CHAPTER X.

LINEAR SERIES—*continued.*

TEETH—RECAPITULATION.

IN this chapter I propose to speak of those matters which seem to have most consequence in the foregoing evidence as to the Variation of Teeth. Each of the following sections treats of some one such subject, specifying the cases which chiefly illustrate it. It will be understood that the sections do not stand in any logical collocation but are simply arranged consecutively. The treatment given is of course only provisional and suggestive, being intended to emphasize those points which may repay investigation.

The subjects which especially call for remark are as follows:

(1) The comparative frequency of dental Variation in different animals.
(2) Symmetry in Meristic Variation of Teeth.
(3) Division of Teeth.
(4) Duplicate Teeth.
(5) Presence and absence of Teeth standing at the ends of series (first premolars, last molars).
(6) The least size of particular Teeth.
(7) Homœotic Variation in terminal Teeth when a new member is added behind them.
(8) Reconstitution of parts of the Series.

(1) *The comparative frequency of dental Variation in different animals.*

The total number of skulls examined for the purpose of this inquiry was about 3000. From so small a number it is clearly impossible to make any definite statement as to the relative frequency of Variation in the different orders, but some indications of a general character may be legitimately drawn.

First, the statistics very clearly shew that while dental Variation is rare in some forms, it is comparatively frequent in others, but there is no indication that this frequency depends on any condition or quality common to these forms. Setting aside examples of the coming and going of certain small and variable

teeth, the animals shewing the greatest frequency of extra teeth were the domestic Dogs, the Anthropoid Apes and the Phocidæ.

Attention is especially called to the fact that the variability of domestic animals is not markedly in excess of that seen in wild forms. From the hypothesis that Variation is uncontrolled save by Selection, there has sprung an expectation, now fast growing into an axiom, that wild animals are, as such, less variable than domesticated animals. This expectation is hardly borne out by the facts. It is true that, so far as the statistics go, supernumerary teeth were more common in domestic Dogs than in wild Canidæ, and though the number of Cats seen was small, the same is true in their case also as compared with wild Felidæ. But though it is true that the domestic Dog is more variable in its dentition than wild Dogs, it is not true that it is much more variable than some other wild animals, as for instance, the Anthropoid Apes or the genus *Phoca*. The doctrine that domestication induces or causes Variation is one which will not, I think, be maintained in the light of fuller evidence as to the Variation of wild animals. It has arisen as the outcome of certain theoretical views and has received support from the circumstance that so many of our domesticated animals are variable forms, and that so little heed has been paid to Variation in wild forms. To obtain any just view of the matter the case of variable domestic species should be compared with that of a species which is variable though wild. The great variability of the teeth of the large Anthropoids, appearing not merely in strictly Meristic and numerical Variation, but also in frequent abnormalities of position and arrangement, is striking both when it is compared with the rarity of variations in the teeth of other Old World Monkeys and the *comparative* rarity of great variations even in Man. If the Seals or Anthropoids had been domesticated animals it is possible that some persons would have seen in their variability a consequence of domestication.

When the evidence is looked at as a whole it appears that no generalization of this kind can be made. It suggests rather that the variability of a form is, so far as can be seen, as much a part of its specific characters as any other feature of its organization. Of such frequent Variation in single genera or species some curious instances are to be found among the facts given.

Of *Canis cancrivorus*, a S. American Fox, the majority shewed some abnormality. Of *Felis fontanieri*, an aberrant Leopard, two skulls only are known, both showing dental abnormalities. In Seals only four cases of reduplication of the first premolar were seen, and of these two were in *Cystophora cristata*. The number of cases of abnormality in the genus *Ateles* is very large. Of six specimens of *Crossarchus zebra*, two shew abnormalities. Of the very few skulls of *Myrmecobius* seen, two shew an abnormal number of incisors. Three cases of Variation were given in *Canis mesomelas*, not a very common skull in museums. On the other

hand the rarity of Variation in the dentition of the Common Fox (*C. vulpes*) is noteworthy, especially when compared with the extraordinary frequency of Variation in the molars of S. American Foxes. The constant presence of the small anterior premolar in the upper jaw of Otters (*Lutra*) of most species, as compared with the great variability of the similar tooth in the Badgers (*Meles*) and in other species of Otters, may also be mentioned.

The evidence given in the last chapter should not, I think, be taken as indicating the frequency of dental Variation in Mammals generally. The orders chosen for examination were selected as being those most likely to supply examples of the different forms of dental Variation, and it is unlikely that the frequency met with in them is maintained in many other orders.

(2) *Symmetry in Meristic Variation of Teeth.*

With respect to bilateral Symmetry an examination of the evidence shews that dental Variation may be symmetrical on the two sides, but that much more frequently it is not so. The instances both of bilaterally symmetrical Variation, and of Variation confined to one side are so many that examples can be easily found in any part of the evidence.

Besides these there are a few cases in which there is a variation which is complete on one side, while on the other side the parts are in a condition which may be regarded as a less complete representation of the same variation. Such cases are *Ommatophoca rossii* No. 320, *Phoca grœnlandica* No. 324, *Dasyurus maculatus* No. 385, *Canis lupus* No. 246, *C. vetulus* No. 248, &c.

In the remarks preliminary to the evidence of dental Variation, reference was made to a peculiarity characteristic of the teeth considered as a Meristic Series of parts. As there indicated, the teeth are commonly repeated, so as to form a symmetry of images existing not only between the two halves of one jaw, but also to a greater or less extent between the upper and lower jaws. It was then mentioned that cases occur in which there is a similar Variation occurring simultaneously in the upper and lower jaws of the same individual. Such similar Variation may consist either in the presence of supernumerary teeth, or in the division of teeth, or in the absence of teeth. It should, however, be noticed that examples of Variation thus complete and perfect in both jaws are comparatively rare. Speaking generally, it certainly appears from the evidence that similar Variation, (1) on one side of both jaws, or (2) on both sides of one jaw and on one side of the other, or (3) on both sides of both jaws are all rare. Of these three the following examples may be given:—

Of (1), *Macacus rhesus* No. 190, *Ateles pentadactylus* No. 196, Esquimaux dog No. 243, *Phoca vitulina* No. 329.

Of (2), *Simia satyrus* No. 166, *Dasyurus maculatus* No. 385, *E. asinus* No. 352.

Of (3), Dog No. 257, *Bettongia cuniculus*, No. 392, *Ateles marginatus* No. 203, *Phoca barbata* No. 318, *Ommatophoca rossii* No. 320.

Of these, further examples may be seen in the evidence given regarding the anterior premolars of *Galictis barbara*, *Meles*, and *Herpestes*.

(3) *Division of Teeth.*

Among the cases of increase in number of teeth are many in which by the appearances presented it may be judged that two teeth in the varying skull represent one tooth in the normal, and have arisen by the division of a single tooth-germ.

Of such division in an incomplete form several examples have been given. The plane of division in these cases is usually at right angles to the line of the jaw, so that if the division were complete, the two resulting teeth would stand in the line of the arcade. Incomplete division of this kind is seen in the first premolar of *Ommatophoca rossii* No. 320, in the fourth premolar of *Phoca grœnlandica* No. 324, in the incisors of Dogs No. 219, in the canine of Dog No. 221, in the lower fourth premolar of *Dasyurus geoffroyi* No. 383. The plane of division is not however always at right angles to the jaw, but may be oblique or perhaps even parallel to it, though of the latter there is no certain case. Cases of division in a plane other than that at right angles to the jaw are seen in *C. vulpes* No. 230, *Phalanger orientalis* No. 368, *Phoca grœnlandica* No. 326 and doubtfully in a few more cases. The existence of the possibility of division in these other planes is of some consequence in considering the phenomenon of duplicate teeth standing together at the same level in relation to that of the presence of duplicate teeth in series. Beyond this also it may be anticipated that if ever it shall become possible to distinguish the forces which bring about the division of the tooth-germ, the relation of the planes of division to the axis of the Series of Repetitions will be found to be a chief element.

(4) *Duplicate Teeth.*

Teeth standing at or almost at the same level as other teeth which they nearly resemble may conveniently be spoken of as duplicate teeth, though it is unlikely that there is a real distinction of kind between such teeth and those extra teeth which stand in series. Duplicate teeth were seen in *Felis domestica* Nos. 286 and 287, *Canis mesomelas* No. 228, *Herpestes ichneumon* No. 300, [*Putorius*] *Vison horsfieldii* No. 311, *Helictis orientalis* No. 312, *Cystophora cristata* No. 322, and perhaps in some other cases. That these cases are not separable on the one hand from examples of extra teeth in series may be seen from *Herpestes gracilis* No. 299, *Cystophora cristata* No. 321 [compare with No. 322], *Brachyteles*

hemidactylus No. 199 [compare with *Ateles marginatus* No. 200], *Phoca vitulina* No. 336; and that on the other hand they merge into cases of supernumerary teeth standing outside or inside the series, and whose forms do not correspond closely to those of any tooth in the series, may be seen by comparison with *Otaria ursina* No. 325, *Phoca vitulina* No. 329, *Phalanger orientalis* No. 372. Though in some cases the shapes of duplicate teeth make a near approach to the shapes of normal teeth, yet they are never exactly the same in both, and teeth whose forms approach so nearly to those of other teeth in the series as to suggest that they are duplicates of them and that they may have arisen by multiplication of the same germ, cannot be accurately distinguished from extra teeth whose forms agree with none in the normal series.

(5) *Presence and Absence of Teeth standing at the ends of Series (first premolars, last molars): the least size of particular Teeth.*

Of the cases of numerical Variation in teeth the larger number concern the presence or absence of teeth standing at the ends of Series. As was mentioned in introducing the subject of dental Variation, in many heterodont forms the teeth at the anterior end of the series of premolars and molars are small teeth, standing to the teeth behind them as the first terms of a series more or less regularly progressing in size. Not only in teeth but in the case of members standing in such a position in other series of organs, *e.g.* digits, considerable frequency of Variation is usual.

Variability at the ends of Series is manifested not only in the frequency of cases of absence of terminal members, but also in the frequency of cases of presence of an extra member in their neighbourhood. An additional tooth in this region may appear in several forms. It may be a clear duplicate, standing at the same level as the first premolar (*e.g.* Cat, No. 270). On the other hand, as seen in the Dogs (Nos. 232 and 233) there may be two teeth standing between the canine and (in the Dog) the second premolar. The various possibilities as to the homologies of the teeth may then be thus expressed. The posterior of the two small teeth may correspond with the normal first premolar, and the anterior may be an extra tooth representing the first premolar of some possible ancestor having five premolars; or, the first of the two premolars may be the normal, and the second be intercalated (see No. 224); or, both the two teeth may be the equivalent of the normal first premolar; lastly, neither of the two may be the precise equivalent of any tooth in the form with four premolars. Of these possibilities the first is that commonly supposed (HENSEL and others) to most nearly represent the truth. But the condition seen in cases where there is an extra tooth on one side only, as in the Dogs figured (Fig. 42), strongly suggests that neither of the two teeth strictly corresponds with the one of the other side. Seeing that in such cases the single tooth of the one side stands often at the level

of the diastema on the other, it seems more likely that the one tooth balances or corresponds to the two of the other side, which may be supposed to have arisen by division of a single germ. On the other hand since the two anterior premolars found in such cases are not always identical in form and size, either the anterior or the posterior being commonly larger than the other, there is no strict criterion of duplicity, and it is clearly impossible to draw any sharp distinction between cases of duplicity of the first premolar and cases in which the two small premolars are related to each other as first and second. These two conditions must surely pass insensibly into each other. If the case of the teeth is compared with that of any other Linear series in which the number of members is indefinite, as for example that of buds on a stem, the impossibility of such a distinction will appear. A good illustration of this fact may often be seen in the arrangement of the thorns on the stems of briars. For large periods of the stem both the angular and linear succession of the thorns of several sizes may be exceedingly regular; but it also frequently happens that a thorn occurs with two points, and on searching, every condition may sometimes be found between such a double thorn and two thorns occurring in series, having between them the normal distinctions of form or size. Very similar phenomena may be seen in the case of the strong dermal spines of such an animal as the Spiny Shark (*Echinorhinus spinosus*). These structures are of course from an anatomical standpoint closely comparable with teeth. In them, spines obviously double, triple or quadruple, are generally to be seen scattered among the normal single spines, but between the double condition and the single condition, it is impossible to make a real distinction.

The remarks made as to the first premolars apply almost equally to the last molar. See *Phoca vitulina* No. 336, *Mycetes niger* No. 206, Man, MAGITOT, *Anom. syst. dent.*, Pl. v. figs. 4, 5 and 6, *Canis cancrivorus* Nos. 251 and 252, *Crossarchus zebra* No. 302.

(6) *The least size of particular Teeth.*

What is the least size in which a given tooth can be present in a species which sometimes has it and sometimes is without it? In other words, what is the least possible condition, the lower limit of the existence of a given tooth? This is a question which must suggest itself in an attempt to measure the magnitude or Discontinuity of numerical Variation in teeth.

The evidence collected does not actually answer this question completely for any tooth, but it shews some of the elements upon which the answer depends.

In the first place it is seen at once that the least size of a tooth is different for different teeth and for different animals.

Considered in the absence of evidence it might be supposed that any tooth could be reduced to the smallest limits which are histologically conceivable; that a few cells might take on the characters of dental tissue, and that the number of cells thus constituting a tooth might be indefinitely diminished. Indeed on the hypothesis that Variation is continuous this would be expected. Now of course there is no categorical proof that this is not true, and that teeth may not thus occur in the least conceivable size, but there is a good deal of evidence against such a view. The facts on the whole go to shew that teeth arising by Variation in particular places, at all events when standing in series in the arcade, have a more or less constant size on thus appearing. Within limits it seems also to be true that the size in which such a tooth appears has in many cases a relation to the size of the adjacent teeth and to the general curves of the series. For example in the Orang, the series of molars does not diminish in size from before backwards, and extra molars when present are, so far as I know, commonly of good size, not wholly disproportionate to the last normal molar. The same is I believe true in the case of the Ungulates. In the Dogs however the series of lower molars diminishes rapidly at the back, and the extra molars added at the posterior end of the series are of a correspondingly reduced size. As presenting some exception to this rule may be mentioned two cases in the Chimpanzee, Nos. 178 and 181 and the case of *Cebus robustus* No. 194, in each of which the extra molar is disproportionately small.

The principle here indicated is of loose application, but speaking generally it is usual for an extra tooth arising at the ends of series to be of such a size as to continue the curves of the series in a fairly regular way. It would at all events be quite unparalleled for an extra tooth arising at the end of a successively diminishing series, as the Dog's lower molars, to be *larger* than the tooth next to it, and with the exception of cases of duplicate anterior premolars (see Dogs Nos. 232 and Cat No. 268) I know no such case. In these besides, the anterior tooth is very slightly larger than its neighbour, and it should be remembered that the first premolar, though the terminal member of the series of premolars, is not actually a terminal tooth.

Examples have been given of animals which seem to be oscillating between the possession and loss of particular teeth, the first premolar of the Badgers, $\underline{p}^1$ of some species of Otter, &c. In these cases we are not yet entitled to assume because in a given skull the tooth is absent, that it has never been formed in it, though this is by no means unlikely, but as already pointed out (p. 228), the fact of its presence or absence may still indicate a definite variation. Attention should be called to the case of *Trichosurus vulpecula*, var. *fuliginosa* No. 378, in which the first premolar is generally of good size if present, and there can be no doubt that it has never been present in those skulls from which it is absent.

Variation of unusual amplitude may be seen also in the molars of *Bettongia* Nos. 389, &c., for while on the one hand the last or fourth molar may be absent, it may on the contrary be large and may even be succeeded by a fifth molar as an extra tooth. All these conditions were seen in looking over quite a small number of specimens.

(7) *Homœotic Variation in terminal Teeth when a new member is added behind them.*

Upon the remarks made in the last Section the fact here noticed naturally follows. We have seen that there is a fairly constant relation between the size of extra teeth and that of the teeth next to which they stand, so that the new teeth are as it were, from the first, of a size and development suitable to their position. We have now to notice also that the teeth next to which they stand may also undergo a variation in correlation with the presence of a new tooth behind them.

It may be stated generally that if the tooth which is the last of a normal series is relatively a small tooth, as for example $\overline{m^3}$ or m^2 in the Dog, then in cases of an addition to the series, by which this terminal tooth becomes the penultimate, it will often (though not always) be found that this penultimate tooth is larger and better developed than the corresponding ultimate tooth of a normal animal of the same size.

Of this phenomenon two striking examples (*q.v.*) have been given, *Canis azaræ* No. 249 and *Dasyurus maculatus* No. 385. Besides these are several others of a less extreme kind *e.g. Otocyon megalotis* No. 256, Mastiff No. 259, Dog No. 260. The same was also seen in the molars of *Bettongia*.

This phenomenon, of the enlargement of the terminal member of a series when it becomes the penultimate, is not by any means confined to teeth; for the same is true in the case of ribs, digits, &c., and it is perhaps a regular property of the Variation of Meristic Series so graduated that the terminal member is comparatively small. This fact will be found of great importance in any attempt to realize the physical process of the formation of Meristic Series, and it may be remarked that such a fact brings out the truth that the members of the Series are bound together into one common whole, that the addition of a member to the series may be correlated with a change in the other members so that the general configuration of the whole series may be preserved. In this case the new member of the series seems, as it were, to have been reckoned for in the original constitution of the series.

(8) *Reconstitution of parts of the Series.*

Lastly there are a few cases, rare no doubt in higher forms but not very uncommon for example in the Sharks and Rays (see

pp. 259, &c.), in which the members of the series seem to have been so far remodelled that the supposed individuality of the members is superseded. In the Selachians several such cases were given, but in Mammals the most manifest examples were seen in the Phalangers and *Ateles marginatus* No. 200 (*q.v.*). In the latter specimen there were four premolars on each side in the upper jaw, and there was nothing to indicate that any one of them was supernumerary rather than any other. In such a case I submit that the four premolars must be regarded as collectively equivalent to the three premolars of the normal. The epithelium which normally gives rise to three tooth-germs has here given rise to four, and I believe it is as impossible to analyze the four teeth and to apportion them out among the three teeth as it would be to homologize the sides of a triangle with the sides of a square of the same peripheral measurement.

Such a case at once suggests this question: if the four premolars of this varying *Ateles* cannot be analyzed into correspondence with the three premolars of the typical *Ateles*, can the three premolars of this type be made to correspond individually with the two premolars of Old World Primates?

In the case of *Rhinoptera* No. 396, for the reason given in describing the specimen, there is plainly no correspondence between the rows of plates of the variety and those of the type, and the rows are, in fact, not individual, but divisible.

Though cases so remarkable as that of *Ateles marginatus* are rare, there are many examples of supernumerary teeth, in the region of the anterior premolars of the Dog or Cat for instance, which cannot be clearly removed from this category. As indicated in the fourth section of this Chapter, it is impossible to distinguish cases of division of particular teeth from cases of the formation of a new number of teeth in the series. Finally, on the analogy of what may be seen in the case of Meristic Series having a wholly indefinite number of members, it is likely that the attempt thus to attribute individuality to members of series having normally a definite number of members should not be made.