CHAPTER XV.

LINEAR SERIES—*continued.*

MINOR SYMMETRIES: SEGMENTS IN APPENDAGES.

MERISTIC Repetition along the axes of appendages is very like that along the axis of the body. Just as particular numbers of segments or repetitions along the axis of Major Symmetry characterize particular forms, so particular numbers of joints characterize particular appendages. Such numbers frequently differentiate species, genera, or other classificatory divisions from each other. In the evolution of these forms therefore there must have been change in these numbers.

Those who are inclined to the view that Variation is always continuous do not perhaps fully realize the difficulty that besets the application of this belief to the observed facts of normal structure. For in those many groups whose genera or species may be distinguished from each other by reason (amongst other things) of difference in the number of joints in some particular appendage or appendages, will any one really maintain that in all these the process by which each new number has been introduced was a gradual one? To take a case: even were evidence as to the manner of such Variation wanting, would it be expected that the Longicorn Prionidæ, most of which have the unusual number of 12 antennary joints, did, as they separated from the other Longicorns which have 11 joints, gradually first acquire a new joint as a rudiment which in successive generations increased? Or, conversely, did the other Longicorns separate from a 12-jointed form by the gradual "suppression" of a division or of a joint? If any one will try to apply such a view to hundreds of like examples in Arthropods, of difference in number of joints in appendages of near allies—forms that by the postulate of Common Descent we must believe to have sprung from a common ancestor—he will find that by this supposition of Continuity in Variation he is led into endless absurdity. Surely it must be clear that in many such cases to suppose that the limb came through a phase in which one of its divisions was half-made or one of its joints half-grown, is to suppose that in the comparatively near past it was an instrument of totally different character from that which it has in either of the two perfect forms. But no such supposition is called for. With evidence that transitions of this nature *may* be discontinuously effected the difficulty is removed.

The frequency of Meristic Variation in appendages is much as it is in the case of body-segments. On the one hand there are series containing high total numbers of repetitions little differentiated from each other (*e.g.* the antennæ of the Lobster), and in these Meristic Variation is common; on the other hand in series containing few segments much differentiated from each other, such Variation, though not unknown, is rare. Of the latter a few instances are here offered. That they are so few may perhaps be in part attributed to the little heed that is paid to observations of this class. Records of this kind might indeed be hoped for in the works of those naturalists to whom the title "systematic" has been given; but unfortunately the attention of these persons has from the nature of the case been drawn rather to features whereby species may be kept apart than to facts by which they might be brought together.

From the lack therefore of records of such variations their absence in Nature must not lightly be assumed. To quote but one case: in the common Earwig the numbers and forms of the antennary joints are exceedingly variable, but in many special treatises on Orthoptera, I cannot find that this variability is spoken of, and if alluded to at all the only notice is given in the form "antennæ 13- or 14-jointed."

ANTENNÆ OF INSECTS.

PRIONIDÆ.

I am indebted to Dr D. Sharp for the information that the number of antennary joints in certain Prionidæ varies. In Longicorns generally the number of joints is constantly 11. Dr G. H. HORN of Philadelphia who is specially acquainted with this group, has kindly written to me that of six species of N. American *Prioni* four species have 12 antennary joints constantly in both sexes. Besides these he gives the following cases of Variation. It will be seen that in both of these the normal number is much greater than it is in the other species[1].

*616. **Prionus imbricornis:** females have very constantly 18 joints; males have 18 to 20. A male in Dr Sharp's collection has only 17 joints in each antenna.

[1] In *Prionus imbricornis* and *P. fissicornis* doubt may be felt whether the trifid apex should be reckoned as one joint or as two, but this applies equally to each individual. I have counted it as one.

*617. **Prionus fissicornis:** the female has 25, and the male 27—30, the note on the preceding species applying here.

618. **Polyarthron.** A Prionid beetle, in which the male has curious many-jointed feather-like antennæ, according to SERVILLE has always 47 joints, but THOMSON (*Syst. Ceramb.*, 1866, p. 284) says the number varies with the species and individually. A male in Dr Sharp's collection has 45 joints in each antenna and a female has 31 in each.

619. **Lysiphlebus** is a Braconid (Hymenoptera) parasite on Aphides. From a colony of Aphides on a bush of *Baccharis viminalis* 121 specimens of *Lysiphlebus* were reared: of these 57 were males and 64 were females.

The number of joints in the antennæ varied as follows:

Males.

14 joints	18 specimens.
15	37 ....
16	1 ....
15 ...... on one side and 16 on the other	1 ....

Females.

12	7 ....
13	54 ....
14	1 ....
12 ...... on one side and 13 on the other	2 ....

In those having a different number of joints in the right and left antennæ, the last joint of the antenna which contained the fewest joints was longer than the last joint of the antenna with the larger number of joints. Nevertheless this relation did not hold throughout; for example in the case of the male with 16 joints, the last joint was of the same length proportionally as that of the males with only 14 joints. As a rule the specimens with fewer antennary joints are smaller than the others.

Variations were also seen in coloration, in the proportional length of the tarsi, and in the presence or absence of the transverse cubital nervure, but none of the characters divided the sample consistently, it was therefore inferred that the individuals belonged to one species of *Lysiphlebus*, (*L.citraphis*, Ashm.)

From another colony of Aphides living on a rose-bush 58 specimens of *Lysiphlebus* were bred, and no characters were found by which these could be separated from those bred from the Aphis of *Baccharis*. In the case of the second sample the joints of antennæ were as follows:

Males.

14 joints	10 specimens.
15	19 ....
14 ...... on one side and 15 on the other	2 ....

Females.

12	2 ....
13	25 ....

The number of antennary joints is employed as a specific character in the classification of *Lysiphlebus* by ASHMEAD, *Proc. U. S. Nat. Mus.*, 1888, p. 664). COQUILLET, D. W., *Insect Life*, 1891, Vol. III. p. 313.

*620. **Donacia bidens.** (Phyt.) A female found by Dr D. Sharp at Quy Fen in company with many normal specimens had in each antenna *eight* joints instead of eleven as in the normal. As shewn in the figure (Fig. 123) the antennæ of the two sides were exactly

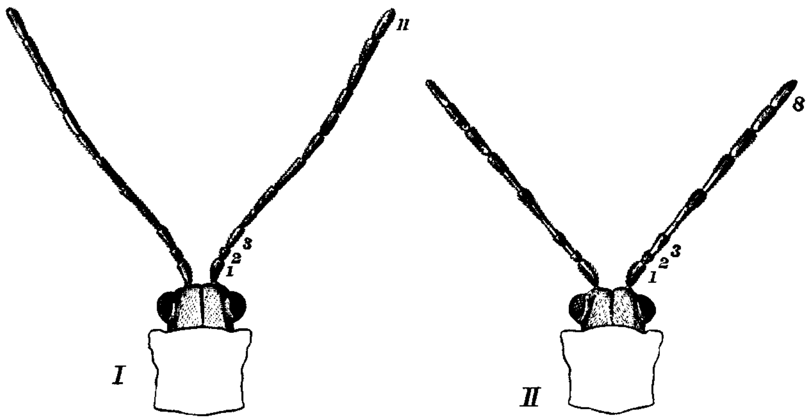


FIG. 123. *Donacia bidens* ♀. I. Normal antennæ, eleven joints in each. II. Abnormal specimen, having eight joints in each antenna. No. 620.

alike, and the insect was normal in all other respects. I am much obliged to Dr Sharp for shewing me this specimen.

Forficula auricularia, the common Earwig. In the various species of *Forficula* the number of joints in the antennæ differs, the numbers 11, 12, 13 and 14 being all found as normals in different species[1]. As regards *F. auricularia* most authors give 14 as the number of antennary joints. SERVILLE[2] gives 13 or 14. A number of adult earwigs examined by myself with a view to this question shewed that there is great diversity in regard to the number of antennary joints. The whole matter needs much fuller investigation but the preliminary results are interesting.

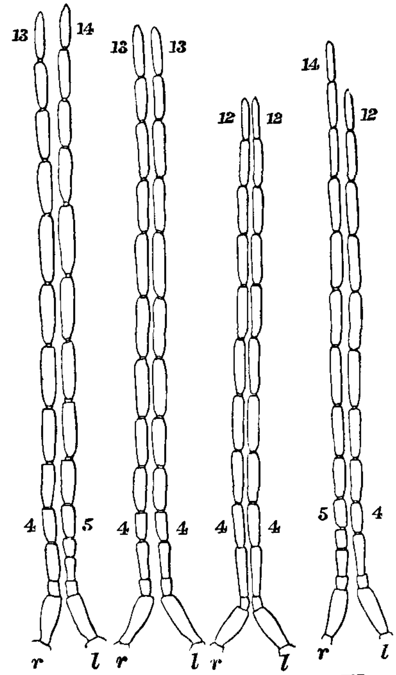
The commonest number is 14, which occurs in perhaps 70—80 per cent. The next commonest is 13, which was seen in a considerable number, while 12, and even 11 occur in exceptional cases. Different numbers were frequently found on the two sides.

[1] BRUNNER VON WATTENWYL, *Prodr. eur. Orth.*, 1882. The number in *F. auricularia* is given by Brunner as 15, but I have never seen this number. It is no doubt an accidental error. The same mistake is repeated by SHAW, E., *Ent. Mo. Mag.*, 1888—89, xxv. p. 358.

[2] *Suites à Buffon: Orthop.*, 1839.

As is usual with appendages the whole length of the antennæ differed a good deal independently of the number of joints.

*621. On comparing antennæ with different numbers it seemed that the proportional length of the first two joints was nearly the same in all, but in the third joint there was great difference, as shewn in Fig. 124. The *left* antenna in Fig. 124, I may be taken to be the normal form with 14 joints. In it both 3rd and 4th joints are small. The *right* antenna of the same specimen has 13 joints and in most of the 13-jointed antennæ the arrange-



I II III IV

FIG. 124. Various forms of antennæ of adult Earwigs (*Forficula auricularia*), all from one garden and taken at one time.

I. Specimen having the left antenna normally 14-jointed, and the right 13-jointed. No. 621.

II. Both antennæ 13-jointed. No. 622.

III. Both antennæ 12-jointed. No. 623.

IV. Right antenna normally 14-jointed; left antenna 12-jointed. No. 624.

Note that the rights and lefts are arranged as marked by letters *r* and *l*. The antennæ were so fixed for drawing in order to bring them side by side after the bend from the first joint. This figure was drawn with the camera lucida by Mr Edwin Wilson.

ment was much as shewn in this figure. As shewn, the 3rd joint especially is here rather longer than in the 14-jointed form, but several of the peripheral joints are also a little longer, so that though the 13-jointed antenna is not as a whole so long as the 14-jointed antenna of the same individual it is longer than its first 13 joints.

622. But besides the common 13-jointed form occasional specimens are as shewn in Fig. 124, II. Here both antennæ are 13-jointed, the 3rd joint being much longer, and the 4th a little longer than the corresponding joints of the normal with 14 joints. Two specimens were seen having this structure in both antennæ, thus presenting a difference which, did it occur in a form known from but few specimens, would assuredly be held to be of classificatory importance.

*623. In another case (Fig. 124, III) each antenna contained only 12 joints, the 3rd, 4th and 5th being all of greater length than in the normal.

624. Fig. 124, IV shews a case in which there was on the right side a normally 14-jointed antenna but that of the left side was 12-jointed, agreeing nearly with those in Fig. 124, III.

In considering these facts the possibility that some or all the abnormal states may result from or be connected with regeneration must be remembered; but from the frequency of the variations, from their diversity, and from the fact that symmetrically varying individuals are not rare, it is on the whole unlikely that all can owe their origin to regeneration. It will besides be noticed that it is in the *proximal* joints that the greatest changes are seen, and it must surely be rarely that these are lost by mutilation.

The difficulty—indeed the futility—of attempting to adjust a scheme of individuality among such series of segments must here be apparent to all. We can see the change in number and the change in proportions, and we are doubtless entitled to affirm that the differences between these several kinds of antennæ are reached by changes occurring chiefly in the neighbourhood of the 3rd and 4th joints; but not only is there no proof that the changes are restricted to these joints, but the appearances suggest that there are correlated changes in many, and perhaps in all of the joints.

Tarsus of Blatta[1].

*625. Among the families of the class Orthoptera the number of tarsal joints differ. In Forficularia the number of tarsal joints

[1] In connexion with variation in the number of joints in legs I may mention the case of *Stenopterus rufus* ♀ (Longicorn) described by Gadeau de Kerville as having each tibia divided into two parts by an articulation (*Le Naturaliste*, 1889, s. 2, xi. p. 9, *fig.*); but upon examination it proved that each tibia had been sharply bent at each of these points, and there was no real articulation. I have to thank M. Gadeau de Kerville for lending me this insect together with many interesting specimens of which mention will be made hereafter.

is 3, in Blattodea, Mantodea and Phasmodea 5, in Acridiodea 3, in Locustodea 4, in Gryllodea 2 or 3[1].

The fact, originally observed by BRISOUT DE BARNEVILLE[2], that in various species of Blattidæ the number of tarsal joints may vary from *five* to *four* is therefore of considerable importance *in a consideration of the manner in which these several forms have been evolved from each other.* The species in which BRISOUT observed this variation were ten in number and belonged to four genera of Blattidæ.

At my suggestion Mr H. H. BRINDLEY has made an extended investigation of the matter and a preliminary account of the results arrived at was given in the Introduction (p. 63). It was found that of **Blatta americana** 25°/₀ of adults have one or

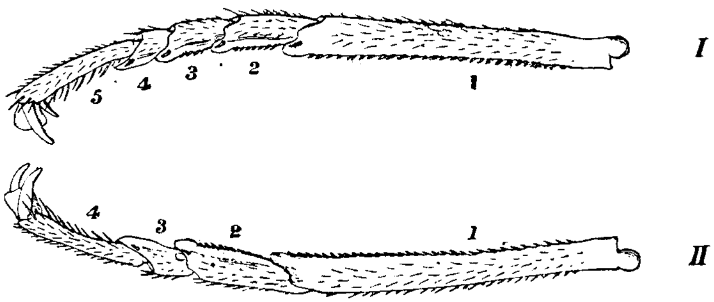


FIG. 125. I. Normal five-jointed left tarsus of *Blatta americana*. II. Right tarsus of the same having four joints.

more tarsi 4-jointed. In **Blatta orientalis** these cases amounted to 15°/₀, and of 102 **B. germanica** examined, 16 had one or more 4-jointed tarsi.

The abnormality occurred sometimes in one leg and sometimes in another, being more frequent in the legs of the second pair than in those of the first, and much more frequent in the third pair than in either. In some specimens legs of the two sides were symmetrically affected, but this was exceptional. Only one specimen has hitherto been met with having *all* the tarsi 4-jointed. There was a slightly greater frequency in females than in males.

When the examination of these abnormal tarsi was begun it was supposed that the variation was congenital, but as explained in a note to the Introduction (p. 65) doubt subsequently arose as to this. It is well known that Blattidæ like many other Orthoptera have the power of renewing the appendages after loss, and Mr Brindley found by experiment that when the tarsus of *Blatta orientalis* is renewed after mutilation the resulting tarsus is 4-jointed. It was also found that 4-jointed tarsi were much more frequent in adults than in the young. The question therefore arises, is the 4-jointed tarsus *ever* congenital?

[1] From BRUNNER VON WATTENWYL, *Prodr. europ. Orthop.*, 1882.
[2] *Ann. ent. soc. France*, s. 2, VI. 1848, *Bull.*, p. XIX.

To this question a positive answer cannot yet be given; but as about 200 young *B. orientalis* have since been hatched from the egg and no 4-jointed tarsus was found among them, while in every instance of regeneration the new tarsus had four perfect joints, there is now a presumption that the variation does not occur congenitally. On the other hand it should be mentioned that the 4-jointed tarsus was seen in 3 specimens, found by Mr Brindley, which by their size would be judged to have been newly hatched. But even if the variation shall hereafter be found to be sometimes congenital it is certain that this occurrence must be very rare, and there can be no doubt that in the majority of cases the 4-jointed tarsus has arisen on regeneration[1].

As mentioned in the Introduction, the existence of the 4-jointed tarsus, whatever be the manner of its origin, raises two questions. Of these the first is morphological, relating to the degree to which the joints exhibit the property of individuality, and the second is of a more general nature, relating to the application of the theory of Natural Selection to such a case of discontinuous change. The interest of the case in its bearing on both of these questions arises from the Discontinuity, which was complete. All the tarsi seen were either 5-jointed or 4-jointed, and in none of the latter was any joint ever rudimentary, or any line of articulation imperfectly formed (except in a single specimen having a deformed tarsus). There were 5-jointed tarsi and 4-jointed tarsi: between them nothing.

Following the usual methods of Comparative Anatomy it must be asked *which* of the 5 joints is missing in the 4-jointed tarsus? With reference to this question careful measurements of the separate joints were made by Mr Brindley in 115 cases of 4-jointed tarsi occurring in legs of the *third* pair in *B. americana;* and for comparison the separate joints of 115 normal 5-jointed third tarsi of the same species were also measured. (It is clear that the legs compared must belong to the same pair, 1st, 2nd or 3rd, for there is considerable differentiation between them. From this circumstance it was comparatively difficult to obtain a large number of cases, and hence the smallness of the whole number measured. But though of course statistics respecting a larger number would be more satisfactory there is no reason to think that by examination of a greater number of cases the result would be materially affected.)

In the two sets of tarsi the total length of each tarsus was reduced to 1·000, the lengths of the joints being correspondingly reduced.

The arithmetic means of the ratios of the several joints to the whole lengths of the tarsi to which they belonged was as follows:

Five-jointed form.

1st joint	2nd joint	3rd joint	4th joint	5th joint
·532	·156	·095	·049	·168

Four-jointed form.

1st joint	2nd joint	3rd joint	4th joint
·574	·183	·064	·179

[1] The circumstance that in Mr Brindley's observations the variation was in all species more frequent in females than in males, and that the frequency differed in

The evidence derived from these numbers lends no support to the expectation that any one particular joint of the 5-jointed form is missing from the 4-jointed, or that any one joint of the 4-jointed form corresponds with any two joints of the 5-jointed; for if the numbers are treated with a view to either of these hypotheses it will be found impossible to make them agree with either. It appears rather that the four joints of the 4-jointed form collectively represent the five joints of the normal.

The other question upon which the statistics bear has already been stated in the Introduction. In any appendage the ratio of the length of each joint to the whole length of the appendage varies; but if it varies about one normal form it will be possible to find a normal or mean value for this ratio, and the frequency with which other values of the same ratio occur will be inversely proportional to the degree in which they depart from the normal value. The curve representing the frequency of occurrence of these values will then be a normal Curve of Error. The form of this curve will indicate the constancy with which the normal proportions of the tarsal joints are approached. If the proportional lengths of the tarsal joints vary little then the curve representing the frequency of their departure from their normal value will be a steep curve, but if these proportions are very variable and have little constancy, then the curve will be flatter. The probable error will thus in the case of each value be a measure of the constancy with which it conforms to its normal proportions. As explained in the Introduction, upon the hypothesis that all constancy of form is due to the control of Natural Selection, it would be anticipated that the 4-jointed tarsus, if a variation, would be very much less constant in the proportions of its joints than the 5-jointed tarsus. It was however found that as a matter of fact the proportions of the joints of the 4-jointed form were very nearly as constantly conformed to as those of the joints of the normal tarsus.

The evidence of this is as follows. The total length of the 5-jointed tarsus being L, and t^1, t^2, &c. being the lengths of its several joints, l, T^1, T^2, &c. representing the same measurements in the 4-jointed form, the ratios $\frac{t^1}{L}$ &c., $\frac{T^1}{l}$ &c., represent the proportional length of the several joints in each case. The values of these ratios were then arranged in ascending order in their own series and the measures occupying the positions of the first, second, and third quarterly divisions noted[1] (indicated hereafter by Q^1, M and Q^3 respectively). The probable error or variation of each ratio $\frac{t^1}{L}$, $\frac{T^1}{l}$, &c. will then be represented by the expression $\frac{Q^3 - Q^1}{2}$. Inasmuch as the joints are of different lengths, to compare the results each must be converted into percentages of the mean length of the joint concerned. These results are set forth in the accompanying tables.

the different pairs of legs may seem to point to the existence of some control other than the simple chances of fortuitous injury. As regards the latter point it is not unlikely that the legs of the third pair, being longer and less protected, may be more often mutilated than the others.

[1] As described by GALTON, F., *Proc. Roy. Soc.*, 1888–9, XLV. p. 137.

Five-jointed tarsus.

	$\frac{t^1}{L}$	$\frac{t^2}{L}$	$\frac{t^3}{L}$	$\frac{t^4}{L}$	$\frac{t^5}{L}$
Q^1	·521	·152	·095	·046	·162
M	·529	·156	·099	·049	·168
Q^3	·535	·160	·101	·051	·174
Mean error as percentage of M	1·3	2·6	3·0	5·0	3·6

Four-jointed tarsus.

	$\frac{T^1}{l}$	$\frac{T^2}{l}$	$\frac{T^3}{l}$	$\frac{T^4}{l}$
Q^1	·565	·178	·060	·172
M	·575	·183	·064	·177
Q^3	·584	·189	·068	·183
Mean error as percentage of M	1·6	3·0	6·2	3·1

It is thus seen that the percentage variation of the ratios of the several joints to the total length is very little greater in the case of the abnormal than it is in the normal tarsus.

As regards the longer joints these results are probably a trustworthy indication of the amount of Variation, but in the case of the shorter joints the errors of observation must no doubt be so great in proportion to the smallness of the lengths to be measured that no reliance should be placed on results obtained from them.

As evidence that in spite of the small number of instances examined the general result is satisfactory it may be mentioned that the mean obtained as the value of $\frac{Q^3 + Q^1}{2}$ agrees fairly well in each case both with the value of M, the middlemost value, and also with the arithmetic mean given above. It may therefore be taken that the curve is regular and the series nearly uniform.

The correlations between the lengths of the joints and that of the whole tarsus have also been examined by Mr Brindley using the method proposed by GALTON *l.c.*, the results closely agreeing with those obtained by the ordinary method here described[1].

If the 4-jointed tarsus be a congenital variation the significance of the fact that the abnormality is in its constancy to its normal hardly less true than the type-form must be apparent

[1] It is hoped that a fuller account of this subject will be given separately. I am indebted to Mr F. Galton for advice kindly given when this investigation was begun, and Mr Alfred Harker has most obligingly given much help in connexion with it.

to all. Yet even if, as now seems likely, the 4-jointed tarsus be not a congenital variation but is rather a result of regeneration, there is still difficulty in reconciling the now established fact that the form of the regenerated part, though different from the normal, is scarcely less constant, with any hypothesis that the constancy of the normal is dependent upon Selection.

If it were true that the smallness of the mean variation of the ratio $\frac{t^1}{L}$, which is ultimately the measure of the constancy and truth to type of the 5-jointed tarsus, is really due to Selection and to the comparative prosperity of specimens whose tarsal proportions departed little from the normal, to what may we ascribe the smallness of the mean variation of the ratio $\frac{T^1}{l}$? Are we to suppose that the accuracy of the proportions of the regenerated tarsus is due to the Natural Selection of individuals which in renewing their tarsi conformed to this one pattern?

We are told that the struggle for existence determines every detail of sculpture or proportions with such precision that individuals which fall short in the least respect are at a disadvantage so great as to be capable of being felt in the struggle, and so decided as to lead to definite and sensible effects in Evolution. If this is so, should we not expect that individuals which had suffered such a comparatively serious disadvantage as the loss of a leg or of a tarsus, would be in a plight so hopeless that even though some of them may survive, renew the limb and even breed, yet, as a class, by reason of their mutilation they must rank with the unfit? Nevertheless we find not only that there is a mechanism for renewing the limb, but that the renewal is performed in a highly peculiar way; that in fact the structure newly produced differs from the normal just as species differs from species, and is scarcely less true and constant in its proportions than the normal itself.

Now if this exactness in the proportions of the renewed limb is due to Selection, it must be due to Selection working among the mutilated alone; and of them only among such as renewed the limb; and of them only among such as bred. Moreover if the accuracy of the form of the renewed tarsus is due to Selection working on fortuitous variations in the method of renewal, and not to any natural definiteness of the variations, the number of selections postulated is already enormous. But this vast number of selections must by hypothesis have all been made from amongst the mutilated—a group of individuals that would be supposed to be at a hopeless disadvantage[1].

[1] The same dilemma is presented in all cases where a special mechanism or device exists (and must be supposed to have been evolved) only in connexion with regeneration. An instance is to be seen in the Lobster's antenna. As is well known the antennary filament of the Lobster when lost is renewed not as a *straight* out-

One or more of the hypotheses are thus clearly at fault. A natural, and I believe a true comment will occur to every one: that probably the injured insects are *not* at any serious disadvantage, and that these mutilations perhaps make very little difference to their chances. But can we admit that the loss of a leg matters little, and still suppose that the definiteness and accuracy of the exact proportions of the tarsal joints makes any serious difference?

The hypothesis, therefore, that the smallness of the mean variation in the proportional lengths of the tarsal joints of the 4-jointed tarsus has been gradually achieved by Selection is untenable, whether that 4-jointed tarsus be a product of regeneration or a congenital variation. But if the accuracy with which the abnormal conforms to its type be not due to a gradual Selection, with what propriety can we refer the similar accuracy of the normal to this directing cause?

Radial joints in Arms of Comatulæ.

The number of radial joints above the basals up to the division of the rays in Crinoids is usually constant in the genera. In *Antedon* and *Actinometra* there are normally three such joints, the third radial being the axillary, and none of these bear pinnules. Both increase and decrease in the number of radials has been observed, but variations from this number are rare, more so than variations in the number of rays. CARPENTER, *P. H., Chall. Rep.*, XXVI. *Pt.* LX. *p.* 27.

626. **Antedon alternata:** specimen having in one ray *four* radials, none bearing pinnules or united by syzygy. *ibid.*, Pl. XXXII. *fig.* 6.

627. **Encrinus gracilis** (fossil): in one ray *four* radials. WAGNER, *Jen. Ztschr.*, 1887, XX. p. 20, Pl. II. fig. 13.

628. **Antedon remota, A. incerta, Actinometra parvicirra** (Fig. 126); one specimen of each of these species had one ray with only *two* radials. CARPENTER, *l.c.*, Pl. XXIX. fig. 6; Pl. XVIII. fig. 4; Pl. LXI. fig. 1.

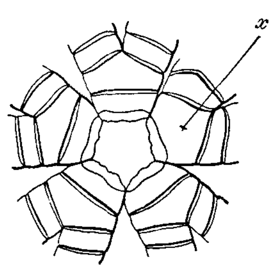


FIG. 126. *Actinometra parvicirra*, No. 628. Specimen having only two radials in the ray marked *x*. (From P. H. CARPENTER.)

growth, as the other appendages are, but when formed again it is coiled up in a tight conical spiral which cannot be extended at all, but is kept firmly in place by the shortness of the skin on the inner curvature. (For figure see HOWES, *Jour. Anat. Phys.*, XVI. p. 47.) During the process of regeneration the antenna is very soft, and were it extended it would from its great length be much exposed to injury. At the next moult after renewal the new antenna is drawn out as a straight filament like the normal, and its skin then hardens with that of the rest of the body. This strange manner of growth occurs only on regeneration. It is hard to believe both

Metacrinus. Some species have normally 5, others normally 8 radials. If there are 5, the 2nd and 3rd are united by syzygy and bear pinnules; but if there are 8, both 2nd and 3rd, and the 5th and 6th are thus united and bear pinnules. In *Plicatocrinus* the number of radials is *two*, and this is also the case in one or two fossil Comatulæ. *Pentacrinus* has normally three radials like *Antedon*.

629. **Pentacrinus mülleri:** specimen having in one ray *four* radials, the 2nd and 3rd *united by syzygy*, though bearing no pinnules. CARPENTER, *l. c.*; and *Chall. Rep.* XI. Pt. XXXII. p. 311, Pl. XV. *fig.* 2.

(1) that the number of individuals that have lost antennæ—a serious injury one may judge—and have renewed them, and have bred, can have been enough to lead to the establishment by Selection of a distinct and highly special device to be invoked solely on the occasion of mutilation of an antenna; and also (2) that the least detail of normal form is of such consequence as to be rigorously maintained by Selection.