most highly organized birds, as the Passeres, the aftershaft is very weak, and in many peculiarly specialized birds, as the owls, American vultures, ospreys, and kingfishers, it is wholly wanting. The second reason for considering it primitive is the process of its development during the formation of the feather. It is needless to republish here the history of a feather's growth, but it may be well to call attention to one or two points. When the malpighian layer covers the feather-papilla, it would naturally be thinnest on the sides. The increased thickness above and below would cause greater pressure on the papilla along the median line on both surfaces, thus causing the grooves in which the rhachis and hyporhachis subsequently develop. Now, it is known that both these grooves occur in those feathers which have an aftershaft, and it is much more probable that, though now the upper groove is the larger, they were originally of equal size, than that the lower groove is a secondary development; because it is difficult to assign any possible reason for its ever beginning at all as a secondary characteristic. The foregoing facts give warrant to the following theory of the evolution and subsequent degeneration of the aftershaft.

Paleontology shows us that flight was an accomplished fact long before birds were evolved, and, since it requires tremendous muscular energy, it would be an obvious advantage to the hypothetical avian ancestor to decrease his weight and, at the same time, increase the non-conductability of his covering. When, therefore, feathers were first evolved from scales, the object in view was increase of heat-retaining power combined with decrease of weight. The most natural way of improving scales in this direction would be to make them thicker and, at the same time, hollow, and continued development along this line would result in making them more or less quill like. Then by dividing longitudinally and at right-angles to the axis of the body the number would be doubled without taking up any more space on the body, an obvious advantage. Constant subdivision, making them more adjustible, more coherent, and more compact, would finally bring about a condition very similar to that of the down-feathers of many birds especially in the first plumage. From this condition it is not difficult to trace the gradual development into a contour-feather in which shaft and aftershaft are of equal size, such a condition, in fact, as we find in the Cassowaries. But in this condition the feathers cause far too great friction with the air to admit of rapid flight, and so there came about the natural evolution of the more coherent, pennaceous feather with its comparatively smooth surface. But the natural curve of the lower half of this primitive feather was up and outwards and in direct antagonism to the down and inward curve of the main shaft, and so, being a hindrance to the required compactness, it gradually gave way and degenerated to its present condition. The rest of the story has already been told; how, where the aftershaft has adapted itself to its sole function as heat-retainer, it is still strong and useful, but in all other cases it is either wholly lost or on the rapid road thereto. Whether subsequent investigations and discoveries in paleontology and histology confirm this theory remains to be seen, but, for the present, it is at least plausible and open to few objections.

BRITISH STONE CIRCLES.[1]

BY A. L. LEWIS, LONDON, ENGLAND.

No. 1. — Abury.

THE largest circle of stones in the world was that of which the remains — few when compared with the magnitude of the structure of which they formed part, but by no means inconsiderable in themselves — are to be seen at Abury, in Wiltshire. Abury village is six miles from Marlborough station (Great Western Railway); it occupies the site of the circles and is mainly built of fragments of the stones which composed them. The monument when complete consisted of a circle of one hundred stones (more or less), of which thirteen still remain above ground and at least sixteen more are buried, some of these are of great size, more bulky than any at Stonehenge, but unshaped and without the cross-pieces which distinguish the latter monument from all other circles. The diameter of this circle was about eleven hundred feet, or eleven times that of the outer circle at Stonehenge; inside it were two other circles,— north and south,— both over three hundred feet in diameter. Dr. Stukeley considered that there was a smaller circle inside each of these, but there is now nothing remaining of them, and it has been doubted whether they ever existed. In the centre of the northern inner circle there were three very large upright stones, forming a "cove" or three sides of a square, of which the open side was toward the northeast, and of these stones two still remain, besides which there are now only three stones of the northern inner circle or circles and five of the southern, and a single stone, which Stukeley said stood in the middle of the latter, has long since disappeared. The total number of stones composing the inner circles, "cove," etc., was, according to Stukeley, eighty-nine.

The circles (and the greater part of the village) are surrounded by a deep ditch, outside which is a high embankment. Aubrey, the first writer who noticed this monument, made a very imperfect plan of it in 1663, in which he represented an avenue of stones leading down in a straight line to the present main road, near the River Kennet, and another avenue of stones leading from the end of it, also in a straight line, but at a right-angle, to a smaller circle on Overton Hill, near the line of large barrows which crosses the main road from Marlborough before it reaches the point where the road to Avebury leaves it. Stukeley delineated these as one avenue running in a curved line about a mile long between the great circles at Abury and the smaller one on Overton Hill, and thought that it represented a serpent, of which the Overton Hill circle formed the head, and the Abury circles some convolutions of the body, the tail being represented by another avenue, which left the great circles near where the church now stands, and curved away to the left, passing two large stones called the "long stones," which are still to be seen,[2] though of the rest of the alleged second avenue nothing remains *in situ*, so that some archæologists think it never existed, especially as Aubrey, who visited the circles more than fifty years before Stukeley, has not left any notice of it. Stukeley, however, spent much more time at Abury than Aubrey did, and obtained much information from the inhabitants as to the former position of stones which had been destroyed within their remembrance, and, as there is much stone used in causeways, etc., over the marshy ground on that side of Abury, it is probable that an avenue of some sort did formerly exist there, but this a point for the visitor to investigate for himself.

The circle on Overton Hill and the end of the avenue adjoining it were destroyed before Stukeley went to Abury, but there are several stones of the other part of the avenue standing and fallen by the side of the road which leads from the main road at West Kennet to Abury village, and in a meadow under the left-hand hedge of the main road there are four fallen stones of the avenue, and, as these follow the curve which the road makes between the barrows and the turn to Abury, they seem to show that Stukeley was right in delineating a single curved avenue in place of the two, meeting at right angles, which Aubrey shows in his plan. This is another point for the visitor to verify, and he will do well to follow the avenue from these four stones to its junction with the circles at Abury, and, having inspected the latter, to go out past the church to the "long stones," and to the Beekhampton Inn, which is on the main road by which he will return to Marlborough, stopping on his way to climb Silbury Hill, the largest artificial mound in Europe. This attracts attention by its regular shape and flattened top, and, as it is due south from the circles at Abury, probably formed part of the monument; it has been dug into, but nothing has been found to show it to be a sepulchral mound, like the smaller barrows which are so numerous in this district. Human remains were found round the Overton circle, but none are known to have been found at Abury, so that it does not appear that the object of these circles was, as some suppose,

[1] It has been thought that many Americans who, when in England, visit Stonehenge may not be aware how many remains of a similar character, which they might also wish to inspect, exist in the British Isles; and the editor of *Science* has accordingly made arrangements for a series of short articles, which shall give a description of each of the principal circles and state what points should be noted and how it may most easily be visited.

[2] These are probably the last survivors of another large circle.

the commemoration of the dead; but the fact that the "cove," or holy of holies, in the centre of the northern circle, faced the sun when rising at midsummer has been regarded as indicating sun-worship to have been the chief purpose of this vast monument, which was in all respects so suitable for a place of assembly for a tribe or nation.

A short distance to the north of the main road from Marlborough to Abury are the remains of a dolmen called the "Devil's Den," and there is another at Rockwell, four miles northwest from Marlborough and two miles northeast from Abury. There was also a circle at Winterbourne Basset, four miles north from Abury, but it is not worth the trouble of a visit, as only three or four stones remain.

PHYSIOLOGICAL CONTRIBUTIONS FROM MISSOURI BOTANICAL GARDEN. I.

BY J. CHRISTIAN BAY, MISSOURI BOTANICAL GARDEN, ST. LOUIS, MO.

THE PLANT CELL.

IN the early part of this year, Professor von Sachs, of Wuerzburg, published a paper on the theory of cells: Beitraege zur Zellentheorie in "Flora," 1892, Heft 1, pp. 57–64. The leading thought of this publication seems to me to form, when combined with the following suggestions, the key and basis for deductions from the very long and interesting series of facts which forms the results of investigations of the later years in the functions of vegetable cells, both mechanical and physiological.

It is not difficult to trace how, even since the epoch of natural philosophy ("die Naturphilosophie"), the science of vegetable physiology has been in want of a solid foundation, a base, upon which the results of investigations in the phenomena of the life of vegetable cells could be firmly built. In the *Botanische Zeitung* a lance was in vain broken for the old theory; somebody then in vain put out the question, what Schleiden would give us instead of the old natural philosophy. Schleiden made no answer, because he had none to give.

The physiology of the plant cell having had since that time no leading exponent is, I suppose, the reason why at present that science merely consists of a series of very interesting, suggestive facts, but without the necessary conjunction with regard to points of view leading to general results.

A great many prominent men have devoted their lives to the study of vegetable cells, and we must allow that botany has now progressed as far as zoölogy, but only with regard to the accumulation of facts, in animal biology the cellular physiology of Virchow, dating from 1858, has arrived at a very high stage of development. Therefore, when thinking of the construction of a comparative physiology of animals and plants, it will be a most thankworthy task to collect all of the thrown facts concerning the physiology (qua biology) of the plant cell and arrange them from a general point of view.

The reason why the botanical part of cellular science has not brought forth general results during this long period is also to be sought in the definition of the cell body in botany. Very few physiologists would allow that the plant cell as well as the animal cell is an organism. Still this definition is to be looked at as a necessary foundation for a clear perception of the phenomena of botanical cellular physiology, both mechanical and chemical. As far back as 1848, one of the most prominent physiologists, N. Pringsheim (De forma et incremento stratorum crassiorum in plantarum cellula observationes quaedam novae. Halae, 1848, p. 38.) reminded us that "cellula est individuum," Hilger and Husemann, Weiss, and A. Zimmermann have told us almost the same, but still we find such definitions as "Grundorgan" (Frank), "Elementargebilde," "Formelemente" (G. Haberlandt). In his excellent "Lectures," Vines calls the plant cell "the physical basis of life." It must be remembered that Huxley ("Physical Basis of Life") only spoke of the protoplasm as the bearer of life. And Huxley himself, when he gave this most ingenious definition, did not see in protoplasm the *physiological basis of life.* Life never rested on a physical basis, nor consisted in physical matters alone.

Nobody will doubt whether a yeast cell is an organism or not.

Professor R. Pedersen, of Copenhagen, for six years my teacher in physiology, first mentioned these facts to me in the winter of 1891, acknowledging the results of this consideration for the evolution of cell theory in botany. Never this explanation was said with regard to the fact that said definition subsequently would form the key to cellular physiology in botany and, I may add, to comparative physiology of animals and plants.

The question is of considerable importance, because the accumulated facts now need a basis. The proposition of Sachs in his recent paper must be said to have come in due time. Yet it evidently ought to be connected with the given definition of the cell. Now we shall be able to arrange the facts in a system, see where vacant spaces may be, and fill up the voids, but up to the present time we were unable to do so.

Taking the "energids" as a basis of vegetable life, Sachs found "a real unity as a basis for the plant body," when we allow an energid to be "one nucleus with that protoplasm which surrounds it and which is commanded by the same nucleus." Then, looking forward, we shall see as one of the necessary results that the cell, often containing more than one nucleus, is really an organism, never an organ. Even without this deduction we may acknowledge the cell as an organism, because it acts as an organism.

Mechanics not being life, life is not mechanics; physiology alone is the science of the functions of life. Therefore, to understand the latter we must find a good physiological foundation for it.

By this explanation I hope to have been able to show that investigations in the life of the plant cell ought to be brought into another trace in the future. More than usual plant physiologists must be aware that they want — as Sachs says — "a scientific language, according to the true scientific idea."

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

An Alleged Mongoloid Race in Europe.

ALTHOUGH it is not usual, and often impracticable, for writers to reply directly to the various criticisms passed upon their books, yet, as an interested reader of *Science*, I may perhaps be allowed to say some words with regard to a review of my "Testimony of Tradition," contributed to your issue of Feb. 10 (p. 82), which I have not had an opportunity of seeing until to-day. This I desire to do in order to remove more than one misapprehension of my meaning in the work reviewed.

"The very slender basis for the whole theory," says the reviewer, "is the syllable *Fin.*" In this he is greatly mistaken. Linguistic comparisons in this direction are certainly made, and considerable stress laid upon them, but these are entirely subsidiary to the important statements quoted in the first chapter. Briefly, these are to this effect: Wallace, a clergyman in Orkney during the second half of the seventeenth century, states that "Finn-men" were at that time occasionally seen off the coasts of Orkney, each "Finn-man" being the solitary occupant of a small skiff. In particular, he specifies the years 1682 and 1684, and another writer (Brand), who confirms his account, gives instances in or about the years 1700 and 1701. Their skin-boats, and the dress and usages of the people themselves, as described by these writers, identify them at once with Eskimoes, i.e., an Eskimo-like race. Of this there can be no reasonable doubt. Both writers state that one of their skin-boats was then preserved "as a rarity" in the Hall of the Edinburgh College of Physicians, and it is added that another specimen was preserved in the parish church of Burray, Orkney. The former statement is confirmed by an entry of the year 1696 in the minute-book of the Edinburgh College of Physicians, which I copied from the original writing and published in my book (p. 10). The writer first quoted (Wallace)