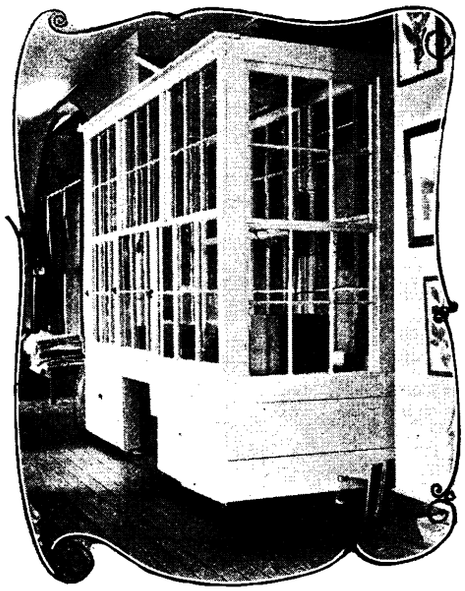
in their proper genus or species, the parts being generally too fragmentary for using ordinary methods of determination.

Many drugs are received, the physical appearance of which alone is not a safe criterion for verification; barks, leaves, stems, and roots often arrive in a crushed and broken condition, which renders it very hard to tell whether or not they are what they purport to be. In such cases the appeal is to the microscope, and here an outfit for histological work has its use. Sections are prepared; the cell-structure and arrangement of tissues almost unerringly reveal the identity of the material. A set of slides of the officinal parts of plants has been commenced and will form a valuable part of the laboratory's equipment.

In the examination of powdered drugs, the compound microscope is indispensable; crystals, starch granules, and fragments of cells often betray adulterations at a small outlay of labor. In addition to the use of the microscope in drug inspection, it is a necessity in investigation along the line of pharmaceutical botany.

Interesting and practical results are expected from the cultivation of medicinal plants in the propagating case. Medicinal plants are grown from the seed with the purpose of learning more about their life history; seeds of adulterants are germinated



PROPAGATING CASE.

in hope of ascertaining the origin of the adulteration, and other work of similar nature, relating to pharmacy, is in progress.

Correspondence relating to botanical origin of drugs and plants, which arises in connection with business, is attended to by the botanist in charge, and in this work the laboratory is of much service.

Daily practical demonstrations are seen of the use of a botanical laboratory in connection with the trade. As an aid in the examination of drugs alone the laboratory finds its existence justified. As a means for investigation, it has great value, and through such means alone can some things, very important to the trade, be worked out.

The discoveries and determinations of adulterations of jalap, cubebs, Arnica flowers, Calendula flowers, and many other important drugs was only possible because botanists worked upon them; it cannot be said to have been otherwise, as pharmacists who have made these discoveries have had botanical training, used botanical methods, and succeeded in so far as they were good botanists.

The laboratory referred to in this article was founded primarily to provide accurate and scientific means for determining plant products used in manufacture; the acquisition of an herbarium which includes representatives of families and genera not medicinal, the provision for plant culture, histology, and microscopy is in recognition of the fact that botany in a broad sense has a direct and practical bearing on pharmacy.

ON THE EMERGENCE OF A SHAM BIOLOGY IN AMERICA.

BY CONWAY MACMILLAN, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

THOSE whose attention, during the past fifteen or twenty years, has been directed towards the various phenomena attendant upon the establishment and modification of university *curricula* will scarcely have failed to notice, in certain quarters, an interesting eructation of courses in biology. Upon even a casual examination these courses, in almost every case, turn out not to be courses in biology at all, but courses in zoölogy masquerading under an attractive but deceptive name. Chairs of biology occupied by men practically ignorant of one-half of the content of the science they profess to teach are not unknown in institutions otherwise altogether reputable. This ignorance of theirs is not merely the normal failure to push beyond the beach-line of the great unknown ocean of truth, but is a failure to comprehend or admit that the ocean extends away equally in both of two directions rather than in one alone. When one remembers how intolerant are most men of liberal education when they discern through the thin veil of pretence the deformity which it tries to hide, it seems remarkable that more vigorous protests have not already arisen against the sham biologist and the sham biology. It is because the writer believes that opportunities for a development of the true biology are lost, sometimes, through the mistaken acceptance of the sham, that he ventures upon the unpleasant task of pointing out what, after careful examination, seem to him the places where the healing cautery should be applied.

First of all, it is important to note what should be the proper limitation of the term "biology." Historically and etymologically it is still to be defined as by Lamarck and Treviranus — both distinguished botanists — who invented it. It is indeed the science of living things; it is that vast mass of knowledge bearing upon the organized world of plants and animals. Biological science is therefore to be set over against physical science in the broadest sense, and is to be considered as a generic name, under which are grouped the specific sciences of botany, zoölogy, and doubtless also psychology, if that is to be considered as co ordinate with zoölogy rather than as one of its subdivisions. Here, then, is the proper definition: "Biology is the science of living things." These are the two groups of subject matter: Plants and animals.

In Germany, and sparingly elsewhere in Europe, a limited and secondary meaning is imparted to the word "biology." Of this use an excellent example is furnished by Wiesner,[1] who groups together the various phenomena of inter-relation between plant and environment under the name of *Pflanzenbiologie*. To this restricted use of the term, Strasburger[2] very properly objects, characterizing it as "fälschlich bezeichnet." This employment of the term, as if it were synonymous with Œcology, does not, however, seem to be prevalent in America, where is to be found the third and most misleading use of the word — as generally exclusive of botany and sometimes also of zoölogy. For example, at Columbia College their exist together departments of botany and biology,[3] and, upon examination of the courses offered in "biology," it appears that they are almost purely courses in animal biology, and indeed this modified term is quietly brought forward in a foot-note. At Columbia College, then, it is apparent that the subject of botany, since it stands by itself under its own organization, is supposed, at least by the "biologists" of that institution, to be quite without the pale of their own science. And a further examination of the circular shows that the biological work is in the hands of zoölogists, both the professor-in-charge and the adjunct-professor being known to the scientific world only through zoölogical research and not through botanical.

The department of biology, then, at Columbia College seems to the writer to have false colors flying at the mast-head.

It is concerning the false use of the word "biology" in some American institutions that I wish particularly to speak. I have

[1] Biologie der Pflanzen, Wien (1889).
[2] Bau und Verrichtungen der Leitungsbahnen, vorwort viii., Jena (1891).
[3] Columbia College Circular of Information, Pt. iv., pp 44-45 (1892-93).

not at present time to discuss the fundamental absurdity of courses in "general biology"—as if it were possible to plunge boldly into comparative study of plants and animals before one has studied plants and animals themselves. It is as if one should enter upon analytical statics and follow it up by geometry and the calculus. The peculiar badness, upon the botanical side, of all so-called text-books of general biology is sufficient to emphasize the point — at least upon the minds of botanists. It is, indeed, impossible to write anything of value upon any subject in which one is not somewhat of a specialist, and the inability of zoölogists to say something worth reading upon the anatomy of *Pteris*, for instance, is not at all to their discredit, but merely marks them as of common flesh with the rest of mankind.

Harvard University is probably the innocent cause of the biology heresy which of late years has spread over the country. With that openness of vision and clearness and accuracy that has from early days characterized what, in biological lines, must be universally recognized as the first institution in America and one of the first in the world, there has not yet appeared any trace — that I am aware of — of the false or sham biology. The two sister-sciences of zoölogy and botany, each splendidly equipped both in the matter of laboratories and libraries, and men, have there developed side by side, as have physics and chemistry in most of the American universities. Botanical science, especially, with its millions of capitalization, has found a congenial home at Harvard. And precisely here seems to have been the difficulty. The endowment, the gardens, the laboratories, the museums, the libraries, the men were not to be easily had by any new institution that might spring up. And yet if the new institution were to be ambitious, it could not willingly see itself in a confessedly subordinate position. How then, without the lavish expenditure of wealth, was the dilemma to be faced?

One finds in the register of a well-known Maryland university[1] a confession of the truth concerning botany, where it is stated, "a third permissible line of specialization commencing at this stage, namely, botany, has always been contemplated since the organization of the biological department, but as yet is not available because of lack of money." While frank confession is held to be good for the soul, it is not certain that higher moral value would not have attached to an honest naming of the zoölogical courses that *were* provided for.

This acknowledged inability of Johns Hopkins University to provide a well-balanced course in biological sciences, together with the unwillingness of that institution to expose her weakness has led to much of the sham biology work that springs up from time to time over the country. The so-called department of biology there is manned by zoölogists, and the men who graduate — many of them honestly enough mistaken — are ready to take upon themselves not the name that belongs to them but that of "biologist." An interesting example of the large views of biological science which may develop in the Johns Hopkins doctor of philosophy lately came under my notice and has some illustrative value. A certain "biologist," some time since, published a pamphlet supposed to convey information concerning biological instruction in America. I do not know what the zoölogists thought of it, but it received a very chilling reception at the hands of the botanists.[2] On account of the particularly shabby treatment accorded the botanical work of the University of Minnesota, I took occasion to administer a mild rebuke to the author of the pamphlet. In reply I was assured that, while he had studied at Johns Hopkins University, he had learned that botany was of value "for teaching children." The cool effrontery of this would have surprised me had I not known the marvellous, sometimes continuous, sometimes sporadic, always insular capabilities of the Johns Hopkins biologist for blatant philistinism in regard to things botanical.

Were it not for the injustice worked upon young men attracted by such wrecker-light use of the word "biology," and, hopelessly injured in their conceptions of what they suppose to be their specialty, it would be far from my thought or wish to draw attention to any weakness in an American university. All know that the struggle for existence has its meaning even for the universities as for other organisms But protective mimicry in a university curriculum is not a pleasing phenomenon. In this particular case too much is at stake, both for the botanist and for the zoölogist, to make science the virtue that it generally is. In days of sharp specialization, such as those in which we live, it must be a source of regret and alarm to well-balanced zoölogists to see so many of those who might be ornaments to their profession led astray by a will o' the wisp chase after the unattainable. Better far to be a respectable zoölogist than a biologist with only one cerebral hemisphere. And the botanists, too, seeing what delusions may gain currency, are dismayed at the spectacle of some distinguished zoölogist perpetrating a confidence-game upon a board of trustees, assuring them that he proposes the establishment of a biological department, and then appearing with little more than mere zoölogy. The most alarming thing of all, both to zoölogist and to botanist, is that, after successfully establishing a school or department of zoölogy under the false name of biology, it should be possible for the mental vision of the founders to become so curiously warped that they will insist with vigor and with all the air of a righteous enthusiasm that the school or department actually *is* biological and that instruction really *is* given in biology. For, to the zoölogist, this must indicate one of two things, either that his *confrere* is unable to comprehend what biology is, or that he is ambitious, in regular old-style, eighteenth-century regardlessness, to announce himself a polymath, and therefore, perforce, a smatterer. And, to the botanist, it indicates the willingness of the "biologist" to make use of means that cannot with self-respect be duplicated by himself in the pushing forward of one line of biological science at the expense of the other.

Fortunately, in America the sham biology has as yet an uncertain foot-hold. At such institutions as Harvard, Pennsylvania, Cornell, Michigan, Minnesota, Leland Stanford, it has no standing. The only critical point which need be particularly considered at present is the new Chicago University. Here one sees again the anomaly of an able animal morphologist announced in the *Programs* as a professor of biology, and one's suspicions are aroused that the same sad blunder is to be made in the west which has already disfigured the biological work of at least one eastern institution of learning. In the announcement of biological work,[3] one finds an exceedingly fair presentation of the illogical character of a "school of biology," and the promise is made that in a few years the school will probably be broken up into several departments. The definition of biology is offered, and one finds it unimpeachable. Apparently, however, there is even here a danger, for, when one turns a page or two, it appears from the classification that botany is held to be co-ordinate with neurology or animal physiology, rather than with zoölogy in the broadest sense. This error in classification is perhaps an inadvertency and perhaps a natural enough one-sided grouping, such as might perhaps be expected of some specialist in a botanical line if he were to try his hand at the organization of a school of biology with zoölogy "not yet provided for."

It is probable that, after all, the better way to develop well-balanced departments in biology is to place the task in the hands of both botanists and zoölogists rather than in the hands of either. There will then be scarcely so much danger of narrowness of view impeding the freest and best evolution. At any rate, this is the plan which has succeeded so brilliantly at Harvard University, and the other plan is the one that has failed so grievously at Johns Hopkins University. It will be a matter of regret if Chicago is really willing long to preserve the present unfortunate attitude, for it must be confessed that the instruction now offered there under the name of Biology is, after all, the half-science, the sham biology.

I make the point that, for educational purposes, "biology" is either a superficial smattering of natural-history facts and methods — and in this case not of any value — or a strong, uniform presentation of the facts both of botany and of zoölogy — and in this

[1] Johns Hopkins University Register, 1891-92, p. 113.

[2] Botanical Gazette, editorial, vol. xvii., p. 260.

[3] Programme of Courses in Biology, University of Chicago (1892-93).

case a very different thing from a sham biology which is principally, or all, zoölogy.

THE AURORA.

BY W. A. ASHE, F.R.A.S. (RETIRED), QUEBEC, CANADA.

SOME notes resulting from a study of the Aurora extending over many years, and pointing out how some of the better known theories fail to account for known conditions of the phenomena, may interest the readers of *Science*.

I regret, that after having endeavored to show how the present theories fail, that I have no theory of my own to advance. I have done a good deal of theorizing on different subjects, at intervals in a somewhat busy life, so that there are few who have a better opportunity of knowing how deceptive evidence is which is *sought for* to support a theory; in other words, how faulty—yet how plausible—the result, when the observed facts are (unconsciously) made to fit the theory, instead of the theory the facts. Argument with such a theorist is futile. To use Professor Swift's words, in *Science* of Dec. 9, " . . . auroræ frequently occur when no spots are visible on the sun, . . . sun-spots are often seen when auroral exhibitions . . . are entirely absent, . . . the advocates of the theory . . . answer to the former, that sun-spots *may* have been on the *other* side of the sun, and, to the latter objection, that there *may* have been auroræ visible in the Arctic or Antarctic regions, or in both." I do not credit those who pin their faith to a connection between the two classes of phenomena, with having to go so far for an excuse, as they generally utterly ignore the want of coincidence, and instead of discrediting their theory (and I need not add that one failure should have very many times greater weight than one coincidence) calmly ignore it, and proceed with their cumulation. I do not wish to be understood as thinking that there are not dispassionate investigators in this matter; I am only pointing out what I believe to be a very common human peculiarity, and one which I believe does much harm in so far as permitting of the propagation of theories which had else died, still-born, on their authors' hands.

"The evidence of the correctness of a theory or hypothesis increases with the number of facts it is capable of satisfactorily explaining. It diminishes with the number of facts it does not explain, and with the number of different ways in which similar phenomena can be explained. A *single fact*, inconsistent with any theory or hypothesis, is sufficient to overthrow it," is a statement of fact that will be most useful to us in theorizing, and serve to measure some existing theories with.

Any theory of the Aurora must account for the following, amongst other, peculiarities, which seem to me to be characteristic of the same. A. —That they most frequently occur in the colder half of the year, being limited, approximately, by the same isothermal lines as far as the southern limit, in the northern hemisphere, of their visibility is concerned, and not depending in this on latitude. It would seem, then, that temperature is a factor in the required theory. B. —Auroral displays do occur in the summer season, when their situation is more equatorial, and, perhaps as a rule, they cover a larger area than the average winter display. It would seem, then, that on the transference of the maximum winter displays from one hemisphere to the other, these displays may take place in intermediate situations. C. —From my experience in these latitudes, summer displays of limited extent seem to be concurrent with a drop in the temperature considerably below that corresponding to the average of the date in question. D. —My experience has been that auroral displays do not occur during generally unsettled weather, requiring (although the particular locality of the display may be largely overcast, permitting only of the aurora being seen behind the clouds or through the interstices) that generally elsewhere the weather should be clear. As though clouds on the horizon of the display (*not* of the observer) intercepted the influence producing the same. E. —The typical aurora, from which are many departures as pointed out by Professor Swift in the communication mentioned, is a narrow circular arch in that part of the heavens away from the sun, the concave side of which is usually well defined, and beneath which is absolute darkness, into which streamers *do not* descend; the convex side of this arch is, generally, illy defined, from which streamers proceed and the light of which is very much less intense than that of the concave side; conveying to me the impression of the light, the visible effect of the influence, being completely cut off by the interposition of the solid mass of the earth, it being assumed to be the intercepting horizon at the altitude of the display. F. —(Speaking still of the typical auroral arch). It is on the lower and brighter side where the greatest horizontal movements and the greatest contrasts in the intensity of its light (forming, amongst other outlines, so called "curtain-folds") are seen. As though at the horizon of the display, our atmosphere, acting as a lense, concentrated the light (the visible effect of the auroral influence) in just such a way as a spherical, atmospherical, lense would, having its centre "stopped" out by such a body as our earth, in which the densest part being next the earth, the greatest relative variation in its homogeneity would exist and the greatest variation in the transmitted light (the visible effect of the auroral influence), resulting in just such movements as we have seen in the typical arch. G. —It has been constantly noted, that two or more observers, situated, say, 100 miles apart, view occasionally, if not always, totally distinct auroral outlines, differing, at times, radically; so that one observer may report a display differing entirely in class and details from the other at the same instant, or even reporting the entire absence of a display when the local conditions were such as would have permitted its being seen had it existed. From this, it appears to me, we must conclude that the light (the visible effect of the auroral influence) has no material existence in that part of the heavens in which it is seen, else, all observers, so situated on the earth that the point of display is above their horizon and this particular point not obscured by clouds, should see the same display, modified only in detail owing to the effects of perspective attributable to the different points of view. H. —There is an intimate relation between the aurora and magnetic storms; not sufficient to permit of our concluding the one is Cause and the other Effect, but sufficient, I think, to permit of the supposition that both are Effects of a common Cause. These appear to me to be some of the more self-evident peculiarities of the typical Aurora.

The theory in connection with the aurora which appears to have the greatest hold on the investigator and the general public, is one which supposes a connection between these displays and certain disturbed — sun-spot — areas of the sun. If one were to accept the evidence that is brought forward to support this supposition, without taking into account the evidence which has, unintentionally, been suppressed, or perhaps it would be better to say, "not advanced," it would be a very hardened sceptic who would not admit that this question had been settled for all time. In *Astronomy and Astro-Physics*[1] it is concluded that auroral displays recur at intervals which exactly correspond with that of the solar rotation, and at the instant when this disturbed area is at the eastern "limb" of the sun. Dropping for a moment the discussion of the cumulative evidence, it is interesting to note the peculiar nature of the force which proceeds from the solar area in this case. If this influence is at its maximum on the appearance of the area on the eastern limb, and not continuous to the western limb, it is evident that the maximum effects are produced horizontally and in one direction only from the sun's surface. It is not impossible that this is so, but it is an unfair assumption to make, apart from any knowledge of a similarly acting force in nature, and in direct opposition to what experience, in other matters, would suggest as the direction in which such a source of energy would produce maximum results. As to the fact of maximum auroral displays occurring at the instant when the disturbed solar area has reached the eastern limb, the coincidence cannot be as great as claimed, or else the occasions on which this has happened have been given undue prominence in collecting facts to suit the theory, for in a communication to the Royal Astronomical Society[2], the Astronomer Royal states, in

[1] Reprint No. 113.

[2] "Monthly Notices," March, 1892.