

THE MAKING OF BIOLOGISTS.

BY PROFESSOR T. D. A. COCKERELL,

EAST LAS VEGAS, N. MEX.

IT is doubtless true that biologists are 'born' rather than 'made,' but it is probably no less true that they may be and are nipped in the bud in many instances by the frost of adverse circumstances. I speak of the making of biologists by the same right and in the same sense that the farmer speaks of raising crops, although as a matter of fact the crops raise themselves by their own inherent vitality. Encouraged by a lively conviction that the infant mortality of biological talent is much greater than is commonly supposed, I have sought to ascertain the conditions which permitted the survival of so much as we actually have, thinking that ways might be found to increase the crop. While neither expecting nor desiring that every one should become a specialist in biology, one may be pardoned for ardently wishing that the existing native talent should be more fully utilized, in view of the innumerable biological investigations lacking investigators.

In the United States to-day there are about four hundred publishing zoologists, exclusive of those whose writings are of little or no importance as contributing to the advancement of the science. The botanists are probably about as numerous, but I have not yet attempted to catalogue them. Of the zoologists about 140 are enumerated in 'Who's Who,' and these include most of those who have done any considerable amount of work, although there are some surprising omissions, and a few nearly as surprising inclusions. It would be a useful thing to publish at some future time a biographical index of all American biologists, living or dead, who have really contributed to the subject. In the meanwhile I have extracted a good deal of interesting information from 'Who's Who,' and a few other sources.

Starting with the idea that 'nature' counts for at least as much as 'nurture,' I looked for racial distinctions. Unfortunately it is impossible to ascertain the exact influence of race upon the development of talent, because those of different races are not subject to the same environment. It is well understood that the Germans, as a people, are inclined to be scientific, and considering the enormous influx of Germans into America, one would look for a large body of German-born biologists. There are, indeed, many German amateurs; but in our list of prominent American biologists the German-born are less than half-a-dozen, the best-known being Loeb, Ortman and Eigenmann. Similarly, the Eng-

lish-born are scarcely worth mentioning; while Norway, Hungary, Switzerland and Canada have single representatives in Stejneger, Heilprin, A. Agassiz and McMurrich. On the whole, the foreign-born element in American biology is insignificant, and as it were accidental.

Such facts as these make us doubt the validity of the opinion that talent will always come to the front, whatever the conditions. Among those who have immigrated from Germany and the British Islands there must have been a larger number capable of biological research than the figures show; but as a matter of fact the conditions surrounding these people were not commonly favorable to scientific work. The same must be true of the French immigrants who settled long ago in the south; they have never yet shown anything like the scientific talent which their origin would lead us to expect.

Dr. G. B. Halsted told me last year that he believed that about one in two hundred persons in this country possessed some sort of mathematical genius. Being afterwards uncertain whether he meant university students or the general population, I wrote to him and received the following interesting reply:

One in two hundred *university students* has marked mathematical ability. Of those who do not get to any university the percentage may be just as high, since only *race*, and not caste, is necessary for this gift. A Hindoo has just been senior wrangler at Cambridge, England; and Gauss was a bricklayer's son. No one with a drop of African blood has ever given us a theorem in mathematics. Shaler accounts for the stupidity of the Romans in mathematics by supposing that the primitive basal race in Italy was from Africa. There is a marked difference between ability in geometry and ability in arithmetic and algebra. The Jews give us more great mathematicians than any other race, but never a geometer. Geometry is hindered by a *necessity* for visualization. Todhunter said with penetrating wisdom that the person who had to see the relations definitely on a figure could not go on in the higher mathematics. Non-Euclidean geometry, my subject, cannot be visualized. Calculating prodigies are usually idiots, absolutely lacking in power of visualization. I enclose you a long account of one such [Jacques Inaudi] which is very definite on this point [*i. e.*, the absence of visualization]. Most eminent mathematicians are deficient as calculators, some do not know their multiplication table. . . . I have never in my life had to extract a root of a number. The thing which seems most to *foster* mathematical ability is use in very early youth, strong stimulation in early youth. (Litt., December 24, 1901.)

With respect to the negro race unfavorable conditions may have had more to do with unproductiveness than is supposed. The Tuskegee Institute under Professor Booker T. Washington has lately obtained the means of carrying on original research in science, and it will be extremely interesting to watch the results. I ventured to ask Professor Washington whether he had observed any scientific talent among his people, and he referred me to Dr. Roscoe Conkling Bruce, who wrote as follows on the subject of talented negroes:

Scientific aptitudes have to my knowledge appeared among the negroes not infrequently. Among negroes who have actually achieved a degree of eminence in scientific research are the late L. A. Willson, of Cleveland, Ohio; T. McC. Stewart, Jr., of New York city; Frederick Hemmings, of Boston; and Dr. S. C. Fuller, of Westboro', Mass. Dr. W. E. B. DuBois, of Atlanta University, has made two solid contributions to descriptive sociology, 'The Suppression of the Slave Trade' and 'The Philadelphia Negro.' Dr. Kelly Miller, of Howard University, has made important mathematical researches. Professor Hugh M. Browne, of Baltimore, is an eminent physicist. Professor George A. Towns, of Atlanta, has written a valuable theory of æsthetics; Professor Ferris, of Cambridge, is now engaged in writing a book on metaphysics. Our Professor Carver, of Tuskegee, has done something in biology. There is frequently noticeable among our students at Tuskegee the scientific attitude and spirit. (Litt., April 6, 1902.)

It should be added that Professor C. H. Turner has done important work on fresh-water Crustacea.

Of course the custom of classing as 'colored' all those who have any negro blood makes it difficult to ascertain the possibilities of talent resident in the negro blood itself. I suppose that most of those above mentioned are of mixed blood, but I have no exact information.

Returning to our birth-statistics of zoologists, we may proceed to discuss the native-born. These people are the descendants of early immigrants who showed little or no scientific ability, doubtless for such reasons as we have already discussed. The tremendous increase of intellectual activity in Europe and America during the last century and a half shows what possibilities may lie unsuspected in a people; for no biologist can suppose that the stock itself has greatly changed in so short a period. The same may be said concerning the recent intellectual awakening of the Japanese, though no doubt these people formerly employed their minds in ways overlooked because unintelligible to Europeans. It seems wonderful to us to-day to receive monthly an entomological journal printed in Japanese and to find some of the best work in biology coming from natives of that country. Who knows but that we ourselves, great as has been our progress, are capable like the Japanese of yet other new births, into fields of intellectual activity hardly yet suspected to exist?

I have classified the native-born zoologists by the states of their birth. New York is easily in the lead, with Massachusetts a good second, Illinois third, Ohio fourth, Connecticut fifth. The more prominent names are as follows:

New York.—Beecher, Bigelow, Birge, Call, Casey, J. M. Clarke, O. F. Cook, B. Dean, J. Dwight, Dyar, Elliot, Gill, D. S. Jordan, Mearns, Merriam, G. S. Miller, Miss Rathbun, Shufeldt, Slingerland, J. B. Smith, Walcott, Ward, Whitfield, Winchell, J. B. Woodworth.

Massachusetts.—J. A. Allen, Beal, Brewster, Dall, Felt, Hitchcock, Lucas, C. D. Marsh, Minot, Scudder, Thayer, Thorndike, Williston. How few of these are to-day identified with Massachusetts!

Illinois.—Coquillet, Gilbert, Hatcher, L. O. Howard, Kofoid, Nutting, Ridgway, Simpson, Stanton, E. B. Wilson, Walcott.

Ohio.—Chittenden, Girty, Pratt, Schuchert, C. H. T. Townsend, Ulrich, C. M. Weed.

Connecticut.—Benedict, Blatchley, Davenport, C. L. Franklin, H. F. Osborn, Mrs. Slosson.

Pennsylvania has given us Ashmead, Bruner, H. C. Chapman, Garman, W. Stone and the late H. Strecker. From *New Jersey* we have Beutenmüller and F. M. Chapman; from *Maine*, Fernald, Verrill and C. B. Wilson; from *New Hampshire*, Nelson; from *Maryland*, Uhler. *Iowa* is the birth-place of Eastman, Evermann, McGee, Springer and Pilsbry; *Michigan* of V. Bailey; *Minnesota* of C. L. and C. J. Herrick; *Wisconsin* of H. Osborn, Ritter and W. M. Wheeler. The South is hardly represented at all; from *South Carolina* come J. A. Holmes and J. P. Smith; from *Kentucky*, Morgan and Miss Sadie Price; *Florida*, *Georgia*, *Louisiana*, *Arkansas*, *Mississippi*, *North Carolina* and *Virginia* do not appear on my list at all! There are, I hope, some zoologists born in these states of whom I have no statistics, but in any event the zoological output of the southern states is wholly insignificant. This fact suggests again the great influence of environment, whatever the blood; and one may add that the tropical English colonies have deprived us of the services of many a good man, who under more stimulating social and climatic conditions promised much.

The civilization of the West is so young that perhaps we ought not to expect much of the native-born therein. As a matter of fact, the showing is small indeed; my records give only these names: *Kansas*, V. L. Kellogg, Marlatt; *Texas*, Vaughan; *California*, T. S. Palmer. Of course there are many others less well known; indeed a very good crop of young men and women, who will be prominent enough in the next twenty years. Everything shows that California, in particular, will be the center of great biological activity; but so far Colorado is by no means doing her part. About fifteen years ago a small body of naturalists founded the Colorado Biological Association, of which the present writer was secretary; but the movement died in 1890, and to-day there are not enough biologists in the state to revive it or found a new society on similar lines. Even the professors in the state university seem to be permitted rather than encouraged to engage in research. However, Colorado has too much natural vigor to tolerate this inertia indefinitely; the time cannot be far distant when there will be an awakening.

I have also catalogued the prominent zoologists under the names of the schools, colleges and universities they attended; but the results are perhaps not very significant. Of course every one knows that many of our leading men (*e. g.*, Jordan, Dall, Uhler, J. A. Allen, Scudder) studied under Agassiz, but it may be doubted whether their interest in

biology was not fully determined before they went to him. I think it will be possible to show in due time, that the critical period for the biologist is much earlier than some of us have supposed, is, in fact, during the years of childhood. This would agree with Dr. Halsted's opinion, expressed above, about mathematicians. The list of those who received no university training is significantly long, including Ashmead, Beutenmüller, W. Brewster, F. M. Chapman, Cockerell, Coquillet, D. G. Elliott, Gill, Lucas, McGee, Miss Rathbun, Ridgway, Schuchert, Simpson, J. B. Smith, Thayer, C. D. Walcott, Whitfield and Uhler. On the other hand, Harvard, Johns Hopkins, Yale, Cornell, Amherst, Michigan and a few others have long lists of prominent graduates, and the list of those who studied in Germany is surprisingly large. In all, 56 institutions in the United States are represented in my list, mostly by only one or two names. There is plenty of evidence that first-class men may come from institutions which do not ordinarily turn out zoologists of any sort, or perhaps ordinarily do turn them out, in a different sense.

Dr. D. S. Jordan is the man who comes first into our mind as a gift from Agassiz. He himself is always ready to insist upon his obligations to that great naturalist; but the following information, kindly supplied to me by Dr. Jordan, shows that he was a good biologist before he ever saw the master.

When a boy I lived on a farm in western New York. I was very early interested in the local botany and had made a collection of the local fauna before I entered college. At college I developed this as a thesis, called 'The Fauna of Wyoming County, New York,' for a master's degree. I was also very much interested in the breeding of sheep, and from my twelfth year to the time I went to college I gave considerable attention to this, having a pretty fair knowledge of all matters pertaining to a flock of sheep. Very soon after entering Cornell I was made laboratory assistant in botany, and was ultimately promoted to an instructorship. I did not take up zoology as a serious matter until after I had left Cornell. At Penikese I was instructor in marine botany. Agassiz thought that I ought to do some work of an entirely different sort, and placed me in charge of the work of collecting fishes, asking me to study the habits of the different forms. On going to Wisconsin—where marine botany is scanty—I was advised by him to take up the anatomy of fishes and especially of the ganoid forms. I did a good deal of work on birds, but deliberately chose fishes because the group was comparatively little known and apparently offered a wide field. The influence of Agassiz was a great element in my scientific progress. Not less great was that of Agassiz's student, Charles F. Hartt, several years ago professor of geology at Cornell—a subject in which I did a good deal of work. (Litt., October 25, 1901.)

It is perhaps by his general influence upon the country that Agassiz did most to promote the study of biology in America. Such a man always attracts to his person the enthusiastic young men who are able to benefit most by his teaching, but who would probably have made good biologists in any case. For most of these, the turning point had been

long ago reached and passed; but Agassiz was able to indirectly influence the young people of the whole country, and though he is now dead, he is not gone, and we are all in some sense his pupils.

Dr. Alfred R. Wallace, writing from Parkstone, Dorset, November 7, 1901, has given me the following most interesting account of his early experiences:

As to my interest in biology, I can trace it I think to two very trifling facts. I doubt if I had or have any *special* aptitude for it, but I have a natural love for *classification* and an inherent desire to *explain things*;—also a great love of beauty of form and colour. The two slight facts are these. When a boy at school I heard a Quaker lady say that she and some friend had found the 'Monotropa,' which was quite a discovery as being before unknown in the district. This, and hearing the names of other flowers referred to as rare, made me think it would be very interesting to know the names of all the plants that grew wild,* but as I had no botanical friends the wish remained dormant, till I was about 15, when I purchased for a shilling (I think) a little book on botany published by the *Society for the Diffusion of Christian Knowledge*, and which contained the characters of about a dozen of the commonest natural orders in Britain. This was a revelation to me, and kept me employed for a year or two determining the flowers I met with if they belonged to any of these few orders. I then bought Lindley's 'Elements of Botany,' I think it was, but was disappointed in finding no more 'orders' described, but details of structure which did not much interest me. When recovering from a serious illness I met with Loudon's 'Encyclopædia of Plants,' and finding that this contained brief characters of all British plants, I amused myself by copying them *all*, except I think the grasses and sedges, on sheets of note paper, which I interleaved in Lindley's volume, and by means of these I was able to determine most of the species I met with, and made a considerable herbarium. The other incident was, meeting H. W. Bates at Leicester and being started by him as a beetle and butterfly collector. The enormous *variety* of form and structure in the beetles attracted me, and I think during all my tropical experiences the collection of these gave as much enjoyment as even the gorgeous birds and butterflies. Classification then began to fascinate me, through Swainson, and the 'Vestiges of Creation,' with the works of Herbert Spencer, started me on the problem of the origin of species; and thus my various mental tendencies had full occupation in the contemplation and study of natural objects. I also, very early, became interested in geology, in mechanics, in physics and in astronomy, and this breadth of scientific interest, though with no direct education in any one of them, has been of great service to me in preventing a too exclusive attention to any one aspect of nature.

With reference to Dr. Wallace's disclaimer at the beginning of his letter, it may be questioned whether there is such a thing as a special aptitude for biology, aside from the combination of just such tastes and aptitudes as he describes. I have always fancied that the same qualities which would make a good historian would make also a good biologist—the interest in living things, the love of detail and of classification, the fidelity to truth, the perseverance in inquiry, the lively imagination, and

* I also heard, to my astonishment, that every minutest *weed* had been described and had a name.

so forth. It is interesting in this connection to note that the ornithologist Coues became a historian during the last years of his life. The love of beauty is also undoubtedly a strong factor in the making of biologists, although there are some good workers who seem to be singularly deficient in this respect.* Many years ago the present writer went with Dr. and Mrs. Wallace to find the daffodils in an English meadow. When we arrived at the place, we found the flowers in profusion, and it was inspiring to see the child-like pleasure the veteran naturalist took in their beauty. Here was a man who could never grow old, to whom nature was a perpetual delight. As I heard Professor C. L. Herrick say in an address to some students, the love of nature is the secret of perpetual youth.

In the first issue of *The Hibbert Journal*, Sir Oliver Lodge writes as follows:

Take a scientific man who is not something more than a scientific man, one who is not a poet, or a philosopher, or a saint, and place him in the atmosphere habitual to the churches—and he must starve. He requires solid food, and he finds himself in air. . . . Take a religious man, who has not a multitude of other aptitudes overlaid upon his religion, into the cold dry workings, the gropings and tunnellings of science, where everything must be scrutinized and proved, distinctly conceived and precisely formulated,—and he cannot breathe.

I think this antithesis is not altogether a natural one, but that, on the contrary, the scientific man *must* be something of 'a poet, or a philosopher, or a saint,' to be completely a scientific man. It will be a sad day for the world when we cease to have men who can live freely in the enjoyment of the universe, and each one is permitted to know only this or that. Let us be free to think and enjoy, even though our thoughts wander far afield, and our enjoyment is not always that of a connoisseur.

Sometimes science suffers greatly in the opinion of those who do not claim to be scientific, just because her proper character is not understood, and it is assumed that she must be cold, hard and unimaginative. I have heard the late William Morris speak contemptuously of science, and in his admirable lecture on 'The Aims of Art' (1887) he says that if socialism does not prevail 'science will grow more and more one-sided, more incomplete, more wordy and useless, till at last she will pile herself up into such a mass of superstition, that beside it the theologies of old time will seem mere reason and enlightenment.' Yet Morris was himself an admirable observer of nature, and possessed many of the best qualities of a naturalist. I suppose the name of psychology would have

* I heard the other day a perfectly authentic story of a teacher in one of our best universities, a man who has done wonderful work in classification, and is far ahead of all others in his particular specialty. One of his students, looking through the microscope, exclaimed at the beauty of some object. The professor immediately shut him up with the remark: 'I should think that by this time you would know that you don't come here to look at pretty things!'

made him shudder, and yet the very lecture cited is really an important contribution to that subject, with its theory of the moods of energy and idleness. The views just expressed seem to be confirmed by the history of one of the most distinguished biologists of this country, Dr. A. S. Packard, who writes me as follows:

I may say that the love of flowers, animals and natural scenery was inborn in me. My ancestry on both sides were ministers, we never had a naturalist in the family, but my father was extremely fond of and appreciative of natural scenery, and was interested in history and archæology. As a child I was very fond of flowers, as were my parents, and as early as I can remember had a flower-garden of my own. When about 14-15 I began to collect minerals, and then shells. My zeal for collecting and forming a museum led an older brother, who also had such tastes, to give me his cabinet, containing curiosities, shells and minerals. I was also an omnivorous reader,—devoured all the books on natural science in the library of Bowdoin College, where I was kindly allowed to browse, long before entering college. When about 16-17 I collected insects in considerable numbers. I was also aided by a maiden lady in Brunswick, Maine, who told me about shells, and aided me in naming my native plants. I formed a herbarium before entering college. From Miss Ann Jackson when a boy I first heard of Lamarck, and of his classification of shells, and of the Lamarckian genera of shells. With, then, an inborn taste for natural history, an aversion to business, and a fondness for books, my deep interest in animal life was sustained and I was impelled to devote my life to biological study. All through college I corresponded with Professor Baird, assistant secretary of the Smithsonian Institution, also with conchologists and entomologists, and this was a constant stimulus to the natural zeal and interest, or passion, for biology which has influenced my life. Also I was a born collector, though I have now no large collections. I trust this will show how I became interested in natural history. Had I been brought up in a city, the result might have been different. (Litt., October 28, 1901.)

It is interesting to think that Packard might have been our leading conchologist, Jordan our first authority on seaweeds. In nearly every case of which I have full information, some other branch of biology was studied than that which afterwards became the specialty. The interest was almost always at first a general one, afterwards limited by circumstances or choice. Of course one has to remember here that nearly all children in rural districts are interested in nature, though so few become biologists. The writer spent part of his childhood on a farm in Sussex, England, and well remembers the interest taken by the children in the first primroses or daffodils of the year, the arrival of the birds, the occurrence of efts (newts) in certain ponds, and such matters. It seems probable that most children are potential biologists, to some extent, but only a few are able to break through the crust of indifference and opposition which surrounds them a little later, and remain naturalists to the end. If this is true, and it is also true that stimulation at an early age is very important, the nature study movement in the schools may yet produce great results for science. However, in the absence of suitable teachers,

and in view of the crowded curriculum and consequent weariness of the pupils, one fears that in many instances the effects of a nature study course may be the reverse of those desired. There may be fatigue and disgust with the whole subject.*

Most of the naturalists who have kindly written me about their early life state that their interest began in the woods and fields—anywhere but in the town. It would seem that the chances are very much against a naturalist born in the city, notwithstanding certain presumed advantages in the way of education.† A good typical instance of the influence of country life is given by Dr. John M. Coulter, the well-known botanist, who writes:

I was brought up in a village and had a strong out-of-door tendency. This took me into the ravines, and woods, and along the streams in the neighborhood almost constantly. My interest for collecting things runs back to a time I cannot recall. The actual selection of botany among other out-of-door subjects was probably determined by the lines of least resistance, in the form of opportunities presented. (Litt., October 24, 1901.)

* Many an English boy has acquired a distaste for the Bible from having to learn chapters by heart, lists of the kings of Israel, and so forth; and this often on Sundays, depriving him of the rest and recreation to which he feels entitled.

† One thing in favor of the city is the museum, where it exists. It is undoubtedly a factor of great importance, as will be shown later on.