Inquiries into the philosophy of zoology / by R. Knox.

Trifolium procumbens. Hop Trefoil.

Probably the plant from which Mr. Gregson bred Coleophora deauratella (Zool. 4030). It is sad that a half-made observation like this should be allowed to relapse into obscurity.

Lotus corniculatus. Bird's-foot Trefoil.

Speyer mentions as feeding on this plant, Leucophasia Sinapis and Thanaos Tages. This plant is rather favored by the larvæ of Tineina, or probably it would be more correct to say that it has undergone more careful scrutiny; Gelechia ligulella feeds between united leaves in May, Gracilaria Kollariella mines the leaves in July, Coleophora discordella feeds on the leaves in autumn and May, and a Nepticula (not yet bred) mines the leaves in July.

H. T. Stainton.

Mountsfield, Lewisham, July 16, 1855.

Inquiries into the Philosophy of Zoology. By R. Knox, M.D., &c.

Part I. — *On the Dentition of the Salmonidæ.*

Zoologist August 1855

In the admirable volume of the 'Histoire Naturelle de Poissons,' in which my esteemed friend M. Valenciennes has discussed the natural history of the Salmonidæ, that distinguished naturalist lays down a doctrine that, in respect of the division of the Salmonidæ into genera or subfamilies, the dentition is the only natural-history character to be absolutely depended on, and that, in point of fact, it has never failed in his hands.

To arrive at this conclusion M. Valenciennes has been forced to exclude from all consideration the natural history of the young, alleging, what no doubt is true in a certain sense, that "the naturalist, as a naturalist, is concerned with or interested only in the adult." By this view, however, my friend embarrasses himself, without seeming to be aware of it, with the difficult question of *age*. Anatomists know well that the *adult* condition is not so easily determined even in mammals, and much less in fishes.

In accordance with views and researches conducted in this spirit, my esteemed friend arrives at the conclusion that the Salmonidæ now

living on the globe, form three distinct subfamilies or genera to be clearly and always distinguished by their dentition. To these three genera or subfamilies he appropriates the names of, 1st, Salmo, 2nd, Forelle or Fario, and 3rd, Salmo Trutta or Trout, names not new to naturalists, though new, perhaps, in their strict application to the three subfamilies of the Salmonidæ, long known and distinguished in Britain as salmon, salmon or sea trout, and trout. These subfamilies then correspond with the arrangement of many European naturalists who know them by the names of salmon, salmon-trout and trout: the salesman, on the other hand, speaks of the Salmonidæ as of two kinds only, — with him what is not salmon is trout, — regardless of affiliations with species higher or lower in the scale, he looks only to the market-value of the fish.

To understand the question at issue between M. Valenciennes and myself, I may first remark that the text of my friend is not clear; the engravings inaccurate and unworthy the high character of the work. It is difficult, as I have experienced, to get artists to copy exactly what is placed before them. The errors in the engravings alluded to must be ascribed to the artists employed; the obscurity in the text M. Valenciennes, no doubt, will himself explain.* Proceeding on principles directly opposed to those of M. Valenciennes, I select, as the starting-point of the inquiry, the dentition of the young of the Salmonidæ; one of the objects held in view being to ascertain whether it be correct to say, in all cases, that "the adult salmon is to be characterized by the persistence of certain vomerine teeth only; the forelle by the presence of others superadded to those of the salmon; the Salmo Trutta by the presence of a dentition wholly distinct from both." The whole of my researches are opposed to this view, which, although seemingly practical, is really not so. It may further facilitate the clear apprehension of the object and results of these inquiries, and their bearing on some important points in the Philosophy of Zoology, if I, in the first place, lay before my readers the dental formula arrived at by M. Valenciennes and subsequently the results of the inquiries I have made into this matter, from which I think it will be manifest to the scientific naturalist that the natural-history arrangement of the Salmonidæ adopted by M. Valenciennes is inadmissible.

1st. The true salmon, observes this distinguished naturalist, is cha-

* Whilst occupied with the correction of the proofs of this memoir, I have just been informed of the death of my most amiable and esteemed friend.

racterized by the presence of certain teeth, placed transversely on the fore part (*chevron*) of the vomer, the rest of the bone being edentulous.

2nd. The forelle or Salmo Fario of all countries and localities may at once be recognized and arranged by the presence of transverse teeth on the chevron of the vomer, and by a single row of teeth extending backwards along the body of the vomer, mesially.

3rd. The trout of all localities is known by a double row of teeth on the body of the vomer, the transverse teeth on the chevron or fore part of the bone being absent or but little distinct (*peu distincte*).

This arrangement is so simple, so clear, so seemingly practical, so easily understood, that one feels a reluctance to disturb it: it reminds me of the arrangement of serpents by their dentition, prior to the extension of the inquiry into the Indian species and those of the Japan seas; like it, the formula applied so well to certain genera of Europe and perhaps of Africa that it was the most natural thing in the world to believe it universally true; but it failed in presence of a more extended inquiry, as the natural-history arrangement of M. Valenciennes, in respect of the Salmonidæ, will be found to do.

I. Select a salmon of such a size, say 30lbs. weight, as to leave no reasonable question of its adult condition, and the dentition will, generally, be as follows:—

Upper jaw.—Maxillary and intermaxillary teeth. .	35 + 35	=	70
Palatal teeth.	17 + 15	=	32
Vomerine (called by some middle palatal) on the chevron 4; on the body, mesially and behind the others, 1 or 2.			6

Now these teeth of the vomer vary much, even in the adult, for sometimes there are none on the body of the vomer, and the transverse may be five in number or reduced to one or two.

In the lower jaw and on the tongue there are,

1st. Mandibular teeth.	18 + 18	=	36
2nd. Lingual teeth.	5 + 5	=	10

As the teeth of fishes, like those of serpents, are constantly being shed and replaced by others, the number of *fixed teeth* becomes unimportant as a natural-history character. Not so the number of mucous cavities destined to receive the teeth; these, no doubt, are constant and determined from the first. I reckon the dentition, therefore, by the number of these mucous cavities destined to receive

the teeth, and not by the number of teeth actually present. So long as these narrow mucous cavities are present, teeth either forming or fixed will be found in connexion with them: their absence implies that the dentition has been exhausted, and that the bone now edentulous will carry no more.

Now, examine the mouth of a true salmon of some 4 or 5 lbs. weight, and, in addition to the transverse teeth on the *chevron*, you will find a single undulating and somewhat irregular row of teeth extending backwards on the body of the vomer, varying in number, but always present. Were this specimen to be classed by the method of M. Valenciennes, it would be called a Forelle, Fario or sea trout, but we know it to be a pure salmon, though with the dentition of the Forelle. M. Valenciennes would no doubt say, "my formula applies only to the adult salmon, and this is evidently not an adult." I admit the force of the objection, so far as it goes, and shall proceed with my inquiry, at the same time remarking that the natural-history character, which not merely fails in recognising a salmon of 4 lbs. weight to be a salmon, but which, if attended to, would lead the naturalist to an entirely false view, cannot be viewed as one of any value.

Now, look into the mouth of a salmon about a foot in length, and the dentition of the vomer will be found to consist of, 1st, transverse teeth anteriorly on the chevron; 2nd, posterior vomerine teeth consisting of a double undulating row, as in the common river trout.

Lastly, as regards the true salmon, look into the mouth of a salmon smolt a few inches in length, and the dentition will be found such as I have just described it to be.

Thus, the dentition of the salmon, from the smolt to the adult, passes through a series of metamorphoses, representing the adult dentition of all the species of the Salmonidæ I have yet examined. The edentulatory process then, in the salmon, is not an accidental chapter in its history, but a philosophical reading of its affiliations with all the salmon kind.

II. The practical history of the dentition of the Forelle or Fario, the sea trout of British naturalists, is the same as in the salmon. As a smolt, it resembles in its dentition, with all other species of the Salmonidæ, the common trout. At a pound weight it still retains a double alternating undulating row of teeth on the body of the vomer, together with a distinct cluster on the fore part of the bone. At 3 or 4 lbs. weight the mesial row of the vomerine teeth from being double has become single; when larger or heavier, and presumed to be older,

these mesial teeth begin to fall out and are not replaced, the teeth on the chevron remaining to the last. In the sea trout, as in the salmon, the progress of edentulation is from behind forwards, and the process goes on until they are not unfrequently reduced to two or three, at which point, in respect of its dentition, the true salmon and the Fario are identical, or nearly so.

Thus the dentar formula of the French naturalist is again at fault. By it alone, the true salmon, from the smolt upwards to the fish of 2 lbs. weight could be distinguished neither from the common trout nor sea trout or forelle; and now we find, that by it alone, the full-grown forelle can scarcely, if at all, be distinguished from the true salmon.

III. Let us now apply the formula to the fish called the Salmo Trutta or common trout, lacustrine and riverine. In the young of all species the dentition is the same. The vomer carries the two kinds of teeth, the transverse and the longitudinal, perfectly distinct. The posterior are arranged in a double interrupted or undulating row, and extend well back on the body of the vomer; the group of teeth in front, already spoken of as the transverse teeth or those of the chevron, are well marked, and quite identical with the species of all the genera of the Salmonidæ. In certain large lacustrine trout I have examined, weighing from 6 to 12, and in one of 20 lbs, there was a double row of teeth on the body of the vomer, but the anterior group on the chevron had disappeared. Thus the law of edentulation in these lacustrine trout was the reverse of that subsisting in the true salmon and Fario, but I do not mean this to be applied to all the species of lacustrine trout, for I have not examined all; and the longer I live and the more extended my inquiries are, the more deeply am I convinced of the error of applying natural-history views derived from the examination of species and genera of one continent or of one country to those of another. Nature admits not of the restrictions laid down by naturalists; an European fact is not an African or Asiatic one,—still less is it kosmic.

As to the river trout I have examined, from a few ounces to 10 or 12 lbs. weight, I have found the law of their dentition to be a double row of teeth upon the body of the vomer, and, in addition, a group of transverse teeth on the fore part of the same bone, perfectly distinct. That there may be riverine species which lose the anterior group, and others which retain these but lose the posterior or mesial, I will neither affirm nor deny; I speak only of what I have seen. For reasons to be afterwards stated, I am inclined to think that this will be found to be the case.

IV. I shall now place before my readers, as briefly as I can, the result of multiplied researches into this subject. As a transcendental anatomist, I naturally commence with the dentition of the young; in its history we have the key to the numerous exceptions, rendering M. Valenciennes' law inapplicable, and to the anomalies and embarrassments of naturalists and others. If we commence the inquiry into the history of the dentition of the Salmonidæ at a stage of their growth when the size of the teeth admits of ready and sure inspection,—let us say in a fish from $2\frac{1}{2}$ to 4 inches in length, we shall find that whatever be the species examined, the dentition is the same. It consists of

Upper jaw.—Maxillary teeth	19 + 19	=	38
Intermaxillary do.	9 + 9	=	18
Palatal	15 + 16	=	31
Vomerine (anterior group or transverse mesial and posterior in a double row)			16
Lower jaw.—Mandibular	18 + 18	=	36
Tongue.—Lingual	5 + 5	=	10

Thus, as regards the dentition, the young of the Salmonidæ is of no species, but a generic animal, whose nearest approach as to type in the adult animal is the common river trout. It possesses all the teeth which any species of the natural family ever has, and more than any adult of any other species, and even in this respect is the perfect animal, *i.e. perfect generically.* By growth, which means merely the metamorphoses or transformations it has to undergo before acquiring its speciality, the generic young of the Salmonidæ simply loses certain teeth, which are not replaced; it does not acquire any new ones not already existing. As the changes are most remarkable in the system of the vomerine teeth, I shall confine my remarks to these.

1st. If the young fish is to grow up a river trout simply, it retains, as seems to me, in some species at least, all its vomerine teeth to its adult condition. I have examined large river trout of England, and such I have found to be the arrangement: the transverse or anterior cluster of vomerine teeth, which M. Valenciennes assumes to be absent in the adult of all trout, are quite as distinct and as large as those on the body of the vomer. Here is the dentition as regards the vomerine teeth of a Kennett trout (Hampshire) caught in the waters of Popham, weighing $9\frac{3}{4}$ lbs.; the anterior cluster of vomerine teeth are large and distinct; they are five in number; they are followed by a double row of teeth on the body of the vomer, also quite distinct;

these are ten or twelve in number. I have also examined a large Thames trout, weighing 5½ lbs.; it has a double row of teeth on the body of the vomer, and a group of perfectly distinct teeth on the chevron of the vomer. There is the skeleton of a very large river trout in the College of Surgeons, in London; the specimen is not favorably placed for the examination of this question, but so far as I can observe, the teeth are arranged as in the Kennett trout: thus, contrary to M. Valenciennes' view, these species of trout are not characterized by the absence of the anterior group, but, by the presence of a double row on the body of the vomer, which I have found to apply to all trout; all are characterized by a double row of teeth on the body of the vomer, but as regards the transverse or anterior teeth, some lose them and some do not; the river trout seem to retain them to the last, and M. Valenciennes admits that they are present in the beautiful trout of the Moselle, that species which he assumes as the type of his genus Salmo Trutta. Here is the description of the dentition of the trout of the Moselle by M. Valenciennes himself: "Il en existe un seul rang, sur chaque palatin et celles de vomer disposées sur deux rangs, sont divergentes aussi même plus fortes; aussi une petite rang transversale sur le chevron."* The trout of Baillon, which M. Valenciennes at first mistook for a salmon, until put right, as he admits, by the fishermen, has a double row of teeth on the body of the vomer, and a complete set of transverse teeth. Now this determination he arrived at from the examination of a young fish 13½ inches long; but with years, the trout of Baillon may lose some of these teeth and assume a different character; in as far, then, as regards the dentition of a Baillon trout of 13½ inches, the fish might be either a common river trout, a sea trout, or a salmon, for at that age the dentition is nearly identical in all; and thus the subfamily to which the Baillon trout belongs has not been determined by M. Valenciennes, and cannot be by his method in a fish of the size quoted.

On the other hand, in certain large lake trout, reported to me as from Ireland, the anterior cluster of vomerine teeth was absent or had disappeared, there remaining on the body of the vomer a double row of teeth: these trout were of great size: now this is the dentition which corresponds to M. Valenciennes' idea of a real trout, but we have seen that it does not apply to any river trout I have yet examined, nor to those of France, nor even rigorously to the celebrated

* Page 321, 8vo edition.

Leman trout, which has teeth on the chevron of the vomer. The adult lake trout I speak of were dark spotted trout with pink-coloured flesh. They all had a double row of teeth on the body of the vomer, whilst the anterior group, called transverse and teeth of the chevron by M. Valenciennes, had disappeared. That they were once present no one can now doubt; the law therefore of edentulation (for, in point of fact, it comes to this) in the lake trout of the species I now speak of, is to lose the anterior group of the vomerine teeth and to retain the double row on the body of the vomer to the last.

On the other hand, in a 4 lbs trout of Loch Leven, the largest of that peculiar species I have yet examined, the anterior clustered vomerine teeth were present, whilst those on the body were assuming the form of a single undulating row, which possibly in time they would have become.

Lastly, M. Valenciennes admits, that in the mouth of the trout of the Moselle, which he views as the type of the order, the clustered anterior teeth are distinct as well as the double row on the body of the vomer, thus excluding the species forming the type of the order from the law he intends shall apply to all.

Thus, the law of M. Valenciennes does not apply to the trout of British rivers nor to those of certain lakes, whilst it expresses the dentition of others. It is not then a safe guide for the determination of the subfamily, Salmo Trutta. Let us now test its accuracy in respect of the remaining subfamilies, the forelle or salmon trout and the true salmon.

If we trace the young of the forelle in its progress towards the adult fish, we shall find that up to a certain weight it retains its original generic dentition, that is, it resembles strictly that of all the salmon kind. At this stage of its growth or metamorphosis it could not be distinguished by the dentition alone from the Salmo Trutta or from the true salmon of the same size: yet neither the salesman, nor the naturalist, nor even the angler, lowest in the scale of observers, experiences any difficulty in deciding on the nature of the fish before him. They do not look at the teeth; they have other much surer characteristics, even at that age. Tracing the forelle until it attains a considerable size, we find at last that the body of the vomer presents a single row of teeth; but the same edentulation has happened to the salmon of the same size: in both, this single row is finally reduced to one or two teeth, and may in both ultimately disappear; even the clus-

tered teeth are ultimately reduced in the very large salmon and sea trout to two or three.

The law of edentulation, then, in the Salmonidæ is curious and interesting, the result seemingly of generic and specific influences. Certain of these difficulties are removed by tracing its history from the young, *i.e.* the generic fish, onwards. In it we find a type including all; it alone is perfect, the species being characterized by a loss of parts and not by any superadded organs. To this conclusion I had long ago arrived by other routes. What is true of the dentition we shall find to hold good in respect of some other characteristics of the generic animal, and to these, after a few additional remarks, I next proceed.

Up to the length of 13 or 14 inches, the dentition in all the subfamilies is nearly the same; at 2 lbs weight the dentition of the forelle and salmon is identical. They are both beginning to lose the teeth of the body of the vomer, and often show a single instead of a double row. At 6, 8, 10 or 20 lbs weight, both have lost the greater number of the teeth on the body of the vomer, but still retain those on the chevron. There may be certain species of the forelle or salmon trout which retain, to a large size, a single row of teeth on the body of the vomer, but I have not met with them.

Throughout the preceding observations I have confined my remarks, with but few exceptions, to species and subfamilies I have myself examined and can command; not that I distrust the observations of others, for what observations can, for example, be more fully depended on than the valuable contributions to Science of my most esteemed friend, Sir John Richardson. If a reference be made to his admirable work, the 'Fauna Boreali-Americana,' it will there be found, that the formula in use by M. Valenciennes, will not, cannot be applied with any success to the vast number of species of the Salmonidæ which people the seas and rivers of the great Continent of America. The Mackenzie River salmon, for example, must be rejected altogether from the natural family of the Salmonidæ, if the dentition alone be regarded, for it has the teeth *en velours*, or like the pile of velvet in narrow bands, and the upper maxillary bones carry none. The Salmo Rossii has thirty teeth on the tongue. Is Scouler's salmon (*Salmo Scouleri*) a salmon, a Fario, or a trout? The palatine and vomerine teeth are implanted in double rows, and there are none on the chevron of the vomer: here is a true salmon, for such I esteem it to be, with a dentition wholly peculiar. The great lake trout of North America has a cluster of

teeth on the anterior part of the vomer, and a double row behind, and herein is directly contrasted with the British lake species. In the common trout of New York there is a triangular cluster of about ten teeth on the anterior part of the vomer: no mention is made of any posterior rows. Such exceptions could be much multiplied; they are sufficient to prove that a dentar formula applicable to the adult Salmonidæ of all species has not yet been found.

Section II.

As it is by the exterior and not by the interior, that Nature chiefly specializes all animals, bestowing on them those outward forms, colouring and proportions, by which they are known to men and animals,—enabling man to distinguish at a glance the lion from the tiger, the zebra and ass from the horse and mule, the dog from the fox and wolf, which the interior, though examined by the profoundest anatomist that ever lived, scarcely enables him to do,—so I return to the exterior of the Salmonidæ to look for other proofs of the existence of the law I now seek to establish; the law by which I endeavour to give the genus or natural family a real existence; to reduce it to materiality; to include it within the range of legitimate science, and to submit it to intuitive or direct inspection; to prove, in fact, the young to be of no species, a generic being, invisible as such to the bulk of mankind, but real, tangible and visible to the scientific.

Coloration of the Salmonidæ.

The system of coloration of the Salmonidæ is either specific or generic. When the individual is in prime condition, perfectly developed, pure in breed, and adult, in as far as we can well determine, the coloration may then be considered specific, may be assumed as unalterable, in a certain sense, and characteristic. Viewed in this way, the coloration, 1st, of the true salmon may be briefly defined as silvery scaly, with a few dark or purple spots above the lateral line; 2nd, of the forelle, less silvery, with numerous dark spots above and below the lateral line; 3rd, of the lake trout, dark or purplish spots, more or less numerous, above and below the lateral line, and of the river trout, red spots more or less numerous above and below the lateral line. Lastly, certain river trout retain throughout life transverse bars composed of numerous minute dark spots; these I shall call parr-markings, as they are most distinct in the little fish

which in France is called *tacon*, in Scotland parr, in England fingerling, a fish of doubtful character, and whose real nature has not yet been clearly determined. I do not mean that these arrangements include all the species of the three subfamilies of the Salmonidæ; but the arrangement is of unobjectionable accuracy, in so far as it goes. There are many foreign species, no doubt, filling up all the gaps in each subfamily, but these have not been, as yet, sufficiently described.

Such is the specific coloration of the three great subfamilies generally. What is the generic coloration, that, namely, which includes all these? What is the coloration of the young, the generic type of the entire family? To describe it, we have only to examine the young of any of the species of any of the subfamilies, and we shall find that its coloration embraces all,—red spots, dark spots, of various hues, parr-markings, silvery scales. The generic animal then is perfect, and represents Nature's scheme; as it grows towards maturity it gradually lays aside its generic characters, retaining the special; if it is to become a river trout it retains the red spots, losing the others; one species, the parr trout, retains, with the red spots, the parr-markings; if a lake trout it loses the red spots, and retains the purplish and dark ones; if a sea trout or forelle it retains the dark spots only; if a salmon it loses all, saving a very few; the fewer it has, the more is it considered as of pure breed. A salmon showing five or six dark spots below the lateral line is looked on with suspicion by the salesmen, as if it had something of the forelle or trout about it; when puzzled, he turns the doubtful fish over and looks at it from several points of view; he is at that moment endeavouring to elicit a correct idea of its proportions, to which he appeals in the last instance. Scientific men would do well occasionally to observe the interested, for wherever self-interest is concerned the senses become exceedingly acute and the powers of observation infinitely refined. As nothing, I imagine, of the nature of gold could escape the eye of the experienced gold-seeker, so nothing that is eatable escapes the notice of the savage Bosjeman: poisonous serpents they distinguish from the innocuous at a glance, and from a drove of ten thousand oxen they will select and claim for their master, after a year's absence, a single animal of a team they once knew. The salesman, then, seldom errs in his discrimination of the fish submitted to his inspection: he knows nothing of Science, but trusts to his tact and instincts. It is the same with woman; she never bewilders herself with Science, but, trusting to

acute observation, she proves generally the best of practical naturalists. That the system of coloration in the Salmonidæ cannot always be depended on in characterizing the species may be admitted without under-rating its value. Human observation is not extremely refined; it is, in fact, extremely imperfect; besides, in the case of the Salmonidæ, the generic colouring is apt to reappear, though imperfectly, even in the adult: hence a fertile source, no doubt, of error. For my own part, I believe the system of coloration of the Salmonidæ to obey fixed laws, and to be constant and regular, the class being free from any influence which obviously affects the colour, namely, domesticity.

Section III.—*The Proportions of the Salmonidæ, as compared with each other and with the Generic Animal.*

The adult well-formed individual of every species of animal has its due proportions characteristic of its nature; with these its movements or style of motion is connected. By these movements it may be recognized by man and other animals when alive; when dead or at rest, its proportions indicate its nature. The distinction extends not unfrequently to sex, in which case the peculiar proportions are said to be sexual. In wild animals these proportions are remarkably constant, suffering indeed but little change or variety, as in the case of the coloration; it is amongst those animals whose nature permits of domestication that we find colour and proportions to undergo changes, which, though limited, are yet remarkable in extent.

Nearly all my early observations, made many years ago, were instituted on the adult specimen, or rather (for it is not so easy to determine what is adult) on individuals which had attained a considerable size. Salmon, sea trout and trout, of various species, were carefully measured and compared with each other, and the results compared, the object being to discover the law of subfamily and species. To these I now add the proportions of the generic animal, as compared with the adult, from which I think it will be manifest that the generic animal has proportions peculiar to itself, yet including the specific, that is, it presents a type out of which all the others may easily be constructed by the comparative enlargement of some measurements and the comparative restriction of others. The tables of these measurements I give at the conclusion of this section; the general results may be stated here.

Tabular view of the relative proportions—

1. Of the head;
2. Of the segment of the body anterior to the anal fin to the length;
3. Of the segment of the body beyond the anal fin to the length—

in the

Smolt.	*Estuary Trout.*	*Leven Trout.*	*Tweed Trout.*
1.	1.	1.	1.
¼ in. nearly.	⅓ in. nearly.	⅓ in.	¼ in.
2.	2.	2.	2.
·571.	·678.	·664.	·664.
3.	3.	3.	3.
15 to 35 or 2·33.	33 to 101 or 3·06.	34 to 100 or 2·94.	32 to 95 or 3·06.

The three great functions of respiration, locomotion and prehension, as represented by the jaws, teeth and fins, may be held, as compared with the general bulk of the body, to offer natural-history characters more or less indicative of the natural state of the individual, and of consequence of the species and subfamily to which it may belong: accordingly it appeared on measurement, that, in respect of the fins generally, the true salmon was much more delicately organised than the salmon trout, a coarser and no doubt a more rapacious fish, and that assuming the head (the gill covers and branchial orifices included) as a tolerably correct measure of the comparative strength of the gills and jaws, or, in other words, of the organs of respiration and prehension, the salmon trout, or forelle, uniformly exceeded the salmon in all such measurements. This law of proportions I found to hold good in all the species of the Salmo Trutta I have yet examined; the coarse fish presenting enlarged proportions of the organs I have just spoken of, as compared with the more delicate species; the common river trout, for example, of the brooks and rivers of Scotland, compared with the estuary trout, and more especially with the delicate char-trout of Loch Leven. The very young of the salmon kind, in its proportions, approaches more nearly the type of the common river trout than any other: as it grows these proportions alter, but even when of 4 or 5 inches in length its proportions are still peculiar, resembling more in their character the type of the river trout than that of the salmon, to which the specimen we know belongs. The measurements were made on the young of salmon from the Tay, the Shin and the Annan.

Thus the young animal, at a certain stage of its growth, is the type not of the species to which it belongs by hereditary descent, but

represents a generic type, transcendental, and requiring for its full development or embodiment in all its material, that is, specific forms, countless millions of years; for as the young, that is, the generic animal, includes many species, perhaps all which the natural family can assume in time and space, so as species die out, others appear, new to the world as species, but not generically. The *ossemens fossiles* belong to species clearly distinct from those that now live; their generic resemblance is undeniable. Species perish, but not genera, and thus the past, present and future, form but one. Species are not convertible into each other by any influences at present known to man: that these species follow each other, agreeably to certain laws, may be admitted, but that it is in the direction of a supposed perfectibility I do not believe, nor ever did. Time, which means plan and circumstances, which mean the geological changes on the earth, are, no doubt, the producing causes of species. Hence, the generic unity of every natural family, and the appearance from time to time of individuals, not resembling the species from which they spring, but others of the same natural family.

As regards the dentition, then, of the Salmonidæ, the young are of no species; on the contrary, they are transcendentally generic, that is, each individual, no matter how descended hereditarily, displays all the characters of all the species and subfamilies of that natural family to which it belongs: as it contains within it the possible of all the species, it seems reasonable to believe, that its development into any peculiar species must be dependent on physical causes at least, which must have a direct relation to the existing order of things. Should a species become extinct, another appears. This implies no new formation or creation, nor after all any real extinction, for the characters of the new species (new to man, who naturally looks only to the adult) and those of the extinct are still included in the young of every species which yet lives, or has lived. What has become extinct, may even reappear; but should the natural family perish all the species cease with it.

Domesticity plays a limited part in the production of varied forms, but these forms do not constitute species: some species are more influenced by domesticity than others; man very little, if at all. It is the same as regards the laws of coloration and proportions: the generic animal includes the types of all.

I have sometimes thought that this law of natural family and of propagation of a generic animal not at first specific may play a part in some phenomena at present inexplicable. For example: all that

is as yet known respecting the river fish called parr was known to Willoughby; even the extraordinary fact that in the female parr the ovaria remain stationary, whilst in the males the milts at certain times become excessively developed. This antagonism in the character of the young has no counterpart, in so far as I know, in natural history. But a still more extraordinary fact, though not so well determined as the preceding, was also known to Willoughby. With this milt of the male parr the ova of a salmon 40 lbs. in weight may be fecundated, whilst the parr itself does not weigh more than 3 or 4 ounces. Now, there is nothing like this in natural history, and the fact stands alone in singularity. Reflecting on these curious facts in the history of the parr, and on others connected with its natural history, I have sometimes fancied that as the parr is a generic animal apparently, upon whose specific form naturalists are not yet agreed, may it not be, that being the product of a generic animal which has not attained a specific form, it may never attain that condition, but remain in this aborted state, a type merely of the salmon kind. In the case of the parr, if this idea be correct, the female remains barren, the male becomes productive: possibly in the great range of the zoological world there may be instances of the contrary, though unknown to me; or it may happen, as a law of nature, that the generic animal of both sexes may grow up unaltered and be productive, the specific forms not appearing in the existing order of things. These are but speculations it is true, but they are speculations supported by laws which hitherto have been, and still are, but imperfectly understood.

I here subjoin a single remark, lest it be supposed that I believe in the reality of species.

Species are only real in so far as regards man's observing powers: they seem to form no part of Natures scheme or plan, which obviously fills up all gaps, leaving no link deficient in the great chain. A serial unity connects all, the past, the present, and the future. Those who fancy that gaps exist mistake merely a deficiency in their own knowledge for a part of Nature's scheme. The transmutation of one species into another I do not believe in, any more than in the three or four successive creations of Cuvier. Unless we are prepared to adopt the doctrine of chance, there can exist only one creative idea, and consequently one creation. The theological doctrine of Socrates, worked into a system by Philo-Judæus and his followers of "the final cause" school, applies merely to simple mechanical laws of obvious signification and application: it has nothing to do with the great laws of life; the laws of formation and deformation; the laws of

unity of the organisation in all that ever lived; the law of serial unity which makes the living and past organic worlds one, and not many.

Nevertheless, to man, species is everything in a practical sense; for, although specific character and structure explain but little in the philosophy of zoology, specialities are the first steps which lead to more important inquiries: without this step philosophic zoology, geology, palæontology, could not be said to exist: hence the intrinsic and enduring value of the labours of the immortal Cuvier.

R. Knox.

Meissen House, Upper Clapton,
June, 1855.

On the Growth of the Salmon, from the Egg to the Adult.

By R. Knox, M.D., F.R.S.E., &c.

All who have angled in such rivers as the Tweed, frequented by salmon, sea trout and river trout, must soon, if they observe at all, have become acquainted with the following facts or appearances:—

1. That river or common trout, whether large or small, may be readily enough distinguished from every other kind of fish caught in the river; occasionally, though rarely, the young trout may be confounded, when about the length of the little finger, with a small fish called the parr, to whose history I shall presently advert, but, in the fresh specimen, and with a good sight, the young trout may always be distinguished from the parr.

2. That these small fish, called parr, are to be found in the rivers frequented by salmon or salmon trout, from the sources to their embouchures, and in such rivers only. But the converse of this is doubted; first, by Mr. Young, of Invershin, who says that there are rivers frequented by parr, into which neither salmon nor salmon trout have ever penetrated; secondly, although I fished the Tyne, in Scotland, a great many times, and had it fished for me by skilful anglers, who knew the river well, I never could find a parr; thirdly, I was present at the fishing of a stream on the East coast of England (North Riding of Yorkshire), on the estate of Mr. Wharton, near Guisborough: the stream was fished with a net (which took everything), from a mill-dam insurmountable for salmon to the sea, yet no parrs were found: nothing, indeed, was taken but—1st, sea-trout of various sizes; 2nd, smolts covered with scales, on their way to the sea; and 3rdly,