truths as the first and greatest aim of science, we may, perhaps, take next some of Francis Bacon's more practical ideas about the objects and aims of science; to increase man's sovereignty over Nature, to compel Nature to be subservient to his will, and to minister to his wants; to restore his lost sovereignty over Creation. And, indeed, when the new truths are discovered, they are soon applied to practical purposes, and to furthering the material good of mankind; but to study science with this object alone is usually pernicious, and always to be avoided.

Some of you will ask me the more direct use of science. I fear I cannot tell you much about this; I would rather refer you to some of the enthusiastic—I hope not exaggerated—articles which have appeared from time to time during the last few years in various journals and magazines. It is directly useful for the purpose of science scholarships at the Universities, which are much on the increase; also it forms a part of the examinations at Woolwich, and for the Civil Service. Scientific appointments are year by year becoming more numerous in this country and in India. Indirectly, science is useful to every one. I say I cannot tell you much about its direct and practical uses, because I believe that the main use of it is to cultivate a certain set of mental faculties, to induce a certain mode of thought. The modes, and tones, and phases of mental action are as diverse as the modes of bodily action, and just as we exercise one set of muscles by rowing, another by riding, and a third by walking, so do we exercise a certain set of faculties when we study classics, another set when we study mathematics, and a third when we study sciences. The cultivation of this habit of thought engenders among other things a habit of observation and a spirit of inquiry. Questions suggest themselves daily, for an answer to which we must apply to science. Why do winds blow and storms rage? What are day and night, summer and winter, sunshine and frost? Of certain common things we rarely think, or if we do we assign the simplest meaning to them. For how many centuries did not mankind believe the world to be flat, the sun to be a globe of fire quenched nightly in the western sea, the sky to be solid, and the stars set into it like gems! Savages still believe that the firmament is a solid dome, and the sun and moon living creatures who walk across it.

The third of our four divisions concerns the methods we shall follow in our study of the sciences discussed above. Firstly:—lectures. It is essential that you should see the various changes wrought upon or within matter; not alone hear about them or read of them. You must not only observe, but you must think of the experimental results; understand them; understand the means by which they are brought about. It will be well for you to take notes, roughly at first, to be copied out afterward, and extended from memory. It is a mistake to take very full notes during a lecture. They may become an almost verbatim report of the lecture; the spirit of the matter is lost because the mind is fixed upon a detail. Experiments also are often lost; and at the end a mass of writing remains, but no knowledge of the work done. It is preferable to write down headings of subjects; the pith and marrow of the subject matter only;—in a word, to make merely an outline of the picture, and to fill in the details afterwards from memory. Sketches of apparatus are always desired among the notes, also any general remarks, and queries. At the end of each lecture you will be questioned, and at the commencement of each lecture the matter of the preceding lecture will be recapitulated; at this time also your own queries will be answered. It is important that you should not allow any subject to be partially understood, or misunderstood. Make a note of any difficulty, and let it be cleared up at the commencement of the next lecture, or at some intermediate time. The misunderstanding of one important fact may render the right understanding of succeeding matter nearly impossible. Then, later in the half, I should like you to read in text-books about the subject of your lectures, and thus to supplement the lecture-work by book-work. The advantage of this will be very apparent when you are examined.

What we desire is that science shall grow up side by side with your other subjects of study, and enter into your daily life. It is thus only that it can possess any real vitality. And if any subject of study possesses not vitality—intense, active, exuberant vitality—it languishes, becomes unhealthy, weak, and ultimately useless. It resembles a tree which loses first one branch, then another, and then dies entirely. And when upon the tree of knowledge a new branch is grafted, we desire to see it growing up side by side with the great branches already there. Our school knowledge—the knowledge which in its entirety ful-

fills the conditions of that comprehensive word *culture*—must be one and undivided; hence a new subject can only flourish when it is woven completely into our school life, when it ceases to be regarded as a something extraneous and beyond the pale. I hope none of you are like the doctors of Salamanca when they were confronted with Columbus, or like the cardinals who passed judgment upon Jordano Bruno and Galileo.

I must add one word in conclusion as to the attitude of mind most conducive to a right study of natural science. In the first place it is necessary to free the mind from previous ideas and conjectures, and to neglect the evidence of the senses unsupported by extraneous means; thus the earth seems to be flat, and the sun to be a glowing disc which moves around it, yet research has proved that our senses here deceive us. Again, how difficult it is to realise the fact that two sounds may produce silence, two lights darkness, until it is experimentally proved that such is the case. It is hard to believe that the force which manifests itself by attracting light bodies when amber is rubbed, is identical with lightning, yet such has been proved to be the fact. We must clear our minds from preconceived opinions before we can profit much by the teachings of science.

Do not be discouraged by the apparent difficulty of science at starting; all things newly presented to the mind require the exercise of some effort before they can be grasped. If the current of our thoughts is to be diverted into a new channel, it must needs require some time to change it from its old course. Comfort yourselves with the knowledge that at the outset you know more true natural science than did Aristotle and all the great philosophers of antiquity. The very science which you learn almost as soon as you know the alphabet, the fundamental ideas about the earth, the sun, the moon, the air, places you at starting ahead, in the matter of science, of the flower of Middle Age erudition: Professors of the Sorbonne, Doctors of Salamanca, Monsignori of the Sacred College. If, at first, the path of science seems to wind uphill all the way, remember that when the toil is over the view from the summit is very glorious. The sun rises upon a new land infinitely vast, infinitely fertile; full of streams by the side of which you may wander, and see all nature reflected in their pure depths.

Above all things, I would ask you to study science reverently. Many of our studies concern the works of man, here we are dealing with the works of God, governed directly by His laws. Surely then it behoves us to bow our heads as we enter the portal of Nature, to be possessed of infinite humility, to assume no prying spirit of curiosity, to have no intellectual pride. Some of you no doubt remember Rembrandt's picture of the "Anatomic Lesson," and the calm, reverent, inquiring look of the students who surround the dead man; a sort of awe in the presence of the wonderful mechanism of the microcosm Man, as we must have awe in the presence of the macrocosm Nature. A something almost akin to the *deisedaimonia* of the Ancients; a reverential fear of that which is obscure, and but partly manifest. I know not whether the smaller and more obscure works of God do not convey this even more than those which are immeasurably greater. S. Augustine says, "*Deus est magnus in magnis, maximus autem in minimis.*" We are scarcely more awed by the myriad stars and suns and systems around us than by the myriad atoms of which the smallest mass of matter consists, and which possess functions, attributes, actions, as definite in character, as varied in form, and as absolutely governed by immutable laws, as the members of systems comprising a million worlds, ten million miles away.

ZOOLOGICAL RESULTS OF THE 1870 DREDGING EXPEDITION OF THE YACHT "NORNA" OFF THE COAST OF SPAIN AND PORTUGAL*

AT the last meeting of this Association, held at Liverpool, I exhibited as one of the trophies of the *Norna* Expedition a new silicious sponge, to which I gave the name of *Pheronema Grayi*, or "the Portuguese Bird's-Nest Sponge;" and on this occasion the following is a brief synopsis of other leading novelties and more general results of the dredging cruise. A few preliminary remarks on the origin and object of the expedition may preface this synopsis—

* Communicated to the Biological Section of the British Association, Edinburgh, August 8, 1871.

To Mr. Marshall Hall, F.G.S., &c., who personally superintended the expedition, are due the thanks of the scientific world for having so generously devoted his yacht *Norna* to the purpose of scientific discovery. This gentleman had early in the year conceived the project of rendering science that service it is to be regretted so few owners of yachts are disposed to contribute; and to him I feel myself under the deepest obligations for the opportunities afforded me during this cruise of acquiring that practical information so keenly appreciated by every working naturalist. Nor must I forget here to associate with his the name of Mr. Henry Lee, F.L.S., the worthy president of the Croydon Microscopical Society, as one of the chief instigators of the scheme, and the person to whom I am especially indebted for my introduction to Mr. Marshall Hall, as one likely to make the most of the opportunities that would be afforded.

Having accepted the last-named gentleman's kind invitation to accompany him as naturalist in a small way to the expedition, it was decided I should memorialise the Council of the Royal Society for a grant to defray the heavier expenses of dredging and collecting apparatus. My application was most favourably received, thanks to the numerous kind scientific friends who supported it, and a sum of 50*l.* was immediately placed at our disposal for the purpose required. My indebtedness to the Royal Society for this liberal assistance has already been acknowledged, though I cannot permit so fit an occasion as the present to pass without once more endorsing it.

By the middle of May everything was prepared, the Trustees of the British Museum, on the especial recommendation of Professor Owen and Mr. Waterhouse, extending me an extra three weeks' leave of absence. The companionship and services of Mr. Edward Fielding were also fortunately secured, whose earlier dredging experiences with Mr. M'Andrew in the Red Sea seemed calculated, as they afterwards proved, to be of the most valuable assistance. Our time being limited, the west coast of Spain and Portugal was decided upon as a locality likely to yield us the most satisfactory zoological results, and on the recommendation of Mr. Henry Woodward we resolved first to proceed to Vigo Bay, where, in company with his lamented brother, Dr. S. P. Woodward, and Mr. M'Andrew, he had in the year 1856 obtained such abundant and valuable material. From thence it was proposed we should work our way down to Lisbon, our particular ambition being to reach the deep-sea fishing ground off Setubal, some twenty miles further south, from whence Prof. du Bocage, the talented conservator of the Lisbon Museum, had obtained specimens of the "Glass Rope Sponge" (*Hyalonema*), and numerous other novel treasures. On starting, we touched and remained a couple of days at Guernsey, and at that spot a few hours spent in shore-collecting rewarded us with the earliest substantial fruits of the expedition; seven more days brought us to Vigo, the point which constituted the first basis of our practical dredging operations.

A detailed list of the numerous species collected throughout the cruise being in course of preparation for the more technical and exhaustive report to be presented to the Royal Society, I here propose, commencing at the lowest animal group, to briefly enumerate some of the more important forms taken, adding such remarks on the characters or connecting circumstances which render them more especially deserving of attention. Of all, the subkingdom of the Protozoa has perhaps furnished us with the most abundant and valuable material, the sponge class in particular contributing many novelties. Before leaving British waters even, the few hours spent in shore-collecting at Guernsey, already alluded to, resulted in the accession of three new species of the genera *Isodictya* and *Hymeniacidon*, which I have placed at the disposal of my kind friend Dr. Bowerbank to be described by him in his supplementary volume of the "British Spongiadae," now closely approaching completion. The moderate depths within the Laminarian and Coralline zones, from the shore line down to fifty fathoms, at which we collected and dredged in Vigo Bay, and afterwards further south in the neighbourhood of Setubal and the Sado river, proved remarkably productive of species belonging to the same group, as also to that of the Calcareous or calcareous spiculed sponges including *Sycon* and *Grantia*, &c. The most interesting of any, however, were the species belonging to the Hexactinellidae, or hexaradiate spiculed sponges, of which the beautiful *Euplectella* and *Hyalonema* form familiar examples. Nine species belonging to this group were obtained at a depth varying from 400 to 800 fathoms off Cape Espichel and Cezimbra, including *Hyalonema*, *Dactylocaelyx*, *Aphrocalistes Bocagii*, *Lanuginella pupa*, and four other species new to science, three out of which necessarily constitute the types of new genera, the residue

again furnishing data enabling us better to appreciate the characters and distinctions of those previously made known to us. The form belonging to the same group, and described by myself as *Pheronema Grayi*, and exhibited at the last meeting of this Association, is the most conspicuous among all these on account of its size, and I would here add a few more words in reference to this particular type. Since last year I have been afforded the opportunity of examining and comparing my own with numerous specimens of Prof. Wyville Thomson's *Holtenia Carpenteri* taken in the North Sea and also in the Atlantic, and from an evolutionist's point of view, this examination has led me to regard my specimens as holding rather the rank of a well-marked local variety than of a distinct species as I at first premised. A comparison of the specimens, now placed side by side in the British Museum collection, will, I think, suffice to prove to all those interested in this subject how strongly marked as varieties these two forms are. Meanwhile, the generic name of *Pheronema* adopted by myself I still retain, as I consider both Prof. Wyville Thomson's form and my own to be local varieties of another species first described by Dr. Leidy of Philadelphia as *Pheronema anna*, and a letter recently received from Dr. Leidy himself more fully convinces me of this, though he has not yet bestowed on it the minute microscopical investigation of its structure needed for the effectual clearing up of this, at present, doubtful point.

In my description of other sponges belonging to this same Hexactinellate group, read before the Royal Microscopical Society, and published in their "Transactions" for November 1870, I have, in creating a new genus and species, *Askonema setubalense*, erroneously associated Prof. Thomson's name with it as having once pronounced the form to be of vegetable and not animal organisation. The mistake arose from the misconception of a name singularly similar in euphony as pronounced to me by Prof. du Bocage, and I here avail myself of the opportunity of rendering Prof. Wyville Thomson that *amende honorable* I feel myself in duty bound to accord to him.

Passing next to the class of the Foraminifera, our gatherings have been remarkably rich both from the coralline and abyssal zones, the latter furnishing us with numerous arenaceous types (*Rhabdomina*, &c.), and the former being notably abundant in species and varieties of *Lagena* and *Cristellaria*. Many of these forms are new to science and await description, and I must not forget to acknowledge here my indebtedness to Mr. Henry Lee for the very great assistance he has rendered me in his skilful preparation of the various gatherings of these minute organisms. To Mr. Henry Hailes also my best thanks are due for similar services.

The Coelenterate sub-kingdom has likewise furnished several new and rare forms, including among the latter category an example of *Hyalopathes pyramidalis*, M. Edw., one of the Antipathidiæ now represented for the first time in our national collection, if not in this country. In the Alcyonarian group, *Veritillum cynomorium*, first taken sparingly in Vigo Bay, and afterwards abundantly in the Laminarian zone near Setubal, excited our warmest admiration.

Nothing can exceed the beauty of the elegant opaline polypes of this zoophyte when fully expanded, and clustered like flowers on their orange-coloured stalk; a beauty, however, almost equalled by night when, on the slightest irritation, the whole colony glows from one extremity to the other with undulating waves of pale green phosphoric light. A large bucketful of these Alcyonaria was experimentally stirred up one dark evening, and the brilliant luminosity evolved produced a spectacle too brilliant for words to describe. The supporting stem appeared always to be the chief seat of these phosphorescent properties, and from thence the scintillations travelled onwards to the bodies of the polypes themselves. Some of the specimens of this magnificent zoophyte measured as much as ten inches from the proximal to the distal extremity of the supporting stalk, while the individual polypes, when fully exerted, protruded upwards of an inch-and-a-half from this inflated stalk, and measured as much as an inch in the diameter of their expanded tentacular discs.

Numerous polyzoa were also dredged up from the various depths, many of which remain yet to be identified; but the allied group of the Tunicata has perhaps furnished by far the most interesting material of the whole molluscoïdan sub-kingdom; surface-skimmings one morning near the mouth of the Sado river having rewarded us with numerous specimens of an *Appendicularia*, which, from notes and sketches made at the time of their capture, I have since found to have presented phenomena seemingly not yet observed by any other naturalist. Hitherto these organisms have been presumed to constitute a distinct genus of

Tunicata *inter se*, or otherwise to be the larval conditions of higher forms. My own observations, however, recorded in the last July number of the "Quarterly Journal of Microscopical Science," have led me to believe that they are the free swimming reproductive Zooids of higher Tunicates, bearing the same relation to them as many free swimming *Medusa* do to some stationary hydroid colony. At the greater depth of 600 and 800 fathoms, various species of *Terebratulæ* were taken as representative of the class Brachiopoda.

Ascending yet higher to the subkingdom of the Mollusca, a large variety of interesting species rewarded our researches. Included among these were—*Fusus contrarius*, a common fossil of the Norfolk crag recently discovered in the living state in Vigo Bay by Mr. M'Andrew, and dredged by us in the same locality; also a species of *Cassia*, remarkable from its being more closely allied to *C. Saburon* and other species inhabiting the Japanese and Chinese seas than to any of its Mediterranean or Atlantic congeners. This circumstance of its affinity is the more remarkable when associated with the occurrence of a species of *Hyalonema* (*H. lusitanica*) off the same coast, likewise scarcely distinguishable from the more familiar Japanese form *H. Sieboldi*.

The Annelida and Crustacea have also furnished a fair quota of new and interesting species, to be reverted to hereafter; and neither taking a step further onwards to the higher vertebrate sub-kingdom has good fortune entirely deserted us. Availing ourselves, through the kind assistance of Prof. du Bocage, of the aid of the native fishermen and their appliances, we secured examples of several rare species of the deep-sea ground-sharks frequenting the Portuguese coast line; and among others a fine specimen of *Pseudotriakis micradon*, a species recently discovered and described by Prof. du Bocage and his gifted collaborateur, Felix de Brito Capello.

Generalising from the whole amount of material collected during our cruise off the Iberian coast, our plunder may be separated into two very distinct groups. One of these, including that collected from the shore line down to a depth of 100 fathoms, presenting an interblending of Mediterranean species with those prevalent on our own more temperate coasts. Among these former I may more especially mention the occurrence of *Dendrophyllia ramea*, a well-known Mediterranean branching coral in great luxuriance at the mouth of the river Sado, this being, I think, the first record of this coral being taken so far north, and also from the same locality *Calappa granulata*, *Maia verrucosa*, *Murex trunculus* and *brandaris*, *Cestum veneris*, *Veritillum cynomorium*, and numerous other species belonging to the various Invertebrate divisions usually regarded as confined to the same more southern area. The residue and far smaller assemblage of species embraces those derived from the abyssal depths of from 400 to 800 fathoms, and all these, including many forms new to science, are characterised by their boreal or cold area facies, and in this respect contribute further evidence in support of the deductions arrived at by Dr. Carpenter, from his own more extended researches into the fauna of these same great depths in connection with the important expeditions of the *Porcupine* and *Lightning*, and with which his name and those of his indefatigable colleagues, Prof. Wyville Thomson and Mr. Gwyn Jeffreys, are so worthily connected.

In conclusion, it is my sincere hope that the rich reward attending our own humble efforts may stimulate other yacht owners to follow the example of my esteemed friend, Mr. Marshall Hall, influencing them likewise to devote their craft for one or a portion of a season to the cause of science, and to the exploration of those new deep-sea fields of discovery, now waiting to yield up the richest treasures to each earnest worker. Such men will find themselves more than compensated for the sacrifice of time or other interests by the fascinating nature of the work they undertake, in addition to earning for themselves the lasting gratitude of the scientific world.

Our well-appointed and expensively-fitted-out Government expeditions should explore the remoter depths; but British pluck and private enterprise should esteem it their especial privilege to unfold to us the yet hidden mysteries of the ocean world nearer home; and if, again, all shall not succeed in discovering new phases of animal life, there is much and even more important work to be effected in ascertaining accurately the bathymetrical range and geographical limits and distribution of those forms already known to us.

W. SAVILLE KENT

PROF. BASTIAN ON THE GERM THEORY*

EPIDEMIC and acute diseases have many characters in common; they constitute a family the members of which are united by a certain bond of unity, though at the same time they are in other respects strikingly different from one another. The "general" character of the symptoms originally gave rise to the notion that these affections were in the main dependent upon changes in the nature and quality of the blood. This view is still the one most commonly entertained, and which seems most likely to be true. And seeing that particular sets of symptoms recur with as much definiteness as individual differences of constitution will permit, we have a right to believe that the changes in the blood—however induced and of whatsoever nature they may be—are definite and peculiar for each of these diseases. The successive changes in the blood which are the immediate causes of the phenomena of small-pox, must be quite different from those giving rise to the morbid state known as typhoid-fever. Variable as these several groups of symptoms are amongst themselves in individual cases, yet is there a general resemblance which suffices to maintain the distinctive nature of each affection. In this broad sense they are undoubtedly entitled to rank as "specific" diseases. They may be presumed to be associated with definite changes in the blood, though we have not a right to infer that such changes of state can only be induced in one way. Many well-known chemical changes are capable of being brought about by more than one agency. And just as there is the best reason for believing that cancer or tubercle may be initiated *de novo* by the operation of irritants upon the tissues of certain individuals, and that such growths may subsequently be multiplied within the body by the contact-influence exerted by some of their disseminated particles; so may we suppose, not only that specific substances (contagia) may be capable of initiating specific changes in the blood, but that certain combinations of circumstances may by their action upon the human body entail similar definite changes and states of blood. Having to do with a perverted nutritive activity and mode of growth in a limited area of tissue, cancer or tubercle may make their appearance; whilst, having an altered nutritive activity and set of changes occurring in the blood, this all-pervading tissue may lapse into the successive states peculiar to one or other of the specific diseases, and so give rise to the symptoms by which they are characterised. This is by no means a forced analogy. Can cancer or tubercle arise in the individual without any pre-existing "hereditary taint"? Can the states of blood peculiar to the several specific diseases arise *de novo*, or independently of contagion? These are questions whose import is really similar.†

One of the great and distinguishing peculiarities of these specific diseases is their "contagiousness." Although very differently marked in the several affections, this property is as interesting as it is important. The fact of its existence seems always to have had a large share in determining the nature of the general views which have been held concerning these affections. Even in remote periods, by Hippocrates and others, they were commonly compared to processes of fermentation; whilst since the time of Linnæus, more especially, attention has been often prominently directed to the many apparent similarities existing between the commencement and spread of epidemic diseases, and the "flight, settlement, and propagation of the insect-swarms which inflict blight upon vegetable life."‡ These

* Extracts from Introductory Lecture on Epidemic and Specific Contagious Diseases: Considerations as to their Nature and Mode of Origin. Delivered at University College, October 2, by H. Charlton Bastian, M.A., M.D., F.R.S.

† This double mode of causation is perfectly familiar to the chemist. Particular chemical changes may occur under the influence of certain general determining conditions, which at other times (in the absence of these conditions) may be even more easily initiated by a single specific cause. The introduction of a crystalline fragment into a saline solution, and its determination of the crystallisation of all the isomorphous salts contained in the solution, seems to be exactly comparable with the "contagious" origin of diseases. But, under the influence of certain favouring conditions, crystallisation may occur without the contact of a crystalline fragment—the process may be "spontaneous" in the same sense that the occurrence of the blood-change may be "spontaneous."

‡ Sir H. Holland's "Medical Notes and Reflections," 2nd edition, 1849, p. 584. On the following page, the same author writes:—"Connected with these facts is the observation, seemingly well attested, that the cholera sometimes spreads in face of a prevailing wind, and where no obvious human communication is present—a circumstance difficult, if indeed possible, to be explained, without recourse to animal life as the cause of the phenomenon. No mere inorganic matter could be so transferred, nor is vegetable life better provided with means for overcoming this obstacle." Whilst on the preceding page, the "animal species" had been admitted to be "minute, beyond the reach of all sense."