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Here was a rich promise of a victorious campaign, and the scientific world already congratulated itself on being able at last to "settle the corona," when suddenly, as a bolt out of the blue, came a letter from the Admiralty *declining even a single ship*, on the ground that such a purpose was entirely foreign to the purpose for which Parliament places funds at the disposal of the Naval Department.

We think we had better leave this astounding statement as it stands. It seems really as if the present Admiralty authorities are in absolute ignorance as to the real facts of the case; as to what England has done before; as to what precedents exist to which men of science can point.

Under these circumstances we trust that an appeal will be made to Mr. Gladstone, whose culture, wider than that of his more prominent colleagues, will at once grasp the huge Philistinism of this proceeding. Should he reverse their decision, which he may fairly do, on the mere ground that it is against all precedent, assuredly the scientific men of Britain will hail it as a happy omen—an indication that the hope experienced by Prof. Huxley at Liverpool the other day will, in time, be realised. If, on the other hand, the decision is to stand, it must be distinctly understood that, both in the judgment of our contemporaries and of posterity, it will, as has been already been pointed out in the daily press, bring shame upon the scientific repute of England, who now, with her forces all ready to achieve another victory over nature, is held back by "My Lords" for the sake of a few pounds sterling. Surely there is little hope for us in such a campaign as this we are to succumb to a

Lust of gold
And love of a peace that is full of wrongs and shames;
Horrible, monstrous! not to be told.

REPLY TO PROFESSOR HUXLEY'S INAUGURAL
ADDRESS AT LIVERPOOL ON THE QUESTION
OF THE ORIGIN OF LIFE

I.

SPEAKING with all the authority which years of earnest and successful labour have conferred, and, moreover, "from the elevation upon which the suffrages of his colleagues had for the time placed him," Prof. Huxley has just given us in his Inaugural Address, as President of the British Association for the Advancement of Science, a "history of the rise and progress of a single biological doctrine"—that first proclaimed by Francesco Redi, and to the effect that *Every living thing proceeds from a pre-existing living thing*.

However reluctant to enter a protest against what has been said by an eminent scientific man, for whom I have always entertained the greatest respect and esteem, I feel so strongly that the representations which have been made concerning a subject to which I have directed the most earnest attention for the last eighteen months, are not only inadequate, but altogether incapable of being regarded as an impartial statement of the main points at issue, that I cannot hesitate as to the propriety of publicly expressing this opinion.

Fearful, therefore, lest harm should be done to the cause of science by this address, through the great influence of the speaker, and mindful of the momentous issues which turn upon the proper solution of the question under discussion, I—sinking all personal feelings, risking all imputations, anxious only that the truth should be known—will venture to state what really

seems to me to be the true aspect of the problem, and how far the remarks of Prof. Huxley really bear upon this, or have been, in other respects, not sufficiently explicit.

The doctrine, whose history Prof. Huxley professes to trace, and whose probable truth he thinks remains unshaken, has reference to a question which is of more fundamental importance than any other throughout the whole range of Biological science. It is either true that *all* living matter, without exception, comes into being in connection with pre-existing living matter, or else it is true that *some* living matter can arise from non-living materials free from all connection with pre-existing living matter. This alternative is one the full meaning of which may, perhaps, be realised better by putting another, which, though strictly analogous, is somewhat freer from mystery. It may, then, similarly be said, it is either true that *all* crystalline matter, without exception, comes into being in connection with pre-existing crystalline matter, or else it is true that *some* crystalline matter can arise from non-crystalline materials, free from all connection with pre-existing crystalline matter. Matter when it passes into the *crystalline* condition exhibits properties of a certain kind, and when it passes into the *living* condition it exhibits properties of another kind, to which we commonly apply the term "vital." Now the question in each case is, whether by mere concurrence of certain physical conditions, aiding and abetting the inherent properties of the matter itself, some kinds of matter can fall into modes of combination called *crystalline*, whilst other kinds are capable of falling into modes of combination called *living*; or whether, in each case, a pre-existing "germ" of the particular kind of matter is necessary, in order to determine, in suitable media, either of these modes of combination. Are we to believe that crystals can appear in no solution whatsoever without the pre-existence in that solution of certain crystalline germs,* and similarly that living things can arise in no solution whatsoever without the pre-existence in such solution of living germs? To many persons it may at first sight seem that there is no analogy between the two cases; such, however, is not the opinion of very many who are best entitled to speak on the subject. It is admitted by them that the analogy is of the closest description; and it is interesting to note that although the actual evidence which can be brought to bear upon these two questions is very similar in kind, and alike conflicting in nature, the generally received opinions as regards the proper answers to be given to these two questions have inclined to the view that, whilst it is possible for crystals to originate *de novo*, it is at present impossible for living things to originate after this fashion.

* It must not be supposed that this is a mere hypothetical case. On the subject of crystallisation generally in supersaturated solutions, I will quote the following passage from Watts' *Dictionary of Chemistry*, Vol. v., p. 349:—"This sudden crystallisation, if not produced by cold, appears to depend essentially on contact of the solution with small solid, perhaps crystalline particles; for it is not produced by passing air previously purified by oil of vitriol through the solution, or by agitation with a glass rod previously purified from dust by ignition. According to Violette and De Gernez, the sudden crystallisation is in all cases induced only by contact with a crystal of the same salt, possessing the same form and degree of hydration as the crystals, which separate out; and in the case of those supersaturated solutions which crystallise suddenly on exposure to the air, it is due to the presence of minute particles of that salt floating in the air. From an experiment of De Gernez it appears that microscopic crystals of sodic sulphate may be obtained by passing air, even in the open country, through pure water, and evaporating the water on a glass plate. Jeannel, however, denies the necessity of contact with the salt actually contained in the solution. He finds, indeed, that a supersaturated solution of sodic acetate may be made to crystallise by contact with any solid substance (a piece of paper for example), and a solution of sodic tartrate by contact with a clean, dry, glass rod." Here, then, we have also a veritable "germ" controversy. I was informed, however, a few weeks ago by Prof. Frankland that even in the case of sodic sulphate it had lately been shown that, *under certain conditions*, crystallisation can certainly take place where no crystalline germ could possibly have existed. The "germ" theory of the origin of crystals in supersaturated solution, has, therefore, been overthrown. This has been possible, however, only because it has been more easy to show that a given set of conditions are inimical to the existence of a crystal, than it has yet been to induce people to believe that any given set of conditions are incompatible with the existence of living matter.

It is worthy of remark, however, that the germ controversy concerning crystals can only be settled in the minds of those who are content to accept the high probability that the properties of any *invisible* portions of crystalline matter would correspond with the properties which similar visible crystalline matter is known to display. It is this reluctance to admit an equally high probability in the case of living matter, which alone causes the sister controversy to continue. Otherwise the question would have been settled long ago.

1 The analogy between the supposed possible origins of crystals and organisms in solutions has been rendered much more obvious since the discovery by the late Professor Graham, that when dissolved the saline substance does not remain as such in solution, but that the acid and the base exist separately, and are separable by a process of dialysis. When crystallisation takes place, therefore, we have a combination of materials taking place similar to, though simpler than, what may be presumed to take place in the genesis of a Living thing.

The question is one of much interest, and it may therefore well be asked why such a totally different verdict should have been given in two cases, the analogy of which is so remarkable. The reason is, however, not difficult to find. Mere theoretical considerations have been all-powerful in influencing the verdict, and in inducing those who are informed upon the subject to read the evidence in different ways. Living things manifest such complex properties that the whole notion of Life has been shrouded in mystery. Biologists at first could not bring themselves to believe—some cannot do so now—that the phenomena which living things manifest are absolutely dependent upon the properties of the variously organised matter entering into their composition. They were obliged to have recourse to some metaphysical entity—some “anima,” “archæus,” or “vital principle”—under whose directing influence the living form was supposed to be built up, and upon whose persisting influence many of the phenomena of Life were supposed to depend. The aid of no similar metaphysical “principle” has, however, been deemed necessary in order to account for crystalline structures and properties. It was in the main conceded by most physicists, and the doctrine remained unquestioned by biologists, that matter of certain kinds might, by virtue of its own inherent properties, aided by certain favouring circumstances—and quite independently of all pre-existing germs—fall into such modes of collocation as to give rise to crystals. But, owing to the influence of the theoretical considerations already mentioned concerning the nature of Life, a similar possibility could not easily be granted in reference to the origin of Living things. Was it not held that the living thing owed its structure or organisation to the active influence of a special and peculiar principle? This “vital principle” was neither ordinary matter nor ordinary force, neither was it in any way derivable from either of these; how then could it be supposed that the coming together of matter of any kind could give rise to a living thing? The aggregate of properties, which we designate by the word “Life,” were not supposed to be dependent upon, to be, in fact, properties of the material aggregate which constituted the Living thing. Life was presumed to be due to the manifestations of a something altogether peculiar—of a “vital principle,” which was inseparable from living matter. Doctrines akin to these having been already proclaimed and disseminated by the influential teachings of Paracelsus, Van Helmont, and others, it cannot be a matter for surprise that the brilliant demonstrations of Redi should have had a great influence in their time. Observation after observation appeared now to confirm the existence of a seemingly universal mode of origin of Living things—a mode too which was more in harmony with the philosophical views of the day than that which had hitherto been deemed possible. Doubts, however, soon sprang up. New means of observation opened up new questions for solution. And what has been the result? Many battles have been fought, many victories have been won, and now the biological doctrines of the day have assumed an entirely new form. The ever-increasing strides of Science have wrought the most fundamental changes in our notions concerning Life. Under the influence of the well-established doctrine concerning Persistence of Force—and more especially since the clear recognition of the subordinate doctrine as to the Correlation existing between the Physical and Vital forces—physiologists have now begun to recognise, and most unhesitatingly to express the opinion, that the phenomena manifested by living things are to be ascribed simply to the properties of the matter as it exists in such living things. No one has expressed himself more decidedly on this subject than Prof. Huxley himself, and he may fairly be taken as an exponent of the modern doctrines on this question. He says:†—“Carbon, hydrogen, oxygen, and nitrogen are all lifeless bodies. Of these, carbon and oxygen unite in certain proportions and under certain conditions to give rise to carbonic acid; hydrogen and oxygen produce water; nitrogen and hydrogen give rise to ammonia. These new compounds, like the elementary bodies of which they are composed, are lifeless. But when they are brought together under certain conditions they give rise to the still more complex body, protoplasm; and this protoplasm exhibits the phenomena of life. I see no break in this series of steps in molecular complication, and I am unable to understand why the language, which is applicable to any one term of the series, may not be used to any of the others. We think fit to call different kinds of matter carbon, oxygen, hydrogen, and

* Buffon, it is true, as Professor Huxley has pointed out, did make an attempt to reconcile two incompatible theories.

† *Fortnightly Review*, Feb. 1869.

nitrogen; and to speak of the various powers and activities of these substances as the properties of the matter of which they are composed. . . . Is the case in any way changed when carbonic acid water and ammonia disappear, and in their place, under the influence of pre-existing protoplasm, an equivalent weight of the matter of Life makes its appearance? . . . What justification is there then for the assumption of the existence in the Living matter of a something which has no representative or correlative in the not-living matter which gave rise to it?”

For Professor Huxley, then, and for all who hold similar opinions on this subject, the constitution and properties of living things are so far comparable with the constitution and properties of crystals, that both, in each case, are alike supposed to be the products of the combination of ordinary matter of different kinds. And, as might have been expected, nearly all the biologists and physicists who hold these opinions, are now inclined to admit their belief in the possibility of the origination of living matter free from the influence, and independently, of all pre-existing living matter. They are quite content to admit that Redi's doctrine may be wrong. Prof. Huxley, indeed, in his recent address, desires us to understand that this is an opinion to which he still adheres; he says:—“I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call ‘vital,’ may not some day be artificially brought together.”

Having reached this stage, having got rid of the supposed necessity for the intervention of a special “vital principle” before living matter can come into existence,* I think it will be seen by all how very important it has become to look into the truth of Redi's doctrine, which has found its best modern expression in the phrase *omne vivum ex vivo*, seeing that that doctrine was born and nourished under the influence of the old, and now well-nigh effete, metaphysical notions concerning Life. Certainly, now that this theoretical barrier has been removed, we ought to inquire more carefully than ever whether there is still a sufficient warrant for the different verdicts which have been given in answer to the questions as to whether crystals on the one hand, or living things on the other, do or do not originate *de novo* in this particular stage of the Earth's history.

Now, at all events, theory inclines no more to the one side than it does to the other; it is quite possible to reconcile this with either view.

Seeing, therefore, that we may now act without fear as impartial judges, let us inquire into the nature of the evidence which alone can be relied upon for the solution of these two questions.

If living things are to come into being *de novo*, they could, or, at all events, are only supposed to originate from the rearrangement of matter which previously existed in a state of solution. And although it is known to be possible for certain kinds of pre-existing solid matter to assume a crystalline form, we will, for the present, confine our attention to the origin of crystals in an apparently homogeneous fluid. Each of these material forms, therefore, would have to commence as a smallest conceivable speck, and each would grow, though differently, by the formation of matter of like kind, under influences generally similar to those which were influential in bringing about the primordial collocation. These primordial collocations, however, are hidden from our view, and will, perhaps for ever, remain so. As a matter of observation, all that we actually know concerning the origin of crystals or of certain living things in solutions is this. In previously homogeneous solutions of crystallisable matter, or in certain apparently homogeneous colloidal solutions, we may, under certain conditions, see the minutest crystals† or living things, respectively, make their appearance. In both cases these are, at first, mere motionless specks, whose *minimum visible* stage may be less than $\frac{1}{1000000}$ th of an inch in diameter. It must either be presumed, in the case of such embryo living things (as most people do presume in the case of crystals), that these, even then, and however minute, represent stages in the growth of later material collocations which had been initiated under the combined influence of existing matter and “conditions” at a point far beyond the reach of our most aided vision; or, on the other hand, it is equally

* It may perhaps be as well to state here that I have not much expectation of influencing those whose belief in the existence of a special “vital principle” remains still unshaken.

† The appearance of the crystals is best watched in the viscid solutions described by Mr. Rainey; since the rapidity of the process is thereby very much diminished, and the forms themselves are also more akin to those of living things. See his work *On the Modes of Formation of the Shell of Animals*, &c., 1858, p. 9.

open for us to suppose that such minutest visible living things had proceeded from the growth of pre-existing germs which were themselves invisible.

This being, as I conceive, the real state of the case, and Professor Huxley being in the position of a person, admitting* that a crystal can be produced *de novo*, admitting also the possibility that a living thing may so arise, but denying that there is any evidence worthy of serious consideration to show that a living thing can at the present time originate *de novo*, let us see on what evidence he has come to this conclusion, and what other evidence he has practically ignored.

In the first place, he does not attempt to deny—he does not even allude to the fact—that *Living things may and do arise as minutest visible specks, in solutions in which, but a few hours before, no such specks were to be seen.* And this is in itself a very remarkable omission. The statement must be true or false, and if true, as I and others affirm, the question, which Professor Huxley has set himself to discuss, is no longer one of such a simple nature as he represents it to be. It is henceforth settled, so far as *visible* germs are concerned, that living things *can* come into being without them. It can now, at all events, be said that *some* Living things do not come from *visible* germs. Who, therefore, in the face of this fact will say that the doctrine *omne vivum ex vivo* remains unshaken? Perhaps, however, this particular case where an exception to the rule is possible, was not known to Professor Huxley. I wish I could bring myself to believe that this was really the case. Certain it is that had he recognised the existence of this apparent exception to the general rule he would then have had to discuss a much more difficult question, and he would have been compelled seriously to inquire into the value of experiments whose existence he has now almost ignored. Again then I affirm that multitudes of minute living things may and do gradually appear in fluids, beneath the microscope, where no *visible* germs previously existed. Here the hypothesis: that *every* living thing proceeds from a pre-existing living thing may break down, and those who wish to establish the continuity of this rule are bound to discuss the nature of the existing evidence which is in favour of the notion of the living things in question originating from pre-existing *invisible* germs, as against the opposite possibility of their having originated *de novo*. The burden of proof rests as much on the one side as it rests on the other. We cannot safely continue to affirm a rule until the cases in which it seems doubtful have been thoroughly discussed. Analogy is often but a treacherous guide.

And, when we come to the discussion of this hypothesis as to the origin of living things from germs which are *invisible*, all alike are rendered, to a certain extent, helpless. No one, then, can come forward, as Redi is said to have done, "strong with the sense of demonstrable fact," and any one who wishes or calls upon his opponent to demonstrate the truth of his views, when the question is one concerning the presence or absence of *invisible* germs, shows himself to be ignorant as to how the matter in dispute can alone be settled. The subject is one in which direct demonstration must give place to reasoning, although experiment and observation may and must be brought forward in support of this. Let those, however, who wish to proclaim the universality of the rule *omne vivum ex vivo*, recollect that, if they expect to influence reasonable people who are themselves competent to form an opinion on the subject, they are bound to consider the *possible* exception to which their attention is directed, and to weigh the evidence for and against the origin of these minutest visible living specks from germs which are supposed to exist, but which are *invisible*.

The reason, indeed, which seems to induce most people to believe that living things cannot arise *de novo*, is because in 999 cases out of a thousand which come under their actual notice, there cannot be a question that a living thing originates from a pre-existing living thing. A rule, which is of such apparently universal application, they say, is most likely to be the rule which applies to any doubtful case. Much is made out of this argument, which is, of course, a very valid one so far as it goes. But, on the other hand, knowing, as I have pointed out, that *any living things which arise, de novo, from non-living matter, must appear in solutions as minutest visible specks*, it need not be a matter of much surprise that this mode of generation is one which is unfamiliar to the world at large. Have we not seen, indeed, that the most accomplished biologist, provided with the very best

microscope hitherto made, though he gets down to a *minimum visible* stage of less than $\frac{1}{100000}$ " in diameter is just as powerless in face of the hypothesis of *invisible* germs as those who worked with the rude microscopes which alone were in vogue two centuries ago? And, more especially is this consideration one which presses for earnest attention, when we further consider that some of the minute living things which first appear as tiniest specks in homogeneous solutions grow into *Bacteria*, and that concerning the real origin of these, *in such cases*, we are as ignorant as we were concerning the real origin of crystals, when they appeared in previously homogeneous solutions. The probability that these latter have originated *de novo* has, of late years, had to be established by a process of reasoning similar to what we are obliged to have recourse to, if we wish to throw light on the question of the origin of these specks of Living matter. *Bacteria* grow, and after a time aggregations of them may be converted under our very eyes into *Fungus*-spores* capable of throwing out a filaments and of developing into perfect plants. Nobody pretends to know, however, how, or whether, the *Bacteria* which make their appearance in a homogeneous solution have originated from invisible *Fungus*-emanations: all that we know is, that in suitable solutions, appearing homogeneous to high microscopic powers, in the course of a very short time, a multitude of perfectly motionless specks appear, in situations where previously no specks had existed. Being motionless and diffused their number cannot be accounted for by any supposed rapidity of multiplication—the only possible explanations seem to be, either that the specks have originated from as many pre-existing germs which were invisible, or else that they have proceeded from material colloccations, which have been initiated in the fluid itself by virtue of the molecular properties of the substances in solution, and the physical forces or sum total of "conditions," acting thereupon.

And this is really the question which has to be considered. When it is supposed that Living things do appear independently of pre-existing living matter, in certain solutions nothing more than this is supposed to have taken place. New Living matter is presumed to have appeared—independently of germs—in the solutions within these flasks, and to have made *its* appearance as living matter may, in certain other fluids, under our very eyes, in the form of minutest visible specks, which have been exposed to great and long-continued heat in hermetically sealed masses. And similarly such specks, are the only forms of Living matter which are supposed to be capable of arising *de novo*. Once formed, it is true, one of these living specks may develop into a *Bacterium*, and this may develop into a *Vibrio* or a *Leptothrix* filament, whilst another of the living specks may develop at once into a *Fungus*-spore.† It should be clearly understood, however, that *all the Living things which are supposed to arise out of non-living materials, are presumed to appear in fluids, and gradually to emerge from the region of the invisible into that of the visible*; at which latter point they, for us, constitute specks less than $\frac{1}{100000}$ " in diameter.

Making no statements whatever upon this subject, however, in support of the doctrine which he considers to remain unshaken, let us see what line of argument Professor Huxley has taken, in order to establish the validity of this belief to the members of the British Association for the Advancement of Science.

The "long chain of evidence" which he considers sufficient to allow us still to place faith in the rule *omne vivum ex vivo*, seems to me, to be, in reality, utterly inadequate for this purpose, and incapable of affecting the real question at issue. Nothing that has been said bears at all upon the problem as to whether it is possible that the minute living specks to which I have referred do or do not originate *de novo*, though, as I have already said, it is these, and such as these only, which are presumed to originate after this fashion. If he had really wished to influence those who are conversant with the subject, it would have been absolutely imperative for Prof. Huxley to have entered fully into the consideration of a subject which I will presently mention, but to which he makes only the most casual allusion. All the facts which he has brought forward—all the references to the investigations of Spallanzani, Schultze and Schwann, Cagniard de la Tour, Helmholtz, Schröder and Deutsch, Tyndall and Pasteur—are simply contributions to the "Atmospheric Germ Theory," tending to show that there are germs of living things in the air, and that the living things found in *some* solutions may have been developed therefrom. But although differing

* I suppose this may fairly enough be presumed even in the absence of any specific statement as to his belief on the subject. This is, however, an assumption on my part.

† See NATURE, No. 35, p. 173, Fig. 3.
See NATURE, No. 37, pp. 221, 223.

from him in my interpretation of the results of some of these investigations,* I am quite content to accept the conclusion which is alone derivable from this long chain of evidence. I am even prepared to grant to Professor Huxley, for the sake of argument, that *Bacteria* may be "suspended in the atmosphere in myriads." The evidence thus referred to, if true in all respects, would have been very valuable if it had been brought against the doctrine that none of the minute living things of infusions derived their origin from atmospheric germs, though it may and does fall utterly powerless before the doctrine which is alone urged, that *some* of the Living things met with in infusions appear to be produced independently of pre-existing living matter. If it could be proved that the air contained five hundred times as many germs as can now be shown to exist therein, this discovery would still be quite compatible with the truth of the other doctrine that under the influence of certain conditions some Living things, appearing as minutest visible specks, do arise *de novo* in solutions.

Whether such an occurrence can or cannot now take place is a question which is not at all dependent upon the prevalence or paucity of germs in the atmosphere. I may also remind Prof. Huxley of a fact which he seems to have forgotten, and that is, that the atmosphere is not the only source of germs. These may be present in the water or in the materials dissolved therein. Seeing, therefore, that in certain experiments which constitute the corner-stones of his edifice of proof, and which are brought forward, I suppose, as being capable of influencing our judgment upon this great question, the materials which were dissolved and the water employed were merely boiled for fifteen minutes, we must look upon this as an admission by Prof. Huxley that in his opinion the exposure of the solution for such a time to a temperature of 100° C. was an adequate precaution to ensure the destruction of all pre-existing living things that may have been contained therein. This is a most important admission—tacit though it be—in the face of other evidence which can be mentioned, and if Prof. Huxley does not really believe this, how is it possible for us to understand what either his argument or science gains from the citation of the following experiments?

Having boiled portions of "Pasteur's solution" for fifteen minutes, in three separate flasks, he placed in the neck of one of them, whilst ebullition was continuing, a large plug of cotton wool, left another with the mouth of the flask open, whilst into the third, when cool, he placed some *Bacteria* taken from a solution of hay. "In a couple of days of ordinary warm weather," he says, "the contents of this [latter] flask will be milky from the enormous multiplication of *Bacteria*. The other flask open and exposed to the air will, sooner or later, become milky with *Bacteria*, and patches of mould may appear in it; while the liquid in the flask, the neck of which is plugged with cotton wool, will remain clear for an indefinite time." And then Prof. Huxley adds:—"I have sought in vain for any explanation of these facts, except the obvious one, that the air contains germs competent to give rise to *Bacteria*," and similar to those with which one of the solutions was purposely inoculated. Now, with reference to these statements, the possibility at once suggests itself, that had a different solution been used in the case where the neck of the flask was plugged with cotton-wool a very different result might have been obtained. In order to throw light upon this subject I have performed the following experiments:—

Immediately after reading Prof. Huxley's address, I procured a piece of cooked meat, made an effusion of the same, and after filtration put it into a flask. It was then boiled for fifteen minutes, after a large plug of cotton wool, 1½" in length, had been pushed into its neck. After this time the plug was rendered tighter by pushing in more wool. Another flask was prepared in

* Neither time nor space will permit of my mentioning these various points on which I am inclined to differ from him. When Prof. Huxley says, however, after a tragical metaphor, "It must be admitted that the experiments and arguments of Spallanzani furnish a complete and a crushing reply to those of Needham," I will only say that I cannot agree with him, and will remind him that, in this case at least, he is not supported by Pasteur, whose logic is so invincible. Pasteur says (*Ann. de Chim. et de Phys.*, 1861, p. 9):—"Un examen impartial des observations contradictoires de Spallanzani et de Needham sur le point le plus délicat du sujet, va nous montrer en effet, contrairement à l'opinion généralement admise que Needham ne pouvait en toute justice abandonner sa doctrine en présence des travaux de Spallanzani."

I would also call Prof. Huxley's attention, as an impartial historian, to some communications made by M. Victor Meunier to the French Academy (*Comp. Rend.*, 1865), from which he will see with reference to the vessels with bent necks, that it is possible to perform these experiments with an "entire success" of a different kind from that to which he alludes. Others besides myself have also performed such experiments with results similar to those of M. Meunier. Much seems to depend upon the nature of the solution employed.

a similar way, only in this, a strong filtered infusion made from undressed meat was placed. At the expiration of the fourth day (Monday morning, Sept. 17th) the weaker solution, still quite clear, was opened, and on microscopical examination of two or three drops of the fluid a multitude of minute motionless particles of various sizes were seen, others in active movement, and two or three *Bacteria* about $\frac{1}{8000}$ " in diameter. The flask containing the stronger solution was opened at the expiration of forty-two hours. The fluid still appeared quite clear, and on microscopical examination of a few drops of the fluid many tolerably active *Bacteria* were found varying between $\frac{1}{10000}$ "— $\frac{1}{1000}$ " in length, besides a multitude of particles, some moving and others motionless.

These results seem to me what might have been expected after what I have made known concerning putrefaction *in vacuo*. It could scarcely be expected that mere filtration of air should be able to prevent putrefaction when it has been already shown that this will take place in the absence of air.

What conclusion, then, is now deducible from Prof. Huxley's three comparative experiments? Certainly nothing that has any value for the support of his argument.

[A strong point made by Prof. Huxley is the supposed fact that the possibility of preserving meat is a fatal reply to the experiments of myself and others. I shall show next week, that the actual facts strengthen my point of view, and that "perfectly good" cases of meat which I have examined have contained *Bacteria* and *Leptothrix* filaments.]

H. CHARLTON BASTIAN

LETTERS TO THE EDITOR

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English Physiology

THE present state of physiology in this country ought to be a matter of regret. Though foremost in many things, Britain is far behind Continental countries in the field of physiological science. We can boast of a few distinguished physiologists, as John Hunter, Sir Charles Bell, and Dr. John Reid; and famous microscopists, as Carpenter and Beale; but a very small number of English names can be cited compared with the host of Continental physiologists, past and present, as Magendie, Müller, Von Bebold, Von Baer, Béclard, Bernard, Brown-Sequard, Du Bois Reymond, Helmholtz, &c. This discrepancy arises not from want of talent, but from lack of opportunity. The mental qualities required by a physiologist, as observation and memory, are developed separately at different periods of life. Hence there are only a limited number of years during which any such branch of learning can be cultivated with fresh ardour, and during which the power termed originality can be brought into play. The Continental schools make use of these precious years by affording those who are naturally inclined to cultivate any one branch of science, full scope for repeating the observations of their predecessors, and for endeavouring to add to the existing stock of knowledge. By having various laboratories and certain paid appointments connected with their universities, they allow young men to devote their whole time and energy to the study of individual subjects, as physiology. Those who set themselves to work of this kind do not look forward to the practice of the medical profession, but purpose to live and work as physiologists. These young men are known by their labours to be specialists, and are proposed by the senatus with which they are connected for a vacant professorship when it occurs. This is the only method of securing original and extensive work in any one scientific branch, as Physiology. It would be well, therefore, if the approaching Royal Commission of Inquiry into the State of Science in this country would not overlook Physiology, but would make some arrangements whereby Great Britain might no longer be stigmatised by her Continental neighbours as "having no Physiologist."

Dr. Stricker, in the two articles he has already communicated to NATURE on "The Medical Schools of England and Germany," has not referred to the Edinburgh University, which possesses the best furnished Physiological Laboratory to be found in Great Britain, and one equal to most of those met with in Germany. The plan recently introduced into this Scottish University of having salaried assistants to the professors re-