

In relation to the preparation of a catalogue of local plants, Dr. J. C. White suggested the desirability of preparing exhaustive lists of the plants of the richer localities, before these shall become picked out or otherwise changed.

June 7, 1876.

The President, Mr. T. T. Bouvé, in the chair. Eighteen persons present.

Dr. W. K. Brooks gave a general sketch of the anatomy of the Tunicata, and showed how Salpa, with its separated sexes and other peculiarities, might be produced on the theory of Natural Selection. Dr. Brooks called especial attention to the locomotive powers of Botryllus, a hitherto unknown fact.

A paper on the Geology of Eastern Massachusetts, by Mr. W. O. Crosby, was presented by title.

The following paper was read:—

GENETIC RELATIONS OF STEPHANOCERAS. BY A. HYATT.

The group which forms the subject of the present paper was first described by Waagen as part of his genus *Stephanoceras*, it being with *Dactylioceras commune* and its allies, united as the "sub-group *a*" under this name.¹ *Cæloceras Pettos* was left by the same author under the title of *Ægoceras*, though the similarities of the latter to *Steph. Humphriesianum* were fully recognized by Waagen in his subsequent paper.² In this paper, also, he restricted the use of the name *Stephanoceras*; and two groups, which had appeared as subgenera of *Stephanoceras* in his first paper, were elevated to the rank of full genera, under the names of *Kosmoceras* and *Perispinctes*.

The preservation of zoological nomenclature in an available form demands above all things that names shall not be uselessly multiplied,

¹ Die Formenreihe d. Amm. subradiatus. Benecke's Geog. Pal. Beiträge, Vol. 2, p. 248.

² Ueb. d. Ansatzstelle d. Haftmuskeln b. Naut. und Amm., Paleontographica, Vol. 17, 5, p. 215.

and for that reason the law of priority has been universally recognized and mercilessly applied. Waagen, and all other German Paleontologists who have quoted his names, have disregarded this law in a wholesale manner. The only reason for this conduct, and the most charitable one which can be given, is, that they considered the new names proposed by Prof. Agassiz and myself as untenable, and unworthy of their adoption. This reason, although perhaps sufficient to themselves and their followers, is no justification for a violation of the rights of priority. The laws of nomenclature do not permit them to describe the same family groups as new genera with new names. New views of the relations of well known species cannot be represented by new generic names because the grouping happens to include a half dozen or more of the previously described genera. What a fearful maze of difficulties this process would lead to if generally adopted! Every man, or set of men, would of course have the same privilege. For example, let us suppose that in my own recent paper on the "Genetic Relations of the Angulatidæ," in the *Proceed. of the Bost. Soc. Nat. History*, Vol. XVII, May, 1874, I had originated a new name for the genus *Ægoceras* of Waagen, because his generic characteristics are of no value for the distinction of groups of generic significance. The genus *Ægoceras*, according to Waagen, contains forms as widely separated as *Psiloceras planorbis*, belonging to the Arietidæ, *Ægoceras angulatus*, one of the Angulatidæ, *Androgynoceras Henleyi*, one of the Liparoceratidæ, and *Cæloceras Pettos* of the Dactyloidæ. According to their development, mode of occurrence in time, and all their adult characteristics, except perhaps "the undivided, horny character of the Aptychus," these forms are perfectly distinct from each other.

The *Psiloceras* becomes the parent form of the Arietidæ in the Lias, the *Ægoceras angulatum* of another distinct series differing wholly in development and form in the same formation. Both of these are probably traceable to a common ancestor in the Trias, according to Waagen and Mojsisovics,¹ and therefore it may perhaps be considered that it is legitimate to join them, but what can be said with regard to the remaining forms? *Androgynoceras Henleyi* is directly traceable to *Deroceras Dudressieri*, the affinities of which cannot be settled with our present knowledge conclusively; but what evidence there is, however, in the development of the young shows

¹See also my paper on the "Genetic Relations of the Angulatidæ," in these *Proceedings*, Vol. XVII, p. 15.

most decidedly, as might be anticipated from the adult characteristics, that the ancestral forms are to be sought in the *Lytoceras* and allied groups, not in *Psiloceran* forms of the Trias. *Caloceras Pettos* is equally of uncertain derivation, though its affinities in every respect show also that it belongs to the *Dudressieri* series.

All of these forms are included under the name *Stephanoceras*, and thus two great groups of Ammonites, the round abdomened and the keeled groups, with distinct systems of development and uncertain derivation are made to appear as one genetically connected series. This, however, would not justify the total suppression of the name *Ægoceras* and the substitution of another for the more limited group, to which it can be properly applied. Scientific courtesy, as well as the strict law of custom, forbids such a course, though here, as in the *Arietidæ*, I must consider the name as used by Waagen utterly devoid of zoological meaning. The structure of the *Aptychus* has, no doubt, some meaning, but it alone certainly cannot unite *Psil. planorbis*, *Ægoc. angulatus*, *Caloceras Pettos*, *Microderoceras Birchii*, etc., into one genus, because as Waagen himself points out, it has the same structure in two other groups, *Arietites* and *Amaltheus*, described by him as distinct genera. If he had joined all these into one group and distinguished them by the *Aptychus*, it would have been more consistent and less objectionable; this characteristic would have at any rate applied to them all.

I allude particularly to this fact because the other characteristics given by Waagen are not applicable to such large groups. Thus in the lower forms of the *Arietidæ* (that is to say, my genera *Psiloceras*, *Caloceras* and *Vermiceras*, including the *planorbis*, *ravicostatus* and *Conybeari* series), the length of the living chamber, one of Waagen's distinctive characteristics, is generally over one volution. In the genus *Arnioceras*, the *falcaries* series, its length is generally less than one volution, from one half to nearly a full volution. In *Coroniceras*, from one-half to one. In *Asteroceras obtusum* the length is from one-half to five-eighths of a volution in large specimens, in *Asteroceras Brookii* about three-fourths. In *Agassiceras lævigatus*, five-eighths to three-fourths of a volution, in *Agassiceras Scipionianus*, about three-fourths. Thus in all the higher genera of the same family it is less than one volution, and so variable that it cannot be very usefully employed, even as a specific characteristic in some species, such *Aster. obtusum*.

The outline of the mouth has been long used to designate subgroups among the Ammonites. This characteristic, like all others, is

of different values in different groups, and the attempt to use it with the same meaning in every group results, as in all other cases, in confusion. Thus in Waagen's diagnoses of the genera *Stephanoceras*, *Perisphinctes* and *Kosmoceras*, we find that they are all three described as having "simple (entire) mouth-openings or ears." In each genus the characteristics of the *Aptychus* are the same, as stated by Waagen, and each has the same variability in the outlines of the mouth. These surely will not suffice to distinguish them, since they are precisely the same in each genus, and we have to fall back on the length of the living chamber or the comparative length of the animal and shell.

I do not mean to be understood as denying the existence of natural sub-groups of generic value, for undoubtedly such do exist, and some of them must bear Waagen's names in nomenclature, but merely to point out the inapplicability of such characteristics as he has arbitrarily employed to distinguish them. In many other groups the outlines of the mouth are exceedingly constant, as in the *Arietidæ*, and are very properly used to designate them in common with other characteristics.

I allude principally to these three characteristics, the *Aptychus*, the length of the living chamber and the mouth outline, because it is only in the application of these that Waagen differs from other naturalists, especially in the former, since Suess applied the two latter to the distinction of his genera *Lytoceras* and *Phylloceras*.

Such differences in the views of Paleontologists as are above alluded to, lie deeper, however, than any such contrasts in the translation and application of facts. They rest upon the different modes of study, which distinguish two schools of Naturalists. In one school the effort is being perpetually made to discover some set of characteristics by which animals may be distinguished one from another. Every new organ, or indication of such, when discovered, is applied at once to the definition of groups, as if this was the great object of all classification. The distinction of groups from each other doubtless represents to a certain extent our knowledge of their organization, but only in proportion to the number of the parts or characteristics which may be employed in classification. Consequently arbitrary classifications based on single characteristics are the most imperfect, since they necessarily leave out of consideration the numberless affinities of the groups, and all the minor points of difference which here and there appear.

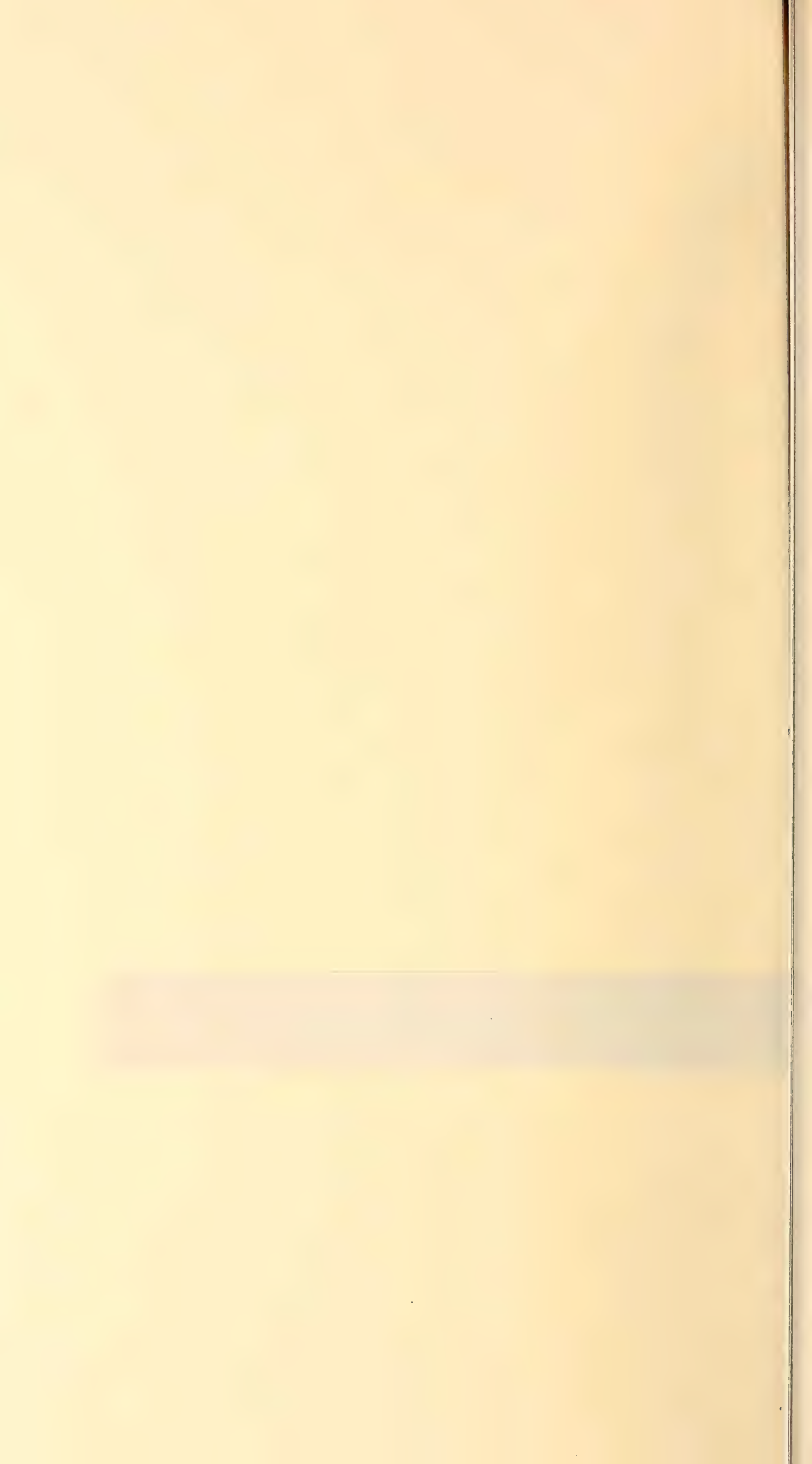
In the other school, a zoologist or paleontologist makes greater allowance for the variability of organic bodies, becomes distrustful of all single characteristics, or combination of single characteristics, and endeavors to combine all possible sources of information in his definition of groups.

The former naturally tends to the formation of large generic groups, those which can be approximately distinguished by some salient structural characteristic, and the latter to the division of these large groups into many minor ones, in order to show the natural affinities and derivation of animal forms.

The former leads to the artificial method of classification which has always, without the slightest reason, been claimed to be the more useful, and the latter to the approximately natural method. The differences are most prominently presented in one, and in the other these are considered of no more importance than any other class of characteristics. The first is certainly the most imperfect and conventional; and why its defects, which are openly confessed, should be regarded as recommendations for its adoption, or how it becomes by means of its confused imperfection more convenient, is equally incomprehensible. Is it more convenient to consider under the same head the genus *Antipathes*, one of the Alcyonoid corals and the *Aplysinæ* among the Keratose Sponges, because their skeleton is identical structurally? This would be considered absurd; but undoubtedly, if found fossil no purely Paleontological student could show an essential difference between them, and according to the demands of convenience, as understood by most of them, this absurdity ought to be committed. Innumerable instances might be quoted of a similar description, but it is unnecessary; practically the natural system of classification is always adopted after a certain lapse of time, and the different artificial and single character systems become obsolete.

I do not mean to underrate the great service done to the Natural History of the Ammonoid and Nautiloid Groups by Dr. Waagen. Waagen's treatise on the Annular Muscle of the *Nautilus* and *Ammonites*, the characteristic position and probable homology of the *Aptychus* with the similarly situated coverings of the heart in *Nautilus Pompilius* and observations on the length of the living chamber, are solid and permanent contributions, which cannot be too highly appreciated; but the mode of application of these to the classification of the Ammonoids is, according to my views, entirely

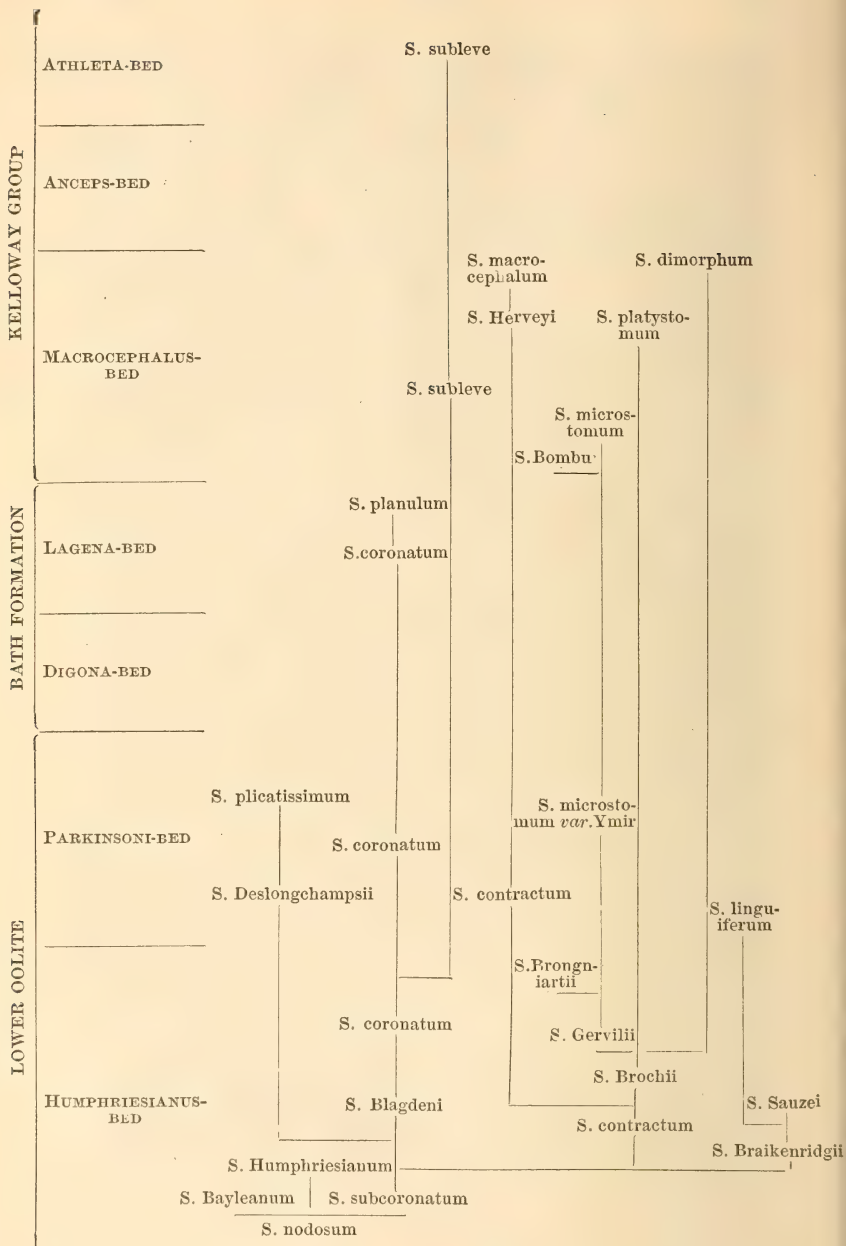
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from the bottom, these words — "nidamental glands above the"



faulty, and calculated only to mislead any naturalist who is desirous of understanding the affinities of these fossils.

There is nothing to be dreaded in new names, except by those who strive to get the animal kingdom by heart, as if the principal business of life was not to understand things, but to be able to indulge in an unending string of parrot talk. New names, like new things of all kinds, are not necessarily bad, they become so only when they violate certain essential restrictions, or are used to represent affinities which have no real existence. Used in a proper manner they are clearly a great advantage, since they force the unwilling or indifferent to pay some attention to the new views announced, and to represent or criticise them more or less in their collections and writings, and in this way they really become one of the most essential instruments in forwarding the general progress of knowledge.

For example, if Quenstedt had given a new generic name to every natural series of the Ammonites, which he has so admirably followed out in his grand work on the Jura, there would have been no occasion for the criticisms made above. Paleontologists would as long ago as the publication of *Die Cephalopoden*, in 1846, have begun to consider them in their natural relations, and now it would have been an act of scientific heresy to think of the Ammonites as anything but a large and important group divisible into many families and genera. Quenstedt's researches failed in this one technical point of apparently no essential value, and one which even now he would probably treat with the contempt born of the habit of contemplating more important things. I consider this, however, to have been a very unfortunate mistake, since it is owing to this, and this alone, that Aug. Quenstedt's work has not been universally known as the only one in Paleontology which at that early period adopted the only true system of classification, and fearlessly recognized the variability of forms and their passage into each other. He studied them in their development, adult characteristics, and even their diseases, and although all his observations were directed towards the definition of strata, struck the key note of true zoological classification in his work on the Jura, p. 20, where he writes, "aber der Fortschritt der Wissenschaft besteht nicht blos im Trennen, sondern auch im richtigen Verbinden, und letzteres — ist entschieden das Schwierigere." His collection and his published works exhibit a knowledge of this group and their true relations which has never been equalled, and which must form the basis of all future classifications, and as



early as 1846 he adopted the mode of work which is fast becoming universal, that of uniting in the same genetic series all forms, however dissimilar in aspect, which can be traced into each other, by means of the young and of the adult characteristics.

STEPHANOCERAS¹ Waagen (Pars).

The earliest observed form of this genus is the *Steph. nodosum* = *Humphriesianus nodosus* Quenst., which occurs in the Humphriesianus-bed. This variety or species, whichever the taste of the reader prefers, has the ribs more prominent and more widely separated than in *Humphriesianum*, the umbilicus larger, and the whorls increasing more slowly in size by growth; this renders the shell altogether more discoidal in aspect. The varieties, however, show a shading of the characteristics in three different directions. One way leads to *Steph. Bayleanum*, and another to *Steph. Humphriesianum*, and still another to *subcoronatum*. Towards *Bayleanum* a retrograde series of changes produces forms more and more discoidal, with whorls increasing more and more slowly in size by growth, until in the typical *Bayleanum* a very distinct species appears, as figured by D'Orbigny, and discussed by Oppel. It occurs contemporaneously with *nodosum*, and also later in the upper part of the Humphriesianus-bed.

In a similar way, by following the indications of the gradually changing varieties we are led to the stoutest, most involute and narrow-umbilicated forms of the typical *Steph. Humphriesianum*. In these the abdomen is also more elevated and rounder, the ribs are finer and more numerous, and the sutures distinct. *Steph. subcoronatum*, as pointed out by Oppel and Quenstedt, is one of the transition forms of *Humphriesianum*, but it has a wider significance when carefully studied in all its varieties. It becomes identical with *Amm. Deslongchampsii* when the ribs are curved and prominently tuberculated, and the abdomen somewhat elevated, though still very broad. The abdomen becomes in some specimens still more elevated, the umbilicus narrower than in the *Deslongchampsii*, the umbilical shoulder of the whorl more abrupt, the umbilicus deeper, the abdominal ribs par-

¹This name, as has been pointed out to me by E. B. Tawney, Esq., of Bristol, has already occupied by Ehrenberg for a genus of Rotatoria, but the termination adopted was spelled with an "o" instead of an "a," Stephanoceros instead of Stephanoceras, and this seems to me quite sufficient under the circumstances to justify its retention.

ticularly fine and numerous, the lateral ribs like those of *Steph. linguiferum* or those of *Steph. Deslongchampsii*. These are apparently identical with the *plicatissimum* of Quenstedt. Both of these forms, *Steph. plicatissimum* and *Steph. Deslongchampsii*, are found in the Parkinsoni-bed.

Some of the varieties of *Steph. subcoronatum* are nearly identical with *Steph. nodosum*, and some of them resemble closely the smaller specimens of *Steph. coronatum* or *Blagdeni*. The forms from Dundry, and also those alluded to in Quenstedt's descriptions of *Humphriesianus*, as allied to *Amm. Brocchii* Sow., show a close series of transitions from the finer ribbed specimens with open umbilici and young like *sub-coronatum* to those with stouter whorls, no tubercles and forms and ribs like true *Brocchii*. The more open umbilicated forms, those like true *nodosum* in aspect, lead by a similar series of gradations apparently into *Braikenridgii*, though here, of course, some doubt must always intervene until the appearance of the ear-like expansions in the latter is fully understood. The connection with *Steph. Herveyi* and *Steph. macrocephalum* can also be traced quite satisfactorily through the series described by Quenstedt, and also studied by myself.

Thus *Steph. subcoronatum* appears theoretically as the typical form of the group, a result which was entirely unexpected, since, until this summary was written, I had always pictured *Humphriesianum* proper as the centre of affinities. Some of the specimens are inseparable from *Humphriesianum* proper until the young are consulted. These invariably show the typical *Steph. subcoronatum* or *nodosum* form and characteristics very distinctly, and are also of a smaller size than the corresponding *Humphriesianum* varieties. The peculiar broad abdomen which characterizes the adults of *nodosum* and the young of *sub-coronatum* and *Humphriesianum*, I shall have frequent occasion to speak of, and as its resemblance is general rather than special, I shall speak of it usually as the Pettos-like form, in allusion to its ancestral derivation.

S. Blagdeni may be briefly described as a huge form of a young *sub-coronatum* of the broad abdomened variety in some of its forms; in others, however, the abdomen becomes elevated, and no line can be drawn between these and the succeeding, or true *Steph. coronatum* series. The peculiar broad abdomened forms which began to appear in varieties of *Steph. subcoronatum* are in *Blagdeni*, the predominate ones, and represent the species. The young changes but slightly by

growth, except in size, and the Pettos-like form is retained throughout life, except in those varieties which approximate to *coronatum*, or more strictly speaking, except in the round abdomened varieties which approximate to the predominant round abdomened forms of *Steph. coronatum*. These last do not alter the peculiar coarse character of the lateral ribs and tubercles of *Blagdeni*, but simply elevate the abdomen and increase in size faster by growth than the normal varieties, so that the umbilici become narrower, and the sides of the whorls more abrupt. These are often called *Amm. Banksii* Sow., but may be distinguished by the young which have the flat abdomen of the true *Blagdeni* until a late period of growth, while the true *Banksii* has young with a more elevated abdomen and larger tubercles. The Pettos-like form of *Blagdeni* and its peculiar ribs are more or less represented in all the young forms of the true *Steph. coronatum*. Sometimes specimens retain this even to an exaggerated degree, growing up to the adult condition with the sides so sharp, umbilici so deep, and abdomens so flat, that they appear as new specific forms, until the connection is traced between them and the normal forms. These are, as in the case of the similar representative forms found in *Steph. subcoronatum*, generally rather small; such is the variety known as the *anceps-ornati* of Quenstedt, and other scattered varieties intermediate between this and the true broad abdomened *coronatum* forms. Both *Steph. subcoronatum* and *Blagdeni* occur associated in the Humphriesianus-bed, and *Steph. coronatum* later in the Parkinsoni-bed, with the exception, perhaps, of the *Banksii* variety, which may possibly occur in the Humphriesianus-bed.

The tendency of some varieties of the preceding species to narrow the abdomen and depress the sides, is more strongly expressed in *Steph. coronatum* than in any other species of this group, it having become characteristic of all the adults of the normal form and of the young, though in many individuals not perceptible until a late stage of growth. This stronger expression of an evidently inherited tendency is accompanied by a correlative tendency to the suppression or absorption of the tubercles and ribs. These changes are retrograde in so far as they produce a form smaller and less ornate than the preceding, and because they may be directly compared with some of the retrograde changes first observed in the old age of ancestral species. The tendency of the old of *Humphriesianum* is to decrease the size of the whorl in every way, and according to D'Orbigny, very old specimens become smooth, losing tubercles and ribs.

In *Steph. subcoronatum* the contraction is also well marked as old age advances, though here, as in *Humphriesianum*, the time at which old age may begin varies greatly. In *Blagdeni* I was not able to observe any very marked old age changes, except perhaps a tendency to narrow the abdomen.

In the *Banksii* variety of *Steph. coronatum* the old age changes are well marked, the tubercles decreasing in size, and the ribs becoming depressed and finally obsolete. In the *planulum* variety of *coronatum* this retrograde tendency is carried out fully, appearing even in the adult shell, so that the abdomen becomes very narrow, and the ribs in some specimens have no tubercles, except in the earlier stages of growth. The extreme changes in the individual figured by D'Orbigny, I have not observed, but his figures are doubtless correct, since the indications of the obsolescence of the ribs, and the depression of the angular sides in the normal variety, are very marked in much smaller shells than those which he describes as having only undulations on the side at the diameter of 230 mm., and that which he figures as entirely smooth at the diameter of 486 mm. None of these are found in his collection, but probably exist elsewhere, although he does not allude to them in this connection. Even at this enormous size, 486 mm., the shell of the normal variety, *i.e.*, that which has the *Blagdeni*- or *Pettos*-like form until a late stage of growth (see D'Orbigny, Terr. Jurass., pl. 169, fig. 1-2, and pl. 168), retains the lateral tubercles, though these are so close to the umbilical edge as to give them an entirely distinct aspect.

It will be observed that these old age metamorphisms of the individual are not only correlative with those occurring in the *planulum* varieties of *Steph. coronatum*, but they also resemble, in a measure, the changes which take place in the evolution of the *Steph. Bayleanum* out of the *Steph. nodosum* forms. This consists simply of a decrease in size of the whorls. When it takes place in an old specimen of *Steph. nodosum* it is an old age degradational change. When it takes place at an earlier stage it produces forms intermediate between *nodosum* and *Bayleanum*; and when at last it occurs at an early age, it changes the quick increase in the growth of the whorls to a slower rate, and produces the narrow whorls and discoidal form of *Bayleanum*. It differs from the old age changes in not going to the extreme extent of destroying the tubercles, ribs, etc.

Quenstedt describes specimens, all of which must, I think, be referred to *Brochii*, in which the tubercles are lost at an early age, but

the growth, on the other hand, is not affected, the increase in size being even greater proportionally than in the normal *Humphriesianum* forms leading into the *macrocephalum* group. Upon the whole, the old age or degradational changes which precede death in the individual, are found to be correlative with the products of degradational changes in every direction, whether they result in producing a discoidal form, like *Bayleanum*, a flattened form, like *Steph. planulum*, or a smooth form, like the last described variety of *contractum*.¹ Above the Bath formation the history of this series is fragmentary; the few specimens I have seen present, for the most part, the broad abdomened *coronatum* form. The forms sometimes referred to this series from the White Jura I do not think can be properly designated as descendants. Quenstedt analyses this question very fully in his diagnosis of the convolutus group, p. 578 of *Der Jura*, and it is also my impression, derived from careful examination of closely allied forms, that even such apparently *coronatum*-like forms as the *Graesianum*, figured by D'Orbigny, pl. 219 of *Terr. Jurassique*, will be found to belong to the *convolutum* or *planulatum* group, and that the true *coronati* have no representatives in the White Jura.

The extraordinary form, *Steph. sublaeve*, to which we now come, presents in its adult condition so close a resemblance to the *Amm. Goliathus* that Quenstedt is evidently in "*Der Jura*" doubtful of its true affinities, though he had previously, in "*Die Cephaloden*," referred it to the *coronatum* group. The development, however, shows none of the peculiar variations observable in the *Amm. Goliathus* group, and the young in some specimens retain the *coronatum* form and characteristics until a late stage of growth. During old age the whorl contracts as it does in *Humphriesianum*. The form and characteristics of the young appear to indicate a derivation from some *coronatum* form, like that found in the Parkinsoni-bed, Museum of Stuttgart Collection. Another characteristic which seems to separate it from the *Goliathus* series is the general tendency of most of the forms to become smooth on the abdomen, at a stage when *Goliathus* is furnished with prominent ribs. Notwithstanding these facts, however, whenever the adult forms come under observation, a similarity becomes apparent which it is at present impossible to explain.

The series which can be followed from *Steph. contractum* to *Brocchii*, and its allied forms, is perhaps the most complete of all others, the

¹ With this compare the old *coronatum* described by D'Orbigny, referred to above.

lines drawn between the different species being so slight that they vary with every locality. *Contractum* can only be separated from *subcoronatum* by the fineness of the ribs on the abdomen, and in the adult by the aspect of the sides. The connection with *subcoronatum* is largely made through the young, which are indistinguishable from the young of that species in some specimens.

The Herveyi-like, or macrocephalum-like forms of *contractum* occurring in the Parkinsoni-bed, have finer ribs than *Herveyi*, but it is probable that they vary greatly in this respect. The young of *Steph. Herveyi* are in some varieties tuberculated, but acquire the aspect and characteristics of the adult of *Steph. contractum*, including the fine abdominal ribs, as soon as they lose their tubercles. Others which have no tubercles acquire this aspect at still earlier age, and these lead into *Steph. macrocephalum*, in which the young are invariably smooth, or not tuberculated.

In *Steph. macrocephalum* we find a series of forms, which become gradually more and more compressed laterally, until they present a very narrow abdomen and whorls of extraordinary breadth. The abdomen, however, does not become sharp, even in extreme varieties.

Throughout this series, as a rule, only the oldest specimens become smooth on the latter part of the living chamber, showing that this is an old age characteristic. The growth maintains the same ratio of increase in the size of the animal throughout life, and the whorl therefore never becomes contracted even in extreme old age. There is, however, here, as in the compressed forms of other series, a noticeable decrease in the size of the species or varieties as a whole. The laterally compressed forms are usually much smaller than the broad abdomened forms, a fact in direct accordance with the idea that they are the senile descendants of the broader forms.

The mouths of this series, like those of all species previously described, present no lappets at any stage of growth, and are very uniform in outline.

Steph. Brocchii is a species with very peculiar characteristics, and its affinities lead in two directions; one towards *Steph. platystomum*, and the other towards *Steph. Gervilii*, and other senile forms.

Some of the varieties do not appear to contract the living chamber at all, or only the very last portion near the mouth. These have the precise aspect of the young of the finer ribbed varieties of *Herveyi*. Others show this contraction in such a marked manner that the in-

ference becomes unavoidable that the living chamber has a tendency to become like that of *Gervilii*.

Starting from these *Gervilii*-like varieties of *Brocchii*, a series can be followed which leads imperceptibly into *Gervilii* proper with its coarse ribs even in the younger stages, and from thence into the smooth, globular, and more involute forms of *Steph. Brongniartii*.

The series from *Gervilii* to *microstomum* is not so complete, but I think no one can examine the forms in Prof. Mæsch's collection, the *Amm. Ymir* of Oppel from the Parkinsoni-bed, without coming to the conclusion that they show characteristics intermediate between true *Gervilii* of the Humphriesianus-bed and the *Steph. microstomum* of the Macrocephalus-bed. The form, size, ribs, and the fact, that in many specimens *microstomum*, like *Gervilii*, does not become smooth on the living chamber, except in old specimens, while in others the form is much more altered and smoother at comparatively early age, are all intermediate characteristics. Their meaning, however, was not perceptible to me until I had become assured that true *microstomum* had no lappets, and was found as the variety, *Ymir*, geologically lower than the typical form.

The peculiarities of the larger *Gervilii*-like varieties of *Brocchii* are exaggerated in the succeeding *platystomum* forms, in which the living chamber presents the irregular form at a very early age, and is usually smooth and much compressed laterally near the mouth. The evidence appears to show that there is a line of forms leading from the smaller *Gervilii* and *Brongniartii* through variety *Ymir* in the Parkinsoni-bed to *microstomum* in the Macrocephalus-bed, and also a line which connects the larger *Brocchii* through their *Gervilii*-like forms, with the true stout-formed *platystomum* of the same bed. The latter is more deficient than the former, since there are no intermediate forms in the Parkinsoni-bed, but this is largely made up for by the close resemblances of some of the adult forms, and of the young of this species to the adults of the normal or untuberculated variety of *Brocchii*. This view of the affinities also explains better than any other the very close similarity of the stout form of the shells throughout, and the peculiar aspect of the living chamber.

Throughout the whole of these series we find similar phenomena to those occurring in the series which spring from *subcoronatum*. Wherever growth is continuous throughout life, old age does not act very distinctly upon the shell in the obsolescence of the ribs or decrease in size of the whorl as a whorl, either in the individual or in the

series to which the individual belongs. This was shown particularly in the *macrocephalum* series, which continued the direct line of those varieties which began with the true *contractum* forms in which the mouth showed little or no contraction. Other series, however, which were followed out from those varieties of *Brocchii* which did show this contraction, manifested a distinct tendency. It was found that in the same variety the living chamber varied not only in different individuals, but at different stages in the same individual. In the young it showed far less the tendency to contract and to become smooth than it did in the old age of individuals of the same varieties. The contraction and smoothness were also less apparent in the earlier or ancestral forms than in the more mature or descendant forms, whether found in the same formation or in distinct formations. Thus following out from *Brocchii* to *Brongniartii*, we find a series steadily decreasing in size, in the regularity of the growth of the shell, and in the size and prominence of the ribs. The contraction and smoothness of the living chamber, at first a variable characteristic, only found in the senile stages of large specimens, become fixed as adult characteristics of all forms in the *Gervilii*-like varieties of *Brocchii*, are inherited according to the law of acceleration in the living chambers of *Gervilii* at an earlier age, and finally constantly appear accompanied by all their attendant degradational or senile characteristics at a much earlier period in *Steph. Brongniartii*.

The series from *Brocchii* to *microstomum*, and also to *platystomum*, were not worked out in accordance with this theory from "a priori" conclusions, but were traced out in accordance with the evidence, and the true relationship not suspected until these remarks were written; nevertheless the same principles appear to hold in them, but not so well or distinctly marked.

The *microstomum* series maintains more determinedly the ancestral *Gervilii* type so far as the aspect of the ribs is concerned, but obeys the same law in the lateral flattening of the living chamber and increasing smoothness of the species.

Steph. platystomum is, however, a notable example of the action of the law of acceleration, since here the smoothness and distortion of the living chamber become constant at a very much earlier age than they ever appear in the large *Gervilii*-like varieties of *Brocchii*, which, according to Quenstedt's and my own independent observations, must be the immediate progenitor.

Steph. dimorphum constitutes a series by itself, or rather it might be said begins one of which it is the only known member. The evidence afforded by the earlier stages of growth indicates a close affinity with *Brocchii*, since the shell evidently continued to increase the size of the living chamber until the adult period. At this stage it began to exhibit very markedly the contraction previously described. The presence of the furrows also shows that this living chamber was never absorbed to any great extent; a very remarkable difference when we consider, that if the furrows were absent many English specimens would be inseparable from *microstomum* in Dorsetshire, and others found in Calvados, undistinguishable from *Brongniartii* of the same locality, and that both of these species habitually absorb the living chamber after every arrest of growth. The mouth outlines agree with those of the preceding series.

The next and last series with which we have to deal is also the most extraordinary.

Step by step, in spite of preconceived notions, the evidence has forced me to refer the whole of these series, which spring from *contractum*, to *Steph. subcoronatum* as the parent form, and this is the case here also.

The connection of *Steph. Braikenridgii* with this species is equally plain, although the large lappets are so distinct that an independent origin might have been reasonably anticipated. The resemblances of the young of *Steph. Braikenridgii*, to the young and adult of *Steph. subcoronatum* are too plain to admit of much doubt, and it is probable that the blank which still exists will be filled, as it has been in the genetic history of *Amm. fuscus* by Quenstedt, by the discovery of intermediate forms having the mouth lappets as a variable or simply adult characteristic. The young of *Steph. Braikenridgii* resemble the adults of *subcoronatum*, with the exception of the contraction of the living chamber. This takes place in young specimens, however, much more slightly when an inch or half an inch in diameter than it does in the full grown, and at no period does it equal the distortion common in the next member of the series, *Steph. Sauzei*. The mouths of both species not only have the lappets, but these are peculiar in arising from the abdomen and spreading out abdominally instead of laterally, in correlation with the abdominal flattening of the outline, which gives the shells a totally distinct aspect from those of any other series. *Steph. Sauzei* accelerates the inheritance of the *subcoronatum* form so much that it is difficult to recognize the affinity

with *Steph. Braikenridgii* in those varieties which grow rapidly in size and have narrow umbilici. In others the *subcoronatum* form is more plainly discernible. This is precisely similar to the relationship which exists between *Brongiartii* and *Gervilii*.

A review of the general relations of the different series exhibits some peculiarities worthy of our attention. If we start from *Steph. nodosum* and compare the different species of each genetic twig or branch, we are struck with the very distinct characteristics of each series of forms.

Steph. Bayleanum is decidedly retrogressive, the size and the involution of the whorls is less than in the type of *nodosum*. *Humphriesianum*, on the other hand, acquires in successive forms finer ribs, rounds the whorls of the adult and increases the amount of the involution, and, in the highest forms, the elevation of the abdomen. *Steph. subcoronatum* holds more closely to the type of *Steph. nodosum*, and forms the centre of affinities for all the remaining groups.

The comparison of these three main groups also reveals the very interesting fact that *Bayleanum* and *Humphriesianum* have no descendants; only the last of the three mentioned, *subcoronatum*, appears to have been fruitful in this respect. *Bayleanum*, in the course of its growth, contracts the whorls at an early stage, thus replacing the *Pettos*-like form by a more flattened, discoidal whorl in the adult stage. *Humphriesianum*, on the contrary, increases in the relative size of the whorls for a considerable time, but sooner or later shows the effects of the contraction of the mouth parts, which appears at first as a transitory characteristic near the mouth of each newly formed living chamber. This contracted part is completely absorbed in the younger and adult stages, when growth is resumed after each season of rest, but not in the old. Therefore after a period more or less prolonged, according to the size and growth force of the specimen, the shell begins to diminish in the size of the whorl and the involution to decrease. This eventually, becomes very marked, especially when it is accompanied, as it must be in extremely old specimens, by the loss of the spines and ribs. The *Pettos*-like form is retained for a longer period in the young than in *Bayleanum*.

Steph. subcoronatum, on the other hand, retains the *Pettos*-like form much longer than the other two, shows hardly any signs of decrease in the rate of increase in the size of the whorl by growth, and therefore presents in many specimens no very marked old age changes in the shells. It is altogether more like the parental *nodosum* or *Pettos*

than any other form. This fact is very significant when we observe how completely it appears to be the genetic source or origin from which spring all the other forms of the group.

If this were an isolated result I should be slow to attach much importance to it, but I am constantly confronted in these researches by the fact, not only that the simplest or most embryonic forms, those standing nearest to the source or roots of a group, are the most prolific; but often that those among their direct descendants which retain this simple structure are the longest lived, most enduring and least changeable of all others. Compare for instance, the slight differences existing between *Steph. subleve* in the Athleta-bed, and *Steph. subcoronatum* or *Blagdeni* in the Humphriesianus-bed, with those between the same species and *macrocephalum* or *platystomum* or *Sauzei*; also the longer existence of this series with that of the other and more changeable series.

Not only are the changes observable in the whole series from *subcoronatum* to *subleve* less marked, but this necessarily correlates with the changes in the course of individual development and growth which are also less marked; there is less force used up in the production of new characteristics in the ancestral forms, and therefore a greater capacity for propagation and resistance to the modifying effects of changing conditions of climate and habitat. The forms of *subcoronatum*, which exhibit no marks of senility even when very large, lead directly into the true *Blagdeni* forms. On the other hand, those which change much in old age exhibit intermediate stages, in which the abdomen becomes rounded and more elevated, and the ribs similar to those of *Deslongchampsii*. Though not able to trace this connection so fully as the others, there seems to be reasonable ground for joining *plicatissimum* with *Deslongchampsii*, since both of these exhibit similar characteristics.

In following the *coronatum* series from *Blagdeni*, we are struck by the gradations which gradually lead the observer from the immature form of *Blagdeni* to the flat-sided, untuberculated form of *planulum*, with its elevated abdomen. This, as I have previously pointed out, is a direct repetition of the retrogressive old age characteristics of the individual, as shown in *Humphriesianum*, and in some specimens of *subcoronatum*.

The individuals of one series, the *macrocephalum* series, show old age only in the elevation and narrowing of the abdomen. There is here but a slight retrogression, so far as the individual is concerned.

The size of the individual continues to increase during life, there is no distortion, and only a normal tendency to the suppression of the ribs. So far as the series, however, is concerned, the size of the later occurring species or normal senile forms is smaller than that of the average of the ancestral forms.

The senile forms of this series and of the *coronatum* series express in the continuous increase of the individual by growth throughout life, and in the absence of all decrease in the amount of involution, a certain power to resist the retrogressive changes which are so marked in other series. The suppression of the tubercles, however, and the narrowing of the abdomen and decrease in absolute size of the terminal species of the series are decisively senile. There is evidently a mingling of opposing tendencies in these forms not found in the senile forms of series, which are more completely changed. Thus in the series from *Brocchi* to *Brongniartii*, there is not only a retrogression in absolute size, but also in the increasing distortion of the living chamber. The period at which the living chamber begins to show a distorted form and smooth exterior, becomes earlier in each species. This is also true of the series leading into *microstomum* and *platystomum*, which present similar characteristics.

In *dimorphum*, however, which appears to be one of this group, a remarkable difference makes its appearance. The living chamber is no longer fully absorbed after each period of arrest in the growth, and an abdominal channel, which was only occasionally visible in some of the *planulum* forms, becomes quite constant. Notwithstanding these new characteristics, the form is evidently retrograde and senile, suffering in some individuals from a very rapid series of senile degradations. This is probably due to the declining force, which prevents the animal from resorbing the walls of the living chamber. A similar state of affairs occurs in the *Sauzei* series, where a new characteristic is added in the shape of mouth lappets, but the inheritance of the distorted form of the living chamber takes place, as in the *Brongniartian* series.

Every one of these series presents three principal stages of growth and development, the young or Pettos-like, the adult, or that in which *Humphriesianum*-like ribs and tubercles and a rounded abdomen appear, and an old age or senile period, in which these ornaments tend to disappear, the shell to decrease in size, and so on. These three stages are present in different proportions in different series. Thus the manifestations of a retrogressive tendency in *Bay-*

leanum are much more prominent than in *Humphriesianum* and *macrocephalum*; and the changes introduced are very distinct in these from what they are in the distorted forms of *Brongniartii* and others; again, the *Pettos*-like form is retained in the full grown and even old specimens of the lower forms of the *coronatum* and *subleve* series, whereas it is only a characteristic of the development of the young in other series.

In fact, the manifestations are exceedingly complicated, and prevent the application of the three stages to the solution of the affinities and to the classification of the genus as a whole, except in a very general way. Thus it may be said that all the lower members of the genus, *Steph. nodosum* and *subcoronatum* and *contractum* are similar to *Pettos*, and that the higher, such as *planulum*, *macrocephalum*, *Brongniartii*, etc., exhibit during the adult period senile characteristics corresponding to the senile characteristics of the individual. But this can only be asserted as we have seen with considerable qualification until each genetic series is considered by itself, then indeed an exact correspondence comes to light between the senility of an ancestor and the senility of the descendant or congeneric species.

This statement exhibits completely the difference between geratology¹ and embryology. With the former it is possible to indicate *only* what must have been the dying forms of the particular genetic series to which the individual belonged, whereas with the assistance of embryology and the history of the younger stages we can with equal probability point out an unknown ancestral form for all the series of a group. The right use of both the correspondences of embryology and of geratology gives the means of mapping out with considerable probability both the past and future of groups from the study of even a limited number of individuals.

The laws of heredity secure the constant inheritance of the adult characteristics of the parents at earlier and earlier periods in successive descendants, until the permanent characteristics of an adult ancestor, or what remains of them, becomes embryological. This tendency to constantly reproduce similar characteristics in successive

¹ From γῆρας -ατος, old age, and λόγος. I have adopted this new term with considerable hesitation and doubt, and have only done so under the pressure of necessity. In no other way can I better convey my conviction that there is a traceable correspondence between all manifestations of decline in the individual and in the group to which the individual belongs, which may, like embryology, be used inductively in reasoning upon the probable affinities of animals.

generations of individuals, has been heretofore supposed to be confined to the inheritance of adult characteristics, or to those characteristics which make their appearance in the parents previous to the period of reproduction.

Heretofore it has also been generally assumed that only the active elements of the growth of the parts and their tendency to the more or less powerful performance of certain functions were necessarily inherited. It has not, so far as I know, been even hinted at that animals could also inherit a tendency to change in a way that was unfavorable to the continued existence of a race or group as a whole. This is, however, not an isolated but a very general fact among the Ammonites. The successive species in almost all large groups sooner or later inherit the old age tendencies of their ancestors so completely, that they manifest these even in their early stages. In other words, they never attain a stage which can be closely compared with the adult stages of the most common or characteristic of the ancestral forms. This is left out. The embryo passes into the young, and the young proceeds by growth to develop parts and organs entirely wanting in those characteristics which distinguished the similar parts and organs of the adults of the ancestral forms. When we compare these accelerated forms, or forms which have thus skipped some of the previously existing stages of their ancestors, with the senile stages of those same ancestral forms, they present a correspondence of greater or less exactness, according to their affinities, sometimes very perfect, sometimes very remote. Thus the old age stages of one of the Arietidæ do not at all closely resemble those of *Humphriesianum*; the complete correspondences are limited to genetically connected series or groups, and sometimes only to organs or certain sets of organs which alone show the effects of senility in the individuals and in the group. The fact of the inheritance of old age characteristics, and of the extinction of types as shown in this way, is, however, of general application, and will probably be found in all departments of the animal kingdom.

Of course it will be readily understood that these statements apply only to the most perfect groups, or those which complete their cycles of forms. It is not intended to assert that every group has an old age, or even that every individual has; on the contrary, there are some forms in nearly every large group among the earliest ancestors which manifest senility very slightly, though attaining a very large size, and there are some groups which show only a partial decline, or

none at all. All of these exceptions, however, can be accounted for by natural causes, and the comparison between the life of the group and the life of the individual is rendered even closer and more distinct thereby. I have frequently, in former publications, referred to these facts, and am interested in them now only in their application to the present group.

We find in looking at the table (p. 366) that all the series sprang from one ancestral form, and that as in many other cases among Ammonoids, the genesis of the forms must have proceeded with comparative rapidity. This of course means with reference not to the number of years, but to the portion of geological time occupied by a series. Thus the whole of the time during which the Oolites were being deposited, was not needed in order to produce the extreme forms of the *Sauzei* group by evolution out of *nodosum*; on the contrary, one single bed contains the entire record of their existence, one minor period alone was amply sufficient for the evolution of the most aberrant form of the whole genus.

If we assume that certain characteristics which show themselves for the first time in the organization of *Steph. Humphriesianum*, *subcoronatum*, *contractum*, etc., were favorable to these forms, and particularly fitted them to sustain existence in these different localities and with distinct physical surroundings; and that these different characteristics were directly due to the necessity of the plastic organization to flow into and fill up certain vacancies, and fit itself to fill these vacancies more and more completely, we can understand how the differences which distinguish the forms have arisen. Thus the peculiar lappets of the rim of the mouth in *Steph. Sauzei*, and the numerous local peculiarities of appearing here and there in the history of every fauna, which are merely varietal and not characteristic of the series or even of the species, could be accounted for. They are characteristics which suddenly appear without having had existence previously in ancestral forms.

Besides these, however, there are numerous other characteristics, those which are derived from ancestral forms and are mostly confined to the young, such as the Pettos-form and characteristics. These are permanent and hereditary, and apparently independent of the surroundings in proportion to the antiquity of their source. Thus the extreme bag-like embryo is invariably present, and there is every intermediate grade from this to the full Pettos-like form and tubercles, etc., which last, on account of their recent origin, are, ac-

ording to the law of acceleration, entirely omitted in the development of the individuals of some of the completely senile or later occurring species. The form of the embryo and the Nautiloid and Goniatic stages which were variable characteristics during the Silurian and Devonian, have become more or less fixed and permanent by constant inheritance, and are at this period in the existence of the Ammonoids, either partially or entirely independent of the action of the physical surroundings, occurring in the embryonic or early stages of the development of the individual, however different its habitat. I do not mean, of course, to assert that even the most invariable of these hereditary characteristics did not arise primarily as the direct product of physical causes, but simply to point out their existing independence, after having become through continued heredity a permanent part of the growth tendencies of the group. The proofs of this have been given in my paper on the "Embryology of the Cephalopods," in which the gradual manner in which the characteristics become less and less subject to variability in the embryo is given in detail.

The differences, then, or those characteristics distinguishing the different series from each other when they first appear, must be largely confined to the adult period in the existence of the individual or to the later stages of the growth of the young, and this is a corollary of the proposition that the differences between the forms are due to the direct action of different physical surroundings upon similar organisms. For if the differences were thus produced we should necessarily anticipate that they would make their first appearance, in most cases at least, after the permanent and hereditary characteristics had been fully developed. In common with Prof. Cope I have repeatedly explained these and other related phenomena, by what we have called the law of acceleration. [It is a universal law of heredity, that previously elaborated, ancestral characteristics tend to be inherited, if inherited at all, at earlier and earlier stages in successive descendants, until they either finally disappear like the Pettos-form in the young *Sauzei*, or become fixed and more or less permanent in the embryo.

Laying aside all of these, we can now turn our attention again to strictly senile characteristics. These are the representative forms which are produced in every series. That is to say, there is a certain parallelism produced by the perpetual reappearance or genesis of similar forms in distinct structural series, and as might be anticipated,

these are due to similar causes, disease, either normal or abnormal, produced by the continued action of unfavorable surroundings on the individual. That old age is a normal disease, or that it at least should be classed with pathological phenomena, can hardly be questioned. If it were questioned, however, the similarities between distorted forms occurring in unfavorable situations and the normal retrogressive changes of old age in a well formed individual of the same series, would settle the dispute; the products of the direct action of disease produced by unfavorable surroundings, and often even by wounds and those due to senility have a wonderful similarity. These senile characteristics may appear, as in *Steph. Bayleanum*, as probably the result of the direct action of certain unknown, but unfavorable causes, upon the organization of *nodosum*, or only slightly, as in *Steph. Humphriesianum* or not at all, as in *Steph. Blagdeni*, which as a descendant of *Steph. subcoronatum* ought, unless sustained by some exceptionally favorable surroundings, to show decisive marks of senility. This case, and that of *Steph. macrocephalum* previously cited, show that the normal retrogressive tendency of old age may occasionally be to some extent counteracted by the process of growth, as shown by the increase in growth of the shell, even in old age, of these two species. This, of course, can only be attributable to some exceptionally favorable circumstances, which for a time give extraordinary power to the organization. But this is only for a time, since in all series having a prolonged existence, old age forms eventually make their appearance just as senile characteristics do in the individual.

Wherever the old age or diseased tendencies make their appearance they tend to the production of similar forms. If mitigated by the very favorable circumstances under which the race is living, and the shell, in consequence of the unimpaired powers of assimilation of the animal, continues to increase proportionally in size and in the involution of the whorls throughout life, we find that a narrow-abdomened, convergent-sided and very involute whorl is evolved in the last or highest members of the series, whether it comes from the round abdomened, or the keeled or channelled groups. If, however, the surroundings are not especially favorable, and the assimilative powers become impaired, as shown at first by the decrease in size of the whorl in the old age of the individual, then all degrees of irregularity in the whorl become manifest in the last or highest members of the series, tending to the production of Scaphitoid forms.

This, in many series, is probably due to the direct inheritance of the

tendency to reproduce the old age characteristics of ancestors, according to the law of acceleration at earlier and earlier periods in successive descendants, and is the normal form of the decline of genetic series; but besides this there are in some species corresponding series of forms, evidently due to the unfavorable nature of their surroundings, which are so quickly produced as to have the effect of simultaneity, as if they sprang at once from one brood. The former may be compared to the normal disease or senile period of a healthy individual, and the latter to the premature old age of an unhealthy or prematurely developed individual.

In the embryo, therefore, we find permanency and exact hereditary similarity; in the later stages of the young and the adult, the novelties of adaptation to new or varied surroundings; and in the old or senile periods, a diseased condition, in which these adaptations or novelties tend to be absorbed or lost, and consequently greater uniformity is noticeable between the old than between adults.

This precisely corresponds to the relations of a group composed of several series derived from a common ancestor. At first, near the point of origin, the series are similar organically, then great structural and morphological divergence takes place, and finally, though they remain structurally just as remote, similar forms begin to make their appearance in the different series.

I might go on endlessly with these comparisons, but it suffices to say that the conclusions which I published in 1866, in the *Memoirs* of this Society,—asserting that the life of an individual, and the life of the genetically connected series to which the individual belonged, could be directly correlated, that a series, like an individual, had only a limited force available for growth, development and propagation, that the three stages of existence in the individual corresponded respectively, the young to the past, the adult to the present, and the senile to the future of the group, whatever it might be to which the individual belonged,—have been confirmed by the minute analysis of the groups of Jurassic Ammonites, and the more minute the analysis the more complete the correspondence.

NOTE. — Having used the word *force* in this essay with a very distinct meaning from that with which I first used it in 1866, it becomes necessary to define it. Organic force or vital force is, in my view, simply an expression for the force resulting from the combination of chemical elements in an organic form.

FIRST SERIES.

Stephanoceras Bayleanum.

Amm. Bayleanus Oppel, Die Juraf., p. 497.

Amm. Humphriesianus D'Orb. (pars), Terr. Jurass., pl. 133.

Oppel did not find the intermediate forms between this species and *Humphriesianum*, and therefore considered it distinct. Although this view is untenable, I retain the specific name in accordance with previous custom, otherwise I should be obliged to use a trinomial designation for this form, and others of the same group. The transition forms from this to the next described, are numerous, and can be observed in any large collection. The young were not observed. According to Oppel, it is found lower than *Humphriesianum* in Germany.

Stephanoceras nodosum.

Var. *Humphriesianus nodosus* Quenst., Der Jura, pl. 54, f. 4.

Amm. Humphriesianus Sow., Min. Conch., pl. 500, fig. 3 (not 1-2).

The typical form of this variety has more prominent tubercles and fewer lateral ribs than the typical variety of *Humphriesianum*. The young also resemble the adults of *Blagdeni* until a later period of growth than in the last mentioned. All these characteristics are subject to great variation, and both by the adult characteristics and development these forms fade into the next described. It occurs in the Mus. Stuttgart Coll., associated with *Sauzei* in the Middle Brown Jura γ . The originals in Sowerby's collection show that the large specimen figured on pl. 500, fig. 3, of his Min. Conch., must be included in this variety, while figs. 1 and 2 must be referred, as they have been, to *subcoronatum*.

Stephanoceras Humphriesianum.

Amm. Humphriesianus Auct.

Var. *Humphriesianus plicatus* Quenst., Der Jura, p. 398.

Amm. Humphriesianus D'Orb., Terr. Jurass., pl. 134-135.

The typical forms are found in the Middle Brown Jura and in the Mus. Stutt. Coll., with the first of the true *coronatum* forms. The varieties appear to have two principal tendencies, one which leads into forms similar to *Humphriesianus plicatissimus* Quenst., and occurs in the upper part of the same formation (*oberer Delta*), and one which approximates to the *Amm. subcoronatus* Oppel. One fine specimen of this form showed an incomplete living chamber at the diameter of 156 mm., about half a revolution in length. This was smaller in

every way than the adjoining whorls, but no signs of old age were visible. The finest suites of this species occur at the Bristol Museum and in D'Orbigny's collection.

One specimen in the latter shows an extremely long and complete living chamber, occupying one and one quarter volutions. The entire diameter of the specimen was 210 mm. The involution of the whorls was noticeably decreasing at about 30 mm., and continued steadily to decrease, accompanied by a corresponding diminution in the size of the whorl until the difference in size and form at the mouth became very marked. This specimen exhibited an extreme variation, and should be more exactly, perhaps, associated with *nodosum*. In other stouter and more normal forms the involution decreases at a slower rate, and begins later in the life of the individual, and in some individuals it is not perceptible at all. It is evident that either no absorption of the living chamber takes place, or only a partial one took place during the growth, since the diminution in the size of the living chamber simply continues that which occurs in the body of the shells, where the sutures are well marked. This may be noticed in any large collection of this species. A fragment of the mouth of a specimen which must have attained a diameter of at least 300 mm., still possessed the tubercles and showed no signs of old age beyond this decrease in diameter. In Dr. Wright's collection a fine specimen (size not noted) exhibited the living chamber and mouth complete; the last whorl was smooth for almost the entire length, the tubercles and ribs small in the adult.

SECOND SERIES.

Stephanoceras subcoronatum.

Amm. subcoronatus Oppel, Jahressch. Nat. Wurttt., Vol. 12, p. 496.

Amm. coronatus-oolithicus Quenst., Die Ceph., pl. 14, f. 4.

Amm. Humphriesianus Sow., Min. Conch., pl. 500, fig. 1-2 (not 3).

This species is distinguished from *nodosum* only by the greater proportionate breadth and flatness of the abdomen, and the abruptness of the umbilical sides, continuous increase in the size of the whorls by growth, finer ribs, and so on. These characteristics may be summed up in a few words as precisely intermediate between *nodosum* and *Blagdeni*. The adults are smaller, but quite similar to the latter, and though larger than the young of *Humphriesianum*, almost identical with them in aspect externally, though probably

differing in the characteristics of the sutures. The similarity of this species to *Braikenridgii* is delusive; its true affinities place it nearer to *nodosum*. The resemblance is due to the retention of the common ancestral Pettos-like form until a late stage of growth, or during the entire life of the individual.

The various changes taking place by growth and development may be studied in any large collection. The contraction of the whorls in size, and the consequent assumption of rotundity, take place in some specimens very markedly, and make them look very like *nodosum*. This change is so great in some very old specimens that they resemble the adult of *Bayleanum*, though their own adult stage, or younger periods, have the normal form of the true *subcoronatum*. In many other specimens, however, though of equal size and apparently the same age, there are no perceptible marks of such changes either in the size, form of the whorls, or ornaments.

Stephanoceras Deslongchampsii.

Amm. Deslongchampsii D'Orb., Terr. Jurass., pl. 138.

This is evidently a form of the broad abdomened variety of *subcoronatum* with prominent spines, described by Quenstedt as a variety of *Humphriesianum*, and as a transition to the *Amm. subcoronatus* of Oppel. A remarkably fine specimen in Quenstedt's collection, from St. Vigor, enabled me to make this comparison. I did not find the original in D'Orbigny's Collection. Quenstedt places it in the *Braikenridgii* series, to which it appears to be allied by the curvature and general aspect of the ribs, but this resemblance it shares in common with forms of the *subcoronatum* series, especially *plicatissimum*. The abdomen becomes considerably elevated, and the sides convergent in the adults.

Stephanoceras plicatissimum.

Amm. Humph. plicatissimus Quenst., Der Jura, pl. 54, f. 3.

This variety has so close a resemblance to *S. linguiferum* in some forms that broken specimens are frequently confounded under the same name. There is a very close resemblance in the sparseness of the lateral ribs, and comparative closeness and fineness of the abdominal ribs, the prominent tubercles and the form of the whorl. The mouth lappets, however, the intermediate forms and the young of *linguiferum* show its affinity with *Steph. Sauzei* to be unquestionable, and separate it widely from this species. Further comparisons show that the real affinities of *plicatissimum* lie with the stouter forms of *subcoronatum*, which have been described as closely approx-

imating to *Humphriesianum*, from which it is sometimes difficult to separate it. It is really a variety of *Deslongchampsii*, with more elevated abdomen and narrower umbilicus.

THIRD SERIES.

Stephanoceras Blagdeni.

Amm. Blagdeni Sow., Min. Conch., pl. 201.

Amm. coronatus Zieten, Verst. Wurt., pl. 1, fig. 1.

Amm. Blagdeni D'Orb., Terr. Jurass., pl. 182.

Amm. coronatus Quenst., Die Ceph., pl. 14, f. 1.

This species, though attaining a large size with fewer whorls, has a most remarkably close resemblance to the ancestral form, *Cæloceras Pettos*, so close indeed that they are very similar, not only in the form and characteristics of the adults, but in the sutures, and in the general history of the development of the young. This greater similarity is directly traceable to the very obvious fact that in this variety of the species the immature *Pettos*-like form, characteristics and sutures, which are common also to the younger stages of all other forms of this genus, are here more strictly retained throughout the entire growth of the animal. This is so strictly carried out, that the shell in most specimens manifests none of the old age characteristics or retrograde metamorphoses previously described in other species, *i. e.*, in the decrease of the amount of involution and size of the whorls. In other specimens great changes take place, but they are very distinct from those of the purely *Humphriesianum* forms. They are first manifested in the elevation of the abdomen, which becomes rounder and more elevated during growth, and the adults become similar to some forms of the next described species. The amount of the involution does not decrease, nor the relative size of the whorl, but the abdomen becomes more elevated and the sides rounder. These forms are similar to *nodosum* in general appearance, but their real affinity with *coronatum* alone stands the test of close analysis.

Stephanoceras coronatum.

Amm. coronatus Brug., Ency. Meth., p. 43.

This species always has in the young, for periods of variable length, according to the variety, whorls which closely resemble in form and characteristics those of the adult of *Blagdeni*.

Variety *Banksii*.

Amm. coronatus D'Orb., Terr. Jurass., pl. 168 (not 169).

Amm. Banksii Sow., Min. Conch., pl. 200.

Amm. anceps-ornati Quenst., Die Ceph., pl. 14, fig. 5.

This variety retains the Pettos-like form in some specimens until a very late period of growth, and in others a close approximation to the next described variety occurs by the elevation of the abdomen in course of growth, and the gradual rounding of the sides and loss of the tubercles. In Sowerby's collection the original specimen exhibits these characteristics only on the last whorl for a limited space, although the specimen attains the large size of 250 mm. in diameter. In the Mus. C. Z. collection one specimen attains the diameter of 220 mm., but exhibits old age only in a slight rounding off of the tubercular projections; in this the sutures are plainly visible throughout. In other specimens, also, the sutures are exhibited in similar relations to the metamorphosed tubercles and form, showing that complete absorption of the living chamber does not occur during growth, and that these changes are truly permanent and retrograde. A form intermediate between these broader and more Blagdeni-like forms and those of the Ornathenthon, or Brown Jura, ζ , occurs in the collection of the Museum of Stuttgart in the Parkinsoni-bed.

The *anceps-ornati* of Quenstedt is in no sense a true *anceps*. It is very similar to "*anceps*," but a close inspection indicates, first, that there are no intermediate forms between the two, and second, that the form in the Museum of Stuttgart, as above quoted, seems to show that it is genetically linked with the *Banksii*- and Blagdeni-like varieties of the earlier *coronatum* forms. It is found in the upper part of the Athleta-bed, in the Museum of Stuttgart collection, associated with *Bel. hastatus*.

Stephanoceras planulum.

Amm. planula D'Orb., Terr. Jurass., pl. 144.

This name is quoted by Opper, as that of a new species, *Amm. Wagneri*; but Opper's comparison shows that he supposed D'Orbigny's figure to represent a species closely allied to "*arbustigerus*," whereas it very accurately shows the characteristics of a well known French form which passes insensibly into "*coronatus*," and is found associated with the latter at Chatillon sur Saone in the Bath-formation of Opper. The originals do not exist in D'Orbigny's collection, but young specimens show that their relations are probably correctly stated, as above.

FOURTH SERIES.

Stephanoceras subleve.

Amm. sublevis Sow., Min. Conch., pl. 54.

Amm. modiolaris D'Orb., Terr. Juras., pl. 170.

Amm. sublevis Quenst., Die Ceph., pl. 14, f. 6.

Amm. sublevis Zieten, Verst. Wurt., pl. 28, fig. 5.

The originals in Sowerby's collection prove the accuracy of Quenstedt's conclusions with regard to the identity of the English, French and German forms. D'Orbigny's collection possesses only a cast, but his figures are quite sufficient.

Amm. sublevis Zieten, which Quenstedt identifies with *modiolaris*, is represented by several specimens in the Upper Brown Jura, Machrochilus-bed, Museum of Stuttgart. One of these is much thinner than the others, and shows a more discoidal young. The rest have very abrupt sides from an early period, and deep umbilicus, but not so deep as in D'Orbigny's figure. These show that the form is not developed as in *Quenstedioceras Leachii*, and others of the *Goliathus* group, to which the adult of the *modiolare* variety seems to be closely allied, but according to the method commonly observed in the *coronatum* group.

A very fine suite of this species exists in Quenstedt's collection, from which I obtained the following observations. One variety retains until a late stage of growth a very close resemblance in form and characteristics to the *coronatum* as figured by D'Orbigny, and which has been cited from the Parkinsoni-bed in the collection of the Museum of Stuttgart. Whether the whorl ever becomes entirely smooth in this variety I cannot say; they attain a considerable size without any marks of such a retrograde metamorphosis. The umbilicus is quite open, and the young in form and characteristics approximate to the adult of *coronatum*. A second variety may be distinguished, which is a true *subleve* form, but still has quite an open umbilicus. This loses its ribs and becomes smooth at a late period of growth on the abdomen, but retains heavy lateral ribs. A third variety has an open umbilicus, but is comparatively smooth at an early age, losing the lateral as well as the abdominal pilæ, and finally the whorl begins to show a retrograde metamorphosis, the size being affected by contraction, as in large specimens of *Steph. Gervillii* or *Steph. Humphriesianum*. A fourth variety has the narrow funnel-shaped umbilici, and the individuals appear to continue to increase in size throughout life

without any contraction in the magnitude of the whorls. These are also smooth in the adult.

The resemblance of the young of the first varieties to *coronatum*, and the mode of growth and subsequent retrograde metamorphosis by a decrease in size, shows that we are dealing with forms derived from the *coronatum* series, and which, notwithstanding the close resemblance of the fourth, or *modiolare* variety, to *Amm. Lalandeanus*, do not seem to lead into this group.

FIFTH SERIES.

Stephanoceras contractum.

Amm. contractus Sow. (pars.), Min. Conch., pl. 500.

Under this name I have, for convenience sake, assembled those forms which are intermediate between *subcoronatum* and the *macrocephalum*, *Brocchii* and *Sauzei* series. They are usually recognized in collections, either as varieties of *subcoronatum*, as *Brocchii*, as *linguiferum*, as *Humphriesianum*, etc., and also as true *contractum*. From this they vary, however, in the fineness of the abdominal ribs and the immature aspect of the lateral ribs. This last characteristic is so marked that the umbilicus resembles that of *Pettos* very closely in the smooth, abrupt aspect of the sides, and the prominence of the tubercles. The varieties lead from a very open discoidal whorl in one direction into the true *Brocchii* form, and in another into the *Braikenridgii*.

Stephanoceras Herveyi.

Amm. Herveyi Sow., Min. Conch., pl. 195.

“ “ Ziet., Verst. Wurtt., pl. 14, f. 3.

The young of this species varies considerably in aspect. Some specimens have a row of prominent tubercles on the side, closely appressed so as to form an almost continuous ridge. Others have them more scattered, and finally there are many without any, and wholly indistinguishable from the untuberculated young of *Brocchii*, if found in the same formation. They are invariably stouter, rounder, and less *Pettos*-like than the young, or even adults of the *subcoronatum*-like varieties of the *contractum* from Dundry, Eng. The peculiar abdominal ribs are in the young no coarser than in *Brocchii*, and it is evidently a lineal descendant of the tuberculated *Brocchii*-like forms of *Steph. contractum*.

Stephanoceras macrocephalum.*Amm. macrocephalus* Schlot., Die Pet., p. 70.

" " Ziet., Verst. Wurt.t, pl. 5, fig. 1.

No line can be drawn between this species and *Herveyi*, which has not many exceptions, but as a rule the forms of *Steph. macrocephalum* may be distinguished by the flatness of the sides and the more elevated abdomen. The young also take on this peculiar form at an early age. Their earlier stages are precisely similar to those of the untuberculated young of certain varieties of *Herveyi*.

The smoothness of the latter part of the living chamber is very perceptible in large specimens of *Herveyi* and of this form, but not in small specimens, though I have seen many small specimens with nearly complete living chambers. This shows that it is an old age characteristic.

SIXTH SERIES.

Stephanoceras Brocchii.*Amm. Brocchii* Sow., Min. Conch., pl. 202.

This is a convenient designation for a number of forms which in the young are undistinguishable from the Brocchii-like forms of *contractum*, or rather fade into them. They lose the tubercles of *contractum* at an early period in their growth, and the form grows stouter and more involute, disguising in the adult the resemblance of the young to *contractum*. Series, however, exist, exhibiting all the stages between them, in the British and Bristol Museums, and a partial one in this Museum. The adults differ from *Brongniartii* so slightly that it is equally difficult to decide on that side, but some forms have a peculiarity of the growth which shows considerable distinctness. They continue to grow or increase in size regularly throughout the entire length of the living chamber during the adult period. A specimen in the Museum of Stuttgart, having the coarse ribs and open umbilicus of the forms which approximate most closely to the true *contractum*, has a nearly complete living chamber, but shows no signs of becoming smooth or contracting the aperture. Either it must have had a much longer living chamber than is usual in *Brongniartii*, or possessed these distinguishing characteristics. The true *Brocchii* forms are therefore simply larger and more involute varieties of *contractum*, and in extremely large old specimens when the whorl permanently contracts the shell, they become in-

distinguishable from the typical *Gervilii*, except by the coarseness of the ribs and the size. There are several fine specimens in Quenstedt's collection, also, which show this very plainly.

There is a very remarkable series of specimens, undoubtedly belonging to this species, which are described by Quenstedt as a fine ribbed variety of *Humphriesianum*. They have no tubercles except at an early age in Brown Jura "γ." The forms in "δ" directly connected with these, show the tubercles even less prominently, while those in "ε" are smooth, like the young of *macrocephalum*. All have the rapid increase by growth in the size of the shell, which is so characteristic of *Brocchii*, as well as the fine ribs and narrower umbilicus. They appear to show a direct connection with *Steph. Herveyi*, but are, in reality, only representative forms, which are direct descendants of *Brocchii*, and resemble *macrocephalum* in the young because of their accelerated development of the ancestral characteristics, leading to the gradual suppression of the *Pettos*-like form and characteristics which they inherited in a modified form from *contractum*.

Some specimens in the British Museum have very coarse lateral ribs, and others the finer ribs of the specimens which resemble *contractum* in the young. The specimens in the Bristol Museum attain a very large size, and in the largest the last whorl or two becomes so contracted and flattened laterally, that it resembles the forms of the *Perisphinctes* group.

Another magnificent suite of this species, labelled *Gervilii*, is to be found in the Museum of Stuttgart. They show the same contraction of the mouth in large specimens, in some to such an extent that the actual opening is triangular. The only partially constant distinction which I can find between this species and the true *Gervilii*, consists in the smoothness of the young of the latter, their usually smaller size, and the slower increase in magnitude of the whorls by growth.

Stephanoceras Gervilii.

Amm. Gervilii Sow., Min. Conch., pl. 184a, fig. 3.

Amm. Brongniartii D'Orb., Terr. Jurass., pl. 137.

The forms of this species are precisely intermediate in point of size, development, and so on, between *Brocchii* and *Brongniartii*. Some of the specimens in the British Museum have finer ribs than the coarser ribbed *Brocchii* of that collection, but the umbilicus is

quite as open, and it is possible that the young have the same resemblance to the young and adults of *contractum*, but this could not be ascertained. The young of the typical English and German forms are precisely similar to the full grown *Brocchii* of the more *contractum*-like varieties, and appear never to have tubercles at any age, being remarkably gibbous even at the earliest stages.

I do not pretend to draw a distinct and definite line on either side of this species, since the indications are numerous that it fades in one direction into true *Brocchii*, and in the other into *Brongniartii*. The latter takes place through the smaller and more involute varieties with globular young and finer ribs. In the Palæontological Collection at Munich there are several species described by Waagen as belonging to *Stephanoceras* which belong to *Gervilii*, or some of the forms intermediate between this and the true *Brocchii* forms, such as *Amm. polyschides* and *Amm. polymerus*. *Amm. evolvens* appears to be a form of *Brongniartii*. The species which occur in the *Macrocephalus*-bed have been named *Amm. Bombur* Opper, and it may perhaps be convenient to retain this name, since they seem to be constantly smaller than typical *Gervilii*, but retain the coarser ribs and more open umbilicus of that species in the young.

Stephanoceras Brongniartii.

Amm. Brongniartii Sow., Min. Conch., pl. 184a, fig. 2.

Amm. Gervilii D'Orb., Terr. Jurass., pl. 140.

The irregular growth of the living chamber, which resembles so closely that of *Scaphites*, becomes in this species a fixed character, and is found at an early age, though less marked than in the adults. The young are smooth until a late stage of growth, when compared with those of the preceding species, very globular in form, and the ribs when they begin to appear are very fine and untuberculated.

I find no mention of this species in my notes on D'Orbigny's collection, and doubt if it existed there, since he does not allude to any originals as belonging to his own collection. The lateral expansions figured by him in the early stages are very distinct in position and form from those of the *Sauzei* group. From the study of several specimens of about the same age, I should think they were very much exaggerated in D'Orbigny's drawing. The edge of the mouth is generally bent inwards, but in some specimens it may be thrown outwards, forming a salient angle, but no wings or lappets were observed in the young.

SEVENTH SERIES.

Stephanoceras microstomum.

Amm. microstomus D'Orb., Terr. Jurass., pl. 142, fig. 3-4.

This is a constant and well marked variety, which differs in the young from *Steph. platystomum*. Many specimens at an advanced age do not become smooth on the living chamber, but others do at a comparatively early stage. It never attains the large size or stout whorls of *platystomum*, and the living chamber becomes remarkably flattened laterally. The living chamber is almost entirely absorbed at each renewal of the shell growth.

I find in my notes no mention of any specimen exhibiting the abdominal lappets figured by D'Orbigny, and a strict examination, including the cleaning of several fine specimens, of D'Orbigny's collection, was equally fruitless. Quenstedt also could not find them on the German specimens, and I am therefore forced to the conclusion that D'Orbigny's figure is erroneous in this respect. Several of these specimens had perfect mouth outlines. An examination of the young led me first to suspect that these lappets did not exist, and that the species must belong to the entire mouth series, and I could not understand their appearance in a form so evidently closely related to *platystomum*. A very remarkable series exists in Prof. Mæsch's collection at Zürich. It is the *Amm. Ymir* Oppel, *Amm. bullatus* Kudernatsch, a variety intermediate between *Gervilii* and this species, and found in the Parkinsoni-bed. The living chamber in one specimen is more than one revolution in length, smooth for a half of its length, and not yet complete.

EIGHTH SERIES.

Stephanoceras platystomum.

Naut. platystomus Rein., Naut. et Argo., fig. 3.

Amm. platystomus Quenst., Die Ceph., pl. 15, f. 3.

Amm. bullatus D'Orb., Terr. Jurass., pl. 142, f. 1-2.

This species is most admirably described by Quenstedt, and the affinities traced to the coarse ribbed varieties of his *Brongniartii*, which are identical here with *Gervilii*. I have only to add that I have verified his conclusions in several collections, but notably in the Stuttgart and British Museum collections. The resemblance which he describes between the form at certain stages and the *Amm. Goliathus* D'Orb., is certainly quite remarkable, but a close examina-

tion shows that it is after all not such as to indicate a genetic connection between them. The angularity of the abdomen of *Amm. Goliathus* is wanting, and the flat abdomen of the earlier stages in that group. The whole development is similar to that of *Brocchii*, and it is only a stouter form of *Gervilii*, with a tendency to form a smooth living chamber.

The living chamber is evidently almost entirely absorbed during the growth of the shell, as may be seen in all large collections. In some specimens of considerable size the living chamber is smooth only for a very short space near the mouth; in others of the same or even smaller dimensions, nearly the whole is smooth. In very large specimens, however, the living chamber appears to be invariably smooth. The irregularity of the growth begins invariably in all specimens near the base of this chamber by the contraction of the whorl, and continues throughout. The increase in size, however, is regular at all preceding periods, whatever the size of the shell. The conclusion is therefore unavoidable, that the living chamber must be almost wholly absorbed in the course of growth. The young are precisely similar to the adults of *Brocchii*.

NINTH SERIES.

Stephanoceras dimorphum.

Amm. dimorphus D'Orb., Terr. Jurass., pl. 141.

The young of this remarkable species at first sight appear to be identical with those of *Brongniartii* or *Gervilii*, but the permanent mouth furrows marking the shell even at an early period, show it to be distinct in its mode of growth. These appear to indicate that the growth of the shell is constant, and that the walls of the living chamber are never absorbed. If so, we have a very remarkable change in the mode of growth. The young evidently retain the *Brocchiian* living chamber until a late period of growth. That is, the living chamber did not exhibit contraction in the young, but like that of *Brocchii*, continued to increase in size towards the mouth except in old specimens. As the specimen reached the adult condition, however, in this species the chamber assumed the usual proportion of that part in *Brongniartii*, and continued to decrease until the death of the animal. This appears to be the only way in which to account for the presence of the permanent mouth furrows.

Comparisons of the young with those of *Gervilii* and *Brongniartii*, seem to indicate a very close affinity; but this evidence, and the

adult characteristics appear to indicate a close relationship also to *microstomum*. I find also in my notes that one specimen in D'Orbigny's collection had young resembling *Humphriesianum*. The only safe conclusion, therefore, is to provisionally trace it back to *Brocchii* as a direct derivative.

There is one significant fact not mentioned by D'Orbigny, which his specimens show. The abdomen is furrowed in many specimens. The mouths, also, of the originals are more compressed than in his figures 2, 4, 8, pl. 141. There is one specimen of this species in the collection at Munich having a most remarkable resemblance to *Amm. globosus* in the form and also in the outlines of the mouth.

TENTH SERIES.

Stephanoceras Braikenridgii.

Amm. Braikenridgii Sow., Min. Conch., pl. 184.

Amm. contractus Sow (pars), Min. Conch., pl. 500.

Amm. Braikenridgii D'Orb., Terr. Jurass., pl. 135.

This species has given great trouble to all who have undertaken to study the question of its affinity. Quenstedt long since pointed out its close relationship to *Humphriesianus nodosus*. The large ear-like expansions, however, which it possesses at an early age, cast more or less doubt upon this apparently unavoidable conclusion. The large and quite complete suite of specimens in this Museum and at Bristol leave, however, but slight room for doubt that Quenstedt was right.

The young in nearly all cases are strictly similar to the young of *subcoronatum*, however much the adults may vary in form and characteristics; a small number of them, however, especially from Dundry, England, are very similar to *contractum* from the same locality though they upon close examination exhibit differences in the thinner forms and slower increase of the shell by growth and in the coarser ribs.

Oppel identifies *Brocchii* with *contractum*, and this appears to be true in most collections, but an examination of the young of such specimens from Dundry shows at once that they in part are true *Brocchii*, and part belong to this species. The *contractum* described and figured by Sowerby I have seen, but my notes thereupon are not satisfactory. Whether any species is really intermediate between this and the *subcoronatum* in all its characteristics I cannot say, but any one who will consult the descriptions of *Amm. fuscus* by Quenstedt, Der Jura, p. 475, which may or may not have the peculiar broad

lateral ear-like expansion of the mouth edge, according to the variety to which the shell belongs, will see that this is a probable inference. These observations can be readily confirmed in any good collection of *Amm. fuscus*, and show that the presence and absence of the ear-like expansions may take place in forms as closely allied as the two alluded to above. Intermediate forms with the lappets as a variable characteristic, or as a characteristic of the adult stage of growth alone, ought to be eventually found in those varieties which approximate closely to *subcoronatum*, if this is a correct view.

Quenstedt alludes to large forms which have no lappets, and these may have some bearing on the question, but I refrain from expressing an opinion since, unfortunately, I have not seen such examples. I would, however, mention that there are certain forms which about evenly divide the characteristics of the two species, but the absence of the mouth makes the reference of these to either *Braikenridgii* or *subcoronatum* doubtful. Some of the latter have the young until a late period, precisely similar to the flat abdomened form of *subcoronatum* with the similar ribs and tubercles; and this is the general character of the development in the larger specimens, but in smaller specimens, especially the English forms, a more contractum-like form becomes apparent at an early stage, and the development approximates to what it eventually becomes in *Sauzei*.¹

Stephanoceras linguiferum.

Amm. linguiferus D'Orb., Terr. Jurass., pl. 136.

The varieties of this form fade into those of *Braikenridgii* by insensible degrees, though the extreme forms differ in the larger comparative size of the whorls, the amount of envelopment, which is greater than in *Braikenridgii*, the peculiar bent aspect of the lateral ribs and the more ornate aspect of the shell, due to this arrangement of the ribs, the fine abdominal ribs and the prominent tubercles. The increase in the size of the shell is constant in this, and also in *Braikenridgii*, there being no regular contractions in the size of the whorls due to growth, as in *Sauzei*. *Amm. Torricelli* (sp. Oppel) is a form of this species, as it appears in Mæsch's collection at Zürich and in the Paleontological collection at the Munich Museum. *Amm. Keppleri* Oppel ought also, according to my views, to be included under this name.

¹ *Subcoronatum* is merely an intermediate form between this species and the true *nodosum*, and therefore I quote from Quenstedt's views as directly confirmatory of the above.

Stephanoceras Sauzei.

Amm. Sauzei D'Orb., Terr. Jurass., pl. 139.

The thick tumid aspect of the young of this shell has caused me repeatedly to place it in the same series with *Gervilii*, but a renewed inspection has just as often brought me back to the same conclusion that this was due entirely to the purely coronatum-like form of the young, which at a very early stage is not round and smooth as in *Gervilii*, but more like *subcoronatum* or *Blagdeni*. This remarkable difference in the development confirms the contrast of structure between the mouth of the shell with its ear-like lappets, and the plain Humphriesianus-like outline of that of *Gervilii*. The form also differs somewhat. The living chamber near the mouth becomes depressed from above, as in *Braikenridgii*, instead of contracting laterally, as in *Gervilii*, and all allied forms. There are several varieties, but the principal are those with open umbilici, in which the young retain the true *coronatum* form until a late stage of growth. These always seem to have prominent tubercles at an early age, and are altogether more similar to *Braikenridgii* than those with narrower umbilici. The last are more involute, have the tubercles later developed, the ribs finer, and the young in form and markings so similar to the young and adults of *Gervilii* or *Brongniartii* that they are often confounded.

This is one of the few instances in which the history of the development and adult characteristics appears to be at variance with the geological record. *Braikenridgii* has only been found in the Humphriesianus-bed, whereas *Sauzei* is habitually found in the lower part of the Humphriesianus-bed, the "Sowerbyii-bed." This, however, is only a slight discrepancy which may arise from false identifications, and I have therefore ventured to disregard it in the genealogical table.

DOUBTFUL SERIES.

Stephanoceras refractum.

Naut. refractus Rein., Naut. et Argo, figs. 27-30.

Amm. refractus D'Orb., Terr. Jurass., pl. 173.

" " Quenst., Der Jura., p. 524, pl. 69.

This bent and distorted form has young which can be compared only with the young of this series, and it is possible that a sufficient number of specimens would enable an observer to trace it directly to some one form. There is, perhaps, more resemblance to

microstomum in the young of the specimens which I have examined, but the large ear-like lappets are very dissimilar characteristics. The abdominal channels are present in some specimens of *microstomum*, and in some of the other species of the group as a rare variation, so that their prominence in this species can not be considered as absolutely conclusive against this view of the affinities.

I have failed entirely in finding any species of the *Parkinsoni* group to which the young might be compared. The development of the ears seem to decide in favor of its association with the *Sauzei* group, but the large rostrum between them is an entirely new organ, not shown in either *Braikenridgii*, *Sauzei* or *linguiferum*. In fact it has the most curious and unaccountable mingling of the characteristics of several groups, with certain prominent characteristics entirely peculiar to itself. Quenstedt quotes one form as found in the *Parkinsoni*-bed, and speaks of this in "Die Cephalopoden" as an undoubted "crippled" *Parkinsoni*. I have failed to recognize this fact in his collection. My notes give me no hints on the subject, and I may have omitted seeing the specimens he refers to.

Whether to connect this species with the *Microstoma impressa* Quenst. of the White Jura or not, I cannot say. There appears to be a close affinity between the development of the young, and the abdominal furrow is well developed; but on the other hand such resemblances might occur in simply representative species of distinct genetic series. The *Amm. Schaphitoides Coynarti* of the Oxford, fine specimens of which exist in the Prof. Mæsch's collection at Zurich, has an irregular form and the same furrow in the abdomen of the living chamber, but the mouth was not shown. *Amm. Chapuisi* and *Collinii* Opper of the White Jura of the same collection, are evidently closely allied to *Amm. scaphitoides*, but like that species resemble *refractum* only very remotely, and I think will be traced eventually to some form in the White Jura.

Section of Botany. June 12, 1876.

Mr. W. P. Wilson in the chair. Twenty-seven persons present.

Mr. Charles Wright made some remarks on the characters of *Rubus villosus* and *canadensis*, calling attention to an in-