrosive sublimate, independently of preserving it from insects, is an effectual check against its fermentation. This salt, however, does not prevent the formation of mouldiness. But as a drop or two of the essential oils above mentioned is a complete security against this, all the causes of destruction are effectually guarded against. Paste made in this manner, and exposed to the air, dries without change to a state resembling horn; so that it may at any time be wetted again, and applied to use. When kept in a close-covered pot, it may be preserved in a state for use at all times.

This principle seems also applicable to the preservation of seeds, particularly in cases where they are sent from distant countries by sea, when it is well known that they often perish from this cause. Dampness, of course, will perform its office at any rate, if moisture is not excluded; yet it is certain, that the growth of the vegetables which constitute mould, accelerate the evil; whether by retaining moisture, or by what means, is not very apparent. This, in fact, happens equally in the case of dry rot in wood, and, indeed, in all others where this cause operates. It is a curious illustration of the truth of this view of a remedy, that the aromatic seeds of all kinds are not subject to mould, and that their vicinity prevents it in others with which they are packed. They also produce the same effect daily, even in animal matters, without its being suspected. Not to repeat any thing on the subject of cookery, I need only remark, that it is common to put pepper into collections of insects or birds, without its having been remarked, that it had the same power of keeping off mould, as of discouraging or killing the *ptinus omnivorus*, or other insects that commit ravages in these cases.

In concluding these hints, I might add, in illustration of them, that gingerbread and bread containing carraway-seeds is far less liable to mouldiness than plain bread. It will be a matter worthy of consideration, how far flour might be preserved by some project of this kind.

Art. III. *Remarks on Marine Luminous Animals. By* J. Mac Culloch, M.D., F.R.S , *&c.*

[Communicated by the Author.]

In my work on the Western Islands of Scotland, I had occasion to take notice of the causes which produce that beautiful appearance of light in sea water, so well known to seamen, and to all indeed who have been in the least conversant with the sea during the darkness of night. I there attempted to prove, that if, in every case it did not arise from the action and properties of living animals, but was sometimes owing to the luminous matter of fish dispersed through the water, yet that all the most conspicuous appearances of this nature were produced by these, and that the brilliant sparks of light, in particular, were always to be traced to some of the vermes or insects, which abound in the waters of the sea.

I have also given a list of such of these animals as had, by various naturalists, been found to possess this remarkable property; and had occasion to lament how circumscribed it was; partly owing to the deficiency of observers in this department of Natural History, and partly owing to unfounded theories respecting the nature and causes of the light of the ocean; in consequence of which, those who possessed the opportunities of extending this examination, had neglected it. I have also observed that many animals either very minute, or absolutely microscopic, and invisible without the use of a lens, existed in the sea; and that the neglect of these more obscure creatures, had probably been one reason why the property of emitting light was referred to the water itself, when it was, in fact, owing to these unsuspected animals existing in it.

The further investigation of this department of Natural History, was, in that essay, recommended to those who might have opportunities of pursuing it, as the subject had not at that time practically engaged much of my time, being occupied by geological pursuits requiring undivided attention, and every leisure moment of the night being employed in registering the observations of the day. But as it is not often that observers feel much interest in pursuing a track which has been laid down by their predecessors, unless perhaps for the purpose of controverting or disputing the principles or facts on which it has been grounded, I thought it right to make use of such further opportunities as might occur towards the accumulation of new matter on this subject, and towards confirming the opinions stated in the paper to which I have alluded. A voyage to the Shetland and Orkney Islands afforded these opportunities; and the result has been to confirm the former views, by a series of observations carried on daily for many weeks. By these a large addition has been made to the list of luminous animals which was given in that essay; and it has been, in particular, proved, that the sea is very often crowded with worms and insects, often nearly invisible; and that the luminous property of the water, not only bears a relation to the existence and numbers of these at any time, but may almost always be traced to the individuals by which it is caused.

Those who are acquainted with this obscure and much neglected department of Natural History, will not be surprised to hear that I cannot at present give names to the numerous individuals which I examined for this purpose. Among them are many objects, of which, not only the names are doubtful, but the very genera, and even the analogies, obscure or uncertain. Many are absolutely unknown, and constitute new species which it will be my business to describe hereafter, when all the requisite comparisons have been made. For the present purpose, it is as unnecessary, as it would be impossible, to enter into details of so extensive a nature as would be required for assigning the names of the various animals in which I have now observed the property of emitting light, in addition to that list which was given in the essay to which I have here referred.

It will not be useless to those who may be inclined to pursue the same train of investigation, to describe the means which I adopted for examining the animals in question; while it will further the purpose of explaining the species of evidence by which I was satisfied respecting the nature of the objects which were examined, and more particularly respecting their powers of yielding light. If there is any deficiency in the nature of this proof, as it relates to some of the more minute animals, there will still remain a considerable number to add to the list formerly given.

It must in the first place be remarked, that the whole of these observations were confined to spaces in the sea never extending above 8 or 10 miles from land; and that they were very generally made in harbours. They cannot in fact be made at sea; at least in a small ship, unless it is smooth water: as the agitation of the water under examination, no less than that of the observer's person, renders it absolutely impossible to catch and detain the objects before a lens in such a manner as to examine or delineate them. At all times, even in harbour, it is sufficiently difficult from the motions of the animals themselves, to obtain such views of them as to satisfy ourselves respecting the nature and characters of those which are minute, and of which the greater number are exceedingly restless and rapid in their movements.

Although a great many of the animals which fell under my notice, were found at the distances from land which I have just mentioned, many were only discovered in harbours, and, nearly at all times they were far more abundant in these situations than in the open sea. Some of them, it is true, seem to disregard boisterous weather; but there were many which almost invariably disappeared on the coming in of a fresh gale, and only re-appeared when the weather moderated. Other changes of weather or wind, often caused them in the same manner to disappear in the course of a few hours. It is probable that these animals, like the leech, are very sensible to atmospheric changes, and that they retire to deeper water to avoid that agitation, which, to many of the larger, would be fatal, from the tenderness of their texture and from their bulk. Many are probably destroyed by the violence of the sea at the surface. These are hints which may be of use to any naturalist inclined to enter on this department of his pursuit, while they assist in explaining the variations to which the luminous property of the ocean is subject; and the addition of a few more will not be misplaced to those who have not hadany experience in these investigations.

These animals always abound most, with few exceptions, in the smallest harbours, and, more particularly, in narrow creeks, among rocks or under high cliffs, where the water is sheltered from the sea and wind, and where it is consequently seldom so much disturbed as in more open places. A large proportion of them indeed seems to be exclusively limited to situations of this nature, being never found in the open sea nor far from shore. Many of the minute marine animals also appear to affect exclusively those shallow and rocky situations where sea weeds abound, and which are equally the favourite haunts of many larger species, such as nearly the whole tribe of crabs, and many others which it is unnecessary to enumerate.

It is in such places then, and at such times, that is, in narrow and rocky creeks or weedy shoals, and in calm weather, that the naturalist will meet with most success; and it is in such circumstances also that the water will be found most luminous.

That it does not always appear luminous in calm weather, and when the vessel is quiet at anchor, is however certain; and it is this which has conduced to mislead observers respecting the causes of the light, as well as to lay the foundation of fallacious prognostics regarding the weather. It requires agitation to elicit the light of these animals in abundance; and as this naturally happens in troubled water, they have been supposed to abound in gales of wind and in a breaking sea, when they are, in fact, comparatively scarce. In calm weather, crowds of medusæ or other very luminous species, will often be floating around, yet betraying themselves only by an occasional twinkle; when any disturbance communicated to the water is sufficient to involve the whole in a blaze of light.

I formerly remarked, that the luminous action was voluntary; and this opinion has been amply confirmed by further attention to the animals possessed of this property. Among millions of these, of numerous species, the usual actions of locomotion will be performed for hours, or for a whole night, without the slightest indication of their presence; or perhaps some individual will give an occasional spark as it passes by, when the dipping of an oar, or the drawing of a bucket of water, is sufficient to render the whole around luminous.

It is by such a test as this, therefore, that a naturalist will be guided in his pursuit after these animals. But it is proper to remark that it is often very difficult to take them, even when we are certain that they abound in the water; and this cause, like others, has often made it to be supposed that the water itself possessed a luminous property, because no animals appeared in a bucket when filled with it. A few bright lights produce a considerable effect in the night, so as to make the sea appear much fuller of sparks than it really is; and it is easy for a body so small as the ship's bucket to miss the animals by which they are produced. Moreover, as many of these creatures, and particularly the medusæ, swim near to the surface, they are apt to slip out with the wave which is produced by lifting the bucket out of the water; so that it sometimes requires many attempts before one can be secured.

There is another circumstance which is also an occasional source of error respecting the existence of these animals in the water when brought up; even when it is highly luminous alongside the vessel. Whether from fatigue, or from caprice, or from some voluntary efforts for an unknown purpose, they often refuse to show their light, even when violently agitated or injured; and, in all cases, when they have been compelled to shew it for a few seconds by violence, they again become dark and refuse to shine any longer. It is not unlikely that this is the effect of exhaustion; because after a repose of some little time, a fresh disturbance often causes them to give light again. A naturalist, unaware of this circumstance, may often imagine that he has failed in procuring specimens, even when the bucket is crowded with them.

Another circumstance leads to deceptions in these cases. In many of the luminous worms and insects, the spot of light appears much larger, if it is not really so, than the body of the animal; and very often a species which is invisible under ordinary circumstances, or only to be seen by bringing it opposite to a bright light in a glass of water, will yield a very brilliant and large spark. Thus, in a ship's bucket, or a basin, it would not be conjectured that any animal existed, when many thousands are present; and, of these, perhaps the greater number, if not all, highly luminous.

It is, lastly, necessary to remark, respecting the size of these animals, as just mentioned, that many of the luminous species are absolutely, and under all circumstances, except when in the act of emitting light, invisible to the naked eye. This effect arises in some measure from the actual minuteness of many, their size not equalling the 100th of an inch; but in many others which subtend a visible angle, it proceeds from their transparency. Even under favourable circumstances, as when placed in a glass of water, where the vision is aided by the magnifying power of this species of lens, they cannot easily be discovered; owing to the water in which they abound being invariably muddy. Those only come into view which approach so near to the fore part of the glass as materially to diminish the column of water between them and the eye; and thus also they often escape observation, and the spectator is surprised to find that he can discover nothing in the light, when the water, in the dark, has abounded in luminous sparks. If the lens is used, it is still only in the observer's power to get sight of those which pass across its focus; so that he is, in this case also, apt to underrate their numbers, or, if rare, to doubt their existence. It is fruitless to attempt to bring them under the eye by using a small drop of water in the manner adopted in microscopic observations; as, even where most crowded, they bear so small a proportion to the water in which they swim, that such a drop may not possibly contain one.

These then are the most important circumstances which the naturalist should have in view in investigating the water of the sea for the purpose of discovering the minute animals which exist in it; whether for the purpose of ascertaining their luminous quality, or of examining their nature and structure. An attention to these cautions will probably assist others, as it did myself in these examinations; and induce them to believe what seems to me fully ascertained, namely, that luminous animals abound in the water of the ocean even when they are least suspected, and that the property of emitting light is probably granted to every one of these neglected inhabitants of the deep.

When the numbers of these animals are considered, it will appear less extraordinary that the water of the sea should be so generally luminous; and, when we attend to their minuteness, it is as little cause of surprise that they should escape ordinary observation. Having necessarily reserved the description and names of the species for future communications, partly for the reasons already stated, and partly because they could not be rendered intelligible without drawings; I shall not enter on this part of the subject, but merely attempt to convey an idea of the numbers of some of the most remarkable individuals which were examined.

In proceeding from the Mull of Cantyre to Shetland, with beating winds nearly the whole way, it is easy to understand that an immense tract of water must have been passed over. Those whose memory can so easily refer to the map of Scotland need not be told of the number of square miles which a vessel must traverse in this navigation. With very little exception throughout all this space, and in every one of the harbours of Shetland and Orkney, the water was full of one species, in particular, of an animal which I think is not yet described. It scarcely ever quitted the vessel, although more abundant in some seas than in others. On a very moderate computation a cubic inch did not contain less than an hundred individuals; and as they were brought up from all depths to which the bucket could be sent, it is useless to attempt a statement even of those which must have been contained in a few cubic feet, much less in the enormous mass of water thus examined. Their numbers, even in a superficial mile, supposing its depth not to exceed a few inches, baffles all imagination. This species was barely visible by the naked eye, when viewed in a glass against the light of the candle or of a moderated sunbeam.

In the same seas, and nearly at all times, the water was found filled with several different species, resembling in size some of the infusoria, and invisible without the lens. To estimate their numbers is equally impossible, but no body of water so small could be brought into a proper situation without being found filled with them. Other animals of larger dimensions, and of many species were equally constant; and, if less numerous, yet ten or twenty were always to be found within the space of a common tumbler glass.

In all these cases the water was luminous; and, that it was rendered luminous by these animals, admitted of no doubt, because the larger individuals could be taken out on a dry body, shining at the very moment of their removal, and then replaced for examination in water; while the light of the whole of these species disappeared when they died, either from keeping the water too long, from warming it, or from the addition of spirits. The facility with which the luminous quality of sea water is destroyed by those means which kill its inhabitants, is in itself a sufficient proof that the cause of this property resides in these.

I must further add, that it is perfectly easy to distinguish the different sparks of light given by different animals; that is, as far as they differ in dimensions; as the bright spot is quite distinct in the larger kinds, in which it also often varies in colour; while, in the smaller, agitation produces a general luminous appearance, in which separate spots, or the distinct action of individuals, is not to be recognised; it is probably therefore rather from this source, namely, the crowd of microscopic worms and insects, that the general luminous track produced by a fishing line, or the faint sheet of light elicited by the dash of an oar, is caused, than by the detached secretions of fishes, or by decomposing animal matter diffused through the water; while the brighter separate sparks arise from the larger kinds, to the size of which they are more or less proportioned. It will in the same way, be found, that the predominance of bright sparks in the vicinity of sea weed, or near rocks, arises from the great number of species, Squillæ, Scolopendræ, Nereides, and many others, which make these places their exclusive residence.

It is now necessary to point out the method used in examining these animals, and deciding on their luminous powers.

With respect to the larger kinds, there is no difficulty; the smaller require many more trials; and where more than one species persist in occurring together, some uncertainty must always remain. Yet where a property is, in so many instances, ascertained to exist, and where it has probably been conferred for the specific purposes formerly noticed in the essay to which this communication must be considered as an appendix, it is not a rash conclusion to consider that no species is exempt from the general law or deprived of this power; since in the most essential circumstances, the habits of all are the same.

These animals, whether the smaller vermes or insects, are very rarely found in clear water, and wherever they are abundant it is muddy, or rather fouled with some animal matter which communicates to it a slight milky hue; although they are not, on the contrary, necessarily present when the water is in that state. It is preferable to examine the water by candle-light, as ordinary day-light is not sufficient for the purpose; and the light of the sun cannot easily be received in such a manner as to be endured by the eye, and, at the same time, to serve the purpose of illuminating the objects. It is desirable to use more than one candle, as it is convenient to have more than one luminous spot under command; the rapidity of the motions of most of these animals, carrying them so quickly beyond the limits of one spot, as to cause considerable trouble to the observer, who has many things to distract his attention at the same time. Some of them are better examined in the brightest light; others at its borders; and, very often, it is necessary to examine the same object in different lights before a just idea of its form can be obtained. A separate light is also required to illuminate the paper on which they are to be drawn; the eye being so far paralyzed by the excess of light required to view them, as not to see in a moderate degree of illumination, and it being absolutely necessary to draw them, without losing the least practicable interval of time after viewing them through the lens. A few seconds are sufficient to cause the observer to forget the exact figure of the parts which he is to delineate.

The most convenient receptacle in which they can be placed for examination is a rummer or conoidal glass, of such dimensions as to contain half a pint. It is, in the first place, quite necessary that they should be at liberty; as it is only when in motion that many of them can at all be discovered, and as the peculiar nature of their motions, which, in all, are very different and highly characteristic, is of great use in discriminating individuals otherwise much resembling each other. It is true, that this is productive of great inconvenience, from their passing so quickly out of the field of view; and thus it often requires a long time and patiently repeated examinations, to ascertain the exact figure of one individual. But it is impossible to confine them in a drop of water, unless when absolutely microscopic, without losing sight of their forms. In this case, they come to a state of rest; and their fins, legs, antennæ, or other fine parts, become invisible, generally collapsing close to the body. Moreover the affection of light produced by the contact of the animal with the surface or edge of the drop, or of that of the drop with the glass on which it stands, totally destroys distinct vision, and renders their forms quite unintelligible. A glass of smaller dimensions, such as a wine glass, is far less convenient than that abovementioned; as the smallness of the convexity produces a much less useful spot of light.

In many cases, where, from excessive activity, it is difficult to catch these objects in the field of view for a sufficient time to study their parts, I have found it useful to diminish their powers of motion. This may be done by slightly warming the water, by suffering it to stand for a few hours in the glass, or by the addition of a small quantity of spirits, and probably of other substances. But slight injuries are sufficient to kill them; and, as they then become invisible, the observer must be on his guard not to exceed in the application of these means.

From the necessity of using a large glass, and the freedom of motion thence allowed, it is evident that a high magnifying power cannot be applied. It is scarcely possible indeed to make effective use of one greater than that produced by a simple lens of half an inch focal distance; and as, with this power the field of view is very contracted, it is often convenient to have two other lenses at hand of one inch and of two inches in focal distance. The very minute ones may be occasionally secured in a single drop of water under a compound microscope; but the observer will be disappointed much oftener than he will succeed in his attempts to examine them in this way; partly from the chance of his failing to find any in many successive small portions of water thus separated, and partly for the reasons just stated.

I have already mentioned almost all that occurs on the method used in determining those species which were luminous. Of the larger kinds, it seldom happened that more than two or three, sometimes not more than one, was contained in a tumbler. Being placed in the dark, and stirred with the finger, the same number of sparks were produced; and whatever failure might here have occurred in one trial, was removed by others made at different times. With regard to the smaller species, it sometimes happened that only one was found on a particular occasion, and the luminous state of that water on agitation proved the property to exist in that individual species. Respecting some of these species, however, doubts may remain; as in some cases no one of them was found alone. But these doubts are of little consequence; since if among so many animals resembling each other in their general characters, and often indeed apparently belonging to the same genus, the luminous property was certainly proved to exist in some, it probably existed equally in all; as there seems no reason to exclude any, or to suppose it especially possessed by one. On this subject, however, other naturalists must be allowed to judge for themselves; and those who are inclined to pursue the same train of investigation will probably complete the evidence respecting some where it is here left doubtful.

I may now therefore conclude this subject by remarking, that, from the investigation of last summer, I have added upwards of 190 species to the list of luminous marine animals. I have already stated the reasons why I cannot as yet give even the names of many of these, of which a considerable number are certainly new, or nondescript animals. That subject must be reserved for a different species of communication; but I shall here add at least the generic names of those possessed of luminous properties, of which the genera are known; since, even in these, some of the species are still unsettled and many are new.

Among these, the most conspicuous are about twenty small species of Medusa, in addition to those already known to be luminous. In the ancient genus Cancer, a considerable number of Squillæ were also found possessed of this property. In the genera Scolopendra and Nereis five or six were luminous, being all the species that came under my observation. Of the remaining known genera in which luminous species were observed, I shall forbear to give any numerical account, but simply add that they consisted of Phalangium, Monoculus, Oniscus, Iulus, Vorticella, Cercaria, Vibrio, Volvox. To these I may also add, among the fishes, a new species of Leptocephalus. The rest consisted of new genera, or, at least, of animals which, for want of correct descriptions and of figures, cannot be referred to any as yet to be found in authors, and of which I trust at some future period to give those drawings and descriptions which are in my possession. It is sufficient for the present purpose to have shewn that the list of luminous animals is very extensive, and to have given this notice of the means used in investigating this object, together with such hints as may be useful to others; little doubting that their labours will ultimately prove this beautiful and remarkable property to be possessed by every one of the inhabitants of the ocean.

But I must not conclude this paper without noticing a circumstance which confirms the opinion stated in the former essay respecting the residence of many fish in depths which, according to Mr. Bouguer's observations, must be supposed inaccessible to the light of the sun; and in which, without that afforded by their prey, it is difficult to understand how they can find their food. It is remarked by the Shetland fishermen, that the ling invariably inhabits the deep valleys of the sea; whereas the cod is always found on the hills, general known by the name of banks. In one of the most productive spots for the ling fishery, the valley which they inhabit is not only very deep, but is bounded by abrupt land or submarine hills nearly precipitous; the water suddenly deepening from 20 and 30 to 200 fathoms. In this, as well as in other valleys in which this fishery is carried on, always very far from the shore, it is found that the best fishing exists at the greatest depths, and it is not unusual to sink the long lines in water of 250 fathoms depth. The time required in setting and in drawing up from this depth, the length of line used, which amounts in some cases even to seven miles, is such as to prevent the fishermen from making any attempts in deeper water; but they are all of opinion that this fish abounds most in the deepest places, and might advantageously be fished for at much greater depths. Now allowing even 1000 feet instead of Mr. Bouguer's calculation of 723, it is plain that no light can exist in these valleys, and that the ling, like other fish which prey in the deep seas, must have some means of seeing his food, as well as of pursuing his social avocations of whatever nature these may be. This can only be effected by the luminous property, either of his prey, or of the animals which abound in the sea, or else by that elicited from his own body.

J. Mac Culloch.

Shetland, August, 1820.

Art. IV. *A Translation of* Rey's *Essays on the Calcination of Metals,* &c.

[Communicated by John George Children, Esq., F.R.S., *&c.*]

Continued from Page 83.

Essay IV.

Air and Fire have weight, and naturally descend.

Had we as free a commerce with the elements of fire, as we have with the air, we should doubtless, be furnished with experiments, to confirm our assertion. True it is, that those increased the latter class of persons from the other two classes, and most particularly from that of agriculture. The same remark applies also to Glamorgan, Anglesea, and Carnarvon. The last-mentioned county is also that which approximates the nearest, in the state of its agricultural population, to that of the aggregate population of the principality; the same being found to be the case in Radnor, for trade and manufactures; and in Montgomery, for that of the unproductive labourers.

Of the thirty-two counties composing Scotland, it may be remarked, that eight are distinguished by an increase of their agricultural population, and twenty-four by a diminution thereof; but of the population devoted to trade and manufactures, twenty-four counties have received increments, and the remaining eight decrements. Sixteen also of the counties have received an augmentation to their non-productive members, and the remaining number a diminution.

The magnitudes of the numbers indicating the extreme changes may considered as remarkable, when contrasted with the corresponding results for England. Caithness, for example, is distinguished by an increment to its manufacturing population of + 1903, and by a decrement to its agricultural members of — 1802. Renfrew has also increased its non-productive members by + 1276, and Clackmannan diminished the same class by — 2210. The county distinguished by the least change in its agricultural population is Dumfries; Selkirk in its families devoted to trade and manufactures, and Peebles in the class of its non-productive members. The families devoted to agriculture in Peebles, approach also the nearest to the change of the aggregate population of the first class; Selkirk also in its trading and manufacturing, and Perth in its non-productive, members, to the respective changes in the aggregate members of the corresponding classes. Caithness presents also an example of a remarkable decrement in its agricultural population, and of a more considerable increase in its manufacturing members; but only a very moderate decrement in its negative members. Clackmannan likewise has very rapidly diminished the latter class, increased in a very great degree its manufacturers, and received a small increase in its agricu population. Inverness presents also an instance of considerable declensions in its agricultural and manufacturing members; and an increment equal to both the preceding decrements, to its unproductive families. A similar remark applies also to Dumbarton and Lanark. The declension of the manufacturing families in Renfrew, and their probable change into the unproductive class, likewise merits attention.

By an inspection of this part of the table, it appears that the aggregate of the *increments* for agriculture, amounts to 1437; whereas that of trade and manufactures is 10,658, the *latter* exceeding the *former* in a greater ratio than that of 7 to 1. The aggregate of the *decrements* of agriculture amounts also to 9,143, and that of trade only to 4,564; the former exceeding the latter in the ratio of 2 to 1.

Art. III. *On the Herring. By* J. Mac Culloch, M.D., F.R.S.

The natural history of the animals useful to man, is not merely an amusing pursuit, but forms one of the most valuable branches of this department of knowledge. Yet it has been the blame of naturalists to have too much neglected this branch of their science, in their attention to classification and nomenclature. If there are not many of the wild or still undomesticated animals from a knowledge of whose habits we might derive advantage, there are still some that are loudly calling for this kind of investigation. From the state of ignorance that we are still in respecting these, we are not only forfeiting advantages which we might secure, but are also subject to serious losses and frequent disappointments.

This is peculiarly true of the herring. The following remarks will show, not only what advantages we might derive from an accurate acquaintance with the natural history of this fish, or with what may be called its moral and political history, but demonstrate the heavy losses in a commercial view, which have been the consequence, not merely of this ignorance, but of false theories on that subject. If it is difficult to acquire this knowledge, we must recollect that nothing remains long impossible to industry and observation. That nothing rational has been yet attempted, is equally a stimulus and an encouragement; nor do I know of any department of this branch of natural science, whence an industrious naturalist might derive more honour, with the additional satisfaction of having conferred solid and important benefits on mankind.

The respect due to Pennant's name, will not permit us to speak lightly of him; yet, on this subject, he seems to have either given way to the influence of his imagination, or to have copied without inquiry from the works of others, what deserves nothing but the name of a pure romance. The readers of his work on *Zoology* must be aware of the theory to which I have given this name. Yet I am uncertain if it originated with himself, or with Anderson the historian of Greenland and Iceland. Since it is necessary however that it should be stated, as the foundation of this brief sketch, I shall give the most condensed view of it that I can, from he latter author. It is marvellous that such a tale should have been copied and quoted, and reprinted, not merely by the herd, but by the careful authors of the French Encyclopædia; and that, thus transmitted, it should not only have been believed for half a century or more, by those who, if they had reflected for an instant, or even opened their eyes, must have seen that it was a fable, but that it should have been the foundation of numerous expensive commercial establishments, standing to this day as testimonials of the fiction of one party, and the credulity of others.

Anderson commences by saying that, in Iceland, the herrings are two feet in length; which is a preliminary worthy of what is to follow. Every summer, he proceeds to say, an army of these fish leaves those northern regions, being chased southwards by whales, grampuses, sharks, and other large predatory fishes. As this army proceeds to the south, it divides into two columns; the eastern one making for the North Cape, and descending along the coast of Norway. This eastern wing, however, divides itself again into two other columns; one of these entering through the Sound into the Baltic, and the other proceeding for the point of Jutland.

This latter again splits on that point into two lines, one of which defiles along the eastern shore of Denmark, and then entering the Belts, reunites itself to the Baltic division; while the other, coasting Heswick, Holstein, Bremen, and Friesland, enters by the Texel into the Zuyder Zee, so as again to return into the north sea.

The second grand division of the original army, which had taken to the westward, is, according to this naturalist, the largest of the two. It proceeds straight for Shetland and Orkney, and thence goes on to Scotland. Here it divides, like the former eastern column into two divisions, or subsidiary columns, one of which proceeds down the eastern coasts so as make the round of England by the British channel, while at the same time it detaches parties into the harbours of Friesland, Holland, Zealand, Brabant, Flanders, and France. The western division, during this time, separates itself again in such a manner as to visit the coasts of Ireland and the western lochs of the Highlands, producing the Irish and Highland fisheries; visiting also the Isle of Man, where the herring fishery is notedly abundant. In its further progress, this Irish and Highland army reaches the land's end, and here finally reunites itself to the eastern one whence it had separated, meeting it at the entrance of the channel. Thus reunited, the great original western division of the entire northern army, makes a rendezvous in the Atlantic, where, it must be supposed, they take an account of the killed and missing, before they return again to Iceland and the Polar seas, to renew the same march in the following summer.

It is sufficient to read this account to perceive, even without evidence to the contrary, or an examination of the subject, that it must be a pure romance. It is plain, *à priori*, that there are no means of ascertaining such a series of facts, nor even of approximating to a much less detailed history than that which is here given; even admitting that the basis of the extravagant superstructure were true. The few facts that I have to offer, will demonstrate that it is an entire vision. That the herring is, to a certain degree, a migratory fish, may be true; but even a much more limited migration than this is far from demonstrable. It is at any rate perfectly certain that it does not breed exclusively in the

Arctic seas, and that it does not, as the author and Mr. Pennant imagine, migrate " heaven directed" to our shores. It is equally certain that it does not take the directions here described along them, that there is no such progress along the east and west coasts from a central point, and no such reunion at the Land's end. It is no less certain that its appearance, instead of being thus regular and constant, is quite the reverse, and that it is marked by extreme irregularity, as well for the period, as for the places visited. Of the imaginary original eastern army, I do not pretend to know much: the few remarks I have to offer, refer principally to the western or supposed Scottish column.

With respect, in the first place, to the original breeding station of the herring, the statement is unsupported by any evidence. We have no actual reports respecting their breeding or abundance in the northern seas. I cannot find that they have been remarked as abounding in the Arctic ocean, nor that they have been observed in the proper icy seas. They have never formed a fishery either in Greenland or Iceland: nor have our whale fishers taken any particular notice of them. It is a pure error to suppose that the great northern whale feeds on them. That fish is incapable, from the structure of its œsophagus and mouth, of swallowing so large a fish; and its food is well known to consist of minute shrimps, beroes, clios, and other marine worms and insects, among which the cancer pedatus and oculatus appear to be the most remarkable. The whale which pursues the herring on the Scottish coasts, is the piked, or bottle-nosed whale; an animal of very different anatomy and habits.

On the subject of the imaginary eastern army, all that appears to have been ascertained relates to the Swedish and Norwegian fisheries. The herrings were first noticed on the coasts of Sweden in 1740, and at that period the Gotheburgh fishery was established. The herrings were also abundant on the coasts of Norway before 1790. After that date they deserted those, and made their appearance at Marstrand. So far also from this visit having been among the first, which it should have been according to Anderson's statement, they did not appear till November, when the Swedish fishery commenced. The produce also was so abundant, that in the short space of three weeks it amounted to 600,000 barrels. Since that period, however, they have deserted this coast.

This statement is sufficient to show the fallacy of the imaginary visit and progress of the eastern division of the equally imaginary Arctic herrings; and I may now inquire respecting the supposed western one that appears on our own shores.

Now, so far are they from being migratory to us from the north, that there can be no doubt of their breeding on our own coasts. Yet the period of breeding, no less than the time of their visits, seems as irregular as every thing else that belongs to this apparently most capricious fish. That they do breed with us, is proved by their spawn being taken on many of the coasts where the full grown fish is found: and if that has not been found on all, it probably depends, partly on want of observation, and partly on the regulation for the minimum size of the herring nets. In Orkney, in 1699, an immense quantity of herring spawn was thrown on shore during some tempestuous weather; proving that they then bred there. Yet, for a long period, they have entirely deserted the coasts of Orkney and Shetland: and it is only within three or four years that the Orkney fishery has recommenced. This circumstance marks a change of haunt and of spawning-places, but not a migration of the full-grown fish; and is plainly inconsistent with any progress from the northward. Had they migrated in the manner stated, they must necessarily have appeared in Shetland and Orkney every year, while they would also have appeared there first, instead of being, as is the fact, utterly unknown about the former islands.

It is difficult, or rather impossible, to account for their thus changing the places of their spawning, not only in these islands, but upon the British coasts in general; but these very changes of haunt prove also that they have no more any fixed rules for it than they have fixed migrations. Whether they did always spawn in these places where they were formerly abundant, cannot now be ascertained. But it is probable; partly from the fact just related of Orkney, and partly because, before the mesh regulation, they used to be taken of all sizes by the country fishermen.

Of these changes of place, the few following will be sufficient example and proofs. In the time of Charles I., and long afterwards, the Long island was their great resort; and at Loch Maddy alone in North Uist, 400 sail of vessels have been loaded in one season. These last events were about the beginning of the last century. At the prior period which I mentioned, buildings were erected in this inlet, and a regular fishery established; but they have long since deserted, not only this spot, but all the shores of the Long island. It is scarcely now even remembered by the people when they last appeared in any quantity.

From the beginning of the last century, for a considerable period onwards, their chief resort was about Loch Ewe, Loch Torridon, and, generally speaking, to the northern lochs of the west coast. About the same period they were then also abundant on the coasts of Sky. This state of things is well remembered, and it lasted for a long time. It is well remembered because it was the cause of much writing; finding its way into such popular works as Goldsmith's light essays, and producing as many pamphlets and as much talk as politics have done at other periods. The poet Aaron Hill, was then entrusted with the direction of one of these fisheries, and if I mistake not, one of Mrs. Charlotte Smith's novels was written in Sky, from a similar connexion on the part of her husband. It is even better remembered by those who sank large sums in this vast speculation. Hence were erected the enormous establishments at Loch Torridon, at Martins' island, and on Tanera, now long become useless; and the anticipations founded on it equally led to the establishment of Steen and Tobermory, and of other towns which have long ceased to make any progress, partly from the desertion of the herring shoals, and partly from the wrong principles on which the Fishery Society proceeded. I may here also remark, that in 1700, when they were abundant in Sky, it was ascertained that they bred there.

These are the losses to which I alluded at the commencement of this paper, which were caused by false views of the proceedings of the herrings. I do not know how far these establishments originated in the Arctic Theory, because some of them are prior, at least to the publication of Pennant's opinions: but it is very certain that many of the more recent ones proceeded on this foundation, believing that the migration of the herring was steady and certain. Nothing else could have led to the sinking of so much capital; the nearly total loss of which has been the result of this false information, or theory, and inconsiderate expenditure.

To pursue this part of the subject; at a later period, they seem to have preferred the lochs further to the south. Thus Loch Hourn and Loch Nevish became the great fishing stations, as did the Sound of Sky. But, warned by their preceding failures, no buildings were erected in these, and the fishery was managed by means of boats and busses in the present method. Thus also they made Loch Fyne one of their principal resorts, moving in a great measure towards the Clyde, or further south; though it also happened that they were abundant in these lochs, and also in the neighbourhood of Sky at the same period. Thus Portree, Scalpa, Loch Hourn, Loch Ransa, and Loch Fyne, have, within a few years, been the great resorts; yet very irregularly: and in this manner has Campbell town, which depends chiefly on the herring fishery, fluctuated between wealth and bankruptcy. For a single season, not many years ago, Loch Scavig in Sky was crowded with them in a manner perfectly incredible. Yet, before and since that period, they have been unknown there; marking in a very pointed manner, the extreme irregularity and caprice of their movements. All these seem mere changes of haunt, unconnected with any particular migration, and for which no causes can at present be assigned.

Vulgar philosophy is never satisfied unless it can find a solution for every thing; and is satisfied, for this reason, with imaginary ones. Thus, in the Long island, it was asserted that the fish had been driven away by the manufactory of kelp; some imaginary coincidence having been found between their disappearance and the establishment of that business. But the kelp fires did not drive them away from other shores, which they frequent and abandon indifferently without regard to this work. It has been a still more favourite and popular fancy, that they were driven away by the firing of guns; and hence this is not allowed during the fishing season. But this, like the former, is *causa pro con causa.* A gun has scarcely been fired in the Western islands, or on the west coast since the days of Cromwell; yet they have changed their places many times in that interval. In a similar manner, and with similar truth, it was said that they had been driven from the Baltic by the battle of Copenhagen. It is amusing to see how old theories are revived. This is a very ancient Highland hypothesis, with the necessary modification. Before the days of guns and gunpowder, the Highlanders held that they quitted coasts where blood had been shed: and thus ancient philosophy is renovated. The steam-boats are now supposed to be the culprits; since a reason must be found. To prove their effect, Loch Fyne, visited by a daily steam-boat, is now their favourite haunt; and they have left Loch Hourn and Loch Torridon, where these have never yet smoked.

The recent and present state of the eastward fishery will furnish facts equally at variance with any theory of the herring; and as it is only by collecting and comparing these that we can form any hopes of attaining a true one, I may state the more important particulars.

In former times, the fishery of the east coast did not commence till that on the west had terminated. It was then supposed, and not very unreasonably, that the fish had changed their ground, and that these were the western herrings. Yet it ought to have been plain that this was not the case, as the eastern fish were entirely different in quality from the western, and very far inferior. At the same time, they were in that condition as to spawning, which proved that they could not have been the same fish. The fact of their being entirely different fish is now at least fully proved, because on both shores the period of the fishery has been the same. It is remarkable also that the eastern fishery has become so abundant, as quite to have obscured the western; while the quality of the fish has also improved, although they continue to be still far inferior. In 1820, this eastern fishery was so abundant as to have overstocked the whole market, foreign and domestic; procuring considerable loss to the merchants, and materially checking its future progress. It is further to be remarked in this case, that so far from there being any indications of a progress from the north, the fishery has commenced soonest on the southern parts of this shore; and, what is also remarkable, that for some years since that, it has become later every year. Of its actual state I cannot speak precisely, because my observations terminated with 1821.

I might extend the same kind of remarks to the English fisheries, but it is unnecessary. That of Yarmouth, and that of the Isle of Man, are among the most steady. A few years ago, they were taken in such abundance for the London market on the coasts of Kent and Sussex, that they could not be consumed, and were employed as manure; and other changes equally unintelligible have occurred on the eastern and southern coasts of England, as well as the north shore of Cornwall.

That this capricious conduct is not peculiar to the herring, is proved by the recent state of the Pilchard fishery of Cornwall, and by the changes which the Sardinian fishery of Britany has undergone. The almost entire desertion of this fish from the former country, where it had been annual and abundant to a proverb, forming a steady and valuable object of commerce, is as yet unaccounted for. Lately, it has shewn symptoms of again returning.

It seems at any rate perfectly ascertained with respect to the herring, that it breeds on our own shores; and this is the important point which the preceding remarks serve to ascertain, though they yet leave the changes of place unaccounted for. It seems to reside permanently in the deep surrounding seas, and apparently round the whole island, though more abundantly to the northward. This is clearly proved by the Dutch fishery, which was carried on at all times in the deep sea, and constituted that very fishery which was supposed to have produced to Holland such enormous wealth, and which excited our jealousy, and stimulated our attempts. This was well known in Pennant's time, and long before, since it is a fishery of a very ancient date; and it ought to have prevented the promulgation of the absurd theory which I have here contested. It is now equally known to ourselves, from our own deep sea fishery; though that is comparatively little pursued, for reasons which will appear hereafter.

The approach to the shores is performed, in the first place, for the purpose of spawning, as this operation can only be carried on in shallow waters; and hence the resort of the fish to the lochs and bays. It is probable also that the pursuit of food is another reason or motive; and, among that food, we may reckon the medusæ and other analogous marine vermes, which are produced in such abundance during the summer, in all these shallow seas. Nor is it unlikely that the herrings are driven in to the coasts by their enemies, the piked whale, the grampus, and the fin-fish, as well as by the cod and other smaller fishes that make prey of them.

If all these motives variously combined will not account for their irregularity, they may at least aid in doing so. Hence, its haunts, as well as its periods may vary. That the season of spawning in different fish takes place at different periods, is apparent from the different states as to fulness in which these are taken at the same time. Hence the periods of their approach to the shores must vary, and hence also the full growth of the young fish must be established at different periods. As to the food, the season and place in which that is produced is known to vary, as does its abundance; and this, unquestionably, must be one of the powerful motives by which their appearance both as to time and place is regulated. The appearance of their great enemies is no less uncertain, and thus also we approximate somewhat nearer to the causes of all these variations. Since there is reason to believe that the herrings feed on the medusæ, and as the presence of these is known by the luminous state of the water, it is very likely that this might, in itself, form some guide to the fishermen for their presence. But as they have not hitherto been aware of the cause of the luminous state of the water, this indication has been neglected. In many seasons, the waters of particular bays are highly luminous, and crowded with these animals; while, in others, they are utterly wanting. We might expect that the presence of the herrings would vary accordingly; but though I have thus observed it, the observations have not been sufficiently repeated to allow of establishing a general rule.

I have already remarked that the season of spawning is apparently uncertain and various, and this seems confirmed by the discordant opinions of the fishermen on this subject. It seems, at any rate, to be fully ascertained, that they spawn in the same lochs where they are taken. The herring spawn abounds in these places in the season of the fishery; and, with small nets, fish of all sizes are taken. The spawn is also then devoured by cod, coal fish, and others which follow them; as they are in great abundance by the sea birds, particularly by the smaller gulls and the terns, which may be constantly seen flocking above the shoals, as the shoals of coal-fish are also found following them. Thus also they are found round the shores of the Isle of Man; and hence it appears that the proper season of the herring fishery in the lochs, is that in which they arrive for the purpose of spawning; and hence the condition in which they are taken. The young also seem to haunt the seas and bays where they have been produced, till they are full grown; but they are now seldom taken under the full size, on account of the strictness with which the law for destroying the small meshed nets has been enforced. The fish which has spawned returns to the deep sea to recruit itself; and thus the shotten herring, as it is called, is seldom taken.

It is further evident that the season of spawning must vary on different shores, because, at the same time, the fish is taken in different conditions on different shores, or is found at far distant times in the same condition. This happens comparatively on the east and west coasts of Scotland; as it does in comparing the west coast, or the Isle of Man, with the eastern coast of England. It would be very important for the fisheries to ascertain the exact season of spawning for each place, on account of the great difference in the goodness of the fish according to the condition in which it is taken. Independent of this, the herring is always in a much higher state of feeding on the west than the east coast, and is also much superior in size, flavour, and quality. In point of flavour, indeed, it is scarcely the same fish; being as much superior as a salmon is to the worst sea trout. This difference, in itself, would be enough to prove that no migration took place from the west to the east coast. I may add to the confusion which belongs to this subject, what I do not pretend to solve; namely, the various conditions as to fulness in which the herring is taken in the same place and at the same time. We might perhaps conclude from this, as from the other facts stated, that the season of spawning is very uncertain, and that, in this case, different tribes of fishes, or different fish, had been intermixed.

It appears to be a further proof against any migration of herrings in a body, even from the deep seas to the shores, that when they first arrive, and for the apparent purpose of spawning, they are not in shoals. They cannot then be taken by nets, from their dispersion. But the Highlanders then fish for them with a feather or a fly, and a rod, and, by this very amusing fishery, they take them in sufficient quantity to render it a profitable occupation; as one man has been thus known to take a barrel and a half, or about 1200 fish, during the few days this fishery lasts. It is thought that they again disperse after spawning before they collect into shoals, so as to give cause for a second fishery of the same nature.

Such are the principal facts which I have been able to collect, respecting the natural history of the herring, and the physical history of the fishery on the coasts of Scotland. Having had but slender opportunities of observation or inquiry, no other apology is needed for not having done more. I believe there is much more knowledge dispersed among the fishermen, for him who might have opportunity and dexterity to extract it. The people observe; but having neither system, nor interest to record, their knowledge is forgotten or neglected, even by themselves. He who should bestow his attention on this subject, for a few summers, might probably attain a knowledge of the most important facts yet remaining, and complete what I have only sketched.

It is the duty of the Board of Fisheries to add this to their other exertions; and if that has not yet been done, it is perhaps because it has been thought sufficiently known, or, possibly, because it is supposed unattainable. It cannot be supposed unimportant; and that it is neither of all these three, I hope I have proved. At least I have justified the criticism with which I commenced on the theory of Anderson and Pennant. It will not be uninteresting to add a few words on the present commercial and political state of the Herring Fishery.

That fishery, so long a subject of anxiety and speculation and regulation, has now arrived at a state more extended than was so long wished for, and so long despaired of. It has occasionally exceeded the demand; and in 1820, it considerably and injuriously overstocked the entire market. It must be known, at least to those who have attended to the history of our commerce, that our anxiety about this branch of trade was excited by our jealousy of our neighbours the Dutch, who were represented as raising gold from the mines of the ocean, and as infringing on our rights and property; insulting our indolence at the same time by their superior industry. I may refer to the pamphlets and newspapers, almost to the romances and poetry of the day, for the public opinion on this subject.

That this subject gave rise to as much nonsense as ever was written, need scarcely be told; while the greater the difficulty which we imagined we found in coping with them in this field, the greater was our anger. These politicians forgot that Holland was overflowing with capital and industry, and was driven to this occupation for want of other employment for its people, as of vent for its capital. They forgot also that the industry and capital of Great Britain were much more profitably, as well as more agreeably, occupied; and that neither force, nor bad writing, nor bounties, nor acts of parliament, would succeed in diverting either from a profitable trade to a bad one, or from occupations of little labour to one extremely laborious and disagreeable. Yet thus were passed the chief Acts of Parliament in Charles the Second's time, particularly after 1672; when it is palpable that they were also as much dictated by a spirit of jealousy, as the desire of gain.

Pursuing the same system, the bounties were established in 1748, and as the quantity or rate of these fluctuated, the herring fishery rose and again declined. It was at a low ebb during the American war, as well as during the last. Nor could any reasonable bounty have enticed capital into it under those states of commerce; though our politicians did not even then appear to have reflected that there was no capital to spare for such an employment, that there were abundant and much more enticing demands on it from other quarters, and that the trade itself had the further demerit of being new, precarious, and disagreeable. This was the true cause of the declension of the herring fishery; and were the same causes to be renewed, it would decline again. If it is now flourishing, it is chiefly from the superabundance of capital, and from the want of better outlets to our industry. England will have cause to lament the day which shall render her the great herring fisher; the rival of the ancient Dutch, and the envy of politicians of the same caliber as Aaron Hill and Oliver Goldsmith.

The raising of the barrel bounty to four shillings in 1815, and the admission of rock salt in 1817, were the last regulations, and those under which this trade is now flourishing. These are all, at least that I shall notice, as I cannot here afford to trace the whole history of the fishing regulations, since they would in themselves make a volume. The chief of the others, however, which do require notice, was the Act for the minimum of the meshes, (a very questionable policy as it regards the domestic fishery,) and the method of gutting and bleeding the fish, as practised by the Dutch. Under this process, where carefully followed, the Scottish herrings are now found to be equal to the Dutch, and to compete with them in the foreign market. The bounty regulation is a very doubtful benefit. It is costly without being necessary; and amongst the fishermen in general, the restrictions and trouble which attend the various regulations, are so great as to make it a very common wish that it should be rescinded, and the whole trade left free. It is argued, on the other hand, that, without force, the fishermen and merchants will make and sell bad fish; to which the obvious answer is this, this would be against their interests, as they would soon have no buyers.

But to pass from this. There has been, under these various circumstances, a progressive increase in the quantity taken; while from 1816 to 1820, beyond which this sketch does not extend, the quantity cured according to the regulations, and therefore entitled to the full bounty, has also progressively increased. But there is another important cause here implicated. The great increase has not arisen from the extension of the Buss, or deep sea fishery, but from that of the boat fishery. This is carried on by the small farmers and fishermen who reside on the sea-shores, who sell to the busses, which thus find it a more profitable trade to buy from them than to fish for themselves. Thus far our fishery differs from that of the Dutch, which was carried on by large sloops or herring busses in the deep sea. Thus the main cause of the increase is not to be sought in the acts of parliament and regulations only, nor exclusively in the superabundance of capital. It has been one chief result of the alterations in the system of Highland farming, by which, in consequence of the allotment of the interior tracts to sheep, the people have migrated to the sea-shores as occupiers of fishing crofts. While this mode of fishing has been found the most profitable, in a commercial view, it has also produced the advantage of finding employment for the formerly unoccupied people of the Highlands, and has been, in fact, one of the great but overlooked benefits, which has flowed from a system against which such a senseless and protracted clamour has been raised.

It is, perhaps, time to reflect whether bounties can any longer be necessary. The solution of this question must be sought in the preceding facts. Circumstances have changed. Capital is now seeking employment. So is Highland industry; so is industry in general. If the bounties force a larger fishery than finds a vent, they are no longer beneficial; they cannot at least be necessary. But I need not dwell on this part of the present subject. I shall, therefore, pass over all that relates to the present legislative regulations, whether as these relate to salt, or to any thing else, for the purpose of offering a few remarks on the singular state of the market.

If we take the year 1820 as a standard, the herring fishery has not only arrived at its maximum, but has exceeded that, and must be reduced. It has, once at least, exceeded the demand, as I shall presently show. Now as the supply appears inexhaustible, and as the demand for food appears equally so, it is an object of curiosity to inquire what it is which has thus brought it to a state of rest; a state of rest which would at least seem to render all further encouragement unnecessary. This is true of other fisheries. The Ling fishery of Shetland is in the same state, restricted by an insufficient demand. If it is inquired why they do not fish more, the fishermen answer briefly, " the people will eat no more salt fish." Thus they account for that limited demand which checks their industry, and which also, as in all similar cases of limited and doubtful demand, generally keeps the supply down to a state somewhat lower than that which would really find a sale. This must be recollected, in examining this question; for however a greater or an occasionally higher sale might occur, it is the business of the producer, for his own interest, first to take care that there is really a demand, and then to watch that his supply shall not exceed it. It is the object of the merchant to see that demand both precedes and exceeds supply.

It appears very difficult, practically, to admit the theory of the fishermen as it relates to the consumption of salt fish. As to the West India demand for herrings, that can be accurately calculated, because it is compulsory on the consumers. The Spanish demand for ling is equally certain and regular; because it is also compulsory from other causes, and because there is no great fluctuation in the number of consumers. In neither case is it a matter of taste or opinion, and it is therefore subject to no caprices. But that the people of Britain who are often in want of animal food, those of Ireland and Scotland in particular scarcely ever seeing it, should refuse to eat salt fish, is hardly credible. They assuredly show no dislike to it on the sea-coasts where they have ready access to it; and in most maritime districts indeed, it forms a principal part of their diet. It is not to be supposed that the labourer of the interior would not eat herrings rather than be confined all the year to oatmeal, potatoes, or bread; and if there is no fish consumed in these districts, it must be from want of knowledge, want of habit, or from defect of the internal commercial arrangements of the county.

That it would be highly advantageous, both to the people themselves and to the merchants and fishermen, to diffuse that habit and that knowledge, can admit of no doubt; as it is folly to say that salt fish is not a nutritious diet. That this has been neglected, is equally apparent; and it seems particularly to have been neglected by our monstrous charitable establishments, in whose department it would seem particularly to lie. If it were possible to excite such a demand, and that a steady one, our fisheries would prosper in proportion, and can now prosper in no other way, as they have overstocked the foreign market; that market which cannot be extended as the home one may. But as long as the fishermen are checked by their frequent losses on a perishable commodity of precarious sale, they must restrict or withdraw. To excite such a fashion or demand, would be an act worth all bounties that ever were invented. The true object of policy is not to produce the article, but to produce a sale for it.

If we reflect on our peculiarly maritime situation, the inexhaustible supply which our seas afford, and the constant occupation for industry here found, it has been a singularly unfortunate circumstance, that those who framed the model of our Reformed Church did not retain at least the weekly fast. It is a misfortune that they had not been persons of more general views, and economists. Much was retained that was matter of indifference on the great points at issue; for the sole purpose of drawing a line short of the extremity of reform. Had this also been retained, a point in itself indifferent, the beneficial consequences would have been very great; as it would not only have operated by its direct effects, but have tended to diffuse the general commerce of fish in the interior of our own country, and the general habit of consuming it. It is easy to conjecture how advantageously it would have operated, when, even now, we derive so much benefit from the fasts of the foreign Catholic church as the ground of a branch of commerce.

But I must conclude this sketch of a subject which might easily be extended to an inconvenient length, and shall subjoin some documents from the official reports, as proofs and illustrations of some of the preceding views and arguments. They will shew among other things, the state of the market and the supply, and the comparative produce of the east and west coasts of Scotland. The period I have selected is one of five years, as I cannot, without trespassing on the prescribed bounds, take a larger one.

In 1815, there were about 160,000 barrels cured; and in 1816, this had increased to 163,000 only. In 1817, the increase was to 192,000; and in 1818, it took a sudden start, and was 228,000. In 1819, it had advanced to 326,000 on the east coast, and we here trace distinctly its gradual increase and parallel course, to the various causes I have already laid down. The increase in 1820 had advanced, even on 1819; but though I have lost this document, the consequences were such as to have left a considerable quantity on hand unsaleable, producing a very serious loss to the merchants.

As to the east and west coasts, in 1819, the proportion was about 81,600 for the latter, that of the former being, as already stated, 326,000; but as the boats of Glasgow, Grenock, and Rothsay, stand for about 53,000 of the latter, and as they buy on the east as well as the west coasts, it is estimated that the eastern was to the western fishery as 280 to 45 nearly. Formerly, the eastern fishery was limited to Wick, which also furnished 21,000 of the produce of 1819. The remainder is, in a great measure, to be attributed to the improvements upon the Sutherland estate.

I must now remark, that the average weight of the herring cask is between 120 and 130 pounds, and that the number of fish averages 800. Now the exportation of white herrings in 1819, was about 227,000 barrels; leaving about 108,500, or eighty-seven millions of fish, for home consumption, exclusive of the comparatively small quantity produced by England and the Isle of

Man. If we take the nearest round numbers, and allow only two herrings a day for an adult, this would be an annual supply of a proportion of animal food for little more than 119,000 individuals. But this quantity would scarcely be a sufficient supply of food for 40,000 persons, allowing six fish a day. It is hardly necessary to remark how trifling a supply this is for the home consumption, in an article of which the production seems to be illimitable. It is plain that much may yet be done towards increasing the food of the people, when the habit shall have been excited, and the circulation of this article better understood. The price is not the obstacle, because the price of 800 fish was only twenty shillings. Animal food could not well be cheaper than when nearly two herrings could be procured for a halfpenny, or when an adult could be completely fed for three halfpence a day. That, with such a price and such possibilities, the poor of this country should have wanted animal food in 1819, when the market was glutted to the ruin of the proprietors, is not one of the least curious facts in a science which has for some time abounded, even to weariness, in theoretical writers. J. Mac Culloch.

Art. IV. *A new Demonstration of* Taylor's Theorem. *By* Edward Wilmot, Esq., T.C.D.

[To the Editor of the Quarterly Journal.]

Sir, *September* 16, 1823.

Those who are in the habit of lecturing in the elementary parts of mathematics, must frequently feel the difficulty of making the common proofs of *Taylor's Theorem* for the development of functions intelligible to the junior students. This difficulty I have myself frequently felt, and I know it is complained of by the professors in the French colleges. I am, therefore, induced to send you a demonstration which appears to me at once simple and valid. It is independent of those assumptions in functional principles which are involved in the proofs, and which, though they are perfectly clear to the expert and practised analyst, are always embarrassing, and often absolutely unintelligible, to the beginner. The proof which way of using very deep ones without destroying their eyes *. I humbly recommend the contents of this paper to opticians, without being at all ambitious to acquire the honour of teaching them their own profession. I have the highest consideration for their practical knowledge, and conceive that one ounce of it is worth a ton weight of that of a mere theorist; at the same time I hope they will accept of my apologies for pointing out a few circumstances to them, (certainly not of much importance,) which the value of their time and the multiplicity of avocations of higher consequence will not usually permit them to attend to. If what I have written shall prove of no service to *them*, it is quite clear that my labours have been utterly useless. Indeed, it is too much the case that the researches of amateurs only terminate in discovering something which was perfectly well known before, and which only therefore serves to shew their own shallow acquaintance with the subject, or in bringing forward something as an improvement which has been tried and rejected long ago by those practically versed in the mysteries of optics.

ART. IV.—*Hints on the possibility of changing the Residence of certain Fishes from salt water to fresh.*—By I. MAC CULLOCH. M. D., F. R. S., &c.

IN the tenth volume of *Tilloch's Journal*, there is a paper on the means to be employed for multiplying fish, translated from one which appeared in the *Moniteur*, by Monsieur Nouel, of Rouen. Although the chief speculations of this writer, which are of a very

* They may, perhaps, also thank me for informing them that Mr. Cornelius Varley, of Upper Thornhaugh-street, Bedford-square, (the inventor of the graphic telescope,) worked the small lenses for me which I have described; they were polished on wax tools, the figure is as correct as that of any shallow lenses, and their image will bear magnifying perfectly well. Mr. Varley and Mr. William Tulley of Islington, are the only individuals I know who can make such deep lenses as they ought to be made.

interesting nature, concern the means of transferring the inhabitants of fresh waters in one country, or those of certain lakes or rivers, to others where they are not found, some hints are also introduced respecting the possibility of rendering certain sea-fish inhabitants of fresh waters. The whole paper is highly worthy of attention; but I am not aware that it has been followed by any of the practical trials recommended by the author, on which its economical value must ultimately depend. An example in point which recently came under my notice in Shetland, has induced me to examine the subject with somewhat more care than the author of that memoir seems to have bestowed on it, and to inquire more minutely into the arguments on which the probability of success rests. The following seem to be the only results which have been obtained, or were previously known with respect to that part of M. Nouel's plan, which relates to the cultivation of sea-fish in fresh water.

The plaice, *Pleuronectes Platessa*, as it appears, has been carried from the North sea to the ponds of East Friesland, where it has become established. The herring is said by Liancourt to frequent the Potowmack, Hudson, Elk, and Delaware rivers; but it has not appeared that the author's project to take it from the Seine into fresh-water ponds has been put into practice. The authority of Twiss for the existence of this fish in the fresh water lakes of Ireland, is more than questionable, and M. Nouel is assuredly misinformed when he states that it is found in prodigious shoals in Loch Lomond and Loch Eck in Scotland, both of them fresh inland lakes. I know not how this author can have thus been misled, unless he has mistaken some of the sea lochs for fresh-water lakes; though he could scarcely have confounded those he has named with any of the western inlets. I shall hereafter, however, point out a fact which renders his assertion possible; though he could not have been acquainted with it, as it is not very long since it was known, and has not been published in any work likely to have reached his hands.

It is also asserted in the same paper, that the salmon, in Scotland, has, in certain lakes, become naturalized, " abandoning their erratic taste, for a calm and settled life." Whether such an experiment might not succeed, by forcibly transporting the salmon to lakes from which they could not reach the sea, is yet to be tried; but certainly there are not at present any salmon found in the Scottish lakes, except where they have the power of making their annual migrations into salt water. That salmon are attached to the particular rivers where they have been spawned and bred, is believed by all the fishermen; but this does not prove that they are naturalized to those fresh waters, as they invariably return to the sea after having deposited their spawn.

According to Pallas, the sturgeon, the sterlet, and some species of salmon reside in the river Kama without ever descending to the Caspian sea; and the authority of such a naturalist is perhaps sufficient to establish this interesting fact.

These, then, are the whole of the proofs which, in M. Nouel's paper, are adduced in support of this project; it remains to be seen by what other facts and reasonings its plausibility may be supported, and an inducement offered to those who have it in their power, to make such experiments as alone can establish it among those facts in natural history which are capable of being applied to the uses of man; to increasing the quantity, or adding to the accessible variety of his food.

In the first place, it must be remarked, that the habits of many sea-fish are, in this respect, so convertible, or so easily assimilated to the requisite change, that a large portion of their time is passed in fresh water. The common salmon, the grey salmon, and the salmon trout, Salmo Salar, Salmo Eriox, and Salmo Trutta, are familiarly known to frequent rivers for the purpose of spawning; returning to the sea when this operation has been performed. The Salmo Migratorius leaves the lake Baikal for the same season; and, with us, the S. Lavaretus, or Gwiniad, and the S. Eperlanus or smelt, also quit the sea; ascending rivers at the spawning season, as does the Salmo Autumnalis, an inhabitant of the frozen ocean.

Now though M. Nouel is wrong in saying that the salmon is found in the Scottish lakes excluded from access to the sea, it is a fact that the salmon trout, or sea trout, as it is called in Scotland, is now a permanent resident in a fresh-water lake in the island of Lismore, and without the power of leaving it or reaching the sea. There, it has been known for a long course of years, perfectly reconciled to its prison, and propagating without any apparent difficulty. If this fish, whose annual necessity for returning to the sea is the same as that of the common salmon, has thus easily become naturalized, there is little reason to doubt that the same experiment would succeed with the salmon itself. The fishermen object to that opinion, that this fish becomes meagre and diseased by its residence in fresh waters, and is compelled to go to the sea to recover itself. But we need not feel much concern respecting their philosophy; while they forget at the same time that it is the operation of spawning by which the fish is injured, and that this consequence happens alike to sea-fish, from the same causes. It remains to be proved that the salmon would not recover itself in fresh-waters, as the sea trout does in Lismore; and this is the experiment which is to be tried before we are entitled to pronounce a negative. To render the salmon a permanent resident of the fresh-water lakes of Scotland, would unquestionably be a great gain; and that this has not been tried, often as it has been urged on those who have the means, is only an additional proof of the plodding incredulity and obstinacy of those who are averse to all innovation because it is innovation, and who believe that they have themselves attained the summit of all possible knowledge.

With respect to the smelt, its delicacy would render it a very desirable acquisition in our ponds, while its size would probably cause it to find an easy supply of food, and its facility of living for a time in fresh water render its naturalization easy. I accordingly caused some trials to be made for this purpose: they did not however succeed, but the experimenter considered that they were not fairly conducted, as the fish had been injured in the transportation. It is obvious that in every trial of this nature great attention to this part of the operation must be requisite.

Since this, a perfect experiment to this effect has been made by Colonel Meynell, in Yorkshire. The fish have lived three years, and it is understood that they have propagated abundantly. They were not affected by freezing, as the whole pond, which contained about three acres, was so frozen over as to admit of skating. As to their quality, it was considered by the fishermen of the Tees, by whom the pond was drawn, that they had never seen "a finer lot of Smelts;" so that in this case there was no loss of flavour or quality.

The common pike, Esox Lucius, which is an inhabitant of fresh lakes with us, is also found in the Caspian sea; proving that this animal among others is indifferent to the quality of the water which it inhabits, and, in this case, permanently so.

It seems to be unquestionable, that in the Dee and some other Scottish rivers, the common eel, Muræna Anguilla, migrates annually to the sea, wherever it has the power of reaching it; returning again to the rivers and lakes which it has generally been supposed permanently to inhabit. The conger eel, Muræna Conger, which is an inhabitant of the sea in general, also frequents rivers; so that, of this genus, there are two at least of which the residence is occasionally convertible.

The Gadus Callarias, or torsk, is also known to enter the mouths of rivers, so that it can reside at least for a time in fresh waters without injury; but it is not known to remain in them permanently. That the Gadus Morhua, or common cod, can reside permanently in fresh water, is proved in Shetland. In the mainland, as it is termed, of that group, the inlet called Stromness-voe communicates with an inland fresh-water lake by a channel so narrow as to admit of a rude bridge by which the opposite shores are connected. In this fresh water, cod are frequently taken; and that the water is perfectly fresh is certain; as the tide is never sufficient to pass the strait of communication, merely damming the fresh water till the ebb again commences. The inhabitants seem to entertain no doubt that the cod remains there for a considerable time; but the subject not having particularly interested them, it remains to be discovered whether their residence is permanent or occasional, or whether they spawn there. If they reside there, even for any length of time, it is probable that this water contains other sea-fishes, by which they are tempted, unless they feed on trout; but I could not discover that any others had been found.

The Gadus Barbatus, or whiting, and the Tricirratus, or rockling, occur in abundance in those Highland sea-lochs where the water is at times perfectly fresh, from the magnitude of the rivers in rainy seasons; not quitting their haunts even when it is deeply tinged by the colour derived from peat. From their permanence in those situations, and from being taken of all sizes, they probably spawn there; and, if so, they offer, like the common river flounder and the pike, perfect examples of the permanent convertibility of the habits of these species.

The Cottus Quadricornis, a native of the Baltic, also ascends rivers, as does the Gasterosteus Pungitius, or stickleback, in our own country. The Pleuronectes Platessa, or plaice, as has already been observed, is naturalized to fresh water in East Friesland: and the P. Flessus, or common flounder, is well known to be permanent in the Thames and other rivers, far within the fresh water, although equally a salt-water fish. The P. Roseus has also been taken in the Thames. I am further informed that a sole was kept in a fresh-water pond in a garden, by a person whose name I need not quote, for a great many years; and if the plaice and flounder can be so naturalized, it is not unlikely that this would prove true of the whole genus.

Although the mackerel is rare in Scotland, it is sometimes taken in the lochs of the western highlands, where the water, from the entrance of rivers, is nearly or absolutely fresh; a proof at least, as in many other fishes, that whatever aversion they may have to residing permanently in fresh water, whether from the want of food or for other reasons unknown to us, they experience no difficulty in respiring in it.

The Mugil Cephalus, or mullet, which is a sea-fish, not only ascends rivers, but has been introduced and detained in ponds; offering another example, like the plaice, of the possibility of permanently naturalizing a sea-fish to fresh water. This fish does not necessarily spawn in rivers; since, in England, it performs this operation on the sandy and muddy shores of the sea. Yet, in Asia minor, it appears that it always spawns in the rivers, ascending the Sturmus, the Meander, and others for this purpose, and producing the Botargo so well known in the market. This is a valuble fact in the question under consideration; as it proves that, in the matter of spawning, fishes are not tied down to those fixed and necessary habits which has been commonly supposed.

As the case of the naturalization of the grey mullet is particularly interesting, and is at the same time unknown, except to the few individuals who caused the experiment to be made at random, it deserves a more particular description; since it offers, together with the instance of the cod in Shetland, another of those facts which have come within my own knowledge.

This experiment is, at the same time, perfect, as much so as that of the plaice in East Friesland; and it holds out therefore a tempting prospect of success in other cases where no trials, either from accident or design, have yet been made.

About ten years ago a number of the grey mullet, about the size of the finger, were placed in a pond of three acres in area, in Guernsey; the water being perfectly fresh. They have since increased in size, as well as in numbers; although, from the small extent of this pond, it is evident that their ultimate increase cannot be very considerable. Fish of four pounds in weight have since been taken from this pond, so that in this respect as well as in their propagation, the experiment is complete and perfectly satisfactory. It is remarked that they are much fatter than those taken in sea-water in their natural state, but that the flavour is not so good.

From this pond a number of small fish were afterwards taken for the purpose of stocking a smaller one. These continued to grow and thrive for about three years; when unfortunately, the occurrence of a severe frost, during which the water was closed up many days, destroyed them.

In this case it is evident that nothing is wanting to the establishment of the fact in question with regard to the grey mullet: and it may safely therefore be named as one of the fish which may without difficulty be naturalized to fresh water, and made use of to increase the accessible variety of our food or luxury, in places where fresh waters abound, and which are far removed from the sea.

This experiment is fully confirmed by the practice of the

Sicilians. In the Lake Biviere, this fish is cultivated for the purpose of food, and because its quality is thus found to be improved. It is an important circumstance also, that the water is here such as would be supposed peculiarly offensive to fishes taken from the sea; as it lies in a marshy plain, and is such that the extent of the lake is twice as great in winter as in summer. Such water must be nearly putrid; and therefore the Mullet at least would probably live and thrive in any ditch or pond.

As its quality is thus also found to be improved, it is plain that the report respecting the deterioration of the Guernsey Mullets is, at best, doubtful; while it is equally probable, from this case, as well as that of Colonel Meynell's Smelts, that the general effect would be to improve, instead of injuring, the flavour of the sea-fishes in general.

Though here somewhat out of place, I may also notice, that Lobsters and Crabs are introduced into the same lake for similar purposes, where they are not only preserved but improve in flavour. It had been concluded, in England, that these animals could not be so cultivated, because an experiment made by Sir Charles Monck failed. We must probably attribute this to some accident; as the Sicilian practice is of long standing, and has been confirmed through an unknown course of years. As to the improvement of the flavour of the Lobsters and Crabs in this case, it is distinctly stated, and it confirms the general presumption that this would commonly be the result; while another confirmation is found in the fact that Oysters acquire their good qualities only by residence in fresh water. Thus the Oysters of Portsmouth and elsewhere are transferred to Colchester; and if those which are called "Natives," possess good qualities, it is because they are produced at the æstuaries of rivers, where the water is considerably fresh, as is the case with those of Milton. In a similar way, Cockles and Muscles are perfectly worthless, except in analogous situations, as is equallly the case with Periwinkles; and it is known to every one, that the best Shrimps are those which are taken on the fresh and muddy shores of England.

The Clupea Sprattus, or sprat, is well known to be taken in the fresh water of the Thames; although it is not ascertained whether it remains for any length of time out of the salt or brackish water. The C. Alosa, however, or shad, ascends rivers to spawn in the spring, like the salmon, returning in the autumn; and its spawn, the white-bait of London epicures, is well known to be taken in the fresh water. It is probable therefore that it spawns there, as the salmon does; and hence also, were this fish worth the experiment, it might probably be naturalized to lakes and ponds. This seems peculiarly plausible in the case of all the sea-fish which spawn in fresh waters; because this is one of the natural operations which we should conceive it *à priori*, most difficult to counteract.

I already noticed that the best known fish of this genus, the herring, was found in the fresh American rivers. And though I was obliged to contradict M. Nouel respecting its existence in Loch Lomond, I may here say that it has been found at different times in Loch Dhu, a fresh water lake in Argyllshire, near Loch Fyne. In this case, it appears to have been introduced during a flood, through the small river by which this piece of water communicates with the sea; being afterwards confined by the subsidence of the water, so as to have remained imprisoned for many years. It does not seem however to have been ascertained whether or not it propagated in the lake; so that this natural experiment still remains incomplete for want of observation. This however is a trial so easily repeated, that nothing probably has prevented it, but that ignorance or prejudice on this subject which it is the main object of this paper to remove, by holding out reasons for probable success.

The Crucian, Cyprinus Carassius, the Bleak, C. Alburnus, the roach, C. Rutilus, the Bream, C. brama, the C. Idus, C. Nasus, C. Aspius, and C. Ballerus, like the pike, seem to inhabit the Caspian sea as well as the fresh waters and ponds of Europe; offering other instances of perfect and permanent indifference to the nature of the waters in which they exist.

The Chalcoides, in the same genus, migrates annually from the same salt lake to the rivers that run into it; and the C. Aphya seems to inhabit indifferently the sea shores and the mouths of the neighbouring rivers.

The Cyclopterus Liparis has also been observed to ascend from the sea into fresh waters; and the same fact is familiar with respect to the sturgeon, the common lamprey, and the lesser lamprey, or Petromyzon Fluviatilis.

Lastly, the Delphinus Leucas, or white whale, is known to ascend the fresh-water rivers of Northern America; but as this animal breathes air, it does not, in that point at least, coincide with the true fishes, which respire water. The appearance of this species of whale seems to have been the chief evidence by which Hearne and Mackenzie attempted to prove that they had reached the sea in their respective expeditions. It is known to ascend the Hudson to a distance of 100 miles and more, above the salt water, and is taken by an established fishery high up in some of the fresh rivers of Hudson's-bay.

Here then is a large body of evidence, derived not only from the occasional, but from the permanent, residence of many sea-fish in fresh waters, and, on the contrary, of some fresh-water fish in salt lakes, to prove the existence, or possibility, of these convertible habits, at least in those species. But it will be convenient to subdivide the considerations which arise out of this subject, as they affect those functions in fish which, as far as this question is concerned, must be considered as of a vital or essential nature; either as they regard the life and health of the individual, or the continuation of the species.

The first of these is the act of respiration. The first doubt naturally arising on this subject is, whether salt-water fish can with impunity breathe fresh water, and the contrary. From the great number of the sea-fish which, either systematically or occasionally, visit fresh water without inconvenience, it is fair to conclude that the latter in no way disagrees with the function of respiration in them. A much stronger confirmation of this is afforded by the facility with which the plaice, mullet, and flounder have been permanently naturalized to fresh water; and by the fact that so many others which are described in the preceding catalogue, seem by nature to inhabit both indifferently. It remains indeed to be proved that any fresh-water species now known as limited to rivers and lakes, can be permanently confined to the sea; but this is a point which can obviously never be determined.

A species of argument might be derived, on this subject, from the probable state of the earth at former distant periods, and from that which has probably been the original condition of many inland lakes besides the Caspian. It is probable that many such lakes were portions of the salt ocean, and that they have been rendered fresh since their separation from it, by the effects of the rivers flowing into them. In this case, the fish which these contain were once sea-fish; and thus perhaps we may account for the double existence of the pike and of those Cyprini above described, in the salt waters of the Caspian and in the fresh lakes of other inland districts. But I will not here lay much stress on this reasoning. It is evident at least, from the preceding remarks, that a change of the medium of respiration is not injurious or poisonous to all those fish which even incidentally pass into fresh waters from the sea, as this effect, if any, ought to be immediate, or at least speedy. If so many species can bear that change in the medium of respiration, it is not unlikely that the whole might, as the general structure of the respiratory organ is the same in all; and it is not therefore likely that this function will be the cause of any great obstruction in attempts to change permanently the residence of fishes from one variety of water to another.

The next important function to be considered is that of nutrition, or the probability that food may be found or provided for those sea-fish which any projects of naturalizing them in fresh waters, may confine to inland lakes. We are so little acquainted with the food of many fishes, that it is not possible to throw much light on this subject; but it is probable that the most important and insurmountable obstacle will be found here. Of many species, it seems to be ascertained that they feed on marine vegetables. Others, like the mullet, are known to plough the sand in search of lumbrici; probably also, of the spawn of other fishes. Some species seem to be especially provided with the means and the desire of feeding on shell-fish; others on crabs or the crustaceous insects; while the northern whale, by an arrangement which must always appear extraordinary, is furnished only with the power of subsisting on animals so small as to be imperceptible, to its sense of sight at least, and which, in the scale of dimensions, lie almost at the opposite extreme to its enormous bulk. Many fish, like the cod, are known to be omnivorous; and of others, it appears probable that they feed solely on the multitudinous tribes of vermes and insects which crowd the waters. It is probable that, with respect to a great number of species, they live in succession on each other, if that expression can be used with propriety; or that, in the myriads of animals of singular and imperfect construction, and often of microscopic minuteness, which crowd the ocean to a degree that almost surpasses credibility, provision is made for the wants, in succession, of all those which successively exceed each other in size, voracity, or activity.

If we were to judge from what is within our reach with respect to many fishes, we should be tempted to imagine that they can live for long periods, even without food, or with a very small proportion. Thus the cod, one of the most voracious, has been kept in perfect condition in Orkney, confined in sea-ponds for three months and more; although no visible animal was admitted with the water which the tide daily brought to its prison. During the whole residence of the salmon in fresh waters, which often extends to a considerable period, it seems to exist with little food; since the few winged insects at which it occasionally rises, can afford no effectual nutrition to an animal of such bulk and activity. The state of the common ornamental gold-fish confined in water-glasses, is equally remarkable; but it is unnecessary to prolong the enumeration of facts which, however difficult to explain, have long been familiar to those conversant with the habits of fishes.

But whatever we may doubt respecting the nature or the necessary quantity of food for fishes, it must be evident that no permanent naturalization of many of them, at least, can be expected, unless the new situation is such as to provide them with a sufficient supply of food. In many cases, perhaps, we may judge for them; and if the proprietor of a Highland lake chooses to eat cod rather than pike, at the expense of a proportion of his perch and trout, and can persuade them to live in his fresh water, it is probable that they will not have to lament the want of food.

In any case, our ignorance on this subject need not be a bar in the way of any experiment on this kind of naturalization. So many species find their food without our knowing the means or the materials, that we may safely trust to their wants and their powers. Besides, as the enormous reproduction of all these tribes is evidently in part destined for the general support in succession of all those of which they are the prey, it is evident that by increasing the population and the variety in any of these watery kingdoms, we increase the means of mutual support. The smaller feed on that which the larger could not find or use; and thus they maintain the existence of their superiors, who, in return, are destined perhaps to maintain them with their own ova or offspring. If again, practically, the plaice and the flounder, natives of the sea, have found the means of permanently feeding themselves in fresh waters, it is not unlikely that many others may there find food unknown to us, and, for want of trial, unknown at present even to them.

But there is no difficulty in feeding them, should that prove necessary. This was a common practice with the Romans; and those who choose to turn to Varro or Columella, may see records of the immense sums which were expended by the Romans in feeding the fish in their vivaria; as they may also see, from the enormous prices paid by Cæsar, Lucullus, and others, to what an extent the practice of keeping fish-ponds was carried, and how important a branch of rural economy this was considered. The consequence attached to fishes by this people is apparent everywhere; and no one need be told of the celebrated Senatusconsultum held on a turbot, or of the fishes which, Martial tells us, came to their owner's call and licked his hands. If, in our own rural economy, it is found profitable to feed pigs and fowls, it would not be less so to feed fish, nor are these tribes, apparently, less omnivorous than hogs.

The last of the important functions of fishes likely to be an impediment to this attempt, is their reproduction, or the act of spawning; or rather, the circumstances necessary to ensure the vivification of the ova. The instincts, as they are called, or the peculiar habits of many fish in this important affair, seem often to be as obstinate as they are peculiar. This is notorious in the case of the salmon; which must not only deposit the ova in a river, but in a remote part of it, and even in the very stream in which it has itself been produced. Many fishes deposit their eggs only on shallow shores, although they inhabit the deep seas. Some frequent the estuaries of rivers for that purpose, others select mud, a third set sand, and others again the crevices of rocks. Yet as this part of the economy of fishes is a matter of necessity, it only remains to consider whether, being deprived of these conveniences to which they are instinctively addicted, they would not soon find it expedient to abandon them, and to adopt those alone which were within their reach. In this respect, the habits of the land animals with which we are acquainted, have been found susceptible of temporary, and even of permanent changes. Little acquainted as we are with the intellectual powers of fishes, or with the variety of character and capacity for education which may exist among them, it is bad reasoning to presume that they are incapable of cultivation or change of habits, and that their sole talents are to catch, and their sole occupation to eat, each other.

Presuming, therefore that the ova must, as a matter of necessity, be deposited somewhere, it may be observed that inland lakes present all the varieties of bottom which are found in the sea. They receive rivers, have muddy bottoms, sandy and gravelly shores, and intricate rocky creeks; and, in some or other of these places, every fish may find a situation for its ova, more or less consonant to its natural habits. Nor is there any reason to suppose that where the parent lives, its offspring could not be vivified; since the vitality of the ova is far less likely to be affected by a change from salt water to fresh, than the complicated functions of the living and full grown animal. In a practical view, the power of continuing the species under such a change, is proved by the facts already cited with respect to the plaice, mullet, and flounder; and it is only to be regretted that no further evidence of this satisfactory nature can be adduced in favour of this reasoning. The double residence, however, of the pike, and of the various Cyprini, already more than once quoted, offers a complete argument in favour of the convertible habits of these species at least, in the business of reproduction as in that of food.

Supposing now that, at least the probability of all these reasonings is admitted, it only remains to put these speculations to the test of more extensive experiments. Nature has executed two, perhaps more; art, in the plaice, the smelt, and the mullet, has carried three more into effect. There appears no practical difficulty attending it; as fish can be transported alive in water, for a great length of time, and to great distances, without inconvenience. If Shetland were differently constituted with respect to the distribution of its population and the residence of its proprietors, a very satisfactory and easy experiment, on the cod at least, might be made in Stromness Voe. It would only be necessary to shut up the very narrow opening by which it communicates with the fresh water, by means of a grating, and time alone would soon determine the question. Should this paper meet the eyes of a body of proprietors distinguished for their intelligence and activity, it may perhaps induce him in whose power it lies, to make this easy experiment. Nor could there, in this place, as in some other situations in Scotland, be any difficulty in extending the same trials to other species of fish. But I need not dwell on this part of a subject which every one is competent to understand, but which not many have the means of submitting to the test of experiment.

On the transportation of fish, I must remark that it is not attended with so much difficulty as is commonly imagined, and that the fault generally has lain with those who have made the attempts. Many fish are exceedingly tolerant of being out of water for a time. The carp is kept in nets, in cellars, and fed thus in Holland. Minnows will live for months, crowded in a quart pot, with as little water as they can barely stir in, or in absolute contact. The whole of the flat fish are similarly tenacious of life; as are the conger, the gurnard tribe, the dog-fishes, and many more which I need not enumerate. The fault of those who have attempted the transportation, has been to take fishes which had been long hooked, dragging upon Long Lines, or entangled for a night or more in a trammel net. Owing to the peculiar distribution of the arteries in fishes, their muscular power is speedily exhausted by violent exertion; and hence they are literally killed, or nearly so, before they are taken out of the water in such cases; an effect which, in the case of salmon and trout taken by a fly, is vulgarly called drowning. This must be avoided; and it is well known that when cod are taken by hand lines, and thence transferred to the wells of the fishing boats, they always live, unless the gills or stomach have been much injured by the hook.

As far as this may be considered a question of economy or utility, it is not necessary to say much. It may perhaps, abstractedly, be deemed of little consequence whether an inhabitant of Germany is condemned to eat roach and gudgeon, or to regale on whiting and smelts; or whether, in a Highland lake, john-dory is to be substituted for pike, and turbot for par. But all the improvements in the details of human life may, if we please, be measured by the same rule. We have naturalized and domesticated the wild animals that walk and fly, to be our fellow-labourers, our companions, our servants in the chase, our amusement, and our food. Nature has given us crabs and sloes, which we have converted by our industry and perseverance into golden pippins and green gages. It is not an illaudable pursuit to apply to the uses of man all those bounties which nature has spread around him; but on the possession and perfect enjoyment of which this law has been stamped, that without labour and industry, they shall not be attained.

Yet while on this question of economy, it may not be improper to suggest a few doubts respecting the prudence of that conduct which, in this country, neglects the sources of rural profit to be derived from cultivating the produce of its fresh waters. In France, it is said that the value of an acre of water is equal to that of an acre of land; and these ponds are rented by great fishermen, or fishmongers, who adapt these systems of fishing their farms in such a manner as to ensure the greatest possible permanent stock of fish; removing the superfluous produce, which would otherwise be devoured or die, without injuring the future population, and thus procuring a constant and regular supply in the season, without the risk of exhaustion.

In Germany, it is well known that the cultivation of carp and other fresh-water fish is a regular object of attention; and although the proximity of the sea may cause us to treat with contempt the painful efforts of our neighbours to do that for themselves which nature has so bountifully done for us, it is assuredly not unworthy the attention of the proprietors of inland counties in Britain, to attempt to produce from them, either rent or profit. Under the present system, the fresh waters of this country are of little use but to furnish amusement to the sectaries of good Isaac Walton, and occupation to those who create flies of which no entomologist ever dreamed. Amusement would not be excluded by profit. If, too, it is said, as it well may be, that, as an article of food, the fresh-water fish are inferior to those of the sea, it must also be remembered that variety, no less than excellence, is one of the great resources, as it is one of the main pursuits, of the noble science of gastronomy.

But, to be more serious, the quantity of fresh waters existing in Britain is so considerable, as, with the exception of Switzerland, to exceed those of any country in Europe. From these, no profit whatever is derived. A Scottish lake, under a regular system of fishing and care, might probably far exceed in value the miserable tract of bog and rock by which it is enclosed. The canals of this country occupy a respectable space, and might, like ponds, be stored with fish, to the probable advantage of the proprietors no less than of the community. Even the rivers are unproductive, with the solitary exception of salmon, and of eels; since the quantity of other fresh-water fish brought to market is far too insignificant to be an object of attention in a case like this where so much more might be effected.

The objection to fishing on canals is the injury which may be done to the banks. That, if it really exists, would cease whenever the fishery should become a farm in the hands of a lessee. In all these cases it is merely supposed that, as in France and Germany, the object should be the cultivation of fresh-water fish. But if as the views held out in this paper attempt to prove, sea fish can be naturalized in canals, lakes, ponds, and rivers, it is not unlikely that the sources of profit might be materially increased. Experience would in a certain time teach us to know the fish that would live together most usefully for ourselves, that would rather contribute to each other's support and to ours, than to their own mutual extermination. As yet, this is a subject little known, because it has been too much the usage to suppose, that as man cannot live in the same element with a fish, he has no chance of acquiring a knowledge of its habits and pursuits.

The lakes of Scotland, of the North of England, and of Wales, offer particular facilities for the naturalization of sea fish, on account of the small distance at which most of them lie from the sea, and of the consequent facility of transporting these creatures in a living state. Should such a project ever be carried into effect, the good consequences are obvious. The facility of commanding a supply of fish would be increased; while that would also become certain, since it would no longer depend on weather, which so often interferes with the regularity of the sea fishery and of the market. The demand and supply might then also be more accurately balanced, as it is in all parallel cases when the steady price of domestic animals for food, is compared with that of those which are the produce only of chance or contingency. It is an unquestionable fact that the produce of fish for consumption may be much increased by the very act of fishing them; or that a certain proportion may be regularly taken away for use, without diminishing this subaqueous population. It is thus that a profit is made by waters which in their natural state yield no supply for man. Nor, in the sea, is the apparent supply for our uses, ever diminished by any quantity which we can consume, provided that, in some peculiar cases, care is taken not to destroy the ova, or the fish under a certain size. How little attention has been paid to this subject, in sea fishing, is proved by a recent Act of Parliament regulating the use of trawl nets in Torbay, and by other regulations of less value, which have occasionally been made for similar purposes.

In the cultivation of fish in fresh waters, the whole management becomes so completely under our command, that there would be no difficulty in framing such regulations as increase of knowledge would soon suggest, and as private interest would follow, or that of the public enforce.

In what precise manner the regularity of fishing increases the supply, or at least does not diminish the production, has not been clearly ascertained. That the several species eat each other's ova and young, and even their own, is very well established. Many devour each other, even at full growth, and it is not unlikely that many also die of disease or want of food. In such cases the steady removal of the superfluous part of the population cannot check its increase. If all the Turks and Egyptians who are to die of the plague next year, were to be devoured by crocodiles, there would be a certain quantity of food gained, and every thing would go on just as before. The empire would not have been a bit less populous or prosperous if the Huns and the Ostrogoths had eaten each other instead of strewing their own bones and those of their antagonists on the banks of the Danube, or the plains of the Campagna.

Respecting the species which might probably succeed in fresh water, it is not possible to offer any very rational conjectures. It is probable that they might most effectually be sought among those genera of which some species are already known to be versatile in their habits. In those genera of animals at least which are natural and not artificial, there are considerable resemblances among the habits and pursuits of the different species. Thus it is not very improbable that as the plaice, the flounder and the mullet, have been naturalized to fresh water, the whole of the fishes of analogous habits, and particularly those of the genus Pleuronectes, might be habituated to inland lakes. The turbot and the sole would be very desirable objects of cultivation. If different species of Gadus have been shown to be at least indifferent to the quality of the water into which they enter, the whiting as well as the cod might possibly learn to inhabit our lakes or rivers, and thus become among the most accessible as it is among the most delicate of fishes. If the smelt could be naturalized in ponds, as I have here rendered more than probable, it would, from the esteem in which it is held, be a peculiarly desirable acquisition. The hints contained in this paper may possibly induce others, who have the means in their power, to assist in the execution of a set of trials which can succeed only in the hands of many, and which must necessarily be the work of time.

It has been suggested that as the flavour of fresh-water fish is far inferior to that of the marine species, the effect of naturalization would be to diminish their value as articles of food. This does not absolutely follow, although it may be thought probable from the case of the mullet above-mentioned, and by the fact that the flavour of the salmon is constantly diminishing from the time it has quitted the sea. If such should prove to be the case, it might indeed diminish the value of the acquisition, but it would not therefore destroy it; nor is it likely that a smelt would ever sink to the scale of a gudgeon, or a whiting to that of a roach.

I have already shewn, however, that this deterioration of quality, so far from being probable, is not at all likely to occur; since with this single exception, supposed to have occurred in Guernsey, and which is probably the report of prejudice, the flavour is really improved in all the cases where the experiment has been fairly tried; and since the transportation, in Sicily, is made with this very object and no other. At any rate, let the trials be made before any such condemnatory judgment is passed.

I will only further remark here, that there is no very good reason why the turtle should not be naturalized. What an acquisition this would be, it may be left to the Court of Aldermen to decide. The animals of hot climates, that live in air, have been so; and and why the submarine, or amphibious ones should not equally admit of this change of habits, I know not, and nobody else does. The turtle might take its place alongside of the peacock and the pintado, and with his fellow turtles of the land; while, if he chose to hybernate, he might find a dormitory in Loch Lomond or elsewhere, to pass the chilling hours of a Highland winter. And the change would be less than in the case of the land animals; since there is not such a difference of temperature in the one case as in the other.

While on this subject, it will not be out of place to mention a parallel object of economy, far less known than it merits, and indeed little known out of Scotland, where it has been practised, although in a very limited manner, for many years. This is the preservation of sea fish in salt-water ponds. There are three of these in Scotland; one in Galloway, another in Fife, and the third in Orkney. In these, even cod are known to live for many months, and to increase in size, without any loss of quality, and without any other food than that, imperceptible to us, which is brought by the daily influx of the sea. In the pond in Galloway, some individual cod have been living for many years, so as to have become tame, if such a word may be applied to a fish, feeding, like hogs, out of a trough when introduced with a supply of food.

This practice is so obvious an extension as it is an improvement of the expedient of using well-boats, as to afford cause of surprise that it has not been adopted by those who are interested. Motives of interest in the proprietors would shortly become matter of advantage to the consumers; and the unsteadiness of a fish-market, no unimportant object of municipal attention, even in London, would cease to be a subject of complaint,

The Romans, who seem to have far exceeded us in all that relates to eating, as they did in a few other matters, were well acquainted with this practice; and the history of their Vivaria has descended to us, with much more that relates to their rural economy, of which this formed a distinguished branch. Columella says, decidedly, that they transported the spawn of various sea fishes to the different fresh-water lakes round Rome, " marinis seminibus implebant," and that this was a regular trade with the early agriculturists of the rustic Republic, before the rich and luxurious took the keeping of artificial Vivaria into their own hands. He mentions the Mugil, which is probably our mullet, together with " lupos, auratasque," two fishes of which we are not now able with certainty to assign the names. He farther alludes to others which he has not named, as being " dulcis aquæ tolerantia." He then passes from the subject, as of too familiar a nature to require a more detailed notice; a stronger proof than even his enumeration would have been, of the facts which I have thus attempted to support from his authority, and of the established existence of a practice which we have lost, and appear, very strangely, to be unwilling to revive. But I must refer your readers to the original, for the whole of this curious chapter, as the translation of it would inconveniently prolong this paper.

The merely temporary naturalization to our lakes and ponds in the case of sea fish, would be no light acquisition to the gastronomer who might desire to have turbot before the season, or to reserve it at five shillings for consumption, when the price has risen to three guineas. If the cod chooses to live in the fresh lake of Stromness-voe, there is no reason why we should not keep them in our own gardens till the day of giving a dinner comes round, or why Mr. Groves should not render the Serpentine a park for surmullets, instead of allowing it to be consigned to frogs and tadpoles. It is to be hoped that the Fishmongers' Company will take these matters to heart, as in duty bound; and that, in the progress of perfectibility, even the odious canal in St. James's Park may become a repository of turtles, instead of what it now is, a Stygian nursery of Malaria and his black host.

There is a subsidiary question arising out of these speculations respecting the convertibility of the habits of marine animals, highly interesting to geology, and on which it will not be out of place to say a few words, although unfortunately not much solid information can be procured respecting it. This relates to the power which many, perhaps all of the vermes inhabiting shells, possess of residing indifferently in fresh or in salt water.

It is well known to geologists that with respect to many, if not all of those deposits supposed to have been formed, like that of Paris and of England, under fresh water, the question mainly rests on this, namely, whether the shells now supposed, from certain analogies and peculiarities of structure, to have been inhabitants of fresh-water lakes, may not have equally existed in salt lakes, or even in the sea. Some experiments towards the elucidation of this subject have been instituted in France; but I need not detail them, as they must be fresh in the recollection of all the readers of this Journal. It has also been recently ascertained by M. Freminville, that in the gulf of Livonia, the shell fish which usually inhabit the sea, and those which belong to fresh waters, are found living together in the same places. While these confirm the general presumption which forms the basis of this communication, their general probability is also strengthened by that analogy. A few facts of common occurrence on our own shores, seem to add additional weight to the opinion that the testaceous fishes in general are not rigidly limited to one kind of water, but are capable of living in both.

On our sea coasts, the common muscle is invariably larger and fatter at the entrance of fresh-water streams into the sea, particularly if these bring down mud, and in these places the water is scarcely salt; yet they live also and propagate in abundance on shores which receive no fresh water. The oyster is transported from the sea to brackish water, where it also, not only lives, but improves in condition. In the same manner the common cockle inhabits indifferently the muddy sand-banks near the æstuaries of rivers, which are always soaked with fresh water, and those sandy or half muddy shores where no such water is found. These are by no means the whole of the instances which might be enumerated in support of an opinion, of which the determination is so important in the present state of geological science; but as this subject is too important to pass lightly over, and as the bounds of this communication are already exceeded, I shall leave it to those who may have the means and the inclination to examine it in greater detail. I will only add, that the same considerations will lead to similar doubts, where it has been attempted by geologists to determine the nature of strata, as to their marine or fresh water origin, by that of the remains of fishes found in them.

Art. V. *Description of* Mr. Cooper's *Lamp Furnace, for the Analysis of Organic Bodies.*

Having had occasion to use Mr. Cooper's lamp for the analysis of organic bodies, described in the last volume of the Transactions of the Society of Arts, and having found it very effectual, we have taken the following account of it from that work, with an abstract of the method of using it; and are enabled by Mr. Cooper's kindness to add the description of some improvements which he has since made on the original apparatus.

Fig. 1. Plate iv. *a a* and *b b*, are two long spirit-lamps, each having ten burners and wicks, the burners of each lamp sloping towards those of the other, as seen in the end view, fig. 2. They are placed in a tin tray c c, mounted on four feet. This tray is perforated in the middle the whole length of the lamp, and as wide as *e e*, fig. 2. The object in sloping the burners is, that they may clear the lamps and approach each other as near as is requisite, yet leave free space for a current of air, the tray being perforated and mounted on feet for this purpose: *d d* are spring wires at each end of the tray, to receive the tube *f f* containing the substance to be analyzed, and to hold it over the flames; by pressing the shoulders *g g*, fig. 2, the wires open to receive the tube, and close on removing the pressure; and should the tube be shorter than the lamps, an additional support on a leaden foot, fig. 3, is placed through the opening *e e* of the tray to rise between the flames, and hold the end of the tube.

The tubes are coated with copper foil, wrapped spirally round them; if each succeeding fold be on half the other, there will be a double coat of copper all the way, if on two-thirds, there will be three layers of copper, by which the glass tube is prevented from bending when hot, and becomes very uniformly heated. The spirals are continued beyond the end of the tube to reach the support, and leave the end within the flames. The dotted line at *h*, fig. 4, shews the end of the tube short of the support, the foil is secured at the last coil by binding wire, as at *i*.

Art. IX. *On the Transportation of Fish from Salt to Fresh Water.*

[To the Editor of the *Quarterly Journal.*]

Dear Sir,

You expressed a desire to know the progress which has been made in the transplantation of fish from salt to fresh water, since the period at which I communicated the paper on that subject to your Journal. Mr. Arnold, who has carried on these experiments, at my wish, with great zeal, has succeeded in adding many more to the list; and, both in respect to the physical fact, and to the question of economy, the success has been far greater than any one was willing to believe.

The list of the additional fish will be seen by comparing that which is appended to this letter with the former one; and as the subject has excited considerable attention, you will perhaps not object to a statement which may attract even more, by presenting, in the form of a prospectus, the essential facts and arguments. It is only by placing them in this form that they are very likely to produce the effect which appears desirable.

I may now, however, subjoin some remarks which could not well find their place in such a statement, and which have been the result of more experience and attention.

It is certain that the flavour of every fish which has yet been tried has been improved; and I can vouch for the superiority of the basse, the mullet, the loach, the atherine, and the sole, from the pond, to those from the sea. This might be expected, for it is what happens notedly with respect to oysters.

The sole becomes twice as thick as a fish of the same size from the sea, and its skin also becomes extremely dark, or nearly black.

The plaise also increases materially in thickness, and loses its spots. In some cases, it appeared three times as thick as in the sea. The basse also turns much thicker, and improves in delicacy.

The mullet almost ceases to grow in length, but enlarges in breadth, and presents a much deeper layer of fat.

Crabs and prawns have found their own way into the pond; as have loaches, and some other small fish; and while, formerly, there were none of the former two, the water is now absolutely swarming with them. Thus also, apparently, the eels have multiplied; as it is now easy to take a cartload at once, where formerly a dozen or two was a large capture. I have thus also more distinctly ascertained, and to the satisfaction of Cuvier, who had been unwilling to admit it, that there are two species of fresh-water eel, distinguished by the comparative acuteness and breadth of the nose.

I have lastly to add an observation inadvertently omitted in the former communication, which may be used as an *à priori* argument for the possibility of this transplantation. It is, that oxygen is much more easily disengaged from fresh than from salt water. Consequently, the act of respiration ought to be easier in the former than in the latter; and therefore it is not to be presumed, as it has been, that sea-fish cannot respire fresh water.

As I have given the shad without its Linnæan name, I think it right to add, that our shad is yet unnamed; because the Clupea Alosa is the Alose of the French, common in the Seine and on the coast of Normandy; a fish as good as our own shad is detestable, and a decidedly different species of this troublesome and ill understood genus. If I have given the vulgar term rock-fish, it is because I wish to reject the term wrasse, for the present, as it stands for a species; whereas the whole of this genus (labrus) is still in extreme confusion, and in one, which I hope to aid in rectifying, with the assistance of Cuvier's materials and our own species.

I am yours, &c., J. Mac Culloch.

Prospectus of a Plan for Preserving and Rearing Fish for the London Market.

From various observations and experiments, of which evidence is subjoined, it has been found that sea-fish will live and thrive, and also breed, in ponds or enclosures; and, with regard to many, it also appears that it is indifferent whether the water is salt, or fresh, or brackish, or alternately fresh and salt.

It is also found that they may be fed in such enclosures, if necessary, as our domestic animals are; but that if sufficient numbers and kinds are placed together, they feed each other without requiring further care.

It is further observed, that every, or almost every species, improves in flavour and quality, as oysters are known to do under transplantation.

It is well known that, of all the fish brought to market, a very small proportion is in good condition, the rest being apparently ill fed; and hence the number of bad fish so well known to fishmongers.

It is much better known that, from bad weather, or other causes, the supply of the market is very irregular. Thus the public suffers when the supply is short, and the merchant when there is a glut. It is not uncommon for a glut to come in London when the town is empty; and, on the contrary, for it to want fish when full.

The proposed plan, if executed, would bring the fish within our own power, to be taken alive when wanted, and, from being better fed, in greater perfection and more uniformly good. It would be like taking stalled oxen, instead of wild Scotch cattle. It would also enable the merchants to regulate the supply by the demand, and thus to satisfy better the public and themselves. The trade would be steady instead of precarious; as the prices to the public would also be. It would be conducted, directly, between the public and the grower, or with the intervention of one retailer only, and thus a heavy cause of complaint be removed. Lastly, the public would be always sure of fish, and it would be sure of them at moderate prices.

Such are the proposed advantages. As far as the species that breed in such confinement, the fish would reproduce themselves, or a pond of this nature would resemble a common fish-pond. For those that will not, if there are any such, the ponds would be mere repositories for keeping alive, till there was a demand, the fish brought into them from the sea. They would also be feeding places, allowing bad fish to improve. Thus far, the fisheries would go on as before, and the fishing-trade would consequently not be injured. It would be increased, on the contrary;

because, with a better-regulated market and more moderate prices, the consumption would be augmented. There can be no objection therefore on the score of injury to the fisheries. The plan is, virtually, one to preserve fish alive after being taken, instead of suffering them to waste, to render them better in quality, and to supply them more regularly.

The plan, therefore, is, to enclose, in any convenient part of the Thames (since the quality of the water is proved to be indifferent,) a space sufficient for the purpose. A dock, or an excavation in the nature of one, would be unnecessary, as the water itself, in many places not navigated, might be enclosed by a palisade. In this, the fish would be received from the fishermen, by means of well-boats, alive. Those which chanced to die would become the food of others. Many would breed, as they have been found to do, and thus also would produce food. But they might also be fed by means of butchers' offal, or others matters easily procured in a great city, as was the practice of the ancient Romans.

From the enclosure, the fish would be taken by nets, the kinds in demand, and the quantity, selected, and the bad fish also returned for improvement. A steam-boat would supply them to London daily, and to any market which might be established; and they might even be brought up alive, so that the unsaleable ones would not be lost.

The only capital required to be sunk, or advanced, would be in purchasing and enclosing a tract of water, and in the general establishment; possibly, in stocking the pond. It could not be very large; but no estimate is now pretended to be given, nor any place pointed out. That needs not, however, be very near to London, as a steam-boat would approximate any distances. After this, the fish would be purchased from the fishermen by contract; and the establishment, beginning to sell, would then pay its way.

The details of evidence in support of the practicability of this scheme are the following:—

There are three or four sea-ponds in Scotland where fish are thus kept: one in Orkney, belonging to Mrs. Stewart; one on the

Firth of Forth, belonging to Sir Robert Preston; and one in Galloway, belonging to Mr. Macdouall.

On the Greek coast of the Adriatic, at Missolonghi and elsewhere, the same has been practised from immemorial time. It is the current practice also of Bermuda, where the inhabitants subsist chiefly on fish.

These are sea-ponds, as the water is salt. But in Sicily, from the most ancient times also, the natives transport lobsters and crabs to a fresh-water and muddy lake, for the purpose of improving them, as they also do mullet.

With respect to fresh waters, we have evidence of the power of keeping and improving sea-fish in them, from the practice of the ancient Romans. From the testimony of Columella, and the other writers, "de Re Rustica," it was the practice of the Roman farmers, in the earliest days of the Republic, to go down to the sea and bring up the spawn of sea-fish to the fresh-water lakes of Rome, where they multiplied and improved. It was a branch of farming. It became the amusement and luxury of the rich and great in the times of Imperial Rome; enormous establishments of this nature were formed, and the fish were often fed at an expense which, as well as the value of the ponds, proves the great extent of these repositories.

Lastly, this plan has been recently put to the test under the direction of the writer of this note, in Guernsey, by Mr. Arnold. In a pond of about four acres only, many sea-fish, which will be found in the following list, are now thriving, and all those which have had sufficient time have propagated: all have improved in quality, and many very remarkably. This pond was at first worthless, containing only a few eels; at present it produces a large rent, and can supply the market when the weather prevents the boats from going out. It is remarkable also, that, since the introduction of the sea-fish, the eels have multiplied a thousand fold, so as themselves to produce a considerable revenue. This proves that fish may be fed, merely, by bringing different kinds together, as is the case in nature. It may be added, that the evidence from this pond is peculiarly satisfactory, as far as relates to the indifference which sea-fish possess as to the quality of the water. Being embanked from the sea, and receiving an insufficient supply of fresh water in summer, it varies, so that while it is perfectly fresh in winter, it is nearly salt in very dry weather, and brackish in various degrees at intermediate periods. Here also, it is remarkable, that while the larger fishes have been placed there, many of the smaller ones, which formerly showed no such desire, have introduced themselves through crevices in the sea-wall, and that it is, in particular, crowded with crabs and prawns.

It is now necessary to subjoin a list of the fishes which, belonging naturally to the sea, have been found to live in fresh waters. Some of these have been forcibly introduced, others seek it for themselves. If the list is still limited, it is because the rest have not been tried; for no fish on which the experiment has been properly tried, has failed. When they have failed, it is because they were previously injured, or nearly killed, in the taking or the transportation. The *cross* indicates those which have been forcibly naturalized in Mr. Arnold's or some other pond.

Conger	Cod
Torsk	+Basse
Sprat	Loach
Shad	Red Loach
Alose (of the French) clupea alosa	+Smelt
	+Atherine
Greater lamprey	+Rock fish
Lesser lamprey	+Cuckoo fish
Stickleback	+Old Wife
Cottus quadricornis	+Sole
Mullet	+Turbot
+Plaice	Sand eel
Flounder	Rockling
Red flounder, pleuronectes roseus	Whiting pout
	Mackerel
White whale	Herring

+Horse mackerel	Crabs
+Pollack	+Oysters
Prawns	+Muscles.
Shrimps	

There appears no reason why turtle should not also be cultivated, whether they would breed or not. The peacock, pintado, pheasant, and common fowl, are the natives of hot climates, and have long been naturalized to cold ones; and there is far less difference between the temperatures of the water in different climates than between those of the air. An excellent turtle has been taken in the Tamar at Saltash, after an unknown length of residence.

ART. X. *On the Impurity of the Pulverized Emetic Tartar of the Shops.*

[In a Letter to the Editor of the *Quarterly Journal.*]

SIR,

I AM induced to request your insertion in the *Quarterly Journal* of the following facts, with regard to emetic tartar. Having repeatedly noticed a portion of insoluble matter in making the vinum antimonii tartarizati, I purchased some tartar emetic in crystals, and much to my astonishment was charged nearly double what I had previously paid for it in powder. I procured samples, from several respectable druggists, and found in all cases the same inconsistency in price. Upon careful examination, however, of the powder, this was explained, for I found in all the samples, after the triple tartrate had been carefully washed out by cold water, at least ten per cent. and in two or three much more, of a powder comparatively insoluble, and which proved to be principally supertartrate of potash and tartrate of lime. I strongly suspect the manufacturers are in the habit, after boiling the tartar with the oxide of antimony and filtering, of evaporating immediately to dryness that portion which is to be sold in powder; this will explain its impurity, and also its cheapness, when compared with that which has been carefully crystallized. As uniformity in so active a medicine is of the utmost importance, I would earnestly recommend my brethren of the profession to purchase this article always in crystals. By the insertion of these observations you will much oblige,

Sir, your obedient servant,

AN OLD PRACTITIONER.

ART. XI.—*Some Account of the late M. Guinand, Optician of Brenets, in the Canton of Neufchatel, in Switzerland, read at the Society of Physics and Natural History of Geneva, on the 19th of February,* 1823 *.

THE Society of Physics and Natural History of Geneva, and the Class of Industry in the Society of Arts of that city, having testified in the most flattering manner their approbation of the specimens of *flint glass*, made by M. Guinand, and submitted to their inspection by M. Houriet; and having expressed a desire to possess some details on the origin of his establishment, they are given with much pleasure in the following notice, which is with greater confidence presented, as M. Guinand himself communicated the principal part of the facts which it contains.

* When the present memoir was addressed to the Society, the interesting artist to whom it relates, was still living, but the intelligence of his decease (at the close of 1823,) was communicated at the same time with the history of his labours. The following pages will show how greatly such a loss is to be deplored. After half a century of research, M. Guinand was the only man in Europe who had succeeded in producing large specimens of that *flint glass* which is so indispensable for the construction of achromatic lenses, and at the same time so difficult to obtain, free from striæ, in pieces of any considerable magnitude. Arrangements had been made by the French government for purchasing his secret, when the artist, verging on his eightieth year, died after a short illness. His son remains in possession of his process, and it is said that he will continue to supply opticians with flint-glass necessary for object-lenses of large apertures, the only ones which collect sufficient light, and which produce a sufficiently exact convergence of the rays to allow the application of eye-pieces of a very short focus, or, in other words, to give them a considerable degree of amplifying power.

This institution, supported and endowed by the general government, is a most prominent object of public attention. Furnishing the executive with a powerful patronage, and supplying well-instructed and capable officers, it has been a favourite of every successive administration. It has hence become, in many instances, the mark and rallying point of opposition; and has, on more than one occasion, been exposed to the danger of destruction by a refusal of the annual appropriation. That policy, however, which strikes at an object of general and acknowledged utility, because its destruction may weaken an opposing party, is mean and contemptible, and has lately received such a defeat as will probably prevent its being again brought forward, at least in the form of an attack upon this Institution. Its friends may therefore indulge themselves in the hope, that its reputation and usefulness will be every year extended, and that it will finally conduce as much to the prosperity as to the scientific reputation of the American nation.

Art. II.—*Further Remarks on the Naturalization of Fishes, by* J. Mac Culloch, M.D. F.R.S.

[In a letter to the Editor.]

Dear Sir,

You will probably not object to my communicating to you, from time to time, any new matter or observations with respect to this interesting subject, which may chance to come to light, whether the result of my own experience or of that of others. If it was rather from the hopes of calling the public attention to this subject, and, in particular, the attention of those who had the power of making experiments, than from any other motives, that I communicated, originally, the scattered and imperfect facts contained in the two former papers, there will not be less use in noting, as they occur, any new facts which may serve to keep the subject alive in the public mind. A periodical journal is, from its very nature, transitory in its effects; and when any subject

'/ Further Remarks

which it includes chances not to meet the public feelings or pursuits, when it chances to be a new fact unconnected with our previous knowledge, its general fate is, to be consigned to speedy oblivion. To keep it alive is, therefore, of use; if, at least, it is one of those facts which may, by extension, be converted to purposes of utility. What I have now to add is indeed so little, that on no other view, perhaps, would it be worth communicating. But in this view every thing will be of use; nor shall I require any apology for the quotation I have made from a paper already printed, since it will be advantageous to the public that the journal which contains the greatest mass of evidence, and which undertook first to examine the subject, should also contain the whole evidence that can be accumulated. If I were inclined to add much to these preliminary remarks, it would be my regret that the subject in general should have met with, not merely neglect, but opposition; as if the infliction of an evil on society, instead of the communication of a benefit, had been meditated. As far as my own personal efforts have gone, and as far also as my own knowledge extends, I have not found a single individual who has been willing to make, or rather to repeat, the trials, even were the readiest and amplest opportunities were present. And this, not only as to fishes, not yet made the subject of experiment, but even as to those of which the success has been demonstrated. On the contrary, the proposition has invariably been met by counter arguments, *priori* arguments; just as if there had been no evidence existing, and as if attempts at the improvement of human life were disgraceful or noxious. Experiment used to be considered the road to knowledge: evidence has commonly been considered a thing to be examined, and, if true, to be admitted. It is probable that opinions on this subject have changed since the days of Bacon; since, at least as far as my acquaintance extends, Mr. Arnold, my original friend and experimenter on this subject, is the only man who has not rejected what has been proposed, and who has gone steadily on in what used to be considered the path of a true philosopher. Doubtless an objector may be allowed to question the personal veracity of a witness: and he may be allowed to suspect the testimony of a projector, who has a private interests in his projects: but those reasons wanting, I know of no solution but that one which I proposed in another place; namely, that pride which, imagining that it has attained all knowledge, is too wise to learn; coupled, perhaps, with the hatred of a discovery which belongs to a therefore hated discoverer. I have no objection however to a better explanation if any one will undertake to furnish it. In this case, the discovery does not fairly admit of jealousy, since the guilty discoverer is Nature herself.

The mention of Bacon's name reminds me of what I had originally forgotten, namely, that he had himself speculated on this very project. It will be found in his Eighth Century of Natural History: but the paragraph contains no evidence, and not much to the purpose in any shape. He remarks that fish used to the salt water "do nevertheless delight much more in fresh;" quoting the salmon and the smelt. "I doubt," he says, "that there hath not been sufficient experiment made of putting sea-fish into fresh-water ponds and pools. It is a thing of great use and pleasure; for so you may have them new at some good distance from the sea: and, besides, it may be that the fish will eat the pleasanter, and may fall to breed." Such was the prophetic eye of him who did not reject experiment, even though it had never been tried. Why is it rejected now? Not because there are no philosophers; but because men who possess money and ponds have no philosophy, and men who possess philosophy have neither ponds nor money.

Thus far, is opinion only: but the two following facts are valuable, because they are natural experiments, and because, being related as mere matters of fact, by persons without any interest in them, and without producing any inference, or being referred to any system, they belong to the purest kind of evidence. They have occurred in the course of my casual reading, since the last communication on this subject.

In the Isle of Osero on the coast of Dalmatia, there is a freshwater lake inhabited by sea-fish; the authority being that of a well-known French artist whose picturesque work on this coast is familiar, though his name has at this moment escaped me. It is somewhat unfortunate that this had not been a more specific object of inquiry, as the names of the fishes are not given; and on searching Fortis for this purpose, I have not discovered what I wished.

The other case is the reverse of this; and though the authority in Phillips's *Collection of Travels* may not be very highly esteemed, there is no reason to doubt the simple assertion of any traveller respecting a well-known matter of fact, and a practice familiar to the natives; particularly when narrated among other casual things, and without conclusions. It is a salt lake at the Cape de Verde, which is inhabited promiscuously by marine fish and by those of the neighbouring rivers. Here also, unfortunately, no names are given; so that that case can be added only in support of the general principle.

The last fact to be here placed, is the one which I proposed to quote for the purpose of keeping the evidence as much as possible together. It is the discovery of the Cockle, or Cardium edule of Linnæus, in a living state, under a peat moss, near Greta bridge, about two miles from the river Tees, and forty miles from the sea. The fact is recorded by Mr. Stark, but belongs to Mr. Witham; and confirming what I had occasion to say formerly respecting other shell fishes, will also prove that, if cockles were worth cultivating, they might be bred anywhere in land, where sand and fresh water exist.

I wish now that those who know Naples, would determine whether the common oyster is really there a native of fresh-water lakes, and fished for common use. So it has positively been asserted to me, by more than one traveller; whereas on examining others, it has been as positively contradicted. Thus difficult is it to extract truth from those who are not in the habit of accurate observation. Be it true, it might possibly tempt those who prefer oysters to opposition, to cultivate them in their lakes; be it true or false, as to Naples, I have little doubt that this is practicable.

In know not, if I formerly mentioned that the Pleuronectes Zimanda was found in the Loire; if not, it will be one to add to the lists formerly given.

ART. III.—*On Pure Caoutchouc, and the Substances by which it is accompanied in the State of Sap, or Juice.* By M. Faraday, F.R.S., Cor. Mem. Inst. of France.

I HAVE had an opportunity latterly, through the kindness of Mr. Thomas Hancock, of examining the chemical properties of caoutchouc in its pure form, as well as of ascertaining the nature and proportions of the other substances with which it is mixed, when it exudes as sap, or juice, from the tree. At present much importance attaches to this substance, in consequence of its many peculiar and excellent qualities, and its increasing applications to useful purposes. I have thought, therefore, that a correct account of its chemical nature would possess some interest.

The extensive uses, both domestic and scientific, to which Mr. Hancock has applied common caoutchouc, in consequence of his peculiar mode of liquefying it, are well known. Hence he was fully alive to the importance of its applications, when in its original state of division. When he gave me the substance, he communicated many of his observations upon it, which, with others of my own, form the present paper.

The fluid, I understood, had been obtained

and was very nearly in the state in which it came from the tree; it had been altered simply by the formation of a slight film of solid caoutchouc on the surface of the cork which closed the bottle. The caoutchouc thus removed was not a 500th part of the whole. The fluid was a pale-yellow, thick, creamy-looking substance, of uniform consistency. It had a disagreeable acescent odour, something resembling that of putrescent milk; its specific gravity was 1011.74. When exposed to the air in thin films it soon dried, losing weight, and leaving caoutchouc of the usual appearance and colour, and very tough and elastic;

202.4 grains of the liquid dried in a Wedgewood basin, at 100° Fah., became, in a few days, 94.4 grains, and the solid piece formed being then removed from the capsule, and exposed on all sides to the air until quite dry, became 91 grains: hence 100 parts of sap left nearly 45 of solid matter. Heat caused immediate coagulation of the sap, the caoutchouc separating in the solid form, and leaving an aqueous solution of the other substances existing with it in its first state.

Alcohol poured into the sap in sufficient quantity, caused a coagulum and a precipitate, both of which were caoutchouc of considerable purity. The alcohol retained in solution the extraneous matters, which, possessing peculiar properties, will be hereafter described.

Solution of alkali added to the sap evolved a very fetid odour, but did not appear to exert any particular action on the caoutchouc.

The sap, left to itself for several days, gradually separated into two parts, the opaque portion contracted upwards, leaving beneath a deep-brown, but transparent, solution, evidently containing substances very different in their nature from caoutchouc itself, and which, considering the specific gravity of the sap and of pure caoutchouc (the latter being lighter than water), were probably present in considerable quantity.

It was found that, by mixing the sap with water, no other change took place than mere dilution. The mixture was uniform, and had all the properties of a weak or thin sap. Heat, evaporation, acids, and alkali, produced the same effects, generally, as before.

When the diluted sap was suffered to remain at rest, a separation soon took place, similar to that which occurred with the native juice, but to a greater extent; a creamy portion rose to the top, whilst a clear aqueous solution remained beneath. Hence it was found easy to wash the caoutchouc, and remove from it other principles which had been generally involved in it to a greater or smaller extent during its coagulation. For this purpose a portion of the sap was mixed with about four volumes of water, and the mixture put into a funnel, stopped below by a cork; in

Precisely in the same spirit he remarks, in the next page, that Barthélemy and Zoéga had *pointed* out the rings a containing proper names: they had, indeed, *said* that they might be proper names, *or* moral sentences, *or* something else; but the only question was, if it was worth questioning at all, to whom belonged the priority of the *demonstration* that they actually were proper names: which, before the publication of the Archaeologia for 1814, was no where to be found. This publication was the first great step after the discovery of the pillar of Rosetta: the second was the identification of the different kinds of characters, in 1816, by means of the Description de l'Egypte: the third, the application of that identification to the names of Ptolemy and Berenice: the fourth, perhaps, was Mr. Bankes's discovery in Egypt, of the name of Cleopatra, which he sent to Paris: and on these grounds are certainly *founded* ALL that is at present known of Egyptian literature, for a very considerable proportion of which we are unquestionably indebted to Mr. Champollion.

* * * *

The French translator of Mr. Browne's ingenious articles which appeared in the Edinburgh Review, has certainly gone a good deal out of his way to find matter of accusation against Mr. Champollion. He quotes the text of a memoir published in 1821, and afterwards *suppressed*, in order to show that Mr. Champollion then continued to believe that the hieroglyphics were signs of things and not of sounds; and that he disagreed with those learned persons who had considered the hieratic writing as alphabetical. The date of this suppressed paper is indeed of some consequence, as determining the period at which Mr. Champollion made his rediscovery of what Dr. Young had published in 1816; that is, the fact of the essential identity of the two systems of writing. But the translator might have found in the beginning of the letter to Mr. Dacier, dated in 1822, the same opinion respecting these systems of writing; that is, the *hieratic* and *demotic*, which, he says, are not alphabetic, but "*ideographic*, like the hieroplyphics themselves," expressing ideas and not sounds: and he adds, that *he* (!) has deduced from the demotic inscription of Rosetta a series of characters which have a "*syllabico-alpha-*

betic value," by which foreign proper names were expressed. (p. 2.)

Nothing can possibly agree better than this with the opinions which Dr. Young had long before published; and which he has since confirmed in his octavo volume; and if Mr. Champollion's ideas upon this subject have sometimes appeared to fluctuate, it has probably been more from a love of system, and a wish to establish originality, than from any new discoveries that he can have made respecting these two modes of writing in particular.

What precise forms of characters may be supposed to answer to the sense in which Mr. Champollion employs the word demotic, cannot very easily be ascertained. It is remarkable that his "SNE" is a group very commonly found in the manuscripts of the Description de l'Egypte, which Mr. Champollion might possibly call demotic; while it cannot be identified in the Enchorial Inscription of Rosetta. This is an instance of the difficulty of finding appropriate terms where we have not exact definitions. The difficulty is not avoided by the use of the word Enchorial, except that it may with perfect safety be applied to such inscriptions as are capable of having any of their words identified with the inscription so called on the pillar itself.

The verification of the chronology of Manetho must naturally be a work of time, even after the complete identification of the names of the kings, which cannot *yet* be admitted to be satisfactory. There is one discordance that it may be right slightly to point out, as it is presented by Plate 43 of the Hieroglyphics: we there find the 29th year of the Sesenchosis of Manetho; and Manetho allots but 21 years to this king, who was the first of his dynasty, and could not, therefore, like Philadelphus, have continued any era from an earlier period.

It is easy to observe, in comparing Mr. Cailliaud's copy of the Tablet of Abydus, as published by Mr. Champollion, with those of our countrymen, Mr. Bankes and Mr. Wilkinson, contained in the 47th plate of the Hieroglyphics, or with the manuscript copy of Mr. Burton, how much more hastily the French traveller had executed his task than *any one* of the three Englishmen.

Another of Mr. Wilkinson's very valuable inscriptions from a temple at Kous, must be allowed to give evidence much more favourable to Mr. Champollion, as far as it regards the signification of the *plough*, which seems to enter into the composition of *Philometor*, as applied to Cleopatra and "Ptolemy Alexander", who are called Philometores Soteres, both here and in Anastasy's Greek Manuscript. The name of Alexander had never occurred to the author of the article EGYPT, but he had evidently a foresight in what way it would make its appearance when he observed, N. 55, "it will appear hereafter, that a knowledge of the enchorial forms may possibly contribute very materially, at some future time, to assist us in determining it:" and he immediately proceeds to the subject of PHNOETIC HIEROGLYPHICS.

The plough seems to be exchanged on the Minervean obelisk for the dentated quadrant and chain, which may hence have been synonymous with the dentated parallelogram or comb: both perhaps having represented instruments which bore the same name, and served the same purposes, though of different forms: they may, for instance, have been rakes or harrows, and may hence have borne some analogy to the plough or hoe. Whether they had names beginning with M, may still be questionable.

Mr. Champollion has endeavoured to explain the absence of the names of our queens from the tablet of Abydus, by saying that it must be considered as a tablet "purely *genealogical.*" First Letter to the D. de B. p. 89. A reader is naturally disposed to acquiesce in this explanation, since Mr. Champollion, who has carefully examined it, asserts it on his own credit; especially as the assertion appears to be supported by a long and minute discussion. Unhappily, however, it is only necessary to compare his brother's chronology in P. 107, with his own Plates II. and III. fig. 5, from which it appears that Amenses, who *reigned* more than 20 years, was the mother of Thuthmosis the second, whose name is in the tablet, while his mother's is *omitted.* It is true that, with his usual ingenuity, Mr. Champollion seems afterwards to change his ground in the same page: for he says, that one only of two brothers or sisters was inserted, in order to keep the number of the *generations* unaltered: and he might have added that Amenses was the sister of Amennphis, whom she succeeded. If he had stated this clearly, the reader might have judged for himself, whether such a coincidence was or was not sufficient to support the chronology of Manetho; which was, however, by no means in want of *such* support: in the article Egypt, for example, Manetho's chronology of this dynasty is fully adopted: and the same 'cartouche' is read *Thuthmosis*, which Mr. Champollion, after all his parade, still admits to be Thuthmosis: nor is there a difference of half a century in the dates assigned to his reign by various chronologists. It was established in the article Egypt, that the name contained that of Thoth, the Egyptian Hermes, and for this reason it was considered as better established than any other of the names of the Pharaohs. Mr. Champollion had never discovered this for many years afterwards: and yet we have been told by an Englishman in the last Quarterly Journal, that to Mr. Champollion the *greater part* of the *discoveries* made by the interpretation of hieroglyphics are owing!

Believe me, dear Sir, very sincerely, yours,

* * * *

London, 24 *Nov.* 1827.

On the Naturalization of Fish. *By* J. Mac Culloch, M.D., F.R.S., &c.

Dear Sir,

As I promised you that I would communicate to you, from time to time, any new remarks or facts which might occur on the subject of naturalizing sea-fish in fresh water, I am pleased to have an opportunity of noticing a few circumstances which may serve to keep alive in the public mind a subject, from which I cannot yet help foroboding useful results, in spite of the neglect and opposition which it has experienced from every person, I believe I may safely say, to whom it has been proposed, except Mr. Arnold. I am perfectly safe in saying, that, with this sole exception, every individual to whom the facts have been described, and the experiment proposed, have replied by doubts, or cavils, or objections of some kind; many, by positive disbelief of the very facts; while the far greater number have been persons, whose entire ignorance of every requisite point of physiology, natural history, and chemistry, must, of course, have rendered their objections sufficiently unworthy of notice, though not sufficient to restrain the confidence with which they have been urged. The satirical writers of the day view this as the character of the age: the more obvious aspect which this disposition presents, is the feeling, as if he who attempted, by suggesting an improvement, to render a service, was meditating an injury, and was an enemy to be opposed at all hazards. I must permit you to settle metaphysical and moral questions so profound as to exceed my own ingenuity.

But I cannot avoid regretting that Mr. Arnold is not the rich and idle proprietor of some of the tens of thousands of acres of fresh water, whether Scotch or English, in which a 'sea-fish cannot possibly live,' or 'would certainly not be eatable:' and, in addition, that, instead of a not very opulent and very busied 'notary public,' he was not in possession of some five thousand of these acres, with as much money, and as much leisure. And I feel bound to add to this apology for what he *has not* yet done, that the expense of such a course of experiments is considerable; at least in this comparison. A superintendent would be necessary; and for the purpose of taking and transporting the fish, still more of drawing nets periodically and frequently, to ascertain the progress of the transplanted fish, there must be expensive assistance, for which, as yet, there can be no returns; while that, in addition to irregularities and rocks in the pond itself, impeding the accurate drawing and examination, must also be the apology for the imperfection of the present additional report as to the success for certain fishes. It is plain that, though ten or a hundred turbots were present in a pond of four or five acres, the fact is, not one that can easily be ascertained. Let those who have money, leisure, and water, and nothing else towards the investigation of this object, restrain, at least, *their* incredulity and opposition; as may also they, very safely, who never saw a fish, except on the stall of a London fishmonger.

With respect now to some facts; it had been said that the water was salt, because this pond was situated at a sea embankment. I stated before, that it admittedt he sea, by leakage, in summer, when there was little comparative supply of fresh water, and was therefore brackish, or saline. I have since ascertained the exact proportion of salt in the water, at those times when the fresh water is least. In the driest and hottest part of one summer, the proportion of salt in it, as compared to the sea without, was at 40 to 150. In another, peculiarly dry, 1827, it was one half; and the water, having then been at the lowest, it cannot even be computed to exceed this. Moreover, this period of saltness cannot easily, even in such a summer, occupy more than the months of June, July, August, and September; or, more strictly speaking, it is probable, scarcely one half of that time in general, in so rainy a climate; a climate equalling Penzance in the quantity of rain.

In winter, that is, during five or six months, or less, if any objector pleases, it is fresh. That cattle drink it freely, is not an exact chemical proof; but I must admit, that I have not analyzed the water at that period, holding the objection in great contempt. It may be sufficient to say, that it then occupies a space of about sixteen acres, or increases to this magnitude from four and a half acres; so that it cannot, at least, be very salt, while the fish, and the mullet in particular, are found in the remotest ditches, among the meadows. But, in defect of an analysis, which I have not had the means of making, there is a valid reason why the water should be fresh when the size of the pond is much extended. The presence of sea-water in it, is, in all cases, the consequence of a depression of the water within the sea-wall, which allows of leakage or infiltration at the upper part, so as, in high tides, to equalize, as far can be done in the short period of high water, the levels within and without. This, it is plain, must cease whenever the water within is higher than the sea without; and hence it is that there can be no access for the salt water in the winter or rainy months.

Enough of the mere fact: the objections derived from which ought not to demand an answer among physiologists; while to those who argue physiological points in utter ignorance of all that belongs to physiology, it is probable that all answer is fruitless. It was stated before; the question is simply twofold;

respiration and food. If fish can breathe indifferently salt water or fresh, for one week or one month, and if, in their new element, translated from salt to fresh, they thrive, or grow, fatten, and breed, the trial of three weeks or three months is a sufficient proof that they will neither sicken nor die of fresh water. If they can find food, it is indifferent whether the medium is fresh or salt. It is the misfortune of the age to understand every thing without knowing its principles; just as every man is now a physician. A few, more profound, who chance to know that salmon divide their time between fresh and salt water, possess other reasons, and find other objections; whcih they must be permitted to explain for themselves. I ought not, while on this particular subject, to omit one fact, which has come to my knowledge since the former papers were written, on the voluntary emigration of a fish, supposed to be peculiarly delicate and peculiarly attached to the sea, into fresh water. This is, that, in Virginia, the herring ascends the rivers, even up into the most minute communicating branches, and as far as it can reach; while a somewhat recent traveller describes them as being so abundant, that it is impossible to cross the fords on horseback during the season of their migration, without destroying them by the horse's feet. To proceed to the *historical* condition of this pond.

I have already stated the difficulties arising from want of leisure and wealth in the proprietor, added to non-residence I should say, whence chiefly has arisen the difficulty of tracing the results. Let these try for themselves, who consider that all this might have been ascertained in a twelvemonth, and with the same means. Since the communications I formerly made, the Pilchard has been introduced. It swam away briskly, therefore it would not die of the fresh water; but it has not been retaken. The retaking of individual fish, to ascertain their presence, is a fundamental difficulty, as I before pointed out.

The Brill has also been introduced since my former list. It has been retaken; and, within one year, had grown to double the original size.

The Turbot. Fifty or sixty were introduced, averaging about eight inches in length. Some were retaken in a year, for the purpose of examination merely, like the former and most others;

they also had grown to double the size. There is no prospect of dying in these cases, it is abundantly plain; that they will breed is probable, but there has been no time, nor would the young have been taken. What is to prevent healthy fishes from breeding? The young, indeed, may be eaten; if so, it is for want of room, or want of a proper balance in this mixed population. No one knows any thing, either of the ordinary growth, propagation, or destruction of fishes; and how then can any one decide on what is regular or extraordinary?

The Wrasse has been retaken after a considerable period; therefore it is not dead.

The Basse has propagated; and so has the Brill.

The Red Mullet has been introduced, and is living.

The Whiting was introduced, and taken in good health many weeks after, but not since.

The Grey Loach is thought to have bred considerably.

The Atherine continues to breed.

I formerly mentioned that the flavour of the several fishes was improved: this is now more positively asserted, in addition, of the Basse, the Plače, and the Red Loach. Others were mentioned in former communications.

Loss of property, or flavour, has been made a speculative objection by the unvarying objectors. General experience has shown, that in all fishes, as far as known, the access to fresh water, or fresh water food, improved the flavour; in many, in oysters, muscles, cockles, shrimps, it is vulgarly notorious; as in mere sea water they are worthless.

There is a popular objection, on this head, made by the country gentlemen, which I must answer; to those who *think* about what they know, it would have been superfluous. The salmon is good when it comes from the sea, and bad when it is returning. Doubtless, it is; while the reason ought to be plain, even to an angler. It is in full health in the first case; in the latter, it has spawned; and, at that period, every fish is proportionally as bad as the aslmon; many are a great deal worse. The fault is not in the water, nor probably in the food; it is in the spawning, and with any food the same effect takes place, in all fishes, everywhere.

I suggested in former communications, that an essential point to ascertain, in any view of economy, or management, would be the proper balance of species; to discover what kinds would so live together that all the species might find food; might breed, each to its useful limits, so as to be serviceable to ourselves, the keepers of the flocks, and without hazard of the extermination of any kind. I may illustrate what is here meant, by a simple fact, in the ordinary economy of fresh water fishes in confinement. Pike and perch can live together, because the natural defences of the perch prevent the pike from exterminating the race, voracious as the enemy is. If trout and pike were confined in a narrow water, the trout would be destroyed.

Or otherwise, it must be our object to ascertain, in an economical view, how to feed, by means of species that we do not desire to eat, those which we do cultivate for our own uses. This is a difficult question, which can only be overcome by time and experience; by knowledge; by knowledge, when we are in a state of entire ignorance; ignorance of every thing that relates to fishes, as great as if they were the inhabitants of another planet. This was one great source of difficulties with us in this case; and I, myself, must plead guilty, I fear, to a general recommendation of introducing every fish as a mere matter of trial; the result of which has been mischievous. The basse appears to have been the great enemy; to have eaten up the greater number of many species, and given no return. It has proved the pike of this pond. This could not have been foreseen; it is a caution for future speculators. Others will be discovered in the course of trial. It appears also that the common crab has proved destructive, probably by eating the spawn of larger fishes. From some enemy or other, the eels, which at first abounded to an incredible degree, have most materially diminished, and so have the shrimps. The latter, at least, appear to have been destroyed by the basse. Time and trial will teach us what to do do in this case; in the infancy of ignorance, man might have supposed that he could keep wolves and sheep in one field, and have constructed a pen for foxes and fowls, rabbits, and weasels. We must not accuse nature of our own ignorance.

The question is here a difficult one; but a little more study of the general habits of fishes, merely as we know them already, and even of their anatomy, will go far to lay the foundation of useful rules on this head, even without a hazardous trial, which may ultimately not become in our power to remedy, as I much fear may prove the case with respect to these unlucky basse. Not to enter on this further than as it may serve for a general illustration of what is here meant, the anatomy of the mullet proves that it lives on worms; on the lumbricus marinus, and others; and so do its habits. So also may the very food of others, as found in the stomach, serve to indicate their natural or ordinary food. Reversely, the anatomy of a cod's jaws, and its stomach also, prove it to be omnivorous, omnivoracious. Or, further, the anatomical character of the diodon proves that it eats shell-fish; as we are equally able to limit the range of food in the flat-fish, which have no air-bladders, and cannot quit the ground.

But in this brief communication, I must not enter further into this subject than is necessary for mere illustration. I may take some further opportunity to point out the probabilities, as to mutual food and protection, in any artificial cultivation of this nature, as they might be derived from studying the little that we do know about the structure and habits of fishes. All that I need add here, is, that I have suggested the introduction of limpets, periwinkles, and cockles; as affording food without furnishing enemies: a matter which had been overlooked. To exterminate the enemies which have been unwarily introduced, will not prove so easy a task; unless, at least, we could find their natural enemies; find the great secret by which alone, in all cases, man can make war on those whom neither his artillery, his physic, nor his politics can reach.

The transportation of fishes has been objected to as difficult. I had occasion to make some remarks on this formerly, and on the vitality of some kinds. The difficulty is not so great as has been imagined. The fact generally is, that fishermen, even down to the very sentimentalists who worship the gentle Izaak, and who are sometimes scarcely possessed of the wit of a fish, treat them as they would a stone; as if they had not lives, and wills, and opinions, and were not part of the same creation as ourselves; as if that creation, which outnumbers ourselves by millions of millions almost beyond algebra to express, was not, like ourselves, under his care. They are easily killed by violence; they kill themselves by over-exertion, from anatomical peculiarities; as every trout-fisher knows; that is to say, the fact, not the cause. Let them be treated with gentleness when taken, as if they could feel; and they will not die in being removed into a cask of water. The flat fish are all peculiarly tenacious of life, so are all those of firm muscles generally: the vitality of the carp and the minnow also is notorious; and so it is as to many other kinds. All these can be removed and carried far, even in straw; but in truth, he who chooses to make his experiments like a philosopher, and who desires to succeed, will not fail.

Yet let me point out what I have suggested to Mr. Arnold, among other things: to him, whose merit as an ardent experimenter, always ready to adopt a reasonable suggestion, and never seeking for an objection, ought to stamp his character as a genuine follower of the true philosophy; the exception, in this particular case, to every one else. This is, to adopt the Chinese method of transporting the spawn of fishes; as affording a far greater facility to the introduction of species. I presume that the general fact must be known to your readers; though I believe that I ought to doubt: because I quoted the same practice from Columella formerly, as in use among the most ancient Romans, among the common farmers.

This substance is perpetually brought up by the trawl net, very injuriously; and in many cases, the fishermen contrive to guess tolerably well to what fish it belongs. That it may be transported to any distance, the familiar practice of China proves: since it is there, a common article of sale in the markets; while there also, I may incidentally remark, the cultivation of fish for sale, their transportation to market, and their replacement in the ponds, if unsold, is as much matter of ordinary farming as the management of a poultry-yard; while the pond is often the most profitable part of the farm. They also, who do not already chance to know it, may be informed, that this species of poultry-yard, or fish-pond, is as easily and regularly stocked in this manner, and managed, as any other portion of the farm: since it is even destroyed, or suffered to become dry occasionally, and again renewed in the wet season, by the means of purchased spawn, or stock; just as a sheep farmer buys lambs to stock his mountains. If England is too wise to learn of Rome or China, or of France and Germany, or even of the experiments on which I have dwelt so much and so often, it must be a pleasing reflection that it is already so amply informed as to have passed the bounds of all possible improvement and all possible wishes. But that I may terminate this particular suggestion, I will only further point out, that lobsters, and the crab tribe generally, might very easily be transported in this manner, and that, in them, it is easily known when the *ovum* has been impregnated, by means of a black spot with which it is then marked.

If I ought to apologize already for the length of this communication, I shall conclude it by saying, that whatever may be judged of the general philosophy of this subject, there is not and never has been any thing to prevent the cultivation of fish, in ponds of salt-water at least, or the preservation of them in any water in which they will live for a sufficient length of time, so as to render that a depôt for the purposes of a fresh store, calculated for the steady supply of a market, iu the manner which I formerly described and proposed. If, after so many years as this proposal has been made, London has not seen, either the facility, or the utility, it will discover them at some future day; just as it discovered, ten years after there had been twenty-six steam-boats on the Clyde, that a steam boat might possibly be of use on the Thames; just as it opposed gas-lights and just as it has adopted gas-lights.

This price is, however, below what the article generally costs in the manufacturers of France, which are mostly on a much smaller scale; that of M. Crespel, near Arras, is stated to cost about 62 centimes, or $3\frac{1}{4}d.$ per lb., that of M. Cafler, of Douay, 7 *a* 8 sous per lb., the former working on a scale of 2 millions, and the latter of 1 million kilograms of roots, in 150 days.

M. Dubrunfaut states, that there are actually in France at pre-present no less than 100 manufacturers of beet-root sugar, which may, he states, furnish altogether from 4 to 5 millions pounds of raw sugar (2000 to 2500 tons) which is not a twentieth part of the consumption of France. The largest manufacturers generally produce 40 *a* 50 tons per annum, some few more; but the average quantity, from his statement, appears to be only 20 *a* 25 tons per annum. He says the manufacturers are increasing in number, but if these data be correct, we are led to wonder why the manufacture has not been extended much more considerably in France, for in that country the duty on imported raw sugar is about 15*s.* 6*d.* per cwt., or rather more than $1\frac{1}{2}d.$ per lb., from which duty the makers of beet-root sugar are exempted; if they, however, can produce their sugar at $3\frac{1}{4}d.$ or $3\frac{1}{2}d.$ per lb., the manufacture must be a very profitable one, as the selling prices are actually $4\frac{1}{2}d.$ *a* 5*d.* per lb., duty paid, and the article cannot be produced in the West Indies, and sold, duty paid, in France for less. Dubrunfaut acknowledges this, and states it as a fact, which ought to encourage the extension of the beet-root manufacture. As, however, it has now been carried on in France to a greater or less extent for above ten years, it seems reasonable to conclude that it does not yield so great a profit as to encourage its ~~grea~~t extension, in preference to other commodities, and, consequently, that it cannot be produced (according to the mode of producing it now adopted) so cheap as is represented by Dubrunfaut.

In England the beet-root, I believe, could be produced nearly as cheap as in France, weight for weight; and as the cost of fuel for the manufacture would be much less, (in France it amounts to about 1-6th part of the whole cost of the manufacture, including the price of the roots,) it might be supposed that it would be a profitable manufacture, the more so as the sugar imported from the British West India colonies pays a duty of very near *3d.* per lb. But it is probable the root would be much more expensive in working, from its greater bulk and less productive of sugar, from the juices not being so well matured by the sun as it is in France. I believe the experiment has not been tried.

In Germany and other countries of Europe, the duties on imported sugar are so small, that it is probable this manufacture will not be attempted.

Art. .—*On the Use of Lights or Fires in the Fisheries. By* J. Mac Culloch, M.D., F.R.S.E. *&c.*

Sir,

I have taken occasion, in a work on the Highlands to which I need not here refer more particularly, to remark on the singular neglect of our fishermen respecting the use of fires or lights; a practice as ancient as it is common throughout the world, among savage as well as among civilzed nations. Some circumstances connected with the fisheries of Cornwall may render it useful at present to recall this subject to the public mind. For the statements, however, I have no authority but the popular one; the representations of individuals, and the paragraphs in the western newspapers; yet I suppose that there can be no great hazard in admitting this as sufficient evidence. The credit, or otherwise, will not, at least, rest with me.

In the salmon fishery, and chiefly in that which is contraband, the use as well as the utility of lights is familiar; and in the work to which I have alluded, I have explained the principle on which it is the object of pursuit to fishes. It is by the light elicited from their own bodies that they become marks to their enemies during the darkness, whether of the night or of the obscure depths of the sea; and thus light becomes, essentially, their leading motive of conduct.

Yet familiar as this fact is as to the salmon, I do not believe that there is a single instance in Britain where this expedient has been adopted in maritime fishing, even by the very individuals themselves, who, from being coast fishers also, might have been expected to transfer a practice so obvious and easy, and so demonstrated as to its utility, from one department of their trade to another. Of so little use is knowledge without reasoning. To the maritime fishermen in general, it is probable that the bare fact itself is not known; though we can scarcely conceive how it should not be known, since it must have been witnessed by seamen innumerable, in the Mediterranean and elsewhere. Could it be made publicly known, it might be productive of great advantages; rather, I should say, could the fishermen be induced to follow it; for the one is, unfortunately, by no means a necessary consequence of the other. If a Welshman cannot be induced to fish at all, it is probable that there may be equal difficulty in persuading a Cornishman to light a fire in his boat, though he had seen the practice and its success for half his life. In the particular instance under contemplation, however, even so improbable an event may perchance happen; since the persons concerned in the pilchard fishery have at least the advantage of belonging to a higher class of society; if, indeed, that be a more tractable class than the one far beneath it. Perhaps when education shall spread wider among all classes, and when education shall become somewhat other than it now is, a few of these troublesome impossibilities will vanish.

The fact itself, the utility, is demonstrated by usages so widely spread that the examples would fill more space than can here be spared to them. That it has been the practice of ancient nations, at various times and places, it would be quite superfluous to repeat. At present, it is found on various parts of the coast of Africa, perhaps on all; as it is no less common in the Eastern islands, and with some of the inhabitants of the South Sea. In the American rivers, it is the constant usage of the boatmen, whether Indians or Europeans; and its success is as notorious as anything can well be. To modern Greece, it has descended from their ancestors; as it is equally the constant usage of Sicily, and indeed of the Mediterranean at large. The effect cannot be questioned. On lighting a fire in the boats, they become immediately surrounded by fish, and it then only remains to take them in the accustomed modes. The process is easy, economical, and effectual; and it is not easy to see what greater recommendations any practice can possess. It is unnecessary to say, however, that it might be improved for the uses of our fishermen, by substituting a more permanent light, by means of lamps; while it would also be a more economical one.

But to come to the question of the Cornish pilchard fishery, which has been the inducement to these remarks, this is an object which, from its extent and value, is of high importance, not merely to the labourers and consumers, but to the large capital which is sunk in this trade, in the shape of buildings, boats, and nets. With some irregularity, it is a trade which, for some years past, has failed, or the fish have deserted the coasts; and when it is considered that the annual returns were formerly so great, it is easy to comprehend the importance of this defalcation.

In the midst of this, we see in the newspapers, lamentations, almost monthly, coupled with requisitions, to fishermen and philosophers alike, to exert themselves in enticing the fish back again; while no attempt for this purpose has been made, though it might be expected that one so obvious as lights might at least have been tried. It must be hoped that this paper may meet the eye of some Cornish philosopher, considering how Cornwall abounds in philosophers and philosophy, and that another summer will not pass without a fair series of experiments on the affections of pilchards as to light.

And there are reasons to believe that this plan would succeed in this especial case; at least if the current opinions as to the late conduct of the fish can be trusted. It is not said that they have deserted the seas of this coast, but merely that they have fallen into the habit of remaining in the deeper waters; in waters so deep as to prevent the seines from anchoring; a matter essential to this class of fishing. For this conduct they unquestionably possess some motives, whatever those may be: probably it is the position of their food: but whatever it is, our business is, not being able to remove that motive, to offer another, and to entice them into the shallow waters by means of light, whether fixed on the shore, or, as is more plausible, floating where necessary.

In this there can be no difficulty and little expense; and if another fact which is here stated is also true, then is there every inducement to the trial; as the pilchard is at least proved to be attached to light, like all other fishes, if, in this case, it is not absolutely seduced from the shores by it. The asserted fact is, that they are found near the Eddystone light-house, and not only so, but in shoals directed towards it. Whether this be true or not, the general fact is true; as, in all cases, light-houses are points of attraction for fish, as effectual as they are for woodcocks. And if it be true that the Eddystone light does seduce the pilchards from their, to us, most profitable road, the problem seems to be solved, and the remedy in the hands of the Cornish philosophers.

Art. .—*On the Diagonal Framing of Ships of War, by* George Harvey, Esq., F.R.S.

The following remarks, on the diagonal framing of Sir Robert Seppings, have been drawn up to assist the young naval engineer in the application of a well-known mechanical principle to the forces operating on the parts of that ingenious system; the proofs hitherto offered respecting the relative positions of the trusses and ties having been derived from experiment *, or from considerations foreign to the legitimate purposes of mechanics.

The misconceptions that at first existed on this important subject, arose from a mistake of the proper applications of trusses and ties; the opponents of the proper positions of the ties having omitted to consider the essential principle in constructive carpentry, that the force which operates *to extend the tie*, should at the same time tend *to compress the truss.* The mechanical lemma

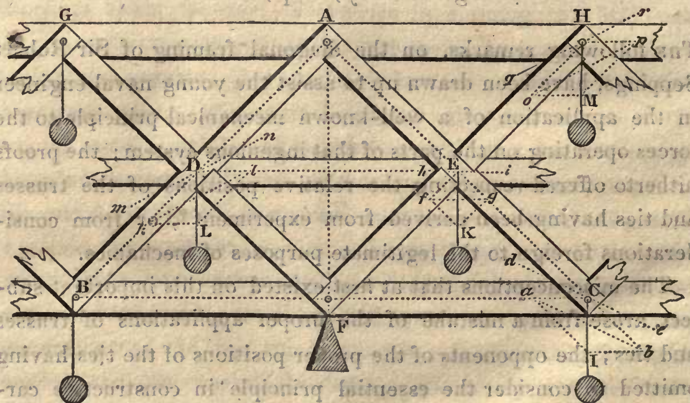
* See Sir Robert Seppings' paper on the 'Great Strength given to Ships of War by the application of Diagonal Braces,' in the *Philosophical Transactions* for 1818.

now to be added will enable the young shipwright to distinguish the parts of the diagonal framing subject to extension, and also those subject to compression; and moreover how, by the operation of the extending and compressing forces, the form originally communicated to the framing may be best preserved, and thus prevent, in the greatest possible degree, the arching of the ship.

Mechanical Lemma *.

Through the point in which the sustaining forces meet, let a line be drawn to represent the measure and direction of the straining force; and on it let a parallelogram be constructed, as a diagonal, having its sides parallel to the sustaining forces. Draw the remaining diagonal of the parallelogram, and, parallel to it, another line through the point where the sustaining forces meet. Then all the parts of the framing on the *same side* of this line, as the straining force, will be in a state of *compression*, and all those on the *other side* of the same line, in a state of *extension*.

Fig. 1.



* For some interesting applications of this well-known mechanical principle, see Mr. Tredgold's chapter on the Equilibrium and Pressure of Beams, in his excellent work on the *Principles of Carpentry*.

THE

QUARTERLY JOURNAL.

October, 1825.

ART. I.—*On the Means by which Crabs throw off their Claws. By* Dr. Mac Culloch.

[In a Letter to the Editor.]

SIR,

IT is well known that the tribe of crabs, using this popular term to comprise many genera of modern naturalists, have the power of parting with their claws by a voluntary effort; and they are thus frequently taken, with one or more of these deficient, or of an inferior size to the rest, since they have also the power of reproducing them. As the nature of this singular process has never been described, and as it appears, at first sight, as it has always been conceived, a very unaccountable effect of voluntary or muscular power, I am induced to send you a sketch of the anatomy of the parts engaged; with an explanation of the mode in which the animal appears to detach the limbs.

This process appears to be effected by these animals whenever so serious an injury has been committed on any of the extreme phalanges as to render the claw useless; no provision having been apparently made to repair any injury of those parts, although there has been one established for reproducing the whole limb. It is very easy to witness this effect when the animal is recently taken out of the water and in a vigorous state; but a very short time is sufficient, in most species, to render the animal too feeble to perform that for which the utmost effort of its muscular powers appears to be requisite. Being unwilling to propagate a method of adding to the torments of animals for the mere gratification of that cruel curiosity in which physiologists have too often, and with justice, been accused of indulging; I will not here communicate the method by which the animals of this tribe may be induced to perform this voluntary mutilation; but it is rather too well known to children who have been brought up on sea-shores.

It is, nevertheless, doubtful whether the effort itself is attended with pain, whatever the previous torment may be; as it seems often to be done without any apparent motive. The whole tribe is of an extremely ferocious and irritable character; and with many, particularly of the younger animals, the mere attempt to take them, even without actual contact, causes them to drop the two hands, or larger claws. Others do it if confined in a box or a glass of water; and almost all of the smaller kinds, or half grown ones, part with any claw by which it is attempted to retain them.

To render the description of this process intelligible, it will be necessary to understand the general structure of the limbs of this tribe. The accompanying sketch, fig. 1, is from one of the small claws of the spider crab, being the species just at this moment under my eye. The structure of the several parts, as well as the form of the limb, is of course somewhat peculiar to this species; but the difference is not material among the whole, and the same explanation and drawing will, with slight modifications, apply to all the instances in which it occurs. Even if I had not accidentally had this species at hand, I should have preferred it; as the structure of the suture where the separation takes place, is rather more distinct and remarkable than in the other species which I have examined.

The limb of a crab consists of six parts, each of which has an appropriate motion in two directions, by means of a pair of muscles adapted to the nature and extent of the space to be described. In the extreme joint, the motion of direct flexion, towards the body, is considerable; but the extension is limited by the structure of the shell; and these motions are produced by two long muscles occupying the second phalanx. The motion of this phalanx upon the third, is lateral in two directions, and tolerably extensive; but less so than any of the direct motions. It is performed by a pair of muscles of considerable power which lie in the third phalanx. The motion of this on the fourth, is a motion of extension and flexion, like that of the first; the latter being, in the same manner, considerable, while the former is limited; and the muscles that produce them are of considerable power, as occupying the great length of the fourth phalanx.

The fifth phalanx is very short, and is articulated to the fourth in an oblique manner, by a very narrow ligament; while the lower shell surmounts the upper one in such a manner as to limit the motion of the latter on the former to a very minute space laterally, which is also somewhat more considerable in one direction than another, but which varies, in this respect, in different species of crabs. These lateral motions are produced by two broad, but very short, muscles; as it will be shortly seen that but a small part of this fifth phalanx can be allowed for them, a great part of it being allotted to the arrangement provided for detaching the limb.

The sixth, or last, phalanx, is extremely short, and is articulated by a somewhat lax ligament to the preceding, which admits also of a direct motion like those of the first and third; but which is, on the contrary, much more free and extensive backwards than forwards. This phalanx is also connected with the former, by short and feeble muscles; but the principal motions in this fifth phalanx, which are amongst the most powerful in the limb, are produced by two long muscles, a flexor and an extensor, which pass quite through the sixth phalanx, and are inserted within the body of the animal. The fifth phalanx therefore moves immediately on the body, independently of the sixth, or is, at least, capable of so doing.

The last, or sixth phalanx, is connected with the body by a very wide ligament, admitting of a very considerable lateral motion, but more extensive inwards than outwards, and allowing the limbs to be folded under the body. Some short muscles are appointed to this office; but it is unnecessary to enter into further particulars; as enough is given in this sketch of the motions of the limb and the position of the muscles, to illustrate the object of this paper. The beauty of the mechanism by which strength of articulation is combined with extent and facility of motion, cannot fail to strike the most negligent observer of nature.

It is in the fifth phalanx that the provision for detaching the limb is placed, and the accompanying sketches will assist in rendering the description intelligible.

It will be perceived that, on the exterior side of this phalanx, there is a pale ring, transversely drawn round it (Plate I, Fig. 1.); and, with a magnifying glass, it is easy to perceive, though much more distinctly in some species than in others, that a very fine line lies in the middle of it, not exactly in one plane, but slightly undulated. (Plate II, Fig. 6.) If the edge of a knife be forced upon this line, it will be found that the phalanx, at the moment it yields, flies asunder with a loud crack. In every part of the shell, the bony matter is deposited in a fibrous manner, transversely to the plate; but at this particular part, the fibres are peculiarly fine and straight, while the structure is also more brittle or tender and the colour paler, (Plate II, Fig. 8.) The division is, in fact, a natural suture; nor is it possible to separate the joint in any other place than where this exists.

If now a longitudinal section of the whole phalanx be formed, the appearance represented in Fig. 7 will be seen. It will be observed, that the suture occupies a thinner part of the shell, or that this portion is more slender than the general shell of the limb, and that it is bounded on each side by two reinforced rings. This is the case at least with the spider crab; but it is less visible in some other species which I have examined, although the peculiar structure of the suture, in other respects, is always to be distinguished. I must nevertheless remark, that in some, as in the lobster and crawfish, the external ring is by no means conspicuous, though the same provision exists in the internal arrangement, nor is it very obvious, externally, in the cancer pagurus. In the same figure, there is a rude representation of the position and insertion of the muscles, as this is necessary for understanding the nature of the action, by which the limb is detached.

It will be seen that the two short muscles which produce the confined lateral motion between the fourth and fifth phalanges, or at A, (in Fig. 1, Plate I,) are inserted above the suture, (Plate II, Fig. 7,) and that the flexor, which alone is visible in this section, and which bends the joint as B, (Plate I, Fig. 1,) is attached below it; the opposing extensor, not visible in this drawing, because occupying that part of the shell which has been removed, has a similar insertion. Thus there is left a vacant space between the two sets of insertions, on each side of the suture; and this, according to the species or size of the animal, varies from a quarter to the eighth of an inch. In the living state of the animal, this is filled with a mucilaginous matter, which coagulates on boiling, so as somewhat to resemble the curd of milk; and which, after the voluntary separation of the limb, forms a protection to the ends of the last pair of flexors and extensors, and to the cavity of the joint. In Fig. 6, these muscles, by which the action of detaching the limb is produced, are represented as separated from their inferior insertions within the body; bearing here the same proportion to the fifth phalanx, as they do in the species from which this drawing was made.

It is now necessary to remark, that, in proceeding to detach the limb, the animal frequently throws the whole of the limbs into a state of violent extension, remaining perfectly rigid, as if under the operation of a tetanus or universal spasm. In other cases, the injured limb alone is so extended; and it is probable that these differences depend on the state of vigour or debility in the animal. When feeble, this action is often continued for some time, or relaxed, and again renewed, without producing the desired effect. But, when the animal is sufficiently powerful, the limb suddenly drops off at the suture, with a loud crack, in a second or two after the extension.

This singular process seems, at first sight, to be capable of explanation, by considering the structure above described, and the positions and actions of the last pair of flexor and extensor muscles; and thus it has been been attempted to explain it. It is obvious, however, on a moment's consideration, that no actions of these muscles, however powerful, could alone produce the consequence in question; as they could have no further effect than that of fixing that part of the fifth phalanx, which is below the suture, more firmly on the body. To explain the mode in which their action is rendered efficient towards the separation of the limb, it is necessary to describe the forms and relations of the fifth and sixth phalanges more particularly; as, in these, the true solution of the difficulty will be found. It is from inattention to these important circumstances, that this process has appeared so mysterious; and assuredly it is difficult, on a first view of the operation as performed by the animal, to witness it, without surprise at the facility with which it is effected, and at the apparent inadequacy of any conceivable means for producing the separation. The obvious effect of muscular action, is to approximate the insertions of the muscles; yet here it appears to act as if it was to separate them.

As it is impossible to render this structure intelligible without drawings, some sketches are added for that purpose; and, as being more obvious in the common crab, (Cancer pagurus,) they are taken from that species. They are limited to the fourth, fifth, and sixth phalanges; being the only ones required for illustrating the subject; and these are numbered, so as to correspond to Fig. 1, Plate I. The place of the suture is indicated in these sketches, as it is not so defined externally as in the spider crab. In Plate I. Fig. 5, is an outside view of part of the limb in a state of flexion; the state of extension being performed by the approximation of the points A, B, until they meet, so as that the indicating lines coincide in a common line C. In Fig. 2, Plate I, the phalanx is in a half extended state, and is further so turned, as to shew more distinctly the forms of the two phalanges at A and B; while, in Fig. 3, Plate I, the extension being completed, the points A, B, are brought into absolute contact at C. Another view of the meeting of those points when in a state of extension, is seen in Fig. 4, where a front view of the limb is given; and here also the coincidence of the two protuberances A, B, as the point of mutual contact, C, is indicated.

In all the figures, the position of the suture is marked; and, in Fig. 2 and 3, an attempt is also made to shew the positions of the flexor and extensor muscles of this phalanx. These, passing through the last, or the sixth, phalanx, are inserted in the body of the shell below, and beneath the suture of the fifth phalanx above, and it is by them that the action of separation is effected. But the mode of action will be more easily understood, by simplifying the appearance of the parts; as is attempted in that which is rather a diagram than a drawing, at Fig. 9, Plate II. In this, the shell is supposed transparent, to shew the directions and insertions of the separator muscles.

The limb being firmly extended, the protuberance A is thus brought to rest firmly on B at the point C, and in such a manner, that the lower portion of the suture itself, just touches the sixth phalanx. If the whole of the fifth phalanx, *above* the suture, could be thus supported on the sixth, it is evident that the contraction of the flexor and extensor muscles, would draw the lower portion of the former towards the shell or body, the latter phalanx being at the same time pressed against it, and thus tend to separate the lower from the upper part of the fifth phalanx. But the necessary freedom of the motion of flexion, would not admit of such a construction; and the effect is therefore produced in a different manner.

For this purpose, the chief operation of the extensor muscle is, as before remarked, to fix the protuberance A firmly on B, which thus becomes a fulcrum, or point, on which the upper portion tends to revolve when the flexor is brought into action. Thus the flexor muscle acquires a lever of considerable power; and, on being caused to contract, it draws the lower portion of the fifth phalanx from the upper, and effects the separation. That this is the efficient cause, is rendered evident by the crack commencing at D; although the whole is completed so instantaneously, that it requires a quick eye to perceive a difference between the commencement and the termination of the process. It is also easy to see that a collateral provision is made for this purpose; as the suture is not only thinner but more feeble at this part; being easily separated by insinuating a knife into it there, while it is scarcely possible to enter the point or edge at the opposite side.

Those of your readers, who may find a difficulty in comprehending the nature of this process, from the preceding description, may easily satisfy themselves respecting it, by examining the structure of the parts, in an animal so common. This may be done, even after boiling; when the structure and disposition of the muscles are, indeed, even more easily understood than in the living animal. But I may, I believe, add, that your London readers at least need not be surprised, if their trials of the powers of the living animals, in this respect, should fail; as they are generally too much exhausted in that market, to enable them to display this extraordinary faculty.

Shetland, *July*, 1820.

EXPLANATION OF THE PLATES I. AND II.

Plate I, Fig. 1. Is a whole leg of the spider crab, intended to convey a general view of the articulations and motions of the legs of this tribe. The extreme, or first phalanx, has a direct motion forwards, but cannot be thrown backwards even into a straight line with the second, being checked by the form of the articulation. These motions are effected by two muscles which occupy the entire length of the second phalanx.

The second phalanx has no direct motions at all, but its lateral motions on each side are tolerably extensive, and are performed by two muscles similarly occupying the cavity of the third phalanx.

The motion of the third phalanx on the fourth is direct; but like the first articulation, this third one is so constructed that the limb can scarcely be thrown back, even into a straight line. But the construction of the joint allows a very extensive motion forwards, and the connecting ligament is therefore lax and broad. The muscles of flexion and extension occupy the whole cavity of the fourth phalanx.

The fourth articulation is very peculiar, the ligament being so narrow as to be scarcely visible; and, in consequence of the form of the shell and the shortness of the muscles, the motion is very confined. It is lateral in either direction. The muscles, by which it is effected, are broad, but they arise from above the suture, or white ring, in the fifth phalanx, and are consequently very short.

The fifth articulation, lying between the fifth and sixth phalanges is very free, and admits of direct motion both ways. But it differs from all the preceding in the great extent of the motion backwards; by which the whole limb admits of being thrown back, so as to be parallel to the flat surface of the animal. It has been already seen that this is the motion which prepares the limb from being detached, and the means by which this is effected will be more fully shown in the following figures. The muscles by which the flexion and extension are performed, and which also by their action serve to separate the limb, are not, as in the former cases, inserted in the next, or sixth, phalanx, but pass quite through it to be fixed in the shell of the thorax. Their origin is below the white ring, or suture, as that of the last pair was above it.

The sixth and last phalanx is articulated to the body by a very wide and lax ligament, admitting, however, only of a lateral motion, which is performed by muscles inserted in its sides, and fixed at the other extremity to the shell of the body.

Plate I, Fig. 2. Represents the sixth and fifth phalanges, with part of the fourth, in a limb of the Cancer Pagurus. The place of the suture, in the fifth phalanx, is less marked in this species; and it was for that reason that the spider crab was preferred for the purpose of showing that part. It is, however, indicated in the figure. The limb is here thrown back by the action of the extensor; and both the muscles are introduced, as separated from the body and passing through the sixth phalanx. The protuberance of the fifth phalanx, which, in the act of detaching the limb, is brought to rest on the sixth at B, is shown at A.

Plate I, Fig. 3. In this figure another view of the same parts is given, for the purpose of shewing the complete extension of the limb at the moment when it is to be detached. At the point C, the protuberance of the fifth phalanx at A, bears strongly on the point B in the sixth, or A and B coincide at C.

Plate I, Fig. 4. Is a direct view of the interior of the limb at the same place, when in a state of extension. This figure is given principally to show the suture, which is very visible in the interior of the fifth phalanx; while it also represents the bearing of the fifth and sixth on each other, on the opposite side at C.

Plate II, Fig. 5. The same parts are here represented in a state of moderate flexion, for the purpose of shewing more distinctly the protuberances of the fifth and sixth phalanges at A and B, which, in the act of extension, are to be brought into contact, or to coincide in a common line C.

Plate II, Fig. 6. Is the fifth phalanx, separated from all its connexions; with its flexor and extensor muscles attached at one end, and the lateral muscles, by which it is connected with the fourth phalanx, shewn at the other. The suture is here distinctly seen. This is a joint of the spider crab.

Plate II, Fig. 7. Is a section of the same phalanx, for the purpose of shewing the suture distinctly, together with the insertions of the upper and under muscles. The ends of both those which lie between the fourth and fifth phalanx are shewn; but in consequence of that, only the flexor beneath is visible. It is here distinctly seen, that the shell is reinforced by a ring on each side of the suture; and that it is not only thinner, but distinctly marked by a line indicating the future division between these.

Plate II, Fig. 8. Represents the dispositions of the fibres at the suture, after the division has taken place. They radiate from a common centre.

Plate II, Fig. 9. Is a kind of diagram, explanatory of the action by which the separation of the fifth phalanx at the suture is effected. The flexor and extensor muscles which produce the disunion of that part, are represented as if the phalanges were transparent, so that their whole course is seen. The support or resistance which the sixth phalanx gives the fifth, by means of the meeting of the protuberances A and B, at C, is also represented. When the limb is thrown into this position of extension by the action of the lower muscles, it is plain that the point C becomes a fulcrum, round which D may be caused to revolve. By means of the action of the extensor, the fifth phalanx is firmly fixed on the sixth, at a point above the suture, and somewhat beneath the upper insertion of that muscle. Thus its principal action becomes that of preserving this position; as it has little or no tendency, from the shortness of the lever thus remaining, to bring back the limb into the state of flexion. Hence that action of the flexor, which would otherwise be exerted in retaining the bent position of the limb, is so counteracted that it tends to draw the phalanx asunder at the suture D, where provision is made for that purpose. It is plain that the action of the extensor tends also to produce the same effect; the great resistance to that flexion, which would otherwise defeat this object, being that of the shoulders of the two phalanges at C.

However obscure this subject may at first appear to an observer, from the obvious tendency of the muscles to bend the limb instead of breaking it, a careful consideration of these drawings, or of the limb of the animal itself with their assistance, will, it is hoped, render it perfectly intelligible.

Art. II.—*On the Fogs of the Polar Seas. By* George Harvey, Esq., F.R.S., L. and E.

It has been commonly supposed, that the fogs which cover the Arctic Seas during the greater part of the summer months, are produced by *the moist air depositing its vapour, in consequence of being chilled by contact with the sea.* But this cause, it is presumed, is not adequate to the formation of mists; since it has been proved by Dr. Wells *, that dew and hoar frost, are the only results which arise from air, either perfectly or imperfectly saturated with moisture, coming in contact with a body colder than itself. To produce mist or fog, as has been satisfactorily demonstrated by Dr. James Hutton †, it is necessary, that volumes of air, of unequal degrees of temperature, and holding moisture in solution, should be mingled together; and the circumstances of the Arctic Seas, during the period when these fogs generally prevail, are, it is presumed, in perfect accordance with these conditions.

Before the end of June, the shoals of ice are commonly divided and scattered; the temperature of the ocean, being at that time, necessarily greater than that of the icy masses floating on its bosom. This inequality of temperature, will necessarily impart a corresponding influence to the air, and occasion the portions of the atmosphere, resting on the broken surfaces of the water, to become warmer than the atmosphere in the vicinity of the icebergs. The cooling influence of the icy masses also, in consequence of their being elevated considerably above the sea, will be diffused, not only by radiations from their upper surfaces, to the canopy of the sky above them; but by horizontal radiations, to

* Wells, on Dew.

† *Transactions of the Royal Society of Edinburgh,* Vol. I.

the air surrounding their sides. A volume of the atmosphere therefore, between two neighbouring masses of ice, will necessarily have its middle portion, of a higher temperature, than that of either of the portions of air, between it and the icebergs *; and the consequence of such an unequal distribution of temperature, must be, to cause the cold air to mingle with that of a higher temperature, and thus to produce mist or fog. The density of such mist or fog will depend on the difference between the temperatures of the mingling volumes, and on the quantity of vapour contained in the air.

The elevation of those mists above the surface of the sea will also be regulated by that of the icebergs, near which they form; since the cooling influence of the frozen mass, by rapidly diminishing above its summit, will as rapidly destroy all tendency in the portion of the atmosphere, above the level of the iceberg, to assume a condition favourable to the formation of mist; thus prescribing to the mist an elevation, dependent on that of the iceberg near which it forms. Captain Ross accordingly remarks, in his Account of the Polar Voyage, " that the fog was extremely thick on the surface of the sea, but at the mast-head, and at the top of the iceberg, it was perfectly clear." Captain Scoresby also, in his Paper on the Fogs of the Polar Seas, read before the Wernerian Society †, alludes to their definite elevation, and to the sky above them being perfectly clear.

It is possible, however, that two icebergs may be situated so near each other, that their reciprocal horizontal radiations, will so cool the volume of air between them, as to reduce it to a temperature nearly uniform; and thereby prevent the formation of mist. The cold volume of air so formed, may, however, pass from

* If the water in the vicinity of icebergs presents considerable inequalities of temperature, the air which reposes on it, must be subject to like variations; and numerous examples of the former are to be met with in the Accounts of the Polar Voyages. Thus Captain Franklin remarks, " the temperature of the surface water was 35° when among the ice, 38° when just clear of it, and 41°.5 at two miles distant."

† *Edinburgh Philosophical Journal,* Vol. VI.

[illegible]

Art. XVII. *Miscellaneous Intelligence.*

I. Mechanical Science.

§ The Arts, Agricultural Economy, &c.

1. *Improvement of Oil Lamps.*—MM. Arago and Fresnel have lately applied the principle of Count Rumford's concentric or co-lateral meshes to the improvement of lamps, intended either for light-houses or theatres, or for other uses where a strong bright clear light is wanted. In order to obviate the difficulty which was formerly found to arise from the carbonization of the wick by the great heat occasioned at the summit of the burner, the oil was made to flow over at the mesh, in the manner proposed and adopted by M. Carcel; and in thus keeping the flame at the top of the wick, a full, clear and steady combustion was obtained. Many circumstances require attention in making these lamps produce their best effect; as the space between the meshes, the size of the air canals, the height of the chimney, the magnitude of the reservoir, &c. When perfect, the experiments made with them, though they seemed to indicate a slight degree of saving in the oil required to produce a certain quantity of light with lamps having two wicks, yet they did not, as a general result, with three and four wicks, justify the opinions of Count Rumford; and the quantity of light produced, was about the same as what would have been given by the same quantity of oil burned in other economical methods. The principal advantage is the power of concentrating all the light into one focus, so that when advantageously placed, as on the centre of a light-house furnished with lens, the greatest quantity may pass from one point through the lenses. The light of these lamps is very regular; for, after twelve or thirteen hours' burning, it does not diminish more than one-fifth,—at least such was the result with a four-wicked lamp placed in the focus of a large lens. The quantity of oil allowed to flow over at the wick, should be at least equal to that which is burned. It is not apparently injured, and is to be returned into the reservoir. In place of the apparatus employed by M. Carcel, to make the oil rise to the wick, MM. Arago and Fresnel placed the reservoir of oil above the height of the burner; and then, by an open moveable tube, which passed into it from the air, the level up to which the oil was required to flow was easily regulated.—*Annales de Chimie*, xvi, p. 377.

2. *Coal-Oil Parish-Lamps.*—It is now some time since the volatile oil, obtained by distilling coal and coal-tar, has been applied in place of animal oil, in producing light. Large quantities of this fluid are prepared at once from the coal in

Scotland, and much is also obtained by distilling coal-tar. When pure, it is limpid and colourless, and closely resembles, if it be not identical with, naphtha. A large district about Fitzroy-square and Charlotte-street has been lighted by this fluid, burned in lamps particularly constructed for it by Major Cochrane; they are patent, as well also as the application of the oil to this purpose. The flame in these lamps is very short, but extremely bright, and certainly far surpasses a common street gas flame in that respect, if it does not also an Argand burner supplied by coal-gas. It has happened now and then, when the wick has been too high, and the oil used has been obtained from coal-tar, that the flame has smoked, the wick become charred, and at times so much vapour has collected in the lamp as at last to explode and burst it to pieces; but this has not happened with the Scotch oil. The lamps in the district before mentioned, have now been in use for a considerable time, and are found to be attended with perfect success.

3. *Lithography.*—A society has been formed at Munich for the imitation of oriental MSS.; the object is by means of lithography to multiply copies of the best works which are extant in the Turkish, Arabic, Persian, and Tartar tongues, and to dispose of them in the East, by the port of Trieste. The cabals of those, whose business it is to write MSS., and the different ornaments with which the Turks and Arabs adorn their writings, have been obstacles to this design hitherto; but by the aid of Lithography, the difficulty it is thought may be overcome. Thus the cheapness of that mode of engraving will contribute to spread to an unlimited extent, the treasures of the best writers of the East.

A lithographic establishment has also been formed in London, for the purpose of facilitating the progress of this branch of art, at No. 1, Wellington-street. Series of the impressions taken from copies of the pictures in the Munich gallery are to be seen there, and give an idea of the powers of the art, far beyond what could possibly be imagined by those who know of it only from description. It contains also a large deposit of Foreign and British Materials, for the prosecution of this pursuit, and many of the finest results that have been produced by it.

4. *On the Potash to be obtained from the Stalks of Potatoes.*

[In a Letter to the Editor.]

Dear Sir,

In *Tilloch's Journal* for November 1817, there is inserted an article on the manufacture of potash from the stalks of potatoes. The experiments are said to have been executed first in France, and the results are all given in weight, from that of the green vegetable to the incinaration of the mixed saline mass, commonly known in our markets by the name of pearlash. The "immense advantages," however, which are to be derived from this practice, seem to depend on a fallacy which is of such a nature, that it appears rather to be the consequences of a direct mis-statement than of any conceivable error. The French statement is indeed followed by a comparative experiment made in Ireland by Mr. Rice, the results of which are far different, and such as to confirm the suspicion here stated. According to the French experiment, the produce of potash per acre, is above 2,000 lbs.; in Mr. Rice's, it is only 201½ lbs. It is true that owing to differences in the method of burning vegetables, whether terrestrial or marine, they are found to yield very different proportions of alkali, from circumstances respecting the peculiar nature of these substances, the mode of their existence in vegetables, and the changes they undergo in the fire, with which we are not yet acquainted. But as the method of drying and burning are fully described in the original experiment and appear to have been accurately followed in Ireland, this cannot account for the extraordinary differences in the results respectively obtained.

Being desirous of further verifying the French statement, which, certainly, if correct, offered no small temptation to agriculturists, I requested my friend Sir John Hay, Bart., to make a large experiment for that end, on his farm near Peebles; and as it was executed with that accuracy which characterizes his whole system of agriculture, his well-known reputation will afford sufficient proof that it was worthy of reliance. I ought, however, to add, that lest any thing should arise to throw a doubt on the event, the directions given in the narrative of the French experiment, were implicitly followed in every particular, from the cutting to the burning of the plant, and that the ashes were weighed, lixiviated, and examined by myself.

The result of two trials on two separate acres, follow; and the Scotch acre, it must be remembered, is one seventh larger than the English. It is presumed that in the original statement the measures were reduced to the English acre. The first acre was a rich loamy soil at King's Meadows; the potatoes were drilled, and produced a good crop. They were cut, as directed, immediately after flowering, left ten days to dry, and burnt in a pit. the produce was 222 lbs. of ashes, and, on lixiviation and drying, these yielded 55 lbs. of impure potash, or mixed salts.

The second acre was a clayey wet soil, with a retentive bottom; but the crop, which was also drilled, was considered moderate. These stems were treated in the same manner; but the burning had been more complete, as the ashes contained less charcoal than the preceding. They only weighed 112 lbs., and produced 28 lbs. of impure potash.

Thus it appears that, in the Irish experiment, the potash procured was scarcely one-twentieth part of that which was said to have been obtained in the French; while, in the two experiments made in Scotland, the produce, in one instance, was only the half, and, in another, only the quarter of that which was obtained from the trial made in Ireland.

It is probable that the Irish acre, if computed according to the lazy-bed system of cultivation, contained more plants than the drilled Scotch acre; and thus the differences of produce between Mr. Rice's acre, and that at King's Meadows, will not be very difficult to reconcile; while the scantiness of the second crop, tried in Scotland, may also suffice to account for the still greater diminution of the alkaline product in that case. Both these trials therefore sufficiently confirm each other; particularly when we further consider the differences in the proportion of saline ingredients which the same plant exhibits in different situations and circumstances, and those further differences in the alkaline product which arise from variations in the treatment previous to burning and during combustion. The French experiment, however, leaves them at an incalculable and incredible distance.

Taking a mean result then from the experiments made in Ireland and Scotland, or even admitting the former to afford a better standard, there is evidently no temptation for agriculturists to repeat these trials with a view to profit. It appears on analysis, that the dry saline residuum, here called in compliance with the French statement, impure potash, does not contain above ten per cent of pure alkali, the remainder consisting of muriate of potash and other ingredients; and it is evident that a much larger quantity would not repay the expenses incurred in the operation,

I am yours, &c.,
J. Mac Culloch.

5. *Apple Bread.*—M. Duduit de Maizieres, a French officer of the king's household, has invented, and practised with great success, a method of making bread with common apples very far superior to potato bread. After having boiled one-third of peeled apples, he bruised them while quite warm into two-thirds of flour, including the proper quantity of yeast, and kneaded the whole without water, the juice of the fruit being quite sufficient. When this mixture had acquired the consistency of paste he put it into a vessel, in which he allowed it to rise for about twelve hours. By this process he obtained a very excellent bread, full of eyes and extremely palatable and light.—*New Monthly Mag.*

6. *New Musical Instrument.*—A musical instrument is now in

Lynn sand, 3 of nitre, 3 of soda, and 3 of Cornwall china clay, This mixture is melted into a frit, and is then ground to a fine powder, 3 parts of calcined borax being previously added.

Some specimens furnished by Mr. Rose, were placed in the hands of Mr. Muss and other artists, to be submitted to experiments. When placed in heats much higher than they would be subjected to in the fair course of enamelling, the glaze remained firm and perfectly uniform, without any specks or splits having been produced on its surface; the colours, even the pinks and chrome greens, coming out remarkably well upon it, and none of them chipping off, as is frequently the case with the colours of the French porcelain.—*Transactions of the Society of Arts*, 1820.

13. *On preventing the Ravages of Moths in woollen Cloth.*—The discovery of an easy and effectual method of preventing the destruction of woollen fabrics and furs by moths, has long been a subject of research, and it still stands, I believe, among the list of premiums in the promises of the Society of Arts. Although the process here in question is known to many individuals, it is not yet known to the public at large, and your Journal offers the means of diffusing it.

The discovery, although accidental, is due to the officers of Artillery at Woolwich, employed in the inspection of clothing returned from Spain. It was observed, that in casks where all other woollen substances were totally destroyed, those cloths that had been rendered water-proof by the common well known processes, remain untouched. Attention having thus been excited to this circumstance, other similar mixed packages were examined, and the results were found to be invariable.

This process has the advantage of being cheap, easy of application, and permanent; since the chemical change produced by it in the surface of the woollen fibre, is not liable to be affected by time. If, in the case of military stores, no other good result were to follow the use of the water-proof process, this would be a sufficient reason for its universal adoption. The effect of all the odorous bodies commonly used for this purpose is transitory, as they evaporate in the course of time; but the aluminous soap which becomes united to the animal fibre in the water-proof process, seems to disgust this destructive larva so as effectually to prevent it, like some dyes, from attempting to devour the wool or other animal hairs, which are its natural food.

There seems no reason why this process should not be adopted in furs for the same purpose; since great losses are occasionally sustained by their destruction. It might with equal ease be applied to them; and as it does not appear to produce any effect on the appearance of the woollen substances to which it is applied, it would probably cause no change in the brilliancy or beauty of those substances, so justly valued for their utility and beauty, and so difficult to preserve without the most watchful attention.

J. M.

14. *Decomposition of Blood.*—M. Vauquelin had occasion to observe the changes produced in five years, in the fluid obtained by washing coagulated bullocks' blood. It appears at first to have contained the serum, and a considerable portion of the colouring matter of the blood, and the results at the end of the time mentioned were:

1. A large quantity of carbonic acid.
2. A large quantity of sulphuretted hydrogen.
3. A large quantity of acetic acid.
4. Ammonia which saturated these acids.
5. An acid and very fetid volatile oil, saturating part of the ammonia. These substances did not exist previously in the blood.
6. It appears that the fixed fatty matter which was found, had existed in the blood previously, as a similar matter was found in recent blood.
7. That the albumen was almost entirely decomposed, slight traces only remaining, and so altered in its nature that it rather resembled glue than albumen.
8. That the colouring matter remained entirely unchanged.
9. That the blood did not appear to contain phosphorus.

M. Vauquelin remarks that the quantity of sulphur in blood is much larger than is generally imagined, amounting to two grammes (about 30 grains) in a litre ($2\frac{1}{8}$ pints). This sulphur had separated spontaneously from the fluid, and formed a ring just above its surface on the glass.—*Ann. de Chim.* xvi. p. 363.

15. *Diod griàfol.*—A liquor is brewed from the berries of the mountain ash, in North Wales, called diod griàfol, by only crushing and putting water to them. After standing for a fortnight it is fit for use, its flavour somewhat resembles perry.

16. *Formation of Alcohol, by fluoboric Gas.*—Some very interesting experiments are detailed in a short paper published in the *Annales de Chimie,* xvi, p. 72, on the action of fluoboric gas on alcohol. They are by M. Desfosses of Besançon. The gas was sent into a portion of alcohol, which became very ethereal in odour, and very acid, even so as to fume. The fluid was distilled, and then rectified, first from potassa and afterwards from chloride of calcium. The ether thus obtained, was entirely analogous to sulphuric ether. It burnt like it, and gave no acid fumes. The specific gravity was .75, being rather greater than that of pure ether, but it had not been washed so

23. *Singular Property of Boracic Acid.*—I mentioned in the 6th vol. of this *Journal*, p. 152 (1819), the property possessed by boracic acid in all states of dilution, of reddening turmeric paper in the manner of an alkali. Since then the attention of M. Desfosses has been drawn to the action of boracic acid on this colouring matter (*Annales de Chimie*, xvi. p. 75.), apparently without a knowledge of the previous remark; and he has shewn that a mixture of boracic, with other acids, reddens turmeric very deeply, and that turmeric, when acted on by this mixture of acids, has its nature altered, for it approaches somewhat to turnsole, and is rendered blue by alkalies.

There is something so curious in this action of boracic acid, on turmeric, that I am tempted to offer a few more results on the subject.

Turmeric paper dipped into a solution of pure boracic acid very speedily receives a slight tint of brownish red, which, when the paper is dry, is very marked, and resembles that produced by a weak alkali. In this state the properties of the colouring matter are entirely different to what they were before: sulphuric, nitric, muriatic, and phosphoric acids, even when very dilute, produce a bright red colour on this paper, and a strong solution of oxalic acid also reddens it. Alkalies on the contrary make it blue, gradually passing to shades of purplish blue, yellowish red, *&c.* As long as the acids or alkalies remain on the paper, if not so strong as to destroy the colouring matter, the new colour remains, but a slight washing removes them, and then the boracic acid tint returns, and the paper has its first peculiar properties. When altered by muriatic acid, or ammonia, the mere volatilization restores the paper to its first state; with the ammonia the restoration is very ready and perfect; with the acid, it is longer and not so complete. If the paper reddened by boracic acid be heated, the yellow of the turmeric is almost restored, and then it takes from acids a weaker red tinge, and from alkalies a more purplish colour than before.

Turmeric, thus altered by boracic acid, is readily restored to its original state by washing; altered turmeric paper when put in water for two or three hours resumes its original properties, and acts as at first in testing the alkalies.

When the altered paper is placed in sun-light a few days, the colour is soon destroyed as with turmeric alone, and then neither acid nor alkali will affect it.

When turmeric paper is dipped into neutral or slightly alkaline borate of ammonia, it soon becomes of the red tint produced by boracic acid, and is, in every respect, as if altered by boracic acid alone; when this paper is made blue by ammonia, the ammonia easily washes out, and the blue tint disappears, and afterwards the boracic acid or borates will wash out and leave the paper as at first.

Borax itself at first reddens turmeric paper because of the excess of alkali, but as the colouring matter becomes altered by the presence of the boracic acid, the tint becomes of a dirty bluish colour, and then the paper is changed by acids or alkalies, just as if it had been altered by boracic acid.

Hence it is probable that the neutral borates have the same power as the boracic acid, of altering the colouring matter of turmeric, for it is not probable there should be an actual separation of the elements of the salts by it, especially as they both wash out from it and leave it unaltered.

Hence also both acid and alkaline borates redden turmeric.

M. Desfosses, proposes this effect of boracic acid as a test for its presence; for a very small quantity of it mixed with other acid has the power of reddening turmeric paper in consequence of these changes.

M. F.

III. Natural History.

Geology, Medicine, &c.

1. *Further Remarks on the Resemblance between certain Varieties of Granite and of Trap.*—J. Mac Culloch.

In a former number of this *Journal* (Vol. X. p. 29.), I gave a detailed account of some interesting facts occurring in Aberdeenshire, respecting the resemblance of certain portions of the granite of that country to some of the members of the trap family. It was there shown, that, in this district, specimens could be procured from the fundamental granite, and connected with the most common varieties by transition, resembling many of the latest greenstones, and even the basalt of most recent origin which is superincumbent on the latest stratified rocks. The series of specimens formed from these places, is not to be distinguished from a common series of basalt and greenstone; but the interesting conclusions to which this fact gives rise, respecting the similarity of origin in these two families, so far removed in position, need not be repeated, as they were sufficiently pointed out in the paper to which I have alluded.

As the instances which I there quoted may, however, seem to require confirmation, particularly to those geologists who are unwilling to abandon the notions in which they have been educated, it will not be useless to point out another set of similar facts, equally open to investigation, and equally confirming the views formerly held out. Setting aside this minor consideration, it is always useful to accumulate examples of any geological fact; particularly of such as, from their novelty, or from their disagreement with former observations, are often, for a considerable time, received with doubt or incredulity. To multiply the places of access to such appearances is also useful; and I can only regret that I have not here to refer to a country more accessible, instead of being, as it is, more remote than Aberdeenshire.

Granite of various characters occurs in different parts of the Shetland islands; where it displays, in a degree of profusion not to be equalled through the whole of Scotland, all these phenomena attending veins, and accompanying its contact with the stratified rocks, which are, deservedly, objects of so much attention to geologists, and which serve to throw so much light on the nature and origin of this substance. But the most entire and extensive tract is found in North Maven, extending over a space which it would be useless to describe in words; as, without a map, no definite idea could be conveyed of it. There are, at least, two very distinct varieties in this district; and, it is not difficult to discover that they are of different eras; since veins of the one variety are found to penetrate into the other, whereas the reverse never takes place.

It is in one of these that the varieties, analogous to those of Aberdeenshire, formerly described, are found; and they present a similar series of graduating specimens; the whole being evidently inferior to gneiss and the other primary strata of that district, and, in many places, graduating into undisputed varieties of the most ordinary granite. To detail the aspects of these specimens, would be merely to repeat that which was said in the former communication on this subject. I shall therefore merely add, that from the ordinary syenitic granite, consisting of hornblende, quartz, and feldspar, with or without mica, a regular series may be traced, passing through numerous modifications of greenstone, not differing from those of the trap family, down to a perfect basalt.

For the information of those who may be inclined to visit the ground in question, I may add that the most convenient situations for examining these appearances in detail, are in the neighbourhood of Hillswick.

2. *On the Deposition of Carbonate of Lime in Wood.*—It is well known that siliceous earth is deposited in many vegetables, particularly in the grasses, in the bark of the *Calamus Rotang*, and in that of *Equisetum hyemale*. The deposit known by the name of *Tabasheer*, is a particularly conspicuous example of this nature. The deposition of carbonate of lime is a more rare occurrence; yet it is found in many pears, and is very re-

markable in the bark or on the surface of *chara vulgaris.* Having accidentally observed one instance of this nature in a very unexpected situation, I thought it deserving of record as adding another illustration of a remarkable fact in vegetable physiology.

A few years ago, when some uneasiness was produced by the rapid consumption of oak in the navy, commissions were sent to various places to procure such woods as appeared to be adapted for ship-building. Among others; many specimens were brought from Sierra Leone in Africa; and, from these, the singular wood under review was selected. Unfortunately, no description of these trees was furnished; so that it is impossible to conjecture to what genus the specimen in question belongs, or whether indeed it belongs to any known genus.

The size of the timber, which is probably still lying in Deptford yard, proves, at least, that it is a large tree. The colour of the wood is that of mahogany, which it much resembles on a general view; being, at the same time, equally hard. But the longitudinal split shows a larger fibrous structure, and, in the transverse smooth section, the grain is coarser, from the large size of the vessels which form the interesting part of this wood.

These vessels, or tubes, are so numerous that they amount to 1,600 in the square inch. Their form is very irregular; seldom round, occasionally oval, but more commonly of a long irregular shape. Sometimes also, two or more ovals are connected by a narrow line. These vacuities in the wood are filled with a yellow carbonate of lime, which bears slight marks of irregular crystallization. But they are not always entirely filled; the wider ones being perforated by a circular tube running through them, and surrounded by the calcareous matter. These orifices are of such a size as just to admit the point of a human hair; it frequently happens that two or more are contained in one of the deposits of the carbonate.

I need scarcely add that the application of an acid excites an active effervescence over the whole section of the wood.

J. M

3. *Breaking out of a Spring.*—A remarkable phenomenon occurred at Bishop Monckton, near Ripon, on April 18th, on the estate belonging to Mr. Sharnock. About two o'clock in the afternoon the attention of a person in that gentleman's service was attracted by a rumbling noise which apparently proceeded from the stack yard, distant thirty yards from the house. He supposed it to proceed from children throwing stones against the doors and wall; but on looking up the avenue, formed by a row of stacks, and leading to the house, he observed a small portion of the ground in motion, which, after continuing in a considerable state of agitation for some minutes, suddenly presented an opening of about a foot square, whence issued a great

importance. We have indeed regretted that Dr. Mac Culloch has so long withheld his practical information on systematic geology, since we perused his work on the western isles of Scotland, a work which displays attainments peculiarly fitting him for the task which he has now undertaken.

After some introductory remarks on the methods of arranging rocks, which have been adopted by different mineralogists, and on the plan of this arrangement and nomenclature, Dr. Mac Culloch gives the following general catalogue of rocks, succeeded by some remarks on their order of succession in nature:

PRIMARY CLASS.

Unstratified.

Granite
Serpentine

Stratified.

Gneiss
Micaceous Schist
Chlorite Schist
Talcose Schist
Hornblende Schist
Actinolite Schist
Quartz Rock
Red Sandstone
Argillaceous Schist
Primary Limestone
Compact Feldspar

SECONDARY CLASS.

Stratified.

Lowest (red) Sandstone
Superior Sandstones
Limestone
Shale

Unstratified.

Overlying (and venous) Rocks
Pitchstone

OCCASIONAL ROCKS.

Jasper
Siliceous Schist
Chert
Gypsum
Conglomerate Rocks
Veinstones

APPENDIX I.

Volcanic Rocks.

APPENDIX II.

Clay, Marl and Sand
Coal
Alluvia
Lignite and Peat.

Dr. Mac Culloch apologizes for the introduction of coal and peat into this list; but the connexion of the former with the strata in which it lies, and the important illustrations of its history afforded by the latter, amply justify their insertion.

With respect to the order of succession of the primary class, the claim of granite to the lowest place is unquestioned, but after it no certainty can be obtained, for the others are all found in its occasional contact and in uncertain order; to illustrate this fact, the author inserts a table shewing the irregular order of succession in rocks, in several parts of Britain.

The 7th, 8th, and 9th chapters relate to the aspect and structure of rocks, and in the 10th their composition is discussed, illustrated by a valuable catalogue of their component minerals.

Dr. Mac Culloch then proceeds to what we consider as a highly important part of geological science, though hitherto very unscientifically treated; we mean, the transition which so often occurs in rocks, not only between the several varieties of each family, but even between the families themselves, in consequence either of their gradual variation of character, or of the loss of one or more of the ingredients which constitute the distinction. Upon these subjects, our author has some excellent remarks; they have generally been slurred over by modern geologists, in consequence of the difficulties in which they involve the theorist; but Dr. Mac Culloch, who is purely practical, and, strange to say, neither Vulcanist nor Neptunist, gives them their due importance and appropriate description.

The 13th chapter contains a synoptic view of the general characters of the families of rocks included in the arrangement before us. To describe the characters of rocks so as to enable the student to recognise them in mass, as well as in hand specimens, is a task of no small difficulty, and one which we do not hesitate to say, Dr. Mac Culloch has performed in a very superior manner; unlike some modern geological writers, who have aimed rather at obstructing the progress of the student, by throwing an accumulation of difficulties into his path, without giving any clue to their solution, he has succinctly, but clearly announced the obstacles, and, in the greater number of instances, has succeeded in their removal.

On the whole, the science of geology, if so it may be called, is much indebted to Dr. Mac Culloch. In his various papers in the Geological Transactions, and in his book on the Western Isles, he has shewn himself an indefatigable collector of facts, and a most observant traveller; in the work before us he appears equally successful as an elementary and systematic writer. We are indebted to him for the following notice of two new minerals, which ought to have appeared in our Number.

2. A new mineral, to which I gave the name of Conite, was described in my work on the Western Islands, as found in Mull and in Glen Farg. It was subsequently mentioned to have been found in the Kilpatrick-hills, and I must now add, to increase the list of its localities, that I have since found it in Sky, in similar situations, namely, investing or filling cavities in trap rocks, and accompanying different members of the zeolite family.

It happened that Professor Schumacher had, about the same time, applied the same name to a variety of limestone, deriving his term from the Greek, κονια or κονις, as applied to chalk or lime. The inconvenience of this was, of course, immediately apparent; and although it is not likely that the term conite, thus used, will long maintain its place in our catalogues of minerals, since, like lucullite, and many others, it only serves to encumber the science with a catalogue of useless names, I have been induced to change the name of the mineral which I have described, and to request you to give it circulation through the medium of your Journal. The name having been suggested from the powdery form in which this mineral has alone yet been found, the Greek word κονις, as applied generally to powder, may as easily be used in compounding the term Konilite. It is not cacophonous, and answers the purpose of describing the most remarkable character of this mineral; while it avoids any collision with the term to which I have alluded.

3. *Native Oxide of Chrome.—A new Mineral.*—The combinations of this metal with two others, namely, lead and iron, under different forms, have for some time found a place in our catalogues of minerals. A place must now also be made for Chrome itself, in that division of mineralogical systems which is allotted to the metals. I am not aware at least, that the oxide of chrome has yet been found by any one in a native state; certainly it has not been enumerated in any system of Mineralogy.

I have recently discovered it here in Shetland, in the island of Unst. It is found in cavities in the chromate of iron, which abounds in this island, so as, for the space of many miles, to be scattered over the surface of the ground, and even to be used in common with the loose stones which it accompanies in the building of dykes.

This oxide is easily recognised by its beautiful green colour, and does not seem to differ from the green oxide produced in our laboratories by the action of heat. In some places it is merely diffused through the fissures of the ore; in others it occupies cavities resembling those of the amygdaloids. It is sometimes found in a powdery form; but at others it is compacted into a solid substance, bearing the marks of a crystalline structure, and somewhat translucent. Although it appears to be in abundance, when the specimens that contain it are broken, that effect is only the consequence of the brilliancy and contrast of its colour with the black and dark grey of the surrounding chromate of iron. It would be very difficult to collect many grains of it in a separate state from any of the fragments of the black ore which I examined.

The green oxide is accompanied by a yellow oxide of chrome, in cavities generally distinct from it, but sometimes intermixed, and in somewhat less abundance. This latter is more generally in the form of powder than the green. As the green oxide of chrome changes to yellow by heating it, M. Vauquelin appears to think that these are distinct oxides; but this point does not seem to have as yet been very satisfactorily examined. For the present purposes, it will, at any rate, be more convenient to consider them merely as varieties of one mineral species. Those mineralogical writers who are desirous of increasing the number of species may easily follow a different course.

The mineral distinction of the oxide of chrome may be comprised in the following terms:

Oxide of Crome.—This mineral is of a bright grass green colour, or else pale yellow; and is found either in a powdery or a compact form. In the former case, the aspect is dull; in the latter, the lustre resembles that of compactly crystallized limestone, or marble. It either invests surfaces, or fills cavities in chromate of iron.

Its specific gravity has not been examined. It is soluble by boiling in the alkalies, and communicates to them a green colour; but the solution is decomposed by further boiling, and the oxide is precipitated. By this character, and by its communicating a green tinge to glass, before the blow-pipe, it may be recognised and distinguished. It occurs in Unst, one of the Shetland Isles.

Lest your readers should conceive that I had fallen into an error, in describing this mineral as new, I ought to add to this communication, that the oxide of chrome, described in Monsieur Lucas's arrangement of minerals, is a very different substance, and, I may add, improperly named. I need not quote from a book which is in the hands of many mineralogists. It is sufficient to remark, that his mineral is a compound substance, into which the oxide in question enters only as an ingredient. It would be proper that its name should be changed, to prevent confusion; the right of possession is clearly in the present substance.—I am, yours, &c.

Shetland, August, 1820. J. Mac Culloch.

4. *On Fullers' Earth in Chalk, by the* Rev. C. P. N. Wilton, *Gloucester.*—The situation of the chalk-pit, in which the fullers' earth is found, is upon the side of a hill, forming part of the range of the South Downs, in Sussex, immediately above the village of Bepton, from whence that portion of the downs derives the name of *Bepton-hill.* It is distant three miles and a half, south, from the town of Midhurst. The elevation of that part of the hill, where the chalk is situated, above the level of the village, is about 400 feet. Upon my first entering the pit, in the month of May, 1820, I was struck with the appearance of an horizontal layer, consisting of a *greenish brown* earth, passing into *yellowish white* and *brown*; which, upon examination, was found to contain the characteristic qualities of fullers' earth. The layer varied from three to four inches in thickness; and was about a foot below the surface of the hill, having the chalk, which is of the upper formation, as well above as below it. The pit abounds with beautiful *chalk* specimens of different

Journal, escaped my observation, until pointed out to me by a friend. That I found the chromate of iron, in the island of Unst, in the year 1803, as stated in your *Journal*, is true; but, having mistaken it for another mineral, and not having published any subsequent notice of it when I ascertained its nature, the honour of that discovery is justly due to Dr. Hibbert. As far as I recollect, there has appeared no notice of my visit to Shetland, except what is contained in my hasty letter to Mr. Neill; and I owe it to the public, to explain how my name has been connected with the discovery.

During my *only* visit to Unst, I found a substance which, at first, I conjectured to be horn-blende; but its great specific gravity induced me to consider it as an ore of iron. It is thus noticed in my original notes, taken on the spot, and still in my possession: "In the serpentine, find some veins of *micaceous iron-ore?*" On comparing it with mineralogical descriptions, I was unable to assign it a place in my collection, until several years afterwards, when the sight of some specimens of chromate of iron, from America, led me to examine the mineral from Unst; and I became satisfied of their being of the same nature. Since that time, it has been arranged in my collection (now deposited in our Royal Institution), as a specimen of chromate of iron from Shetland; and as such it has been shewn in my lectures. But as I consider priority of publication the fairest claim to the merit of discovery, I regard Dr. Hibbert as entitled to the honour of having added an article of considerable importance in the arts to the native productions of our common country.—I have the honour to be, Sir,

Your most obedient Servant,

THOMAS STEWART TRAILL.

Liverpool, March 14, 1821.

IV. GENERAL LITERATURE, &c.

1. *Recent Discovery of a Fragment of Art in Newfoundland.*—A discovery has been made in Newfoundland, during the last summer, which, trifling as the object is, has not a little exercised the conjectures of the antiquarians of that island. About half a mile from the shores of Gander Bay, there was found a fragment of a small pillar of white marble. This fragment is octangular; about 18 inches long, and 10 inches in diameter. Its surface is as much corroded by the effects of the weather, as those parts of the statues of the Parthenon which have suffered most. It is probable, consequently, that it has lain there for a considerable time.

It cannot have been left in ballast, because it is half a mile inland, and because no ships can come within three-quarters of a mile of the shore of this place. This part of the country is not inhabited, and no similar stones, or works of art, could be found on searching in the same neighbourhood. I must also observe, that the texture of this marble is very remarkable, resembling none that I have ever seen, and perfectly different from any of those used in sculpture or architecture. It is of a yellowish white colour. The texture is in some places crystalline granular, of a large grain; but there are every where intermixed with it parts of very complicated curvatures; capable of being separated in succession, in parallel curved laminæ as thin as paper. These scaly concretions are sometimes an inch or more in dimension. Besides this, there are found distinct irregular laminæ of hard calcareous clay, or very argillaceous earthy limestone dispersed through the stone.

If the Newfoundland antiquaries cannot settle this obscure point, it must be left to the ingenuity of those who have reasoned so ably on the works of ancient art, found in many parts of America. In tracing the migration of Asiatic nations thither, it is easy to settle a colony, and build a city, in Newfoundland.

J. M.

2. *Consumption of Food in Paris, for* 1819.

Wine	hectolitres,	805,499	or 21265173.6 galls.
Brandy	ditto	43,849	1157413.6
Cider and perry	ditto	15,919	420261.6
Beer	ditto	71,896	1898054.4
Vinegar	ditto	20,756	547958.4
Oxen	head,	70,819	
Cows	ditto	3,561	
Ditto, milch	ditto	2,918	
Calves	ditto	67,719	
Sheep	ditto	329,070	
Hogs	ditto	64,822	
Cheese	kilogrammes	1,267,564	or 2796934 lb. avd.
Sea fish	in value, frc.	8,165,520	or £340,230
Oysters	ditto	821,618	34,234
Fresh-water fish	ditto	502,780	20,949
Poultry and game	ditto	7,161,402	298,392
Butter	ditto	7,105,533	296,064
Eggs	ditto	3,676,502	153,187
Hay	trusses	7,822,640	
Straw	ditto	11,054,371	
Oats	hectolitres	923,022	24,367,781 gall.