IN the mind of any one at all practically acquainted with science, the appearance of a new edition of the 'Vestiges' at the present day, has much the effect that the inconvenient pertinacity of Banquo had upon Macbeth. "Time was, that when the brains were out, the man would die." So time was, that when a book had been shown to be a mass of pretentious nonsense, it, too, quietly sunk into its proper limbo. But these days appear, unhappily, to have gone by, and the same utter ignorance of the public mind as to the methods of science and the criterion of truth, which were evidenced to a Faraday by the greedy reception of the table-turning folly, have encouraged the author of the 'Vestiges' to venture upon a tenth edition, "with extensive additions and emendations." We doubt not that this edition--very pretty and well got up it is--will be as greedily swallowed by those to whom it is offered, as any of the other nine, to the great glory and no small profit, of its modest and ingenious author. We grudge no man either the glory or the profit to be obtained from charlatanerie, and we can hardly expect that those who are so ignorant of science as to be misled by the 'Vestiges,' will read what we have to say upon the subject; but a book may, like a weed, acquire an importance by neglect, which it could have attained in no other mode; and, therefore, it becomes our somewhat unpleasant duty to devote a few of our pages to an examination of some of the leading points of this once attractive and still notorious work of fiction: indeed we feel the more called upon to undertake this criticism at present, since, as we shall see, the 'Vestigiarian' has bolstered up his case by the use of names and authorities, which, were it justifiable, might give a certain value to his statements.

It would be no less wearisome than unprofitable to go into a detailed examination of all the blunders and mis-statements of the 'Vestiges'--to drag to light all the suggestions of the false and suppressions of the true, which abound in almost every page, and which, in a work of such pretension, of such long elaboration, and so filled with whining assertions of sincerity, are almost as culpable, if they proceed from ignorance, as if they were the result of intention. We propose, therefore, to confine our attention to the fundamental proposition of the book and to some one or two of those matters connected with the biological sciences, which come more particularly within the province of this review.

The Vestigiarian modestly tells us, that none of his critics have rightly conceived "the fundamental proposition of the work" (Proofs, &c., Ivi); and in answer to the reproach of superficiality, he says, that "to be a superficial book, it has been remarkably hard to understand" (Ibid). We really must suggest that difficulty of comprehension is by no means a test of depth of thought, and that it would be well to leave out, in the eleventh edition, the confession, that this book, so popular with the mob, is incomprehensible to the thinker. Obscurity is more often the result of the muddiness than of the depth of the stream of thought. This, by the way, however: for, lest we should fall under like condemnation, we quote here the author's own words, that "The actual proposition of the 'Vestiges' is 'creation in the manner of law,' that is, the Creator working in a natural course, or by natural means." (Proofs, lix.) Here then is the idea of the book, and if the author has not demonstrated this, it is so much waste paper. There is, however, one preliminary which must be settled before passing to the question of
demonstration—namely, has this potent proposition, as it is here expressed, any intelligible meaning at all?

What is the sense of the terms "Law" and "Nature"? Nature is, of course, the totality of all laws, and therefore our inquiry is limited to the question of the meaning of "Law." As we prefer not to adopt any definition not admitted by our author, we will turn to his own pages though there really are authorities (Sir John Herschel, or Mr. John Mill, for instance), to whom we should give a preference—especially as the Vestigiarian does not pursue that pleasant and useful habit of being consistent with himself, but has one theoretical meaning, which he defines and writes about, and one practical, which he acts upon. [3] The former is brought forward explicitly in controversy; the latter implicitly in the body of the book. The former may be met with in the controversy with Dr. Hitchcock.

"Law, I have over and over again said, is merely a term of human convenience to express the orderly manner in which the will of God is worked out in external nature; and He must be ever present in the arrangements of the universe, as the only means by which they could be even for a moment sustained." (Proofs, lix.)

We perfectly agree with this definition of Law; but suppose that we substitute it for the word law in the portentous formula we have cited above, thus—"Creation took place," "in the orderly manner in which the will of God is worked out in external nature," "he being immediately present;" and, stripped of unnecessary verbiage, it comes to this, that "Creation took place in an orderly manner, by the direct agency of the Deity." A proposition which is as old as the Book of Genesis.

As exhibited in controversy explicitly, then, the proposition of the Vestiges' is, as a scientific explanation of Creation, not a whit in advance of the notions entertained by our grandmothers; but the tacit, implied proposition which the author, whenever pressed, denies, but always acts upon, is very different. The Vestigiarian, in fact, with no small pride, contrasts this his own private notion—1. With the allowing of the existence of any "dominion of marvel;" 2. With the notion of creative fiat, interferences or interpositions of creative energy—with the need of a "special attention" "whenever a new family of organisms is introduced;" 3. With the "undignified" notion that the nodulosities and corrugations of a cephalopod are "worthy of the particular care of that same Almighty who willed at once the whole means by which infinity was replenished with its worlds."

What then is this real proposition of the 'Vestiges'? It is simply, exhibited in all its naked crudeness, the belief that a law is an entity—a Logos intermediate between the Creator and his works—which is entertained by the Vestigiarian in common with the great mass of those who, like himself, indulge in science at second-hand and dispense totally with logic. To use a phrase of M. Comte's—the mind of the Vestigiarian is in the metaphysic stage, and confounds its own abstraction with objective fact.

A few citations will abundantly bear out what we have said. Thus at p. 307, "natural laws" are said "to produce winds" and are "sometimes unusually concentrated in space or in time, so as to produce storms and hurricanes, by which much damage is done."

Again, at p. 307, we found the following mysterious passage:—

[4] The laws presiding over meteorology, life, and mind, are necessarily less definite, as they have to produce a great variety of mutually-related results."

"Indefinite laws"! "which produce results" ! !

Once more:—

"The Creator, then, is seen to have formed our earth, and effected upon it a long and complicated series of changes, in the same manner in which we find that he conducts the affairs of nature before our living eyes; that is, in the manner of natural law. This is no rash or unauthorized affirmation . . . . . It is a point of stupendous importance in human knowledge; here at once is the whole region of the inorganic taken out of the dominion of marvel, and placed under an idea of divine regulation, which we may endlessly admire and trust in." (p. 113.)

And again (p. 114) with regard to the modes of origin of organic bodies.

"The Eternal Sovereign arranges a solar or an astral system, by disposition imparted primordially to matter; he causes, by the same majestic means, vast oceans to form and continents to rise, and all the grand meteoric agencies to proceed in ceaseless alternation, so as to fit the earth for a residence of organic beings. But when, in the course of these operations, fungi and corals are to be for the first time placed in those oceans, a change in his plan of administration is required. It is not easy to say what is presumed to be the mode of his operations. The ignorant believe the very hand of the Deity to be at work. Amongst the learned, we hear of 'creative flats,' 'interferences,' 'interpositions of the creative energy,' all of them very obscure phrases, apparently not susceptible of a scientific explanation, but all tending simply to this,—that the work was done in a marvellous way, and not in the way of nature. Let the contrast between the two propositions be well marked. According to the first, all is done by the continuous energy of the divine will,—a power which has no regard to great or small: according to the second, there is a procedure strictly resembling that of a human being in the management of his affairs. And not only on this one occasion, but all along the stretch of geological time, this special attention is needed whenever a new family of organisms is to be introduced: a new flat for fishes, another for reptiles, a third for birds; nay, taking up the present views of geologists as to species, such an event as the commencement of a certain cephalopod, one with a few new nodulosities and corrugations upon its shell, would, on this theory, require the particular care of that same Almighty [5] who willed at once the whole means by which INFINITY was replenished with its worlds!"

If the author of the 'Vestiges' really means by law, simply the mode in which the "Will of God"—who is ever present in the arrangements of the universe—takes effect, as he says he does, what meaning is there in the passages we have just quoted? If everything is the direct result of the Will of God, what does his theory differ from that of the "learned," at whom he sneers? If the Deity be ever present, and phenomena are
the manifestation of his will–law being simply a name for the order in which these occur—what is every phenomenon but the effect of a "creative flat," an "interference," an "interposition of creative energy?" If everything be the expression of the will of a present Deity—as the Vestigiarh affirms when it suits him—the introduction of every "new family or organism," must be an act of "special attention;" and upon his own showing, the Vestigiarh should believe, that the "corrugations and nodulosities" upon a cephalopod's shell, as much require "the particular care of the Almighty," as "the replenishment of infinity with worlds."

But, truly, what an entirely false and mean view of Nature is revealed in this very phrase, what utter snobbism and philisterei of conception. What is great and what is small in nature, from whose bountiful hand all things are poured out equally complete and equally perfect? Why should not the chambers of a cephalopod's shell be as worthy of the particular care of the Almighty in their production, as our Vestigiarh himself, or any of the other nebulae? What are Alps and Andes but "corrugations and nodulosities" upon the mother earth, whose majestic he slanders? What are the worlds, whose magnitude excites his admiration, but "corrugations and nodulosities" upon the bosom of the infinite universe? We are half inclined to doubt whether our author has progressed even so far as the "metaphysic" condition of mind, or whether he has yet emerged from that Fetish worship, where reverence is proportionate to the bigness of the idol.

Totally inconsistent with itself—the product of coarse feeling operating in a crude intellect—the boasted fundamental conception of the 'Vestiges' turns out to be unworthy of serious attention, and might be well left to find its own level, were it not that the Vestigiarh has mixed up and confounded together with his supposed explanation of creation, this "creation" in the manner of law, the totally independent idea, which took its origin in far other heads—that the past may be interpreted by the present; and that the succession [7] of phenomena in past times, took place in a manner analogous to that which occurs at the present day. Such a proposition is the base of the modern science of history, whether natural or civil: its truth or falsehood is a perfectly legitimate subject of inquiry, but the result neither increases nor diminishes the "region of marvel."

If with Sir Charles Lyell we affirm that the physical forces at present at work are sufficient to account for the changes undergone by the earth's surface in past ages, we do not render those changes either more or less wonderful than they were before—nor do we in any way account for them—we merely state them in a readily conceivable form.

So, if with the Progressionists, we conceive that species of living beings undergo transmutation at the present day; that this transmutation is from a lower to a higher type; and that all the kinds of living beings which have ever existed upon the earth's surface, have originated in this way; the idea is a perfectly legitimate one, and must be admitted or rejected according to the evidence attainable: but if fully proved, it would not be, in any intelligible sense, an explanation of creation; such "creation in the manner of natural law," would, in fact, simply be an orderly miracle.

In truth, every one who possesses the least real knowledge of the methods of science, is perfectly aware that "natural laws" are nothing but an epitome of the observed history of the phenomena of the universe; and to assert that the Creator, from whom these phenomena proceeded, worked in the manner of natural law and that, therefore, there is no scope for wonder, is as if one should say that, in ancient Greece, he worked in the manner of Grote's History, and that, therefore, there is nothing remarkable in Greek civilization—that is to say the phrase is simply ridiculous and unmeaning.

On the other hand, if by the expression, "creation took place in the manner of law," we mean only that the new phenomena were correlated together, or succeeded one another in a manner analogous to that in which certain phenomena are correlated or succeed one another at the present day, if we assert that the civilization of ancient Greece was developed in the same manner as the civilization of a new community at the present day; we have a scientific proposition which is intelligible and is capable of proof or disproof; but the demonstration of the analogy of two sets of phenomena, each of which is marvellous, does not, so far as we know, diminish the marvellousness of either. The production of Goethe and Schiller by German civilization, is analogous to that of Shakespeare and Milton by English civilization—but we do not perceive that the fact of the origin in [7] either case is thereby rendered less wonderful, or in any way explained.

Whether true or false, then, the scientific basis of the 'Vestiges' cannot bear out its speculative conclusions; for the progression theory, if true, would be no explanation of creation. But has the progression theory any real foundation in the facts of paleontology? We believe it has none, and for the following reasons.

In the first place, with respect to plants. We must altogether demur to the assumption at p. 54 Of the 'Vestiges,' that "the numerous fungi and other lowly forms, could scarcely have left clear memorials of themselves in the rocks, or in the masses of coal. "Lichens, at any rate, are hard and indestructible enough, and had there been a "cryptogamic age," in which the flora was composed of fungi, algae and lichens, we see no reason why the two latter should not have been preserved. But so far from there being reason to believe in the absence of higher plants in the early ages, the fact is, as even the author of the 'Vestiges' admits, at p. 59, that in Portugal, and in America, in the lower Devonian and even in the Silurian—that is, the lowest fossiliferous—rocks, not only ferns, but lepidodendra, which are among the highest cryptogamic forms, have been discovered. Even supposing then that the ludicrous classification of plants, quoted with apparent approbation, italics and all, from an article in the 'Quarterly Review,' by our Vestigiarh, were correct, the first plants would still be the very highest cryptogamia, and not low forms, as they ought to be.

There are two points which should be carefully remembered by every one who would understand the total inefficiency of the progression theory as applied to plants, but which are not mentioned by the Vestigiarh—the first is, that during the carboniferous epoch, ferns existed, so closely resembling those of the present day, that it is doubtful whether they are generically different (Lyell, 'Manual,' p. 310); and...
secondly, that the lycopodiaceæ and equisetaceæ of those days, were much more highly organised plants than any of their present representatives; so that we can definitely say, as regards the cryptogamia, that since the carboniferous epoch, there has been no advance in some respects, and a very decided falling off in others.

Precisely similar arguments apply to the lowest discovered remains of animals. These have been found in the Llandeilo flags, at the bottom of the Silurian system, and are cystideæ, graptolites, trilobites, [8] and linguleæ—the latter being the oldest and lowest. Linguleæ, however, are anything but the lowest in the scale of organization of their class; they have a well-developed intestine and well developed hearts, a nervous system, and long, peculiarly organized arms. So far from the brachiopoda being, as our author states (p. 199), "the first animals we meet with in this line, having parts capable of commemorating their existence," there lies beneath them, in the zoological scale, the vast series of the polyzoa, the great majority of which possess hard parts, eminently preservable; to say nothing of the tunicata, which the Vestigiarian, guided by his second-handed information, supposes to be unpreservable (ibid.); while, in fact, their integuments are always woody in composition and often so in hardness.

As to the graptolites, the assertion of the Vestigiarian, at p. 34, that they are "a humble polypian family," is untrue. All the evidence that we have leads us to believe, that they were either pennatulidæ which belong to the more highly-organized helianthoid polypes—or polyzoa, which are higher still. Here, again, the lower forms of polypes, the sertularians, are eminently preservable; so that had they first existed, the sponges and foraminifera, are the most easily preserved of all, from their calcareous spicula and shells; but of these hardly a trace has been found in the lowest strata. This fact is indeed adverted to in the Proofs and Illustrations (p. x. ii.), where the author, treating of the forms of animals in ascending order, illustrates his own geological lore by placing foramenifera (sic) after polypiaria.

Had the first crustaceans been low forms, we should have had daphnidæ and cyprideæ in the Llandeilo flags. What is the fact? The first crustaceans are trilobites, which, there is every reason to believe, resembled the limulus, the highest of the eitomomorastic crustaceans. However, supposing that the trilobites are very low crustacea, still, in the series of annular animals, annelids are below them, and should have been found earlier. The reverse is the case.

As respects the cystideæ, we must remark, that the absence of any living type which at all resembles them, should lead us to be excessively cautious in drawing conclusions as to their real nature, particularly if we consider the very extraordinary facts which Professor Müller's researches have recently revealed to us, with regard to the relation of the adult forms of echinoderms to their larvae; and which are a sufficient answer to Agassiz's dreams upon this subject, quoted at p. xiii. of the Illustrations. However, the author of the 'Vestiges,' in what he has to say about the crinoids and cystideæ, exhibits a [9] more dense ignorance as to the facts of comparative anatomy than is even usual with him. The crinoidea, says he, "might be compared to a lowly kind of star-fish fixed on the top of a flexible stalk, arising from the sea bottom. . . . . It is a very humble animal, only, indeed, a stomach, with arms wherewith to supply itself with food." We have a sort of notion, on the other hand, that some ten or fifteen years ago, one Johannes Müller—of whom our erudite Vestigiarian may, perhaps, have heard, in the course of his laborious and conscientious zoological studies—wrote a long essay upon the organization of the Pentacrinus Europæus, in which he showed that the crinoids have a spiral intestine, provided with a distinct anus,—thus standing higher than some asterideæ,—a very distinct water-vascular system, with ambulatory feet, and a blood-vascular system. In truth, the crinoids are as highly organized as the asterideæ; and the prevalent notion that they resemble the larval forms of other echinoderms, has been long since upset by the discoveries of Müller, Busch, &c., which demonstrate that all echinoderms, so far from being fixed, are locomotive active swimmers in their youngest stage; and that the larve of crinoids (comatula) resemble those of the highest holothuriadæ.

As for the other animals of the lower Silurian period, the Annelids and the Molluscs, the assertion at p. 41, that the paleontology of the lower Silurian period exhibits families, "generally speaking, low in their respective lines of gradation," is as little borne out for them, as for the others to which we have referred. The often-repeated conclusion drawn from the nautilus-like form of the shell of Lituites and other lower Silurian genera, that these were tetrabranchiate cephalopods, ceases, as Mr. Austen has well shown, to have much weight, when we consider, that if we did not happen to be acquainted with the animal, the same thing would be (and indeed was) said of Spirula; and again, it is more than probable that the Shell of Bellerophon is not that of a pteropod, but of a heteropod, the most highly-organized among the mollusca cephalopoda.

Such is the Fauna of the lower Silurian strata. It contains animals which are, to use the weakest phrase, far above the lowest in their respective lines, and of the very lowest classes of animals, sponges, foraminifera, and sertularian polypes—all of which are very easy of preservation—it offers few traces.

The facts which we have stated are notorious; they have been insisted upon by Sir Charles Lyell; they are taught every year by Professor E. Forbes, in his public lectures at the School of Mines; they are denied by no one; and it was, therefore, with a feeling closely allied to disgust that we perused pages 140 and 141 of the [10] 'Vestiges,' in which we find the barefaced assertion, that the doctrine of the progression of animal forms in time, is "only feebly disputed by one or two geologists;" that "it can be asserted, on the authority of the first naturalists of the age, that, in all the conspicuous orders of animals, there have been, in the progress of time, strong appearances of a progress of forms, from the more simple to the more complex;" that "the general fact of a progress in all the orders is not to be doubted;" while there is not the slightest reference to the explanation of the appearance of progression in some groups, afforded by the known laws of bathymetrical distribution, so admirably developed by Professor Forbes. It may be, however, that Forbes and Lyell are the "one or two geologists," whose opinions are treated with so much contempt by our Vestigiarian.
The most prominent argument made use of by those advocates of the progression theory, from whom the Vestigiarian derives his information, is drawn from the nature of the paleozoic fishes. Agassiz, the great investigator of these animals, whose lively fancy has done at least as much harm to natural science as his genius has assisted its progress, maintains that the Ganoid and Placoid fishes of the Devonian epoch, represent the embryonic stages of osseous, or, as he calls them, "more perfect" fishes, in their heterocercal tail, cartilaginous skeleton, and more or less persistent chorda dorsalis. The Vestigiarian, who parades Agassiz on all occasions as the philosophical naturalist of the day,—a circumstance in itself sufficiently indicative of his own scientific knowledge and judgment,—greedily seizes upon this notion, re-enforcing it in the Proofs and Illustrations of the present edition by the authority of the writer in the 'Quarterly,' from whom he quotes the following passage:

"It is no argument against the views that naturally arise out of the summary of the facts of Palæontology, as they are now known, to urge that 'the fish and reptiles of the secondary rocks are as fully developed in their organization, as those now living.'—Sir Charles Lyell... One of the leading distinctions amongst animals is the position of the skeleton; the great binary division of Lamarch into vertebrata and invertebrata was based upon this distinction; and Cuvier's supplementary labours, which made us better acquainted with the real nature and value of the invertebrate groups, have served in the main to confirm the reality of the great characteristic manifest in the internal or external positions of the skeleton.

"We have already adverted to the fact, that no completely ossified vertebra of a fish had been discovered in the strata of the Silurian and Devonian period. Those strata are of enormous extent, and have [11] been most extensively investigated. As regards the internal skeleton these primeval fishes were less fully developed than those of the tertiary and existing seas.

"[Their external or dermal skeleton] was not only developed in excess, as compared with the great majority of recent fishes, but presented in its form and structure a closer analogy to the exoskeletons of invertebrata than that of any known fish which possesses the same system of hard parts well calcified. In Pterichthys, Pamphractus, and Coccosteus—e.g., of the Old Red Sandstone rocks of Scotland, the exo-skeleton presents the form of large plates, either symmetrical, or articulated symmetrically by straight sutures, like the shell of the lobster. The large calcified dermal shield which protected the head of the Cephalaspis, has often been mistaken for that of a trilobite of the division Asaphus" (pp. xxiii.-iv.).

All this is ascribed by the Vestigiarian to Professor Owen, but we really must, however unauthorizedly, interpose to save the learned Professor's reputation, and to protect him against the ascription of supposititious writings, with which his known and published opinions are totally at variance. Is it conceivable that a man who ventures to write upon matters of comparative anatomy should be unacquainted with Professor Owen's Hunterian Lectures upon fishes? But the whole of Chapter VI. in that excellent work is devoted to a most successful demonstration of the non-embryonic nature of cartilaginous fishes, and the author speaks, not without some contempt, of the progressionists:

"Yet there are some who would shut out, by easily comprehended but quite gratuitous systems of progressive transmutation and self-creative forces, the soul-expanding appreciations of the final purposes of the fecund varieties of the animal structures, by which we are drawn nearer to the great First Cause. They see nothing more in this modification of the skeleton, which is so beautifully adapted to the exigencies of the cartilaginous condition of the reptilian embryo in an enormous tadpole, arrested at an incomplete stage of typical development. But they have been deceived by the common name given to the plagiostomous fishes the animal bases of the shark's skeleton is not cartilage..."

In like manner the modifications of the dermal skeleton of fishes have been viewed too exclusively in a retrospective relation with the prevalent character of the skeleton of the invertebrate animals" (P. 147)

And again at p. 148:

"These teleological interpretations of the dermal bony plates may [12] give some insight into the habits and conditions of existence of those Ganoid and heavily protected Placoid fishes which so predominated in the earlier periods of animal life in our planet; whereas these Ganoids and Placoids have hitherto been viewed almost exclusively by the light of the analogy of an embryonic 'Age of Fishes,' or explained by the hypothesis of transmuted Crustacea. Some have gone so far as to affirm that in all those solid parts that cover and shield the exterior of the body of the sturgeon and analogous fishes, there is nothing in the least analogous to any part of the internal articulated skeleton of the vertebrata; but that 'it is entirely a remnant of the superficial shells of the invertebrata.' You would hardly suppose, from these exaggerated expressions, that both Ganoid and Placoid plates are as richly organized and permeated by nutrient vessels as the bones within; and that they present the same microscopic structure as the ossified parts of the endo-skeleton which they serve to protect."

And in addition we find, in the arrangement of fishes "in the ascending series," at p. 47, that the Ganoid fishes are placed above the Cycloid and Ctenoid fishes, and the Placoid fishes again above them.

We cannot but think that any man who is acquainted with these published opinions of the Hunterian Professor, and can ascribe the article in the 'Quarterly' to him—or, on the other hand, who, not being acquainted with them, can dare to write on the Palæontology of Fishes, must have a superhuman allowance of the "aes triplex" about his conscience;—perhaps, however, as the incognito of the Vestigiarian does away for the necessity of the presence of this "exo-skeleton" in his countenance, the principle of "balancement" may account for its over-development in the other region.

Our critical arm, however, is really weary of smiting this straw giant, and it will be some relief to ourselves and our readers to digress for a short space on to the general question of the organization and position of the Ganoid tribes, inasmuch as they seem to us to form the key of the position of both the progressionists and their adversaries.

The arguments of those who maintain the low position of the Ganoid and Placoid fishes of the Palæozoic period, are the following:
(a) The imperfect development of their vertebral column, and its non-ossification.

(b) The existence of an extensive exo-skeleton.

(c) The heterocercal tail.

[13]

(d) The tadpole-like appearance of some genera, such as Cephalaspis, &c.; the position of the viscera, anus, &c., in these genera.

(a) To say nothing of Professor Owen's argument as to the possible teleological meaning of the comparatively soft state of the vertebral column--of the fact that it is ossified to a very considerable extent in a manner (loc. cit., p. 147) totally different from that of an embryo--and of its histological difference from the embryonic tissue, we find that the amount of cartilage in the vertebræ, or the incompleteness of the ossifying process, bears no relation whatsoever to the position of the fish in the scale, or to the rest of its organization. This is, we know, a bold assertion, but the facts are open to every one. If we compare, for instance, the vertebra of a shark with that of a pike or salmon, we shall find the amount of osseous matter and its arrangement to differ very little (see Williamson, loc. cit.); while, on the other hand, in the Helmichthydæ--a highly interesting class of fishes, to which Professor Köliliker has lately directed particular attention--the vertebral column contains a complete chorda; and though this is surrounded by flexible thickened portions which represent the bodies of vertebra, these are not true vertebrae, but mere thickened and slightly calcified portions of the sheath of the chorda. But these Helmichthydæ unquestionably belong to the division of the Mureniæ, and, as Köliliker says, "are osseous fishes, almost without bones, with a chorda extending to the skull, and almost a vertebrate."

Again "the skeleton of the Lepidosiren is said by Professor Owen to manifest," upon the whole, the highest grade which is attained in the class of fishes (loc. cit. p. 83; but in this very fish the embryonic state of the bodies of the vertebrae as a continuous chondrogelatinous chord remains, though the neur- and par-apophyses, many cranial bones, and the maxillary, mandibular, hyoidean, and scapular arches are well ossified (loc. cit. p. 57). Well worthy of the attention of palæontologists, especially as contrasted with the paragraph from the 'Quarterly,' above quoted, is this important passage, at p. 57 of the same work:

"The fact of many fossil Ganoid fishes showing the same parts of the skeleton petrified and undisturbed, but without a trace of the central elements of the vertebrae, shows that the transitorial condition of the Lepidosiren skeleton was not uncommon in the primæval [14] members of the class. So far as the observations of M. Agassiz have extended, not one of the fossil fishes hitherto discovered in the Silurian and Devonian rocks, the most ancient in which remains of that class have been found, manifest a vertebral centrum; and not many have shown neural and haemal arches and spines."

Here we have the highest authority for believing that the Lepidosiren is the highest member of its class, that it has an unossified vertebral column, and that the Silurian and Devonian tribes resembled it in this respect. What becomes, then, of the reiterated argument as to the inferiority of the Ganoid fishes, drawn from this very fact?

(b) It is amusing to finding writers who argue to the low position of the Ganoid fishes from their resemblance to vertebrate embryos, in the same breath urging the excessive development of the exo-skeleton as confirmatory of their views. Is it not perfectly clear that so far as the Ganoid fishes have an exo-skeleton, they depart from the organization of a vertebrate embryo, and that, therefore, the two trains of reasoning are inconsistent? So far as their exo-skeleton approaches an invertebrate development, to precisely that extent they diverge from embryos, which have no exo-skeleton. But it is true that the Ganoid exo-skeleton in any way approximates that of the vertebræ or that it is more developed than that of osseous fishes? We totally deny either statement. The arrangement of the plates upon a Pterichthys, or Holoptychus, or a Coccosteus, is totally unlike anything articulate--unless that notable analogy brought forward by the author of the article in the 'Quarterly,' that they have straight sutures--"like the shell of a lobster" (an M in Macedon and an M in Monmouth"), is to have any weight; or that still more forcible evidence that somebody has "mistaken" the head of a Cephalaspis for that of an Asaphus. The author of the 'Vestiges' has "mistaken" the pen of the 'Quarterly' reviewer for Professor Owen's--would a sane man take this as evidence of the fact?

In the second place, it is not true that the Ganoid exo-skeleton is either more extensive or better developed than that of osseous fishes, unless mere thickness is to be called better development. It seems to be forgotten that a perch has as complete an osseous covering as any extinct Ganoid fish; every scale being as truly a bony structure as the bones of its endo-skeleton; and that the scales of the Gurard and Trunk and File fishes are as thick and as strong as those of any extinct Ganoid.

(c) Similar arguments apply to the heterocercal tail-fin; the Lepidosiren, "the highest fish," has no tail-fin at all; a particular in [13] which it is exactly resembled by Coccosteus, Pterichthys, and Cephalaspis; which have been on this ground, among others, relegated to the lowest division. Again, the "Salamandroid Lepidosteus, with its lung-like air bladder," is, among the Ganoid fishes, accounted the highest by reason of the ball and socket structure of its vertebrae, but it has a heterocercal tail; while the Amia, which has ordinary vertebrae, has the tail homocercal. Surely criteria like these, which can be shown to fail in obvious instances, should hardly be applied to so obscure a subject as Palæontology.

(d) Perhaps the most singular mode of proving the inferiority of organization of Cephalaspis, &c., however, is by comparing them to tadpoles of Batrachia (Agassiz). Surely, if this argues anything, it is that they are higher than other fishes. The grounds of the comparison are worth noting; they are these: the large head, undistinguished from the thorax the aggregation of the viscera anteriorly--the position of the anal fin and vent immediately behind the cephalothoracic expansion; and the appropriation of the rest of the trunk for locomotion. Any one
who will go into the market and buy a sole, may satisfy himself that on these grounds that unhappy fish has hitherto been raised beyond his proper position, and is no better than an upstart tadpole; and the Gymnotus and the Amblyopsis, will no less learn to "begin with shame to take a lower place."

We must hold, then, until altogether new evidence is brought to bear upon the point, that there is no evidence whatever to show that the extinct Ganoid fishes were not as highly organized as the recent Lepidosiren: that the strong presumption is that they were, and therefore that so far from resting content with Sir Charles Lyell's modest supposition, that "the fish of the secondary strata are as fully developed in their organization as those now living," we might very reasonably assume that they were more highly organized, inasmuch as the Lepidosiren is more highly organized than any other fish.

It may be readily comprehended what validity there is in the whole argument of the 'Vestiges,' as regards the successive development of life upon our planet, when its foundation appears to be thus baseless and rotten. We have submitted this portion of the work to a more detailed criticism, because its positions are maintained by some whose opinions are entitled to respect; the rest has no such claims upon us, and neither space nor inclination allow us to do more than lay before our readers specimens of a farrago, of whose value they may thence judge. We must remind them that this is the tenth edition of the book, "with extensive additions and emendations."

[16] The Physiology of the Vestigiarian:--

"Nutritment is converted into these (nucleated cells) before being assimilated by the system." (p. 127.)

"The Volvox globator can hardly be distinguished from the germ which, after passing through a long foetal progress, becomes a complete mammifer, an animal of the highest class." (p. 128.)

"The globules of the blood are reproduced by the expansion of contained granules." [!] (p. 128.)

Pages 133-138 are occupied by all the old nonsense about the Entozoa and Mr. Crosse's Acartis.

At p. 144, it is stated that the mammalia in the foetal state "have a branchial apparatus. Afterwards this goes back, and the lungs are developed from a different portion of the organism." The bronchial clefts are here absurdly mistaken for a branchial apparatus.

Page 148. "Amongst phanerogamous plants, a certain number of organs are always present, either in a developed or rudimentary state." [!] We should be glad to be informed in the next edition what these organs are, and what their number.

At page 166, the Vestigiarian quotes Dr. Carpenter, to the effect that each germ must have a certain peculiar definite capacity of development, and makes the following sapient commentary:

"I would venture to remark that, without seeing the germ of a particular being maintain in the tendency to the parental form in the nidus of an animal specifically different from its parent, we are not entitled to assume that it has 'a certain capacity of development peculiar to itself.' Its capacity of development may be quite indefinite, and only bound down to the attainment of the parental form by being kept and nourished by the parent." (p. 166.)

Has this profound naturalist ever heard of a cuckoo, or of an ichneumon fly?

The knowledge of the Literature of the subject possessed by the Vestigiarian.

At page 147 we are told:

"Embryonic Development, first surmised by the illustrious Harvey, afterwards illustrated by Hunter in his wonderful collection at the Royal College of Surgeons, Embryonic Development has latterly become a science in the hands of Tiedemann, St. Hilaire, and Serres."

If the Vestigiarian had ever read a page of Harvey, he would find him quoting his predecessor, Fabricius, who like himself by no means "surmised," but worked out development in the chick. No mention of Wolff, or Von Baer!

At p. 171, the theory of the Alternation of Generations, one of the [17] best established and most notorious scientific generalizations of the day, is talked of as a "late curious investigation by a Danish naturalist;" and we are told, patronizingly, that "Such matters are as yet obscure, however highly they may promise in time to illustrate this question." This ignorance is the more unpardonable, as though the author of the 'Vestiges' is totally unacquainted with foreign literature, the perusal of Professor Owen's 'Parthenogenesis,' published years ago, would have been simply sufficient to give him more just ideas. But we suppose it was pleasanter to generalize than to learn.

The comparative Anatomy of the Author of the 'Vestiges'.--

"The Tunicata are similar in all essential respects [to the Brachiopoda and Lamellibranchiata] except in being of humbler organization." [!] (p. 199.)

"Between the invertebrate animals and the fishes, the junction is tolerably clear at one point. This is where the cephalopodous mollusks connect with such fishes as the myxine or hag, and the lamprey . . . . . The affinity to the cephalopods is fully admitted. It is seen in the nature of the skeleton, in the character of the investing skin which ejects a copious secretion whenever the animal considers itself in danger, in the power of respiring through the gill apertures without any dependence for that function on the mouth, and in the eight free filaments seen in some species extending forward from around the mouth." (p. 208.)
This choice morsel of zoological reasoning may be left to itself, especially as a few lines further on, we have the old nonsense about the cephalopod being a vertebrate folded upon itself (which was exposed and set aside twenty years ago by Cuvier) formally reproduced. The assertion which we have signalized by italics is quite an effort of genius as a piece of effrontery.

At p. 210, the humbler forms of fish are said to approach the annelides, which is equally untrue; and a little further on we find it said that the fistularide approximate the vertebrata. [1]

Surely we have waded far enough through this lumber-room of second-hand scientific furniture, this attempt to build a tower of Babel heaven-high with half-burnt bricks; at any rate, far enough to convince the reader that however the Vestigian may wince under the remark, Professor Sedgwick was quite justified in asserting that he is "not only unacquainted with the severe lessons of inductive knowledge, but possesses a mind apparently incapable of comprehending them."

We look for evidence of knowledge, and we find what might be picked up by reading 'Chambers's Journal' or the 'Penny Magazine.'

[18] We look for original research, and we find reason to doubt if the author ever performed an experiment or made an observation in any one branch of science. We seek for acuteness of thought, and we find nothing but confusion of ideas, and an ignorance of the first outlines of speculation. A spurious, glib eloquence, an affectation of reverence for truth and of scientific modesty, are not wanting to remind the curious observer all the more strongly of the total absence of that careful research and fair representation of both sides of a question, which should be the first-fruits of the latter qualities.

The author of the 'Vestiges' plumes himself greatly, and is much praised by others, for the calm and philosophic style of his book; and he complains bitterly of the opposite tone adopted by certain of his reviewers, especially by Professor Sedgwick. The handling of the Woodwardian Professor may have been a little more rough than should be seem a Cambridge Don; but to a thorough, an earnest, and above all, a genial man, who has made truth the search of his life, and knows the difficulties of the road and the stern practical discipline required for success—to such a man, a Hotspur resting after the extreme toil of the fight, there is a source of wrath, such as the author of the 'Vestiges' is obviously quite unable to, understand, in the cool interposition of a mere sciolist with his "hypotheses" in a neat pouncet box, who would have been an astronomer—but for sitting up at night; a geologist—but for soiling his fingers; a physiologist—save for "the dirty and unhandsome corse;" attempting to divide the spoil he was incompetent to win, and cutting his fingers with the weapon he is unable to handle.

But truly, as a man sensitive to criticism, and particular about the preservation of his own incognito, our Vestigian conducts himself somewhat oddly. In a note (p. lix., Appendix) to the present edition, forgetting the garb of meekness assumed throughout the text, he ventures to sneer at Professor Sedgwick and the "mechanical department of the one science in which his name has a place," and at Dr. Clark, of Cambridge. It is needless to justify the reputation of either of these gentlemen against such attacks; but we dare venture to predict, that should the author of the 'Vestiges' ever be so ill advised as to let his name be known, it will be found prominent neither in the mechanical nor any other department of even one science—unless the science of a Mechanics' Institute, which is about the calibre of our author's, is to be called a mechanical department of science. And however proud our Vestigian may be of his notoriety, we may remind him, that had Dr. Clark, of Cambridge, whose extensive knowledge and sound judgment are well known, [19] been so misguided as to write the 'Vestiges' in his student days (as any sharp, careless lad might), he would simply have burnt it subsequently; and yet, though he had thereby escaped being known 'outside the walls of Cambridge.' his scientific reputation, in the mind of every one conversant with these matters, would have stood incomparably higher than if he had published it. Any man of science of ordinary judgment has considered and rejected the notions which the author of the 'Vestiges' advances as great facts.

Not less remarkable than the infelicity of his sarcasm is the want of knowledge of the etiquette usual among authors displayed by this unfortunate scientific parvenu. An article which appeared in the 'Quarterly,' and to which we have already made frequent reference, is repeatedly quoted, and attributed to Professor Owen, obviously without authority. In any case the attribution of anonymous writings without very good grounds is a proceeding in very questionable taste, and in the present instance it is particularly so; for, to say nothing of that wonderful classification of plants into Cryptogamia, Phenogamia, Gymnosperms, and Dicotyledonous Angiosperms which the Hunterian Professor must feel truly gratified to have laid to his account, the paper in question contains a most unjust and unworthy reference to a gentleman whose scientific zeal, extensive information and kindly readiness in communicating it, have won him the good-will and respect of every one but the writer of that article—we mean Professor Quekett. To ascribe to that gentleman's nearest colleague this underhanded attack upon him, is a most marvellous béïte, not less remarkable than the critical sagacity which would fain make Professor Owen express opinions which are in direct contradiction, as we have shown, to his published works.

In conclusion we cannot address to our Vestigian a peroration so condescendingly benevolent as that with which he leaves Professor Sedgwick. (Proofs, li.) We do not "part with him in perfect good humour," but in a very bad humour. We desire too much to have some value set upon our praise, not to speak boldly where great demerit calls loudly for censure. In the popular mind the foolish fancies of the 'Vestiges' are confounded with science, to the incalculable diminution of that reverence in which true philosophy should be held; and we should be unjust to our readers, and false to our own belief, if we commented upon them in any terms but those of the most unmitigated reprobation.

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[1] "Now we suppose it will be admitted the Cryptogamia, Phenogamia, Gymnosperms, and Dicotyledonous Angiosperm, constitute a succession, and a progressive one."
See, also, Owen, loc. cit., p. 13. "Sharks and rays, called amphibia nantes by Linneus, "in explanation of the phrase "higher fishes," in the text.

See Professor Williamson: Structure and Development of Scales and Bones of Fishes. Phil. Trans., 1851.