great extent of vacation as an evil. With the vacation shortened it would be easily possible to bring these young men into active life at least a year earlier than is now possible, and that would be an immense gain.

From the professors' point of view the circumstances are very different. To few professors is the vacation time wholly a period of vacation. On the contrary, it is a time which he can utilize for study, for research and for the increase of all his mental equipment upon which his proficiency as a professor depends. Moreover there is often work upon examination papers or upon a committee of one kind or another, which the professor must carry on during the vacations while his students are idling. For the professor the vacation is certainly a great advantage and I think from the standpoint of university service it is an essential factor in maintaining his efficiency. If therefore the vacations are shortened, it seems to me that every university should provide additional liberty for its professors. The tendency has hitherto been rather to demand too much teaching from professors, but if they teach too much they cannot be qualified to teach in the best manner and with the greatest efficacy, because every professor, to remain efficient, must have time for study; he must advance, he must grow intellectually, and from mere teaching he can never grow.

A consideration of the circumstances therefore suggests these two thoughts: first, that for the benefit of the students the amount of vacation at our universities should be diminished; secondly, that if this is done, then, to preserve the efficiency of the professors, the amount of free time accorded them during term should be increased.

Charles S. Minot.

Harvard Medical School, March 5, 1902.

## *THE INTELLECTUAL CONDITIONS FOR THE SCIENCE OF EMBRYOLOGY.*

### I.

Much has been written, from time to time, about the conditions which must be fulfilled by a scientific account of the generation and regeneration of living things out of eggs, although little has been said about the intellectual conditions. We may, nevertheless, find the study of these conditions both interesting and instructive.

Our chief interest in embryology is the hope for a scientific account of ourselves; but we cannot undertake to account for anything unless we know what it is that we undertake to account for.

My purpose is not to give a scientific account of mind, nor to discount the future progress of science. I do not believe we are likely to know anything about the natural history of mind except what we find out by scientific discovery; nor do I believe we are ever likely to have a complete scientific account of anything, or to reach a point where no new discoveries are needed.

My purpose is a more humble one: to do what I can to keep the way clear for progress in embryology, by trying to free my own mind, and the minds of others, from all notions which imply that embryological science is impossible.

#### PART I. THE DOCTRINE OF THE CHASM.

The notion which, for reasons which will soon be made clear, I have called the doctrine of the chasm, is dry and difficult and unattractive, and as my only aim is to find a way for the embryologist across the chasms which are said to lie in his path, I have made no attempt to stimulate the interest of the reader, confining myself to the briefest outline which will serve my purpose, even if this outline be more arid than the works in which the doctrine of the chasm is defended.

1. *Among the things of which he hopes to, some day, give an account, the embryologist must include men who think and act.*

Of all the facts that are made known by experiments upon the generation and regeneration of living things, the one we are least likely to doubt is the existence of the experimenter. We may question the value of his results, but we are not likely to doubt that he did, or tried to do, or thought that he did, the things he describes.

The experimental embryologist comes out of an egg, and he must himself be included among the facts of development which are the object of the observations and experiments and reflections by which he seeks to account for the production of living things out of eggs.

Since some of the things that come out of eggs observe, and reflect, and try experiments, the production of living things out of eggs cannot be adequately explained, or accounted for, unless the production out of eggs of things that observe and reflect and try experiments is also explained or accounted for. To make good its claims to our favorable consideration, embryological science must undertake to account, in good time, for minds, in exactly the same sense of the word as that in which it undertakes to account for bodies and brains.

2. *The intellectual powers by the aid of which we make scientific discoveries come out of eggs.*

Honesty, and independence, and accuracy, and determination, and good sense, are essential to sound progress in scientific discovery. The investigator who is no biologist may take his own honesty, and independence, and accuracy, and determination, and good sense, for granted, as ultimate facts that do not need to be accounted for. But honest men, and accurate men, and independent men, and resolute men, and men with good judgment, all come out of eggs, and the embryologist cannot forget that they are among the natural phenomena of which he hopes to, some day, give a scientific account.

The final and decisive test of any explanation of the generation of living things out of eggs is the account which it gives of the origin and significance of our ability to observe and reflect and try experiments; for no scientific discovery is worthy of confidence, unless our intellectual means for finding out things are sound and trustworthy. Thus, the progress of embryological science must bring us around, sooner or later, by a new path, to the old question: What is science? What is it to know a thing? It may be that we shall find, from this new point of view, something in knowledge that has been neglected, or too little considered, and we may thus be helped to better notions.

3. *No embryologist can, knowingly, hold any opinion which excludes the possibility of embryological science.*

Each student of science must devote himself to some small part of the realm of nature in order to make progress. We study simple phenomena in the hope that we may pass, in time, to those that are more complex and difficult. If astronomers, and chemists, and students of physics, and embryologists, and zoologists, see fit to temporarily lay aside the natural history of mind, as a problem which does not, for the time, interest them, nor seem to concern them, or as something that is too hard for them, no one can doubt their wisdom. But if their methods and results lead them, or seem to lead them, to the conclusion that what has thus been temporarily laid on the shelf can never be taken down from the shelf, is it not clear that there has been a mistake somewhere? Any method of embryological research which leads to the conclusion that there is a 'chasm' which is 'intellectually impass-

able,' between the facts of embryology and the facts of consciousness, is self-condemned, because it denies the possibility of a science of embryology. Any method of embryological research which leads to the conclusion that the phenomena of consciousness are not phenomena at all, but 'epiphenomena,' and the mere empty and meaningless accompaniment, or by-product, of phenomena, is self-condemned; because the phenomena of knowledge—of embryology, and of everything else—are phenomena of consciousness.

4. *Many eminent authorities tell us an embryological account of human minds is impossible.*

It is well known that many writers, who claim to speak of the meaning of modern science with authority, have been led to believe that the facts of consciousness can never be brought back into the system of science.

Thus, for example, Tyndall tells us: "The passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass by a process of reasoning from the one phenomenon to the other. They appear together, but we do not know why. Were our minds and senses so expanded, strengthened and illuminated, as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electrical discharges if such there be; and were we intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem, How are these physical processes connected with the facts of consciousness? The chasm between the two classes of phenomena would still remain intellectually impassable."

If for *brain* we put *egg which gives rise to a brain,* this statement must mean one of two things: Either there is a chasm, which is intellectually impassable, between the facts of embryology and the facts of consciousness; or else there are two sets of embryological facts—physical and psychical—separated by the impassable chasm; and, therefore, two equally independent and distinct sciences of embryology. Tyndall cannot admit that the facts of physics may have their being in a knowing mind, for, in this case, there would not be any chasm.

Professor James, who is also a believer in the chasm, tells us there is a 'link' or bridge, but as he also tells us 'we do not know, and most authorities believe we never shall know, and never can know,' what the link is, or where the bridge is, neither link nor bridge is of much practical use to embryologists.

According to the system of scientific philosophy which finds expression in these extracts, the embryologist may hope to pass from the physics of atoms and molecules and organic matter, to physical eggs and physical men; and, if there be any psychical atoms and molecules and compounds, he may hope to pass from them to psychical eggs and psychical men; but the chasm between the sort of eggs we know and the sort of men we know is intellectually impassable.

Herbert Spencer, who is held to be the philosophical spokesman of modern science, is also a believer in the chasm; and he tells us that mind is 'something without any kinship with other things; and from the sciences which discover, by introspection, the laws of this something there *is no passage* by transitional steps to the sciences which discover the laws of these other things.'

We may pass, by a process of reasoning, from a physical candle to a physical burn, and, if this system of philosophy is to be trusted, we might, if we knew a psychical candle, pass from it to a psychical pain, but we can never pass from a physical candle to a psychical pain by any intellectual process, nor know a burn hurts in the way we know a flame burns.

5. *The chasm is not an easy thing to understand.*

Many questions are too hard for us, for we are very ignorant, and we have only feeble and incomplete command of the scientific method of finding out things; but these familiar truths are not what Tyndall and Spencer have tried to express in the passages I have quoted. These passages are no humble confession of ignorance. They are very positive assertions that something—an intellectual grand canyon—is very definitely known. We are told that we know—know with certainty—that the method which is used in physical discovery is fundamentally and utterly inadequate for dealing with the relation between bodies and minds—utterly inadequate for dealing with the relation between eggs and the thinking men who come out of eggs. The grand canyon is not merely difficult. It is utterly impassable.

6. *We are told that there is a chasm, because I cannot know the minds of other men in the way I know my own mind.*

Among the reasons which are given for belief in the chasm, the simplest is my alleged inability to know the minds of other men in the way I know my own mind. But I can never know my own body in the way I know the bodies of other men. I can have no more immediate perception that there is in my head a sphenoid bone which has arisen, during my younger stages, through the union of a presphenoid, a basi-sphenoid, two ali-sphenoids, two orbito-sphenoids, and two pterygoids, than I can have immediate perception that there is in Timbuctoo a man with a mind as much like my mind as my body is like his body. My conviction that I have passed through embryonic stages like those described in the text-books is even more remotely inferential than my conviction that my own familiar friend has a mind like mine.

The chasm between my embryonic history and that of other human beings is utterly impassable, yet its impassability is practical and not intellectual. I find no more logical difficulty in believing that I could perceive the resemblance between my brain, or my embryonic history, and those of other men, if I were in the proper place at the right time with suitable means of observation, than I find in the belief that I could thus perceive the other side of the moon.

If there is a grand canyon, it must be of a different sort from the chasm between my body and those of other men, for this is not intellectual, but practical.

7. *There is a chasm, we are told, because I know my own mind by introspection.*

It is, unquestionably, through introspection that I know my own mind and this is the reason why we are told that there is an impassable chasm between mind, on the one side, and brains and all other material things, on the other.

A moment's reflection is enough to show that it is through introspection—through comparison of my sensations, and recollections, and expectations, and other mental facts, and through reflection upon them—that I find out anything. If I neither felt nor reflected, I should not know anything. It is through reflection upon my thoughts and feelings that I make scientific discoveries about my mind, and about the minds of other men, and about everything that I know. As I have only this one way to find out anything, it is hard to imagine

where the impassable chasm is, but what chiefly concerns us now is the wide diffusion of belief in its reality.

8. *The chasm is said to be between the things I may know, or might know, and something unknowable.*

The chasm cannot be between my mind and anything I know, or may know, or might know if I had the opportunity, because the things I know are in my mind, and I can never know anything except knowledge. So we are told that it is between things that are knowable and something that is not only unknown and unknowing, but unknowable.

Believers in the chasm do not all put it in the same place. Some declare that we know nothing but the molecular or electrical changes in our ganglion cells. Forgetting the existence of their own thoughts, or else dismissing them as mere 'epiphenomena,' without significance, they tell us that the chasm is between these physiological changes and the real world to which we try to refer them.

We have no immediate knowledge of our own brains, but we do know the thoughts that arise in our minds, and Tyndall tells us the chasm is not between the physiological changes in our brains and the facts of physics, but between thoughts and the physiological changes in our brains.

A third, and, on the whole, a more consistent notion, is that we know *impressions,* but can never know the thing impressing, nor the thing impressed, nor whether the thing impressing and the thing impressed are two different kinds of unknowables, or only two unknowables of the same kind. This is Spencer's opinion, as I understand it, and it is the opinion of many scientific men.

We know phenomena, or appearances, they tell us, but are altogether put off with appearances, and can never know either things or minds as they are in themselves. We know the eggs in our minds, and the hens in our minds, but as for knowing eggs as they are in themselves or hens as they are in themselves, that, we are told, is forever out of our reach on the other side of the chasm. We may know the human ovum in our minds and the thinking man in our minds, but the human ovum as it is in itself and the thinking man as he is in himself, are utterly unknowable.

When the fact that we know the hens in our minds is joined to the notion that our minds are in our heads, we reach the interesting, but startling, opinion, that the hens we know are the hens inside our heads. Efforts to escape this strange admission by the assertion that we know only the appearance, and not the reality, of hens in our heads, lead one to suspect that the intellectual chasm may not be a grand canyon after all, but only a common bog in which the wayfarer is the more completely mired by his own struggles.

He who believes he can never know anything as it really is, can never know whether what he thinks he believes or disbelieves is really what he thinks it is, rather than something quite different; so the question whether he can believe or disbelieve anything is not without interest, although we need not go into it now.

9. *The chasm is not between the things we know and the things that remain to be known.*

The embryologist is well aware that he cannot hope to find out all there is to learn about hens' eggs, or about his mind, or about anything else; but he attributes this truth to the boundless wealth of nature, and not to any inherent weakness in his methods. In this meaning of the words, he has no expectation, and no hope, that he will ever know a hen's egg as it really is; and if the chasm were only between the things he knows and the things he has not yet found out, he would frank-

ly and humbly admit its existence and its practical impassability. But it is said to be a chasm between things knowable and things utterly and absolutely unknowable, and not a chasm between the things that are known and the things that remain to be known.

The translator of Haeckel's 'Riddles of the Universe' tells us in his preface, that the chasm has been devised by the Roman Catholic theologians for their own evil ends, but it is not kind to lay upon the backs of these heavy-laden and weary creatures a burden which Tyndall and Spencer and others have shown themselves so eager to bear with jaunty dexterity.

It is true that the slow and heavy intellect of the embryologist cannot aspire to the subtile agility which some show in dodging chasms.

"And now," says the author of 'Father Tom and the Pope,' "I have to tell you ov a really onpleasant occurrence. If it was a Prodesan that was in it, I'd say that while the Pope's back was turned, Father Tom made free wid the two lips of Miss Eliza."

"It is kissing my housekeeper before my face you are, you villain?" says he. "Go down out of this," says he to Miss Eliza; "and do you be packing off wid you," says he to Father Tom, "for it's not safe, so it isn't, to have the likes of you in a house where there's temptation in your way."

"Is it me?" says his Riv'rence; "why what would your Holiness be at, at all? Sure I wasn't doing no such thing."

"Would you have me doubt the ividence ov my sinses?" says the Pope; "would you have me doubt the testhimony ov my eyes and ears?" says he.

"Indeed I would so," says his Riv'rence, "if they pretend to have informed your Holiness of any such foolishness."

"Why," says the Pope, "I'v seen you afther kissing Eliza as plain as I see the nose on your face; I heard the smack you gave her as plain as ever I heard thundher."

"And how do you know whether you see the nose on my face or not?" says his Riv'rence, "and how do you know whether what you thought was thundher, was thundher at all? Them operations on the sinses," says he, "comprises only particular corporal motions, connected wid sartain confused perciptions called sinsations, and isn't to be depended upon at all. If we were to follow them blind guides we might jist as well turn hereties at onc't. 'Pon my secret word, your Holiness, it's neither charitable nor orthodox to set up the testimony of your eyes and ears agin the characther ov a clergyman. And now see how aisy it is to explain all them phewnomena that perplexed you. I ris and went over beside the young woman because the skillit was boiling over, to help her to save the dhrop of liquor that was in it; and as for the noise you heard, my dear man, it was neither more nor less nor myself dhrawing the cork out of this blissed bottle."

"Don't offer to thrape that upon me!" says the Pope; "here's the cork in the bottle still, as tight as a wedge."

"I beg your pardon," says his Riv'rence, "that's not the cork at all," says he, "I dhrew the cork a good two minutes ago, and it's very purtily spitted on the end of this blessed cork-schrew at this prisint moment; howandiver you can't see it because it's only its real prisence that's in it. But that appearance that you call a cork," says he, "is nothing but the outward species and external qualities of the cortical nathur. Them's nothing but the accidents of the cork that you'r looking at and handling; but, as I tould you afore, the real cork's dhrew, and is here prisent on the end of this nate little

insthrument, and it was the noise I made in dhrawing it, and nothing else, that you mistook for the sound of the *pogue.*"

You know there was no conthravening what he said; and the Pope couldn't openly deny it. Howandiver he thried to pick a hole in it this way.

"Granting," says he, "that there is the differ you say betwixt the reality of the cork and these cortical accidents; and that it's quite possible, as you allidge, that the threw cork is really prisent on the end of the schrew, while the accidents keep the mouth of the bottle stopped—still," says he, "I can't onderstand, though willing to acquit you, how the dhrawing of the real cork, that's onpalpable and widout accidents, could produce the accident of that sinsible explosion I heard jist now."

"All I can say," says his Riv'rence, "is that it was a rale accident any how."

"Ay," says the Pope, "the kiss you gev Eliza, you mane."

"No," says his Riv'rence, "but the report I made."

"What makes you call the blessed quart an irrational quantity?" says the Pope.

"Because it's too much for one and too little for two," says his Riv'rence.

"Clear it of its coefficient, and we'll thry," says the Pope.

"Hand me over the exponent then," says his Riv'rence.

"What's that?" says the Pope.

"The schrew, to be sure," says his Riv'rence.

"What for?" says the Pope.

"To dhraw the cork," says his Riv'rence.

"Sure the cork's dhrew," says the Pope.

"But the sperets can't get out on account of the accidents that's stuck in the neck of the bottle," says his Riv'rence.

"Accident ought to be passable to sperit," says the Pope, "and that makes me suspect that the reality of the cork's in it afther all."

"That's a barony-masia," says his Riv'rence, "and I'm not bound to answer it. But the fact is, that it's the accidents of the sperits, too, that's in it, and the reality's passed out through the cortical species as you say; for, you may have observed, we've both been in real good sperits ever since the cork was dhrawn, and where else would the real sperits come from if they wouldn't come out of the bottle?"

"Well, then," says the Pope, "since we've got the reality, there's no use in throubling ourselves wid the accidents."

"Oh, begad," says his Riv'rence, "the accidents is very essential, too; for a man may be in the best of sperits, as far as his immaterial part goes, and yet need the accidents of good liquor to hunt the sinsible thirst out of him."

10. *The assertion that each thing has a mind of its own is irrelevant.*

One way of rescuing science from the dilemma of the chasm, which has the approval of many modern students, is to assert that every living thing, or every thing, has its own mind, and does what it does because it chooses; and that eggs and candles are, in fact, psychical eggs and psychical candles.

"Call an organism a machine if you will," says Professor Ward in his recently published Gifford Lectures, "but where is the mind that made it, and, I may add, that works it?" And he answers his question by the assertion (I., p. 294) that the mind that makes the living organism is inside it and identical with it, and that every living thing takes conscious and efficient part in its own production. The context shows that Ward believes it is as a conscious and voluntary agent, and not merely as a part of an intended system of nature, that the hen's egg is said to help to make itself into a chick. The mind that

is said to be 'inside it and identical with it' is an individual and particular mind, and not the *anima mundi,* nor the mind that presides over the universe. The notion that each thing has its own mind, or is a mind, has nothing in common with the opinion that it is in one sustaining mind that we and all things have being.

The notion that now concerns us reaches its logical culmination in Major Powell's assertion that "Every body, whether it be a stellar system or an atom of hydrogen, has consciousness as judgment and choice." If a hen's egg would describe to us the way in which it makes a chick, I should be delighted to listen and learn from it; but, until it does, embryologists must struggle along in the old-fashioned way.

If each thing has its own mind, and is identical with it, there is, of course, no chasm, because we are really studying psychology, when we think we are studying physics. But this way of escape from the chasm leads us into new difficulties, which are just as impassable as the chasm, and very much more practical.

Even if we admit that the hen's egg may have, or be identical with, a mind as good as a hen's mind, the hen's body is so fearfully and wonderfully made that the wisest man, whose mind is assuredly better than a hen's mind, is at present utterly incompetent to make, or even to understand, a hen. If it is by wisdom that hens are made, it must be by a higher wisdom than a hen's, for this cannot attain to such a work.

It is not by studying the consciousness of atoms and molecules, and material things, that we have found out how to make chemical compounds, and machinery and books; and if we are ever to find out how to make living eggs, one may safely predict that it will not be through the study of the judgment and choice of the eggs of sea-urchins and frogs and hens.

Haeckel, who declares that Berkeley, of all men, believed that 'one thing only exists, and that is my own mind,' also tells us of his own belief that "the two fundamental forms of substance, ponderable matter and the ether, are not dead and only moved by extrinsic forces, but they are endowed with sensation and will (though, naturally, of the lowest grade); they experience an inclination for condensation, a dislike of strain; they strive after the one, and struggle against the other." Only they know nothing about it, for Haeckel tells us: "I conceive the elementary psychic qualities of sensation and will which may be attributed to atoms, to be unconscious." Still, while they do not know it, "every shade of inclination, from complete indifference to the fiercest passion, is exemplified in the chemical relation of the various elements towards each other, just as we find in the psychology of man, and especially in the life of the sexes. This fundamental unity of affinity in the whole of nature, from the simplest chemical process to the most complicated love-story, was recognized by the great Greek scientist, Empedocles, in the fifth century B. C., in his theory of 'the love and hatred of the elements.' It receives empirical confirmation from the interesting progress of cellular psychology, the great significance of which we have only learned to appreciate in the last thirty years. On these phenomena we base our conviction that even the *atom* is not without a rudimentary form of sensation and will."

Words are democratic, and one is, intrinsically, as good as another. What common folks call *things,* may be called *minds,* or *abracadabra,* or *x,* by any one who so chooses, provided he know what he means, and make himself understood; but if he thinks that, by calling *things minds,* he can find out anything which would not be

within his reach if he called them *x*, he seems to me to be misled by words.

As an explanation of the generation of chicks from hens' eggs, the fantastic and pantheistic animism of the passages I have quoted is irrelevant and useless, and no student of Berkeley's works, whether his frame of mind be critical or responsive, can confuse it with the sublime conviction of this thinker that it is in one sustaining mind that we and all things have being.

12. *Belief in the chasm may be due to some error in the description of the way in which we find out things.*

There are no paradoxes nor contradictions in nature. When facts seem to contradict one another, better knowledge is continually showing that some mistake has been made. If physical science leads us, or seems to lead us, to the belief that the chasm between an egg and the thinking man who comes out of an egg is intellectually impassable, the embryologist must ask where the mistake is.

It is a hard thing to believe that, beneficial and good as science has shown itself to be, it can lead us into opinions which cannot be maintained and made consistent. Science is justified in her works, and I find it hard to believe that the paradox of the chasm can be due to the method in which discoveries are made, or that this method can involve us in contradictions, and lead to intellectual disaster.

On the other hand, it is not a hard thing to believe that there may be some error or omission in the account which successful scientific investigators give of their method. He who reflects upon the perplexities which come from the misuse of words will find it an easy thing to believe that an account of the way in which things are found out may be so imperfect that it is practically equivalent to error, leading those who try to find out things by following it into contradiction and absurdity. It may be that the philosophical spokesmen of science have been drawn into paradoxes and contradictions and doubt of the plainest things, because they have mistaken some crude and imperfect account of the way in which we find out things for the way in which we really do find out things. There may be, in knowing, something so familiar and obvious that it is commonly left out of the description of the process of knowing.

13. *We are told that we know things when we comprehend them, but knowledge may be comprehension and something more.*

The eloquent plea for science, as a guide to conduct, with which the author of a new 'Grammar of Science' begins his book, must strike a responsive chord in the mind of every student of nature.

"Apart," he says, "from the increased physical comfort, apart from the intellectual enjoyment which modern science provides for the community, there is another and more fundamental justification for the time and material spent in scientific work. From the standpoint of morality, we have to judge of each human activity by its outcome in conduct."

Something in my own mind vibrated in harmony with the author's words as I read; but, as he is soon led, by his definition of science as *the analysis and classification of facts,* to believe and to teach that our conduct is nothing but a *routine,* over which we have no real control, and for which we have no true responsibility, his premises seem to compel me to look at his book from the *standpoint of morality,* and to *judge of his intellectual activity by its outcome in conduct.*

I am puzzled, in my attempt to do this, by a moral question about the publication and sale of this book. My difficulty is this. The author's definition of science, as the analysis and classification of facts, leads

him to believe, and to teach, that "the universal validity of science depends upon the similarity of the perceptive and reasoning powers of normal civilized men." A writer on the meaning of science, whose name does not appear in our author's bibliography, showed, some two thousand years ago, that the sale of this opinion for money is not honest; for if the verdict of civilized men be the criterion of science, the way to find out what nature really is must be by ballot. This old writer therefore says that our author is disingenuous when he asks us to buy and read his book in the hope of learning something which he is not able to deliver to his customers, since he himself believes we can get it only through the verdict of civilized men. If the 'Grammar of Science,' is anything more than a ballot, I see no way to acquit its author of the charge of obtaining money under false pretenses.

Has not the merest savage a criterion of science which will bear him up though all men be against him? May he not appeal to nature in the same confidence that he will bring to his side all normal civilized men who do not wilfully turn away their eyes?

Herbert Spencer, who also tells us knowledge is the analysis and comprehension of facts, tells us, furthermore, that this is one of the proofs that we can never know anything as it really is, because the thing as it really is is separated, by an impassable chasm, from the appearance which is all we can know.

"For if the successive deeper interpretations of nature which constitute advancing knowledge are merely the inclusion of special truths in general truths, and of general truths in truths still more general, it obviously follows that the most general truth, not admitting of inclusion in any other, does not admit of interpretation. Of necessity, therefore, explanation must eventually bring us down to the inexplicable. The deepest truth we can get at must be unaccountable. Comprehension must become something else than comprehension, before the ultimate fact can be comprehended."

We undoubtedly comprehend a thing when we know it, but it does not follow that we know a thing when we comprehend it. The conclusion does not follow from the premises. Knowledge may be comprehension and something more, and the assertion that comprehension is knowledge, as well as all the books of synthetic philosophy that are built upon this assertion, may, perhaps, turn out to be nothing more than a new illustration of the fallacy of the undistributed middle.

14. *Knowledge must be something more than comprehension, because the known world grows with knowing.*

Here I must stop, for the present, leaving for some future occasion the attempt to find out, in the interest of embryological science, whether this account of knowing is, or is not, complete. But, before I end, I ask you to take away with you, and to consider, this familiar truth: Each scientific discovery shows us new and unsuspected wonders in nature. The unexplained things which are brought to our knowledge by each scientific explanation far outnumber the things it explains. The progress of knowledge is no mere comprehension, or gathering in. It is more like sowing seed than gathering a harvest, for the known world grows with knowing.

We are told that "when every fact, every past or present phenomenon of the universe, every phase of present or past life therein, has been examined, classified, and coordinated with the rest, then the mission of science will be complete." But if we are to judge the future by the past, classification and coordination will always continue to show us more unclassified and uncoor-

dinated things than they classify and coordinate.

May it not be because of the inexhaustible bounty of nature, and not because comprehension is knowledge, that we can never know anything as it really is?

Each new encyclopedia is bigger than the one before, and so, no doubt, it will be to the end. If knowledge were nothing more than comprehension, or the analysis and classification of facts, the progress of science should be bringing us nearer to universal knowledge, but each new discovery puts it farther from our grasp than before, and they who know most are most convinced of its unattainableness, not because the reality of things is unknowable, but because of the innumerable multitude of things knowable.

W. K. Brooks.

Johns Hopkins University.

## *THIRD ANNUAL MEETING OF THE BOTANISTS OF THE CENTRAL STATES.**

FIRST SESSION, HULL BOTANICAL LABORATORY, ROOM 13, TUESDAY, 9 A.M.

The meeting was called to order by C. R. Barnes. About seventy botanists were present. J. M. Coulter was elected chairman and Albert Schneider secretary. After a few preliminary remarks the chairman called for the reading of scientific papers, which were presented as follows:

Charles F. Millspaugh: 'The Clothing of an Islet.' (No abstract furnished.) Illustrated by lantern slides.

George H. Shull: 'Variations in Several Species of *Aster*.' Counts were made of bracts, rays and disk florets in *Aster Shortii* Hook., *A. Novæ-Angliæ* L., *A. puniceus* L., and *A. prenanthoides* Mühl. The result of these counts gave but a single instance of a maximum falling on a member of the Fibonacci-series, 3, 5, 8, 13, 21, etc., the rays of *Aster Shortii* presenting a strong mode on 13; a general result giving but slight confirmation of Ludwig's results on various other Compositæ. The counting of the parts of heads collected on September 27, 30, October 4 and 8, from a single small plot of *Aster prenanthoides*, and comprising collectively all the heads produced in one season, showed, alike in bracts, rays and disk florets, a constant fall in the mean number and a corresponding shifting of the modes from the beginning to the end of the flowering season. This fact must be taken into account in the determination of place modes. There is a close correlation between the number of rays and the number of bracts, due to the fact that the rays are axillary to the inner bracts. In the four species studied the degree of imbrication of the bracts, and also the difference in form and size between the outer and inner bracts of the head are proportional to the number of bracts which bear no rays in their axils. A complete account of these studies will appear in the *American Naturalist* for February, 1902.

Edwin B. Copeland: 'The Influence of Metallic Poisons on Respiration.' Experiments with *Elodea, Callitriche,* a crucifer, fish and frog larvæ, using as stimulants copper, zinc, cadmium, silver and mercury, agree in showing that the respiration may be stimulated by a small fraction of a fatal concentration. With increasing concentration the acceleration of $CO_2$-evolution is greater, sometimes reaching above 25 times the normal. Evolution of $CO_2$ continues undiminished after plasmolysis is suspended by the poison. Copper and zinc cause the evolution of considerable $CO_2$ from boiled *Elodea*.

Frederick C. Newcombe: 'The Sensory Area of the Roots of Land Plants.' In the roots of land plants, sensitiveness to exter-

* Held in connection with the meeting of the American Society of Naturalists, at the University of Chicago, December 31, 1901, to January 2, 1902.