

some months before they had found a large bone there about eighteen inches long which had been taken by some professor of the University.

Mr. Bouvé thought this object was a natural production, in which opinion other members who examined it concurred.

ON REVERSIONS AMONG THE AMMONITES. BY PROF. A. HYATT.

In some remarks relating to the origin of characteristics among animals, Mr. Hyatt stated that he had recently discovered a series of reversionary characteristics among the Ammonites which might be considered worthy of exceptional consideration.

These are the peculiar extensions of the pilæ (ribs so called) and of the intervening sulci, or lateral depressions, across the abdomen or external periphery of the shell, characteristics found especially in *Microceras planicosta* and *laticosta*. The genus which was founded upon this peculiarity and the ("Discoceratidæ") Arietidæ, having been recently subjected to a revision, certain similarities of a very remarkable kind were observed.

It was found, that among the Arietidæ, *Coroniceras rotiforme*, occurring in the "Bucklandibett" of Opper, *Cor. nodosum*, in the upper part of the same bed, *Amm. Birchii*, just above this in the "Tuberculatusbett" and *Asteroceras obtusum*, still later in the "Obtususbett," all exhibited to a greater or less degree the planicostan pilæ on the abdomen during some stage of growth in certain individuals.

In *Coroniceras nodosum* this is especially remarkable, and the contrast between the young in those individuals which show this stage, and the adults, with keel channels and septa all so typically arietian in character, is very great. In all these species the planicostan stage appears only in a limited number of individuals in each species, and is always succeeded in course of growth by the features just described of keel, channels and septa, peculiar to the family of the Arietidæ. In *Ophioceras raricostatum*, however, the latest occurring species of the lower Lias which has the typical septa of this family, the planicostan stage is superseded in course of growth only by a keel, this species having no channels.

Of course, in trying to account for the presence of this transient characteristic, one follows the family back to its lowest representatives. These may be said to be two species, *Caloceras torus* and *Arnioceras cuneiforme*, the former closely allied to *Psiloceras psilo-*

notum in its septa, and the latter also in its external characteristics. None of the lower forms, however, display, so far as observed, the planicostan stage, though they occur earlier than the species which do exhibit this peculiarity. The planicostan abdomen, therefore, must either be a new characteristic suddenly interpolated in the growth of some individuals, or a reversion to certain ancestral characteristics which have been discontinued for a time in the lower members of the family.

The lower forms of the Arietidæ, *Caloceras torus* and such species as *Amm. nodotianum*, with which this species is closely allied, have septa that are similar to those of certain Triassic species, such as *Amm. Brunneri*¹ and *Amm. Batteni* Strachey, which also resemble *Psiloceras psilonotum* in their septa and forms.

The affinity, therefore, is doubly proved through the latter species, which is a contemporaneous form, and by direct comparison. Besides these there are other species, such as *Amm. lævidorsatus* Hauer, and *Clydonites quadrangulus* Hauer, which show us that the planicostan abdomen is by no means a new feature. Thus, though we cannot assert that the Arietidæ are directly traceable to species in the Trias having the planicostan abdomen, we can say that the family on its lower borders have affinities with Triassic species, and that the planicostan abdomen is found in the Trias. It is probable, therefore, that the same modification, when it occurs in the higher Arietidæ, after a certain interval of time is a reversionary feature.

The young of *Coroniceras nodosum*, *Amm. Sauzeanus* of D'Orbigny, is succeeded in the next bed, the "Tuberculatusbett," by a new form, *Microderoceras Birchii*, whose young are entirely distinct in their mode of development from any of the Arietidæ. They are at first very cylindrical and smooth, then two rows of tubercles are introduced; and sometimes, though rarely, a specimen occurs in which the planicostan abdomen is presented. The septa develop to a more complicated outline in a shorter time than any of the species which follow in the same series or any species among the Arietidæ.

Very similar to this in its adult ornaments and septa is *Microceras biferum*; in fact, I was disposed to think them members of the same genus, until I became aware that a representative species, "*Microd. Hebertii*," existed in the middle Lias. This establishes a distinct series for *Birchii*, and makes it necessary to employ a different name.

¹ Haidinger's Abhand., Bb. 3, p. 23, pl. v, figs. 7-9. Mem. Geol. Survey of India, Stol., vol. v, pl. i, p. 59; pl. v, figs. 2, 3.

The series which we are now considering, has three other closely allied species in the middle Lias.

The first is *Microceras laticosta*,¹ whose young are precisely similar in all respects to *Microceras biferum*, though the adults differ considerably, the planicostan abdomen being brought out more distinctly in the adult stage than in *biferum*. Associated with this species is *Microceras crescens*, whose septa in the young have the same characteristic outline and proportions as in the adult of *Ophioceras raricostatum*, though the whole form and external features identify it with *Microceras laticosta*. Then there is *Microceras arcigerens*, whose septa in the young are like those of the compressed form of *raricostatum* at an earlier age, just before the minor lobes and cells attain a decided prominence.² The whorls in this species are flattened dorso-abdominally. The dorsum is broader than the abdomen, and this, together with the flattened aspect of the whorls and the early development of the closely set pilæ, gives an umbilicus closely simulating that of *raricostatum*.

The genus *Androgynoceras* returns to the peculiar pilæ and tubercles of *Microderoceras Birchii* in the adult, though retaining the adult characteristic of *Microceras* until a late stage of its growth. This is especially remarkable in *Androgynoceras hybridum* (D'Orb.), but becomes confined to an earlier stage in *Androgynoceras appressum*.

The next genus of this same genetic series exhibits in *Liparoceras indecisum* the planicostan abdomen not later than the fourth whorl. In *Liparoceras Henleyi* this is apparent at an earlier stage only, and in *Liparoceras Bechei* it is absent altogether.

The same mode of growth is here returned to, which was first observed in *Microderoceras Birchii*; namely, a smooth, round whorl, succeeded immediately by two lines of tubercles or spines, erected upon pilæ which do not cross the abdomen, except as fine, distinct linear ridges. The difference between the two species, in other respects, is very great, sufficient, in fact, to constitute very distinct genera. It will be observed that we have here a closed series, one in which the

¹ In the Bulletin of the Museum of Comparative Zoology, No. 5, this species appears under the names of *Microceras sinuosum* and *Microceras maculatum*, two species which I now regard as the compressed and gibbous forms of *Mic. laticosta*.

² This compressed variety is the one figured by Sowerby, and can only be doubtfully referred to the same species as *O. raricostatus*, which is much flatter on the abdomen, and altogether different in form as well as smaller, though precisely similar in the septa.

genetic connection is traceable from species to species, and these species agreeing quite closely, even as regards the two most widely separable forms in the proportions and outline of their septa. The planicostan abdomen is a reversionary feature, occurring transiently and rarely in *Microderoceras Birchii*, but becoming characteristic of the adult in *Microceras biferum*, and the prominent peculiarity of the remaining forms of this genus.

That this is not an artificial arrangement may be seen by consulting the geological succession of the groups. *Microderoceras Birchii* is found in the "Tuberculatusbett" of Oppel. *Microceras biferum* and *Microceras laticosta*¹ in the "Oxynotusbett," the latter, however, lasting into the middle Lias. In this formation it overlaps *Androgynoceras*, which appears in the "Jamesonibett," followed, and perhaps associated, with *Liparoceras Henleyi* and *Liparoceras Bechei*.

Ophioceras raricostatum, with its keel and septa, development and form, allying it closely with the Arietidæ, and indicating that its true position is at the head of a series of this family, occupied geologically an earlier position in the "Raricostatusbett" of the lower Lias, than the two species which resemble it in the middle Lias. These are, undoubtedly, part of the *Amm. capricornus* of Oppel, and are therefore found in the "Davöibett" of that formation.

The planicostan abdomen which occurs occasionally in the young of *raricostatum* before the keel appears, leads to the conclusion, if we credit the hypothesis of evolution, that *Microceras crescens* and *Microceras arcigerens* derived their peculiarities from the same source, and are either directly or indirectly the descendants of this or some other common ancestor. I am disposed to credit the latter supposition. The septa examined were those of young specimens, and in the case of the last named it will be noticed that the resemblance is remarkable in the external features of the shell as well as the septa. No one, however, I am confident, without having subjected them to the closest scrutiny would suspect that they could be separated from *Microceras laticosta*, with which they are also associated geologically. Again, this species is genetically connected with *Microceras biferum* on the one side and with *Androgynoceras hybridum* on the other. According to Quenstedt, the former species is hardly separable in some of its varieties from *Ophioceras raricostatum*, but if the septa are examined closely they are found to differ, and the young are different.

¹ *Microceras laticosta* here includes also the *Amm. capricornus* of Oppel and the two species alluded to in the note above, as *M. maculatum* and *M. sinuosum*.

The superior lateral lobes of *Microceras biferum* always, even in the young, seem to possess a median, minor cell which is absent in *O. raricostatum*. The latter species is much the largest, and the adult septa differ widely. No genetic connection is traceable in their development except in very general terms. On the other hand, the affinities of *M. biferum* in all respects point them out as degraded and dwarfed descendants of *Microderoceras Birchii*, which precedes them, also, in time.

There are other forms, however, which render these questions still more puzzling. A series of single spined or armatus-like species begins with *Deroceras planicostatum*, *Dudressieri* and *Deroceras ziphius* in the "Obtususbett," and is continued by *Deroceras confusum* in the "Raricostatusbett." The development of *Deroceras armatum* does not join it directly with any of these species, and since it occurs only in the lower bed of the middle Lias it need not be considered in this connection.

Deroceras Dudressieri has the planicostan abdomen in the young, but in the adult possesses the abdomen of *Microderoceras Birchii*, and in fact differs from that species at this stage principally by the absence of the inner line of spines; the septa are very similar in both. *Deroceras ziphius* differs more widely from *Microderoceras Birchii* than *Deroceras Dudressieri*, but in features which it is not important to discuss here. Then we have *Deroceras planicosta*, which never parts with the typical planicostan abdomen, though in the adult it acquires a single row of spines, as in *Deroceras Dudressieri*; and lastly, *Deroceras confusum* (*Amm. Lohbergensis* Emerson), which differs somewhat from *D. planicosta* in the septa, but more in the slighter form of the whorl.

If, now, we examine closely the development of the septa in *Microderoceras Birchii*, we find that it equally resembles the development of the septa in all of the members of the two series just described, which exhibit the planicostan abdomen largely in their growth. The septa of *Microderoceras Birchii* on the first quarter of the third whorl acquires three minor cells, and the superior lateral lobes become divided, first by the rise of minor cells from the sides of the superior lateral cells. During the same stage a very minute crenulation becomes developed from the side of the inferior lateral cell; this, however, does not increase as fast as its opposing cell, which eventually reaches a very large size, equally dividing the superior lateral lobes.

In *Deroceras Dudressieri* this process is repeated at about the same period, but the dividing cell does not reach a similar prominence, nor do the septa in general terms become quite as complicated as those of the adult *Microderoceras Birchii* until a much later period. Thus, while the lobes and cells of the former have become almost as complicated as in the adult, on the last quarter of the fourth whorl, those of *Deroceras Dudressieri* are a full revolution later in reaching the same stage, and are never so deeply cut or foliaceous even in the adult as in the adult of *Microderoceras Birchii*.

The first stage in the development of the latter corresponds to one which occurs in a precisely similar manner in *Deroceras planicosta*, but not until that species nearly reaches the completion of its fourth whorl. In *Deroceras confusum* there is no constancy in the development of the minor cells. Two opposing cells may be brought out unequally, as in the young *Birchii*, or symmetrically, or only one, invariably that from the side of the superior lateral cell. In other words, the adults have all the modes of division found in the different stages of growth of *Birchii*, according to the stage at which arrest of development has occurred. In neither *Deroceras planicosta* or *Deroceras confusum* do the septa reach a stage of complication comparable with any but the youthful stages of *Deroceras Dudressieri* and *Deroceras Birchii*. *D. ziphius* was not examined, but the septa probably accord with the growth of the external ornaments and pilæ which place it near *D. Dudressieri*. The condition of *D. Dudressieri* and *D. ziphius* in the adult stage corresponds in their single external line of spines and rounded abdomen to the early stage of *M. Birchii*, before the internal line of spines is brought out; that of the adults of *Deroceras planicosta* and *D. confusum* to the young of these two species when the spines are developed, and the abdomens still have the planicostan folds. This characteristic, it will be remembered, occurs also in some specimens of *Microderoceras Birchii*, but is only faintly expressed; in *Deroceras Dudressieri* and *Deroceras ziphius* it is constantly expressed in the young, to a later period in the former than in the latter, and is of constant adult value in *Deroceras planicosta* and *Deroceras confusum*. The inference seems to be unavoidable that the species of this series, which occur later in time and are all smaller than *Microderoceras Birchii*, are really dwarfed and degraded descendants of this comprehensive species.

Considering the septa in the next series, we have first *Microceras biferum*. The superior lateral lobes in this species constantly

divided equally, as in the adult of *Microderoceras Birchii*; the superior lateral cells are divided into two unequal portions by a large minor cell, and are very similar in outline to the young of *Deroceras Dudressieri* on the fifth whorl, and to the young of *Microderoceras Birchii* at an earlier period, while the cells are broader and less deeply cut than they were observed to be upon the latter part of the fourth whorl. The young of *M. laticosta* are precisely similar to the young and adult of *Microceras biferum*, but the septa bring out equally the opposing median cells, and the superior lateral lobes thus become unequally divided. In the adults they reach a state of complication comparable to those of *Microderoceras Birchii* and *Deroceras Dudressieri*. With *Microceras laticosta* are associated the strongly reversionary species, which only need a keel to be classified with the Arietidae. This is especially the case with *Microceras arcigerens*, whose septa, in one specimen, are remarkably similar in proportions and outline to those of *Asteroceras obtusum*, and what is still more remarkable in this same specimen, a slightly raised siphonal line is plainly apparent between the prominent planicostan folds.¹

In *Androgynoceras hybridum* an equally complicated state of the septa is reached at an early stage, and still earlier in the succeeding species of *Liparoceras*.

Microceras biferum is of small size, about an inch in diameter, and at the latest stage assumes a double row of spines, or is smoother; the pilæ in all cases closely simulating those of the adult *Microderoceras Birchii* at this period. Thus it may be said to play the same part that *Deroceras Dudressieri* does in the armatoid or single spined series in its external characteristics and form, while in its septa it corresponds to *Deroceras planicosta*. In the same way *Deroceras laticosta* may or may not have the double row of spines, but never has a single row,² and never in the adult returns to the rounded abdomen and peculiar pilæ and ornaments of *Microderoceras Birchii*. *Androgynoceras*, however, does return to this condition in the adult, but at the same time another tendency is developed both in

¹ A close comparison with *Zieten Amm. Turneri*, which I regard as a variety of *Asteroceras obtusum*, shows, however, that a discrepancy exists in the proportions of the abdominal lobe and in the remaining general characteristics of form, which do not permit any attempt to trace a direct genetic connection.

² *Microceras biferum* occasionally has a broad projection on the pilæ which might be mistaken for a single spine, whereas it is really formed by the coalescing or arrested development of two rows,

the form and septa. One is a greater degree of involution, the outer whorls as they grow, beginning to spread laterally over the sides of the inner whorls, and the septa keeping pace with the increased breadth of the sides, adding to the number of the auxiliary or inner lobes and cells. This higher degree of complication is carried to its greatest development in *Liparoceras*; which, however, in its highest species, *Liparoceras Bechei*, returns wholly to the mode of growth originally observed in *Microderoceras Birchii*. It proceeds directly from the young, smooth, round-abdomened stage, to produce the double row of tubercles, without the interpolation of the planicostan characteristics. It may be possible that the planicostan stage occurs in some individuals, but this would only complete the parallel with *Birchii* which sometimes faintly expresses this reversionary feature.

The conclusion with reference to this series appears to be, that its members are also at first degraded descendants of *Birchii*, but instead of steadily decreasing in size and ceasing to exist, they first decrease and then speedily increase in size again, adding new elements of complication to the mode of involution, and increasing the number of the lobes and cells. All my attempts to trace a direct connection with those members of the *Psiloceratidæ* and *Arietidæ*, which approximate to these series, have signally failed. The planicostan abdomen and the similar septa and forms which are found in the adults of *Psiloceras*, *Caloceras*,¹ and *Ophioceras*, and in *Microceras* and *Deroceras* can be viewed merely as reversions, indicating, as in the different breeds of pigeons, only a common ancestry.

It should be observed also, that where reversion is apparently piled upon reversion, as for instance, in the return of the Birchean characteristics in *Androgynoceras*, after an interval caused by the prepotent development of the planicostan abdomen, and an interval of time also, that this is not a reversion at all. It is, in fact, the resumption of a normal tendency beneficial to the race, which for a time has been entirely suppressed by the prepotent influence of a true reversionary feature.

This can be doubly proved. In the *Deroceran* series, where no tendency to increased complication or size is observable, the race becomes enfeebled and dies out almost immediately. In the *Microceran* series, where a constant effort is observable to retain the double

¹ A new genus, of which *Caloceras torus* and *tortilis* are types.

row of spines, to complicate the septa and increase the size, the law of acceleration is brought into full play, and overcoming the tendency of the species to be arrested in development both of size and characteristics, counteracts this tendency and reproduces the usual or natural succession of forms and characteristics.

This may be substantiated in any series of Ammonites. By comparing the lower forms with the higher of the same series it will be found that in most instances, when the series is complete, the species, as in *Androgynoceras* and *Liparoceras*, increase the extent of the involution and the number of lobes. This is precisely what occurs in the Arietidæ, which are even more successful in suppressing the reversionary planicostan tendencies than the Microceran series.

In this family the higher forms, *Asteroceras stellare*, *Asteroceras acceleratum*¹ and others, are much more involuted than any of the lower forms, and this is still more strongly expressed in their descendants, the Amaltheidæ and Hildoceratidæ of the middle and upper Lias.

It may be objected that *Microceras biferum* is a young form of which we do not yet know the adult. Its size, the limited number of the whorls and the likeness of the septa, in the full grown specimen, to the young of *Deroceras Dudressieri* and *Microderoceras Birchii* might be considered as proof of this supposition. The development is just intermediate between that of *laticosta* and *Birchii*; any larger forms could therefore only intensify this relation.

Besides the negative evidence, however, that no large specimens have ever been found, there is something positive.

The possession of prominent tubercles makes it probable that quite an advanced stage of life is reached, since at a corresponding age in *laticosta* no spines are yet developed.

Similar doubts with regard to the size of *planicosta* and *confusum* in the Deroceran series are answered with more difficulty. The gradual decrease in size which the series makes from *Microderoceras Birchii* through *D. Dudressieri*, *D. ziphius* and *D. planicosta* to *D. confusum*, in all the dimensions of its whorls, when the full sized shells are considered, and the fact that these species, especially *D. planicosta*, have been very extensively collected, appear to make it probable that we now know the shells as they occurred in the localities and strata in which they are found. That they may be dwarfed speci-

¹ New species, which has the abdomen like *Aster obtusus*, but is more involute than any other species of Arietes.

mens which did not develop beyond periods corresponding to the younger stages of lower species appears to be very probable.

Quite a strong confirmation of this tendency of *Birchii* to have dwarfish descendants is to be found in its own series, if we may so call the only species which succeeds it and inherits all of its peculiar characteristics. *Microderoceras Hebertii* Opp.¹ of the middle Lias is precisely similar to *M. Birchii* in all its characteristics, except the smaller size of the spines and the shorter diameter of the full grown shell. The superior lateral lobes are not invariably equally divided by a median minor cell, as in D'Orbigny's figure of this species, but sometimes are unequally divided, this cell being thrown to one side as in *Hebertii*. We know that *Microceras Hebertii* is very much smaller than *Microderoceras Birchii*, because the shell enters upon the old age or senile period of growth before the latter has attained its fullest adult condition.² The whorls themselves do not differ in size, so that the shell compares with *Birchii* in the same manner that *biferum* or *Deroceras Dudressieri* compares with it, and in the same manner that *planicosta* and *D. confusum* or *laticosta* compare with these two; they are as large as the young of the species which they resemble in many cases in their whorls, the only difference being that they do not have as many whorls, or attempt to develop the septa beyond a certain youthful or immature condition. They may be said to be arrested in development so far as size is concerned, and retrogressive in development when the reversionary characteristics are considered.

Darwin's close and exhaustive work upon the reversionary characteristics of domesticated breeds is, to a certain extent, unsatisfactory, since, while it points to a probable ancestor, it cannot, from the nature of existing animals, show the preëxisting steps by which the change has been accomplished. The element of time, also, is comparatively short, and the whole evidence is necessarily hypothetical.

In the cases given above, however, it will be noticed that while the facts are not so numerous and conclusive as in the great pigeon argument, they possess the additional confirmation derived from the consideration of the manner of their introduction and their serial succession in geological time.

¹ This is the *Amm. brevispina* D'Orbigny (not Sowerby).

² It should have been mentioned that *D. Dudressieri* begins its old age period on the eighth whorl, while still very much smaller than the adult *M. Birchii*.

It will be noticed that these reversionary species¹ all descend from one, to which they may be traced by all the evidences within the scope of observation, and that this single ancestor has occasionally in its own development, characteristics which do not occur in its own series in any of the faunæ of the lower Lias below its own level, and between it and the Trias.

The objection will naturally suggest itself, that perhaps *Microderoceras Birchii* is a migratory species from India, or somewhere out of Eastern Europe, and that in its native haunts we shall probably find the missing links which connect it with the Trias, and farther find that these have the same reversionary features in their growths. But it must be remembered that the planicostan abdomen occurs in some individuals only, a fact very strongly in favor of the supposition that it is a reversion. Darwin's observations seem to establish the fact, that reversions are transient characteristics, and peculiarities directly inherited are, on the other hand, more or less constant, appearing in every individual of the species. Farther, the Arietes are a group native to Eastern Europe, during the Lias, and they most unquestionably revert just as the young of *Microderoceras Birchii*, and in precisely the same transient manner, to the planicostan abdomen,—or rather, as it ought to be called, the Triassic abdomen, in allusion to the age from which it is derived.

LIPAROCERATIDÆ.

MICRODEROCERAS.

Microderoceras Birchii.

Amm. Birchii Sow., Min. Conch., vol. III, p. 121, pl. 267.

This well known species has septa which are different from those of the so-called *Amm. brevispina* of D'Orbigny. A perfect specimen of the French *brevispina* possessed by the Museum is a much smaller shell than the *M. Birchii*, having fewer whorls and entering upon the old age period, whilst the typical *Birchii* is still in its prime. In the young the tubercles and pilæ of *brevispina* are just as prominent during the younger stages of growth as in *Birchii*, but in the adult the spines and pilæ are less prominent, though the latter are more closely set upon the sides of the whorls. The septa, according to

¹ And I might add other species, which are not necessary to the present argument.

D'Orbigny's figures, differ more from *Birchii* than they do from *Amm. muticus*, a true armatoid species, though I think this difference, perhaps, is less than it appears to be from D'Orbigny's figures. *M. Birchii* has two series of forms, as is usual among the Ammonites, one a thick gibbous form, and the other thinner. *Brevispina* is therefore a different species, a stunted or dwarf descendant of *Birchii*.

The young of *M. Birchii* are round, smooth shells, like *Thysanoceras fimbriatum*, marked by prominent lines of growth which represent transient mouths and finally pilæ. They increase very gradually in size, and acquire a line of genicular tubercles on the fourth whorl, which augment rapidly in size and prominence. On the first quarter of the fifth or last of the fourth whorl an internal line of tubercles appears. These increase very slowly in prominence, until they equal those of the outside line. Occasionally the pilæ become bifurcated, and sometimes they cross the abdomen, producing a very faint resemblance to *planicosta*. This last, however, is very faintly and very seldom expressed, and then at a comparatively late period of the growth, so that *Birchii* cannot be said to closely resemble *D. Dudressieri* in this respect.

The septa on the first quarter of the third whorl acquire three minor cells on superior lateral cells, and the superior lateral lobes become divided by the rise of a minor cell from the side of the superior lateral cell. On the last quarter of the fourth whorl these have already become equally divided by the increase of this cell, and the lobes and cells possess much of the adult complication, though the lobes are no deeper than the abdominal lobe. From this it may be seen that the progress in complication is very rapid. Since on the third whorl even the septa have already become nearly as complicated as those of *planicosta* at a very much later period, and on the fourth whorl are very similar to those of *D. Dudressieri* on the sixth whorl. And on the early part of the fourth whorl, when the superior laterals become equally divided, they must be very similar to those of the adult *M. biferum*, and in fact cannot do otherwise than closely resemble them. Sometimes the young have broad tubercles with the pilæ split into two or three parts as in *subarmatus*, etc.

Microderoceras Hebertii.

Amm. brevispina D'Orb., Terr. Jurass., Ceph. p. 272, pl. 79.

“ *Hebertii* Opp., der Jura, p. 278.

The *Amm. brevispina* figured by Sowerby, appears to be a different species from this, one that shows more prominently the planicostan pilæ. In fact, Sowerby's figure resembles closer what I have called *Microceras sinuosum* (*laticosta* Sow.) than anything else. These distinctions, and the geological gap which divides the two species, induced Opper to give it a new name.

MICROCERAS.

Microceras biferum.

Turrillites Valdani D'Orb., Terr. Jurass. Ceph., pl. 42, figs. 1, 3.

Amm. bifer bispinosus Quenstedt, der Jura, p. 104, pl. 13, figs. 10, 11 and 13.

Amm. polymorphus mixtus Quenstedt, der Jura, p. 128, pl. 15, fig. 12.

M. biferum Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 80.

This species has septa very distinct from those of *D. confusum*, and they approximate more closely in their outlines perhaps to those of *Psiloceras psilonotum* than to *Caloceras torus* or *Ophioceras rariocostatum*. This is due to the presence of a median cell in the superior lateral lobes in both *psilonotum* and *confusum*, and the outlines of the lobes and cells which are very similar also. The species is of small size and may be readily distinguished from *O. rariocostatum*, with which Quenstedt thinks it to be very closely allied. The young are not so cylindrical as the young or adults of *rariocostatum*, and above all they are never flattened dorso-abdominally with bulging sides, as in the typical *O. rariocostatum*. In fact, the abdomen in the young is considerably more elevated, the whole shell being thicker and larger in the young as well as in the adult, than *Ophioc. rariocostatum* at the same age or the representative species, *D. confusum*. Subsequently, in many individuals, a much closer external similarity is brought about, and this is especially remarkable when the planicostan variety of the young *rariocostatum* is compared with the adult of *biferum*.

When fully developed, the species may or may not have two rows of spines, as the pilæ may extend into one large, undivided projection which cannot be called a spine, but is only a prominent, truncated pilum, with or without very slight points or spines at either extremity.

Quenstedt remarks that these tuberculated varieties, when unsymmetrical, correspond to D'Orbigny's *Turrillites Valdani*. Another variety presents only smooth pilæ, and these when unsymmetrical are, according to Quenstedt, identical with *Turr. Coynarti* of D'Orbigny.

This unsymmetrical form is less common than in *D. confusum*, at least in the collection I have examined; and I have never found such specimens as are mentioned by Quenstedt, which, though unsymmetrical in the young, become symmetrical in course of growth. Most of the specimens that I have yet seen have this tendency to form a spiral, expressed on or towards the right side,—remembering that the external periphery is the abdomen and not the dorsum as is generally supposed—on the same side, in fact, as the want of symmetry so frequent in the lobes of *Psil. psilonotum*.

Though this species has been placed in the same genus as *M. confusum*, I think it can only be considered as one of a different series of planicostan forms, those with two lines of lateral tubercles.

Variety *mixtum*.

The two specimens of this so called species, if the label from the Museum of Stuttgart is reliable, agree very closely with the figure of *Amm. polymorphus* quoted above, and in their septa with *M. biferum* of the same age, as well as with some of the other figures of *Amm. Polymorphus* given by Quenstedt. It may be a variety of that species. One specimen has the Turrillite deformity so often found in *M. biferum*.

Microceras laticosta.

Microceras laticosta Sow., Min. Conch., vol. VI, p. 106, pl. 556, fig. 1.

“ *brevispina* Sow., “ “ “ “ fig. 2.

“ *sinuosum* Hyatt, Bull. Mus. Comp. Zoology, no. 5, p. 82.

“ *maculatum* Hyatt, *Op. cit.*, p. 82.

The young of this species resembles *Microceras biferum* so closely in all its characteristics, that it does not differ so much from it, as the different varieties of that species do among themselves. The form of the whorl in most individuals begins very soon to exhibit a flatness of the abdomen and sides and a sharp bending forward of the pilæ on the abdomen, which are the only distinctive characteristics. The septa are not precisely similar. The differences, however, increase with age as the septa become more complicated and the pilæ more prominent. Two rows of tubercles are acquired in some specimens during the adult stage. The abdomen is still deeply sinuous as in the typical *M. biferum*.

There are two forms of this species, one flatter and less robust than the other, which I have called *M. maculatum*. This has no spines, at least none are apparent upon the casts.

In variety *sinuosum*, the age at which the tubercles are assumed

varies exceedingly, as well as the size and prominence of these and the pilæ upon which they stand.

There seems to be one constant difference between this species and *M. biferum*. The superior lateral lobes are unequally divided into three minor lobes instead of, as in *M. biferum*, being equally divided into two. The young septa are precisely similar in development, and also similar to those of the adult and young of *Deroceras planicosta*; the superior lateral lobes being at first equally divided by a cell arising from the side of the superior lateral cell. This is subsequently met by a cell advancing from the other side and making the usual threefold division of the lobe.

Microceras crescens.

M. crescens Hyatt, Bull. Mus. Comp. Zoology, no. 5, p. 82.

In this species we have a form which is intermediate between *M. laticosta* and *Ophioceras raricostatum*. It agrees with the latter in its septa, and with *M. laticosta* in its pilæ and general external characteristics of form and growth. In one specimen from Rautenberg, there is a Turrillite distortion, but the deviation of form is in this case very marked toward the left instead of the usual dextral twisting. The superior lateral cells are broad and very slightly indented by the minor, divided into two unequal portions, however, by one minor lobe slightly larger than the rest. The superior lateral lobes are equally divided, the inferior laterals very shallow. All the cells are very broad in comparison to the lobes. The superior lateral lobes are about two-thirds as long as the abdominal lobe, and the inferior not more than half as long as the superior lateral.

Microceras arcigerens.

Amm. arcigerens Phill., Geol. York, p. 163, pl. 13, fig. 9.

M. arcigerens Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 82.

In this species the septa are very peculiar. The outlines are remarkably simple. All the lobes are remarkably broad, the superior laterals and abdominal nearly of the same height, and the inferior laterals fully two-thirds as long as the superior laterals. The whorl is compressed abdomino-dorsally, and much broader on the dorsal than abdominal side. This, and the prominence of the closely set pilæ in the young, gives the shell a very decided resemblance to *O. raricostatum*. It will be observed that in this case the resemblances to *O. raricostatum* are in those very external characteristics in which none could be traced in *M. crescens*.

DEROCERAS.

Deroceras Dudressieri.

Amm. Dudressieri D'Orb., Terr. Jurass., Ceph., p. 325, pl. 103.

From France, this species comes to us with the name of *Amm. brevispina*, and from England, as *Amm. armatus* or *Birchii*. With none of these except *Amm. armatus* has it any close affinities. From *Amm. armatus* it differs in the septa, besides having very different young. The shell is strongly pilated and tuberculated and has the planicostan abdomen very distinctly marked, whereas *Deroceras armatus* does not repeat this last feature so decidedly, being much more cylindrical and smoother. The pilæ are also closer together in *Deroceras Dudressieri*, the spines and pilæ also being filled with solid, shelly matter, instead of the spines alone, as in *D. armatus*. Oppel has stated that he found *Amm. Dudressieri* of D'Orbigny in the English lower Lias, and this species is so closely similar in all respects to D'Orbigny's figure of this species, that it seems to be the only one he could have seen. *D. confusum* comes so near to the young of this species that in external characteristics they seem to be nearly identical.¹

The young is smooth for the first four whorls; the pilæ begin on the fifth, but the tubercles are hardly visible until the last half of the sixth. Soon after the pilæ begin to appear, first as folds on the sides, they stretch across the abdomen and form the planicostan flexures. Though there are some slight differences between the young of this species, on the fifth and earlier half of the sixth whorl, and the typical *planicosta*, both in the shell and septa, they are hardly sufficient to distinguish the two forms separated from the adult whorls. On the seventh whorl the spines are very large but decrease in prominence on the eighth, the pilæ approximating more. The abdomen also becomes more elevated and rotund instead of rather flat-tish, and the whole form approaches closely to what it is in *Birchii*. The first three whorls have sides widely divergent; these become rounded on the fourth, flattened on the fifth and sixth, divergent on the seventh, and rounded on the eighth. On the latter part of the tenth whorl the tubercles entirely disappear, the pilæ being reduced to mere folds. The period at which these characteristics may be obtained or

¹ From this I of course exclude the form figured by Quenstedt as having a keel in the young.

parted with, is subject to considerable variation, sometimes an entire whorl earlier or later.

Deroceras ziphius.

Amm. ziphius Ziet. Verst. Wurt., p. 6, pl. 5, fig. 2.

D. ziphius Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 81.

This species occupies a position precisely intermediate between *D. confusum*, *D. Dudressieri* and the true armatoid, large, single-spined species like the typical *armatus*. It has, in the young, an abdomen similar to the planicostan abdomen observed in the two first named species, and in the adult it drops this characteristic for an abdomen similar to that found in *D. Dudressieri*, assuming at the same time a row of large single tubercles. My observations were made upon a single specimen, but they are confirmed by Quenstedt who takes a similar view of the relations of this species from more extended experience.

Deroceras planicosta Hyatt.

Amm. planicosta Sow., Min. Conch., vol. 1, p. 167, pl. 73.

Microceras planicosta Hyatt, Bull. Mus. Comp. Zoology, no. 5, p. 80.

For the first four whorls this species is smooth, and the whorl is remarkably broad, with gibbous sides. On the fifth whorl the pilæ are introduced as depressed folds, and gradually increase in size. Spines are never developed in the majority of the specimens, but in a few cases they may be noticed rising either on the cast or the shell, during the third quarter of the sixth volution and becoming quite prominent on the last quarter. The number of pilæ on a single whorl, the time at which they cross the abdomen, and the presence or absence of tubercles, vary remarkably. The abdomens of some specimens may be crenulated by the first pilæ, or they may remain smooth even throughout the fifth whorl, and the number of pilæ vary from twenty in some to twenty-six in others.

The septa also in the young, instead of retaining the usual proportions of the superior lateral cells and lobes, almost obliterate these two which are represented, as in the adult of *Coroniceras tenue*, by a row of minor lobes and cells. It, however, still retains the peculiar median cells of the superior lateral lobes, which are so characteristic of the three series of planicostan forms. These begin to show themselves as lateral expansions or crenulations of the superior lateral cells on the latter part of the fourth or early part of the fifth whorls. The subsequent division of the superior lateral cell into two unequal por-

tions by a pointed minor lobe, the depth of the superior lateral lobes about equal to the abdominal lobe, and the shallowness of the inferior lateral lobes, together with the great breadth of the cells and simplicity of outline of the cells, and absence of numerous minor lobes and cells, are all characteristics of the Arietidæ.

They show that *planicosta*, and the series to which it belongs, come nearest to this family; in fact, are precisely intermediate between the Microceran series and the Arietidæ. If, indeed, specimens of *D. confusum* sometimes have a keel as stated by Quenstedt, the evidence is still stronger. In the adult the triplicate division of the base of the superior lateral cells, and the outlines of the septa, remind us forcibly of *Caloceras torus*, the lowest of the Arietidæ, though the shallowness of the inferior lateral lobes still remains. This, however, is probably sometimes found in *C. torus* and in those specimens in which the development of the pilæ is retarded, an external similarity to the smooth abdomen and fold-like lateral pilæ of *C. torus* is also produced.

***Deroceras confusum*.**

Amm. confusus Quenstedt, der Jura, p. 127, pl. 75, fig. 89.

“ *planicosta* Sow., (pars) Min. Conch., vol. iv, p. 149, pl. 406, not 73.

Microceras confusum Hyatt, Bull. Mus. Comp. Zoology, no. 5, p. 80.

Amm. Lohbergensis Emerson, Die Liasmulde von Markoldendorf, p. 61, pl. 3, fig. 3.

In this species the first three and a half whorls are smooth and flattened ventrally, the sides bulging as in *O. raricostatum*. This resemblance is still further increased by the development of the pilæ. On the latter part of the fourth, fifth and sixth whorls the resemblance to *raricostatum* is very close, or rather to the earlier stages of that species before the keel appears. On the sixth whorl the tubercles begin to appear and the form changes to a more laterally compressed and thinner whorl, and the tuberculated pilæ cross the abdomen as in the typical *planicosta*.

The septa on the fifth whorl are quite like those of *raricostatum* in their outlines, though the inferior auxiliary lobes and cells slope inwardly and posteriorly. All the shells examined were small, hardly more than an inch in diameter. The developmental resemblance to *O. raricostatum* does not extend to the septa. These have a close similarity to those of *Caloceras torus*, differing however in one

essential point,—the presence of median minor cells which equally divide the superior lateral lobes. This characteristic, though it may be absent in many specimens, is so constant that it prevents the direct connection of the young of this species with the young of *C. torus* or *O. raricostatum*, which it otherwise so closely imitates.

The resemblance to the young of *Microderoceras Birchii* is not so close, however, in external features, though the septa are very closely allied. The Turrillite variety is quite common in this species, whereas it is not so common in the true *Amm. planicosta* Sow.

One of Quenstedt's figures of this species represents a young shell decidedly keeled. This, I think, cannot be of the same species, and his accompanying descriptions do not justify its associations with his *Amm. Bronnii*.

The variations in the lobes are excessive. The median cells of the superior lateral lobes are usually largely developed, often, though not invariably, retaining the youthful or one-sided aspect which they have in the young of *Deroceras planicosta* and *M. Birchii*. In some specimens, however, they are very small, and the lobes are unequally divided by two very minute minor cells. These lobes, in other words, may be equally divided, or have all the gradations from this to a state of unequal division. The same lobes are either longer, equal to, or shorter than the abdominal lobe, but seem invariably to greatly exceed the inferior lateral lobes.

***Deroceras densinodum*.**

Amm. armatus densinodus Quenstedt, der Jura, p. 105, pl. 13, figs. 9, 10.

D. densinodum Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 84.

This species does not apparently occur in the middle Lias as stated in my paper in the Bulletin of the Museum of Comparative Zoology, but only in the lower Lias. The mistake resulted from an erroneous reading of the label on the specimen. It may be only a variety of *D. confusum*, but the young differ somewhat, the abdomen is narrower and the septa are invisible in the single specimen of *D. densinodum* in the possession of the Museum.

According to Quenstedt's figure this species is really an *armatus* in which the young is pilated or ribbed at a very early period, instead of being smooth as in *armatus* proper. Having only the young it is impossible to say much about the affinities of the shell; it is, however, evidently a member of the planicostan group or series of *Deroceras*.

ANDROGYNOCERAS.

From the specific descriptions it will be seen that we have here two groups or series, both developing from the first variety of one species, *Androgynoceras hybridum*. From this we have the series in which acceleration of development produces the flattened abdomens and broad whorls of the second variety of *A. hybridum*, and of *Liparoceras indecisum*, the more elevated, though still broad whorled adult of *L. Henleyi*, with young just like the adults of *A. hybridum*, second variety, and finally the high whorled *L. Bechei*. The amount of involution is just proportionate to this progress, reaching to the first line of tubercles in the first three forms, to the second only in the adults of the fourth, and to the second in both the young and adults of the fifth.

The second offshoot or series contains only one species, *A. appressum*, which is highly accelerated when compared with *A. hybridum*. This has remarkably flattened sides and the connection with the other is shown by the development of the young. Whether this ought to be set aside as a distinct genus, or not, will depend upon the discovery of other descendants.

***Androgynoceras hybridum*.**

Amm. hybrida D'Orb., Terr. Jurass. Ceph., p. 285, pl. 85.

And. hybridum Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 83.

For six volutions the shell is apparently inseparable from certain forms of *M. laticosta*. Upon the seventh whorl, instead of continuing the same degree of increase in size, a more rapid enlargement takes place, the lateral pilæ become less prominent and more crowded, sometimes coalescing near the umbilicus. The inner tubercles in the latter case, also, either partially or entirely coalesce. The abdomen in the meantime has become more prominent, less furrowed, and more rounded, and the sides converge outwardly. The abdominal pilæ split up each into several minor ridges on the latter part of the seventh whorl, reducing these furrows to a minimum.

A variety of this species from Schippenstadt and Semur completes the same stages of growth as have been described in *A. hybridum*, a full volution earlier. It has at the end of the sixth volution a whorl nearly as large and of the same form, but much broader in proportion to the length than in the first. The pilæ begin to take upon themselves similar characteristics. I am unable to state whether this or some intermediate form between this and the first variety is the

one described by D'Orbigny ; or with any certainty, whether the first variety is a distinct species, though it seems to be such.

Androgynoceras appressum.

And. appressum Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 83.

For perhaps the first four or five volutions the shell is similar to the young of thinner varieties of *M. laticosta*. The extent of envelopment, also, is slight ; soon however, on the last of the fifth or first of the sixth the planicostan pilæ split into several ridges united at either end by tubercles. The abdomen at this period, the inclinations of the sides, etc., closely resemble the characteristics of the adult of the first variety of *A. hybridum*.

LIPAROCERAS.

Liparoceras indecisum.

Lip. indecisum Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 8.

This is evidently a very much more accelerated form than even the second variety of *A. hybridum*. It still preserves, however, the form of the adult of this species. The young, if I am correct in referring a young specimen from Rautenberg to this species, has planicostan pilæ certainly until after the completion of the fourth, and probably until near the end of the fifth volution.

Liparoceras Henleyi.

Amm. Henleyi Sow., Min. Conch., vol. II, p. 161, pl. 172.

Naut. striatus Rein, Naut. et argo., p. 85, pl. 8, figs. 65, 66.

L. Henleyi Hyatt, Bull. Mus. Comp. Zool., no. 5, p. 84.

This species differs from the last in not repeating the planicostan abdomen at all, unless upon a volution preceding the last quarter of the third. This seems improbable, though it may occur in some specimens. At this period in the specimens examined all the adult characteristics were well developed, and it only remained for them to increase in size. The form of the shell is also precisely that of the adult *A. hybridum*, second variety, or at least of that shell at the end of the sixth volution.

The *L. Henleyi* differs from *L. Bechei* in having larger and more prominent tubercles, a broader whorl in proportion to the height, and in the slighter involution of the young. For the first four whorls the involution does not reach the internal line of tubercles, leaving a larger umbilicus than in *L. Bechei*. In one specimen from Lyme Regis the only distinction from *Bechei* consists in this single

characteristic. Usually, however, the angular, prominent, ribbed tubercles of the younger whorls at once show great differences. While *L. Henleyi* thus seems to show variations advancing towards *L. Bechei*, the last never has a variety like *L. Henleyi*.

Liparoceras Bechei.

Amm. Bechei Sow., Min. Conch., v. III, p. 143, pl. 280.

“ “ Ziet. Verst. Wurt., p. 37, pl. 28, fig. 4.

Lip. Bechei Hyatt, Bull. Mus. Comp. Zool., no. 5, pl. 84.

Fold-like lines of growth are prominent in the young, which are otherwise smooth and rounded. These increase in number and sharpness until they become true pilæ.

Two lines of tubercles are introduced, also, in the young, but appear either quite late or comparatively early on the third whorl.

The septa on this volution precisely resemble the septa of the nearly adult *M. laticosta*. They have very broad abdominal and superior lateral lobes; the latter unequally divided. The siphonal cells are very large. In one specimen a very decided resemblance to *A. sternalis* is produced by the angulation of the abdomen and the unusual development, for so young specimens, of the lateral pilæ with their tubercles on the last quarter of the third whorl.

Section of Microscopy. October 12, 1870.

Mr. E. Bicknell in the chair. Fifteen members present.

Mr. C. Stodder exhibited a slide containing albumen coagulated with carbolic acid, which had been carefully sealed in July, 1869. With a high power, he showed that the particles were in continual vibration. He thought the appearance of this preparation was identical with what was represented in figures published by Dr. Lionel S. Beale, in his germ-theory of disease.

Dr. C. Ellis remarked, that all such particles from their minuteness, appeared alike; and that any solid in a state of fine subdivision exhibited this molecular motion. Their motion was no proof that they were alive.