DEPARTMENT OF THE INTERIOR

MONOGRAPHS

OF THE

UNITED STATES GEOLOGICAL SURVEY

VOLUME XLIV

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

PSEUDOCERATITES OF THE CRETACEOUS

BY

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Edited by T. W. STANTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

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EDITOR'S PREFACE.

Soon after Professor Hyatt's lamented death, January 15, 1902, it was the writer's sad duty, as a representative of the United States Geological Survey, to examine all the paleontological collections and manuscripts in Professor Hyatt's house in Cambridge, in order to take possession of those belonging to the Survey. The manuscript of the present volume was on his desk and contains the results of his last work, in which he was actively engaged on the day of his death. Fortunately it was almost ready for the printer, and although the careful reading of the manuscript to determine the author's exact meaning and intentions has consumed considerable time, the changes, either in arrangement or in wording, and the additions that have been found necessary are very few indeed. These changes are all indicated in their proper places by footnotes or bracketed statements signed by the editor's initials, except the unimportant verbal change of "Cretacic" to "Cretaceous," made for the sake of conformity with Geological Survey usage. In his recent writings Professor Hyatt consistently followed the International Geological Congress rule of ending names of all periods and systems with "ic."

The preparation of this work occupied a large part of Professor Hyatt's time for several years. As early as 1897 a manuscript with the same title was submitted to the Director of the United States Geological Survey for publication, and soon afterwards the preparation of the illustrations was begun. A copy of this original manuscript now in my hands shows many important differences in arrangement, classification, and nomenclature from the later manuscript, indicating that it had been thoroughly revised and recast in connection with a restudy of the fossils.

Although there are some minor inconsistencies, and there would doubtless have been some other changes and additions if the author had lived to see the work through the press, it is believed that as now published it fairly presents his latest views. The illustrations were all made under Professor Hyatt's supervision, except a few, which were definitely selected and indicated by him, and most of which are copies of published figures. He had also mounted the figures on the first twenty plates and had written the descriptions of nineteen of the plates. The other figures were nearly all labeled with specific names. The manuscript was in two packages, one of which began with the "General remarks," followed by Pulchelliidæ, Knemiceratidæ, Engonoceratidæ, and Placenticeratidæ, which is nearly the arrangement of the original manuscript of 1897, while the second package began with Mojsisoviesiidæ and ended with Coilopoceratidæ. The plates arranged by the author contain all the illustrations except the Placenticeratidæ and a part of the Engonoceratidæ. By transferring the introductory "General remarks" from one package to the other and then uniting the two packages the descriptions fell into practically the same arrangement that was adopted for the figures, and which evidently represented the author's latest views as to their relationships. The assignment of the families to higher groups was not fully carried out by Professor Hyatt, and it is thought best not to attempt to complete it, in view of the fact that his opinions as to the definition and limits of the different superfamilies evidently were much modified, though never formulated, after the publication of his chapter on Cephalopoda in Zittel's Text-book of Paleontology. In that work he divides the Ammonoidea into several suborders, and between these and the families there is another unnamed category of groups, which may be called superfamilies, such as Mammitida, Cosmoceratida, etc. Part of the Pseudoceratite families are there referred to Mammitida, part to Placenticeratida, the Pulchelliidæ were accidentally omitted, and other families were not there described. In the present paper a list of the families belonging to the Mammitida is given, but beyond that group the classification is doubtful. In connection with the description of Vascoceras, Cosmoceratida is mentioned in such a way that the reference of the genus to that group may be inferred, and later in the manuscript the heading Mantelliceratida is inserted, but there is nothing to warrant the assumption that the latter term was intended to include Heinziidæ, Pulchelliidæ, Knemiceratidæ, Engonoceratidæ, and Placenticeratidæ. In the published work above referred to, the two families last named are united with Sphenodiscidæ to form the Placenticeratida, but with the removal of Sphenodiscidæ to Mammitida it seems probable that the superfamily Placenticeratida was abandoned.

The multiplication of families, genera, and species will be understood by all who are acquainted with Professor Hyatt's habit of attempting to express in the terminology every important fact observed in the course of his investigations.

In characteristic fashion the author plunges into the midst of his subject, beginning his introduction with a discussion of the sutural details of Jurassic ammonites, not tarrying even to define the title of the paper or to make a formal statement of the problems involved. In a footnote on page 546 of Zittel's Text-book, where he first used the term Pseudoceratites, he states that it "is a descriptive expression for the Placenticeratida and Tissotidæ of the Cretaceous, which are morphic equivalents of some Triassic genera of the Discocampyli as regards both suture and shell form. Their origin is traceable, however, to different groups of the Pachycampyli, a suborder which appears to have been initiated in the Jura along with the Leptocampyli. It is, therefore, improbable that the Pseudoceratites were directly connected with the Triassic Discocampyli." In a letter written December 26, 1901, in response to an inquiry from the Geological Survey office, he gives the following somewhat more definite statement of the scope and purpose of the present work: "I am at work finishing a 'Monograph of the Pseudoceratites of the Cretacic.' This is an artificial group, including, for convenience of treatment, all the retrogressive genera of the Cretacic that have sutures with simple outlines resembling those of Triassic cephalopods, formerly included under the name Ceratites. The known genera described and figured are Buchiceras, Tissotia and its allies, Sphenodiscus, Knemiceras, Engonoceras, Placenticeras. The aim of this publication is to give as full treatment as possible of the structure and relations of these genera, in order to determine as far as practicable to what groups among the normal progressive forms they are most nearly related."

It was Professor Hyatt's custom, in citing the authority for a species, to give the name of the author who first referred the species to the genus in which it is now retained, instead of citing the one who first proposed the *specific* name. Thus he wrote *Placenticeras placenta* Meek, although the form was described as *Ammonites placenta* by DeKay. This is not in accordance with the rule usually followed by zoologists, and the citations have been changed so that each specific name is followed by the name of the original describer of the species, with the author's name in parentheses if the generic reference has been changed.

When the figured specimens were at the Geological Survey in the hands of the artists, Professor Hyatt requested the writer to examine them carefully and give him notes and comments as to the localities and horizons of the specimens from his own collection and from other museums. The quoted statements concerning various species that appear in the manuscript were extracted from the notes the writer then forwarded to him.

The appended tabular statement is intended to show the relative positions of the various marine Cretaceous horizons and formations mentioned in the text. It does not imply accurate correlation of American and European horizons, the line between Lower and Upper Cretaceous being probably somewhat higher in America than in Europe.

The figured specimens that are mentioned in this paper as belonging to Professor Hyatt's private collection have now become the property of the Museum of Comparative Zoology in Cambridge.

The writer has supplied the table of contents, the formal bibliographic list, and the descriptions of the plates after Pl. XIX.

T. W. Stanton.

CLASSIFIED LIST OF FAMILIES, GENERA, AND SPECIES.

In the following list all the groups that are described and all the species that are definitely referred to the genera herein treated are arranged according to Professor Hyatt's classification as given in the text. The purpose of the list is to bring together in compact form for easy reference the large number of described species that are here referred to new genera.

The classification is incomplete and in some cases probably misleading. For example, some of the genera under Cosmoceratida are not assigned to families, and it is very doubtful whether Professor Hyatt intended to place in Mantelliceratida all the families here arranged under that superfamily. It is evident that the author's published views concerning that group had changed, but unfortunately he had written no revised description. It is therefore necessary to leave the groups classified according to the arrangement of the manuscript without inserting the names of any other superfamilies.

T. W. S.

MAMMITIDA.

MOJSISOVICSIIDÆ.

Mojsisovicsia Steinmann.
    durfeldi.

BUCHICERATIDÆ.

Buchiceras Hyatt.
    bilobatum.
Roemeroceras Hyatt.
    gabbi.
    syriaciforme.
    attenuatum.
    subplanum.

PSEUDOTISSOTIIDÆ.

Pseudotissotia Peron.
    galliennei.
    tunisiensis.
Choffaticeras Hyatt.
    barjonai.
    meslei.
    douvillei.
Hemitissotia Peron.
    cazini.
    batnensis.
    morreni.
    tissotiæformis.
    djelfensis.
    ceadouroensis.
Plesiotissotia Peron.
    michaleti.

TISSOTIIDÆ.

Tissotia Douvillé.
    tissoti.
Subtissotia Hyatt.
    inflata.
    intermedia.
    peroni.
    africana.

Metatissotia Hyatt.
- fourneli.
- robini.
- nodosa.
- haplophylla.
- ewaldi.
- auressensis.
- slizewiczi.

Paratissotia Hyatt.
- grossouvrei.
- thomasi.
- ficheuri.
- serrata.
- regularis.

Incertæ sedis.

Tissotia cossoni.
- globosa.

Heterotissotia Peron.
- neoceratites.

Sphenodiscidæ.

Indoceras Noetling.
- baluchistanense.
- acutodorsatum.

Libycoceras Hyatt.
- ismaele.

Sphenodiscus Meek.
- pleurisepta.
- lobatus.
- stantoni.
- lenticularis.
  - var. splendens.
  - var. mississippiensis.
- beecheri.
- konincki.
- binckhorsti.
- ubagshi.
- rutoti.
- siva.

Eulophoceratidæ.

Tegoceras Hyatt.
- mosense.

Lenticeras Gerhardt.
- andii.

Paralenticeras Hyatt.
- sieversi.

Eulophoceras Hyatt.
- natalense.

Coilopoceratidæ.

Platylenticeras Hyatt.
- heteropleurum.
- pseudograsianum.
- gevrilianum.

Coilopoceras Hyatt.
- colleti.
- novimexicanum.
- springeri.
- requienianum.
- grossouvrei.

Aconeceras Hyatt.
- nisum.

COSMOCERATIDA.

Vascoceras Choffat.
- hartti.

Tolypeceras Hyatt.
- marcousanum.

Barroisiceras Grossouvre.
- desmoulinsi.
- haueri.

MANTELLICERATIDA.

Mantelliceratidæ.

Metasigaloceras Hyatt.
- rusticum.

Pseudaspidoceras Hyatt.
- footeanum.
- conciliatum.
- cunliffi.
- crassitesta.
- euomphalum.
- deciduum.
- schlüteri.

Diadochoceras Hyatt.
- nodosocostatum.

Pedioceras Gerhardt.
- cundinamarcæ.
- caquesensis.
- ubaquensis.

Douvilleiceras Grossouvre.
- mammillare.
- orbignyi.
- spiniferum.

Schlueterieeras Hyatt.
- nodosoides.
- vielbanci.
- laubei.
- michelobense.

Sharpeiceras Hyatt.
- laticlavium.
- schlueteri.
- inconstans.

Acompsoceras Hyatt.
- bochumense.
- essendense.
- renevieri

Mantelliceras Hyatt.
mantelli.
couloni.
picteti.
vicinale.
ushas.
indiauense.
domeykanum.

METOICOCERATIDÆ.

Metoicoceras Hyatt.
swallovi.
gibbosum.
whitei.
acceleratum.

HEINZIIDÆ.

Heinzia Sayn.
sayni.
corioli.
heinzi.
hispanica.
pulchelliformis.
provincialis.
matura.
ouachensis.
Carstenia Hyatt.
lindigi.
caicedi.
subcaicedi.
tuberculata.
galeata.
Gerhardtia Hyatt.
galeatoides.
galeatus.
veleziensis.

PULCHELLIIDÆ.

Nicklesia Hyatt.
moltoi.
levyi.
nolani.
lapparenti.
alicantensis.
karsteni.
lenticulata.
didayana.
dumasiana.
Subpulchellia Hyatt.
oehlerti.
fouquei.
sauvageaui.
castellanensis.

Pulchellia Uhlig.
nicklesi.
schlumbergeri.
columbiana.
selecta.
bettneri.
changarnieri.
kiliani.
ouachensis.
compressissima.
Psilotissotia Hyatt.
chalmasi.
mariolæ.
defforgesi.
reigi.
haugi.
Lophobolites Hyatt.
cotteaui.

KNEMICERATIDÆ.

Knemiceras Böhm.
syriacum.
compressum.
var. subcompressum.
attenuatum.
gabbi.
uhligi.

ENGONOCERATIDÆ.

Protengonoceras Hyatt.
gabbi.
planum.
emarginatum.
Engonoceras Neumayr.
belviderense.
uddeni.
serpentinum.
pierdenale.
var. commune.
subjectum.
gibbosum.
stolleyi.
complicatum.
emarginatum.
roemeri.
Neolobites Fischer.
vibrayeanus.
choffati.
peroni.
Metengonoceras Hyatt.
inscriptum.
ambiguum.
acutum.
dumbli.

Placenticeratidæ.

Placenticeras Meek.
- guadalupæ.
- sancarlosense.
  - var. pseudosyrtale.
- planum.
- newberryi.
- syrtale.
  - var. halei.
- intercalare.
- placenta.
- stantoni.
  - var. bolli.
- pseudoplacenta.
  - var. occidentale.
- whitfieldi.
  - var. tuberculatum.
- spillmani.
- telifer.
- ? fallax.
- ebrayi.

Placenticeras warthi.
- memoria-schloenbachi.
- depressum.
- grossouvrei.
- incisum.
- milleri.
- schlüteri.
- orbignyanum.
- polyopsis.
- crassatum.
- tamulicum.
- pseudorbignyanum.
- subtilistriatum.

Diplacmoceras Hyatt.
- bidorsatum.
- canaliculatum.

Incertæ sedis.

Styracoceras Hyatt.
- balduri.

Table of horizons mentioned in this work.

	Upper Missouri.	Texas.	Gulf border.	New Jersey.	Europe.
Upper Cretaceous.	Montana: Fox Hills.	Navarro, Eagle Pass.	Ripley.	Manasquan (Upper marl).	Danian.
	Montana: Fort Pierre.	Taylor, San Carlos.	Selma (Rotten limestone).	Rancocas (Middle marl). Monmouth (Lower marl).	Senonian: Campanian. Santonian. Coniacian.
	Colorado: Niobrara.	Austin.	Eutaw.	Matawan (Claymarl).	
	Colorado: Fort Benton.	Eagle Ford.			Turonian.
	Dakota.	Woodbine.			Cenomanian.
Lower Cretaceous.		Comanche series: Washita: Buda.			
		Comanche series: Washita: Denison: Grayson. Main street. Paw Paw. Marietta. Denton.			Albian, Gault.
		Comanche series: Washita: Fort Worth.			Aptian.
		Comanche series: Washita: Preston: Duck Creek. Kiamitia.			
		Comanche series: Fredericksburg: Edwards. Comanche Peak. Walnut.			
		Comanche series: Trinity: Paluxy. Glenrose. Travis Peak.			Neocomian: Barrémian. Hauterivian. Valangian. Berriassian.

PSEUDOCERATITES OF THE CRETACEOUS.

By Alpheus Hyatt.

GENERAL REMARKS.

So far as I have been able to see, either in figures or in specimens, the Ammonitinæ of the Jura have only one large first lateral lobe, even in highly involute forms, as demonstrated by the admirable researches of Buckman[a] upon *Hyperlioceras discoidum*, *subdiscoidum*, etc., and the same has been shown by Oppel's figures[b] of *Neumayria discus*, *hochstetteri*, and *aspidoides*, and Quenstedt in *Amm. truelli*,[c] and the similar hollow-keeled forms also in *Neumayria serrodens* (pls. 24, 69), *Polyplectus discoides*, and *capellinus* (pl. 53), which have a very deeply divided and double first lateral, and in *Neumayria discus* (pl. 57) in which there are apparently two or three principal laterals, but in the neanic stage only one bifid first lateral The Arietidæ seem to have two principal saddles owing to the great development of first auxiliary, but this occurs only in the ephebic stage. *Aspidoceras* and some forms of other genera often have two well-divided principal lateral saddles, but this again occurs through the late division of the primitive lateral.

In fact, it may be confidently stated that in the Jura all of the Ammonitinæ have but one principal lateral saddle throughout the neanic stage, and when, as very rarely occurs, two or three principal laterals are either apparently or actually developed, they occur as purely secondary, or rather, tertiary developmental changes in the ephebic stage.

This fact is of importance because of its bearing upon the biology of Ammonitinæ in the Cretaceous. With regard to these, it may be stated that they are distinctly tachygenetic or accelerated in development when

[a] Inferior Oolite Ammonites: Palæont. Soc., Vol. II, pp. 40–49.
[b] Pal. Mittheil., pl. 4.
[c] Amm. d. schwäb. Jura, pls. 24, 69.

compared with the Ammonitinæ of the Jura. All of the forms so far investigated, which have more than one principal lateral saddle and lobe, acquire these characters a stage earlier than the Jurassic species. They appear, as stated above, in the neanic stage and are secondary modifications of the outlines of the primitive first laterals of the nepionic stage.

The same law seems to hold in a modified way for the development of an extra number of auxiliary lobes and saddles such as appear in *Neumayria*, but my materials have not enabled me as yet to follow this out. This statement appears at first sight to be antagonized by that made with reference to the arrested development of the sutures in genera like *Protengonoceras*, *Engonoceras*, etc., which have undivided or bifid saddles and lobes only slightly digitated at their extremities. But it will be shown in the generic description of *Placenticeras* that the arrest of development takes effect in these Pseudoceratites of the Cretaceous only after the three principal lateral saddles and lobes are formed in the neanic stage. Consequently, up to this stage, the development is more complex than in the young of Jurassic species or any others which have only one principal lateral at the same age. This statement clears up the extraordinary relations of these forms to their apparently more complicated allies of the Jurassic, and accounts also for the apparent discrepancy existing between the highly involute compressed character of the whorls during the neanic stage and the very simple aspect of the lobes and saddles; that such highly involute compressed forms in the Jura, usually combined with the development of highly complex lobes and saddles, has been recorded by me in other papers and by many other writers; consequently, when one meets the Pseudoceratites of the Cretaceous he is apt to imagine them to be what Barrande has called "anachronisms," and difficult problems for the evolutionist. They are unquestionably difficult, but they are no more anachronic than any of the forms usually named as having this paradoxical character. They are simply excellent examples of arrestation of development taking effect locally and upon certain structures. These, if I have rightly understood the researches of my deceased friend, Professor Cope, the most brilliant investigator and profoundest thinker on evolution that America has produced, are good examples of his law of retardation in development, and also excellent examples of the different way in which I look upon the same phenomena. I have never regarded such cases as examples of a tendency to retardation of development. A distinction exists between arrestation and retardation in development, which is of great importance. Arrest of development occurs in many ways. It may take effect locally, as upon the sutures, stopping them from developing in complexity of outline beyond a certain measure, and thus retaining a semblance to their own young and apparently reverting to the condition of the same parts in more ancient animals of their own stock. It may take effect upon the whole organism, as in *Baculites* and other uncoiled forms, apparently causing the entire animal to revert in its characters to a primitive form. There are innumerable degrees between these two extremes which it is not necessary nor appropriate to mention here. Retardation is distinct from these and of much rarer occurrence. [a]

The development can not be said to have been retarded in these retrogressive forms, since it begins and for a certain period in the ontogeny progresses in parallel lines with the ancestors of the group, but passes through the modifications more quickly according to the law of tachygenesis. After this its progress is quite suddenly and decidedly arrested, and the succeeding stages are no longer parallel with those of their ancestral forms. The complexity of the outlines of the lobes and saddles in species of *Engonoceras*, for example, does increase even in the later stages; but this increase is very slight, and the result is a retrogressive form that mimics to a certain extent primitive forms among Goniatitinæ and Ceratitinæ. Such examples may, nevertheless, belong to the highly accelerated class, as is shown by the earlier development in these Pseudoceratites of the Cretaceous of the three principal saddles that only appear in the ephebic stage of the highly progressive forms among Ammonitinæ of the Jura. Retardation of development certainly does not take place in their early stages. Can it be said to take place because they do not subsequently proceed to develop numerous marginal lobes and saddles on the borders of these same lobes and saddles?

Retardation of development can mean but one class of phenomena, viz, those cases in which a character appears in the ontogeny of descendants later than the stage at which it appeared in the life of their ancestors. In cases of retrogression such as are noted above, and in all examples of this class with which I am acquainted, the complication of the lobes and

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[a] Bioplastology and related branches of biologic research; Proc. Boston Soc. Nat. Hist., Vol. XXVI, p. 79, etc.

saddles by the addition of marginals during the later stages of the ontogeny does not occur; the inexact parallelism is produced by the dropping out of this stage completely, not by its later and later development.

Cope, in his great work Origin of the Fittest, writes as follows:[a]

* * * The acceleration in the assumption of a character, progressing more rapidly than the same in another character, must soon produce, in a type whose stages were once the exact parallel of a permanent lower form, the condition of inexact parallelism. As all the more comprehensive groups present this relation to each other, we are compelled to believe that acceleration has been the principle of their successive evolution during the long ages of geologic time.

Each type has, however, its day of supremacy and perfection of organism, and a retrogression in these respects has succeeded. This has, no doubt, followed a law the reverse of acceleration, which has been called retardation. By the increasing slowness of the growth of the individuals of a genus, and later and later assumption of the characters of the latter, they would be successively lost.

To what power shall we ascribe this acceleration, by which the first beginnings of structure have accumulated to themselves through the long geologic ages complication and power, till, from the germ that was scarcely born into a sand lance, a human being climbed the complete scale and stood easily the chief of the whole? * * *

Acceleration signifies addition to the number of those repetitions during the period preceding maturity as compared with the preceding generation, and retardation signifies a reduction of the numbers of such repetitions during the same time.[b]

Thus, from Cope's point of view, tachygenesis is the law of progression, and retardation is the law of retrogression, and they are both essential parts of his law of acceleration and retardation.

These quotations show that we both have the same conception of the proper use of the word "retardation," but we differ in the application of it. He applied it to such cases as are described here among Pseudoceratites, whereas I regard these as true arrests of development and not as retardations.

Retardation is exceedingly rare among Ammonitinæ, and as a rule in other parts of the animal kingdom, and the only examples I am able to cite are like those given below in *Placenticeras*, where the more complex species like *whitfieldi*, that are obviously descended from species like *P. syrtale*, have apparently the nodes and ornaments smaller and developing, as a rule, later than in that species, and finally, in extreme forms like those of typical *whitfieldi*, disappearing altogether.

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[a] P. 142.

[b] P. 182.

As a rule, among Ammonitinæ the reverse is the case, and the disappearance of characters takes place through the earlier and earlier development and shorter and shorter life history of each characteristic, or through tachygenesis, as stated and illustrated in many of my papers. Here I have space only for one quotation, which will serve to show my meaning more plainly:

> Specialization by reduction of parts is evidently included under the head of retardation by Cope; thus in Origin of the Fittest (p. 353), he says that "change of structure during growth is accomplished either by addition of parts (acceleration) or by subtraction of parts (retardation)." So far as my experience goes, in the major number of cases the parts or characters that are undergoing reduction disappear according to the law of tachygenesis. They reappear in the ontogeny at earlier and earlier stages, or exhibit this tendency in the same way as characters of the progressive class, but their development is not so complete as in ancestral forms. In this sense they can be regarded as retarded or thrown back in their development. There is, however, another way of formulating the expression of this. Instead of regarding this disappearance by retrogressive gradations as due to a tendency opposed to acceleration, is it not a tendency of the same kind? That is to say, do not the parts and characters show a tendency to disappear earlier and earlier, and are they not in most cases at the time of disappearance present only in earlier stages of growth than that in which they originated in ancestral forms?
>
> Is not the case of the wisdom teeth exceptional? The frequently extremely late external appearance of these is not accompanied by a later origin of their rudiments in the jaw. Although they may not appear in many cases above the gum until a person is past fifty, is not this real retardation due primarily to the fact that they are deficient in growth power (tending to disappear from disuse, etc.), and secondarily to their internal position? When they cease to be able to break through the gum will they not still continue to develop at the same stage as the other teeth, and will not their rudiments be likely to be present at this early stage long after they have ceased developing into perfect teeth? [a]

The whalebone whales are examples of this kind so far as the teeth are concerned, although here the disappearance is correlated with the development of whalebone from the rugæ of the roof of the mouth. Nevertheless the suppression of the teeth in full-grown animals does not take place by later and later development, and the rudiments of the teeth are still present in the early stages.

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[a] Bioplastology: Proc. Boston Soc. Nat. Hist., Vol. XXVI, note to p. 80.

SYSTEMATIC DESCRIPTIONS.

MAMMITIDA.[a]

This group in my chapter on Cephalopoda in Zittel's Text-book contained a number of keeled families, in which either the keel was preceded by a median line of tubercules, or, if this stage were omitted, the smooth keel arose upon the venter in forms that were apparently closely allied to the more primitive genera having these tuberculated keels. The Mammitida included Mammitidæ, Peroniceratidæ, Prionotropidæ, Hystatoceratidæ, Lenticeratidæ, and Tissotiidæ. To these I propose to add now the Mojsisovicsiidæ, Buchiceratidæ, Pseudotissotiidæ, Eulophoceratidæ, Sphenodiscidæ, and Coilopoceratidæ.

MOJSISOVICSIIDÆ Hyatt.

The single genus and species described below can not be even provisionally included in any of the groups to which it is supposed to be nearly related, and the following discussion of its generic affinities shows this conclusively. The dorsal sutures are not yet known, and this is the only defect in the evidence that establishes it as an independent group, probably belonging to the parent stock or stem of the Pachycampyli.

MOJSISOVICSIA Steinmann.

The interesting species used as the type of this genus has a form which is similar to that of *Agassiceras* of the Lower Lias in being smooth and discoidal, with flattened sides, narrow umbilical zones and rounded venter. The section is what I have called helmet shaped, like *Agas. striaries.* It differs in having no raised line or keel, and therefore comes a little nearer to *Psiloceras.* The sutures bear a similar interpretation, since, although these are very immature, there are four lateral bifid saddles with

[a] A penciled note at the top of this page of manuscript says "Revise list." Just what changes the author would have made can not be known, but it may be inferred that Lenticeratidæ was dropped as an abandoned family, and that possibly Coilopoceratidæ was assigned to another superfamily. It is obvious that his conception of the group Mammitida had become very different from that expressed by him in Zittel's Text-book.—T. W. S.

subphylliform marginal saddles and excessively short pointed marginal lobes that are hardly more than serrations. The ventral lobe is very broad and divided. The first and second lateral lobes are narrow and similar to those of *Buchiceras*, but it should be noted that the dorsal sutures are unknown, and these may be quite distinct. The third lateral lobe is entire, and the fourth saddle hardly past the entire stage, exhibiting only a slightly trifid outline. Such sutures exhibit affinities with the smooth primitive ancestral stock of the Psiloceratidæ of the Jura and other forms of Pachycampyli descended from these because of their massive broad saddles, so entirely different from the narrow, excessively branched saddles of the Phyllocampyli and Leptocampyli. I do not, of course, mean that *Mojsisovicsia* is probably descended directly from *Psiloceras*, but it may be a Cretaceous member of a primitive stock which began with *Psiloceras* in the Jura. The intermediate forms are as yet unknown or have not been published. The existence of such a trunk or main branch of a primitive stock from which all of the more complex groups are lateral offshoots has been inferred from the ontogeny as the most probable way to account for the ontogeny of the primitive species of these groups. Thus in the present instance the smooth discoidal young of *Buchiceras* and other genera can be readily accounted for if the comparison between them and the later stages of *Mojsisovicsia* is admitted. If such a stock of primitive forms existed, it is also easy to account for the maintenance of such primitive smooth psiloceran-like shells in the later nepionic and sometimes in the neanic stages of Cretaceous forms Otherwise the continued renewal of these in the ontogeny at such late stages must be referred to more ancient ancestors than any represented in the Jura.

MOJSISOVICSIA DURFELDI Steinmann.

Pl. I, figs. 1–3.

Mojsisovicsia durfeldi Steinmann, Neues Jahrbuch für Min., Geol., und Pal., 1881, II, p. 143, pl. 6.

The peculiar fossil described under this name has a compressed discoidal shell with slight constrictions, open umbilici, and smooth surface that in external aspect resembles *Tranceras* and also some of the discoidal Desmoceratidæ like Pseudophyllites Kossmat, but has entirely different sutures. These have an aspect similar to those of *Buchiceras bilobatum*, but the form of the volution differs so widely that no further comparisons can be made with this genus. The living chamber is short, the aperture has a blunt rostrum, there are shallow sinuses on the edges of the venter, a broad lateral rostrum on either side, and shallow sinuses between these and the umbilical shoulders, and probably a crest on the dorsum.

The ventral lobe is very broad and short, with a broad short siphonal saddle. There are three bifid lateral saddles, with an incomplete apparently entire saddle at the line of involution. The lobes are short and much narrower than the saddles, and the entire outlines of both lobes and saddles have short obtuse marginal saddles and narrow, short, pointed, simple marginal lobes.

The species is known to me only through Steinmann's figures, which are reproduced on Pl. I, figs. 1–3, with the single exception of his enlarged drawing of the side view of fig. 1.

Locality: Pariatambo, Peru.

Age: Albian (?).

BUCHICERATIDÆ Hyatt.

It has been found impracticable to unite the genus *Buchiceras* with any known family, on account of its peculiar development and sutures. The approximation to the Hystatoceratidæ is close, so far as the earlier stages are concerned, the compressed, comparatively smooth-keeled young in the neanic stage having considerable resemblance, but these similarities are lost in the subsequent development, owing to the partial suppression of the costæ and the very distinct sutures. The development and sutures separate these forms completely from *Knemiceras.* They are separable from Tissotiidæ by their first lateral saddles and their ventral lobes, and from *Barroisiceras*, which they also resemble, by the absence at all stages of a third line of tubercles and by their sutures.

The sutures are similar to those of the discoidal smooth shell of uncertain affinities described as *Mojsisovicsia* by Steinmann.

So far as known there are no representatives of this genus except in South America. It should be remembered, however, that all information heretofore published has come from this single fossil.

The second genus included in this family, *Roemeroceras*, has similar ventral lobes and siphonal saddles, and the young, although quite distinct in being less compressed in the early stages, acquire a similar keel at a later age, and similar form and ornaments.

BUCHICERAS Hyatt.

This genus was formerly described by myself as including several different species that have since been separated into distinct genera, by Douvillé, Grossouvre, and others, and by myself, in Zittel's Text-book of Paleontology. The affinities of *Buchiceras* are not, in my opinion, very close to any of the forms formerly referred to *Acanthoceras* as supposed by some authorities. The sutures are quite distinct from those of any of the families of Mammitida on account of the extraordinary breadth of the second lateral saddles. The development is similar to that of some forms of Hystatoceratidæ and Peroniceratidæ in that it is at first discoidal, compressed, and smooth, then keeled, becoming costated and tuberculated later, and the sutures approximate more closely to those of the young of these families perhaps than to others. Nevertheless the ontogeny differs in that *Buchiceras* does not subsequently acquire prominent costæ, and the keel tends to disappear instead of becoming larger with increase in size of the volutions. The nodes, on the other hand, increase in size and prominence, especially the inner row on the umbilical shoulders. The faint serrations on the keel and other ornamentation suggest affinities with *Barroisiceras*, but the sutures and the absence of a third line of lateral tubercles, which appear in some forms of *Barroisiceras*, are not favorable to this solution of the affinities. The same objections apply almost equally to keeled forms of the Prionotropidæ in which the young resemble more or less closely those of *B. bilobatum*. The dorsal sutures are very remarkable and perhaps may eventually assist in placing this genus in closer connection with others. The primitive first lateral saddle is retained in *Buchiceras* until a late stage, and perhaps throughout life; it is undivided, except by small entire marginal lobes, but it is distinctly bifid.

Buchiceras bilobatum Hyatt.

Pl. I, figs. 4–9.

Buchiceras bilobatum Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 370.
Buchiceras bilobatum Douvillé, 1890, Bull. Soc. géol. France, 3d ser., Vol. XVIII, p. 284.

The young, for the first two, and perhaps part of the third volution, must have had smooth sides and was obviously very discoidal, flat, and keelless. The aspect of this species must have been very similar to *Mojsisovicsia*. The keel comes in upon an elevated venter previous to reaching the diameter of 5 mm. and is faintly sinuous during the latter part of the volution seen in Pl. I, fig. 4. These faint undulations are due to prolongations of the costæ that pass between the tubercles on the ventro-lateral angles. This keel, which is a mere angle on the venter, was obviously continuous before the costæ appeared and is practically continuous subsequently, owing to the minute character of the inflections. Upon the last of the outer volution at this diameter, the first of the fourth volution, the outer line of tubercles appears and is connected by costæ with the inner line. The last are very widely separated at first and become nearer only in later stages. The larger costæ at this age are separated by single, arcuate costations terminated outwardly by minute tubercles and fading out internally about halfway across the volution. The umbilical zones are not differentiated from the sides. The side is evenly plano-convex from the keel to the line of involution and the inner, uncostated part is smooth, except where interrupted by the inner tubercles or extensions of the tubercular terminations of the larger costæ. The tubercles and nodes are opposite, not alternate. The sutures at this age consist of two large saddles (Pl. I, fig. 9), a narrow first lateral lobe in the center of the lateral zone and a broad second lateral on the umbilical zone. The inflections are all apparently entire. In succeeding stages the lobes remain in the same position, there being but one in the center of the side between the two rows of tubercles and one on the umbilical shoulder, but as the shoulder becomes more prominent and the umbilical zone broadens, other lobes and saddles appear internally. The venter broadens with age, the keel becoming more obscure in consequence of this; the sides become flat and convergent; and the umbilical shoulders broaden out more than the venter, the increase in the umbilical zones making the umbilici very deep. The keel on the cast at this mature stage is faintly undulated, and the lateral costæ, although very obscure, cross the venter and interrupt the keel between each pair of opposing ventro-lateral nodes. These widely separated serrations are so faint on the cast that they entirely escaped my observation on former occasions. They in fact can be felt more easily than they can be seen. This is also the case in the earlier stages described above. The inner nodes are always larger and fewer than those on the edges of the venter. The second lateral saddle remains broader than the first lateral, even when the shell is somewhat over 40 mm. in diameter. It occupies a trifle more than half of the side and encroaches on the umbilical zone (Pl. I, fig. 8).

The ventral lobe is very widely open at the base and longer than the first lateral lobe. The two arms are blunt and very small. The siphonal saddle is phenomenally short and broad, with a faint centran marginal lobe and an equally faint marginal rounded ·saddle on either side. The first lateral lobe is funnel shaped, broad at the base, short and narrowing rapidly to a bifid termination. The second lateral lobe is very much smaller and shorter, and entire at the end. The third lateral saddle is small, entire until a late stage, but becoming bifid later. Beyond are two small entire saddles and two corresponding lobes or what may perhaps be more accurately described as a bifid lobe and a bifid saddle.

The first and second lateral saddles have internal ridges, but these coalesce, forming a short, flattened area along the mesal plane, which becomes deeply convex toward dorsum and venter. There are only two broad saddles and two narrow lobes on the dorsum, and these have no connecting ridges with the external saddles. The surfaces of the wings of the septa are strongly inclined inward, the outer sutures being considerably in advance or orad of the inner ones. This gives a remarkably concave aspect to the wings of the septa on either side of the dorsum.

The dorsal sutures, which were worked out with difficulty, show that the inner arm of the bifid fourth lateral saddle passes across the line of involution, coalescing with the third dorsal saddle. The antisiphonal lobe is asymmetrical, entire at the top, unequally serrated on the sides, and bent over to the left until the tips touched the inner angles of the first pair of dorsal saddles to the right of the mesal plane of the body. The first pair of dorsal saddles are deep and broad with broad entire bases. The first lateral lobes are small and unequally bifid, the sides being coarsely serrated. The second dorsal saddles are much inclined and obscurely tridentate or entire. The second dorsal lobe is very small and entire. The third dorsal saddle is a part of the fourth lateral, as stated above, and is entire.

Vestiges of the shell were present upon this cast in a few places and showed coarse lines of growth. Unfortunately the shell covering the venter of the young whorl was chipped off in cleaning this part for drawing, and evidence of the statement made above with reference to the keel was lost.

Locality: Cachiyacu, west side of Hullagua River, Peru.

Age: Upper Cretaceous.

ROEMEROCERAS Hyatt.

These shells were so similar to the type of *Buchiceras* in external aspect that I formerly supposed the type of this genus to be an older stage of *B. bilobatum*, but more prolonged acquaintance with these forms shows that they are not in the same generic group. While the bifurcated costæ, the large nodes on the umbilical shoulders, and the nodes on the ventro-lateral angles are the same, the involution is greater, the lateral zones more compressed and broader, the umbilici narrower, the young have larger nodes, and the keel entirely disappears in the full-grown shells, except perhaps in *R. gabbi*. The sutures are also quite distinct, and similar to those of Tissotidæ in some species, but the first lateral saddles tend to develop three arms in some species and the bases of the other saddles are apt to be dentated more or less completely. The ventral lobes are similar to those of *Buchiceras* and entirely distinct from the broad ventrals of the Tissotiidæ. The same characters appear to unite *Knemiceras* with *Roemeroceras*, but the development and full-grown shell in *Knemiceras*, especially the invariable presence of the concave venter, seemed to place it in closer association with the Pulchelliidæ.

Roemeroceras gabbi n. sp. Hyatt.

Pl. II, figs. 1–3.

Ammonites bilobatus Gabb. 1877, Jour. Acad. Nat. Sci. Philadelphia, 2d ser., Vol. VIII, p. 270, pl. 38, fig. 3.

In my revision of this form I made too great allowance for the possible variations due to age, and misled Professor Gabb in identifying this fossil with *Buchiceras bilobatum*. As compared with *B. bilobatum*, the nodes on the umbilical shoulders are much less prominent and more numerous and more closely approximated, the venter has large ridges not present in *bilobatum*, and the flatness and proportions of the saddles are too distinct to occur in the same species, even though allowance be made for the sutures in *gabbi* being nearly one volution older than those examined in *B. bilobatum*. The sutures of this species approximate more closely to those of *R. syriaciforme* than to those of any other species, but *R. gabbi* differs in the greater number and smaller size of the nodes and costæ. Fig. 3 of Gabb's plate shows the lateral aspect with an outer line of nodes lower on the sides and a sinuous outline to the venter which does not appear in *syriaciforme*, and also a stouter and more quadragonal volution than any other species of this genus. The originals of this species were not reexamined. They could not be found in the Academy's collection at the time of my visits, nor has subsequent search, made by the kindness of Professor Pilsbry, brought them to light.

Locality: Quebrada de Colpamayo, Department of Cajamarca, Peru.

Age: Upper Cretaceous.

Roemeroceras syriaciforme Hyatt.

Pl. I, figs. 10–14.

Roemeroceras syriaciforme Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 371.

This species reaches a diameter of 90 mm. in one cast without a living chamber. The sutures are approximated and overlap internally on the auxiliaries, showing that the gerontic stage has begun. The ornamentation and form are the same as in *bilobatum*. When the cast is only 29.5 mm. in diameter there is, however, no difficulty in separating this from *bilobatum*. It is more compressed, the sides broader, the venter narrower and flatter. The sutures have more resemblances to those of *R. gabbi*, but the saddles and lobes are never so short, nor truncated, the saddles being narrower and the lobes broader. The ventral lobe and siphonal saddle are similar, but narrower and less digitated. The first lateral saddles are similar in being bifid and rather broad, but already at this early stage show denticulations over the entire base. The first lateral lobe is similar but less deeply divided, by the similar marginals. The second lateral saddles are unequally bifid with bases rounded or approximately phylliform, entire, and unlike those of *gabbi*. The second lateral lobes are quite broad, apically like the first laterals, but are unequally quadrifid. The third lateral saddle is as broad as the second lateral, and also bifid. It occupies part of the side and also part of the umbilical zone, the marginal lobe being upon the umbilical shoulder. Inside of this there is one broad bifid saddle reaching to the lobe at the line of involution. There are therefore four saddles at this early stage very like those of *gabbi*, except in having rounder bases. Later, on the same volution, this inner saddle becomes divided into two by a median marginal lobe, and still later a small lobe makes its appearance at the line of involution, completing the outline of the innermost lateral saddle. There are then five saddles and six zygos lobes on either side.

The oldest sutures are very much changed, and look like those of a distinct species, but are obviously in the gerontic stage. The bases of the saddles are nearer together, the entire parts of the sides much elongated, and the lobes longer and narrower and the digitations situated at their apical ends much deeper. The saddles are longer and broader, with entire bulging sides, and the marginals not increased in number, but much longer and larger.

The sutures have at this stage close similarity to the peculiar outlines attributed to *Ammonites syriacus* by von Buch (fig. 1 of pl. 7 in his Über Ceratiten), but the first lateral is not so broad and does not have the minute phylliform marginals of that figure. The marginals on the first lateral saddles, and also in the first lateral lobe, are tongue shaped.

The fourth and fifth lateral saddles are entire, tongue shaped, and divided by a narrow bifid lobe. The young sutures, until a late neanic stage, have outlines similar to those of some species of *Tissotia*. After this the outer saddles become completely denticulated, and again, as described above, lose a considerable part of these denticles in old age.

Fragments of the shell were present on the largest cast. None of the specimens was incrusted by any extraneous growths that could be shown to have fastened themselves on the surfaces of the casts.

The figure of the young in an early ephebic substage (Pl. I, fig. 12) is a very near approach to the old specimen which was crushed on one side (Pl. I, fig. 10), but of course, owing to differences of age, the nodes are larger.[a] There are fifteen nodes on the ventral border and six on the umbilical shoulders on one volution of the younger specimen, and eleven on the outer and seven on the inner row of the old specimen. The bifid costæ are also present in the younger specimen, mingled with single ones, as in the old stage. The keel disappears on the last quarter of the outer volution, both on the cast and on the shell, in the young specimen, and is absent also in the older one. The young shell was seen in a section of the specimen represented by fig. 12 of Pl. I, and although not perfect enough to figure, showed that when about of the same size as the young of *B. bilobatum* (Pl. I, figs. 5, 7), it had a similar keeled form.

Locality: Cajamarca, Peru.

Age: Upper Cretaceous.

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[a] See also description of *R. attenuatum* Hyatt.

ROEMEROCERAS ATTENUATUM (Hyatt).

Pl. I, fig. 15.

Buchiceras attenuatum (pars) Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 372.

The cast differs from *syriaciforme* in having more numerous nodes on the inner line. On the outer volution, at a diameter of 64 mm., there are about nine on the inner row and sixteen on the outer, whereas in *syriaciforme*, at a diameter of 90 mm. there are seven on the inner line and eleven on the outer line; in another specimen of *syriaciforme*, at a diameter of 73 mm., there are the same number; in another, at a diameter of 34 mm., there are six on the inner and fourteen on the outer line; in another, at a diameter of 41 mm., there are seven on the inner line and fifteen on the outer.

There are faint signs of a keel on the type specimen, showing that it belongs in this genus. The general form is much more compressed than that of *R. syriaciforme;* the venter is narrower and the keel is also less developed. The volutions are more enveloping, and the umbilicus is smaller. The specimen is a cast, partly crushed on one side and somewhat worn on the other, but although the sutures are not consequently perfect they are entirely distinct from those of other species. The first lateral lobes are bifid and shorter than the ventral lobe. Instead of being of about the same length or longer than the ventral, as in *R. syriaciforme*, all the saddles are broad and very short, as are also the lobes. The first lateral saddles and lobes are completely denticulated by marginals. The second lateral is trifid, the third and fourth saddles are bifid, and there is a fifth saddle, but this is on the line of involution and very narrow. The second lateral lobes are trifid. The third lobe is in the umbilical zone and bifid, but otherwise entire, and the fourth is very small and apparently entire, but too much worn to make observation certain.

There are incrusting ostreans upon both sides of this cast and they appear to have been attached to a fossil cast.

This species is founded upon a single fossil cast, one of the two used for the description of *Buchiceras attenuatum* Hyatt, but not the type. The latter is to be found on page 151, under the name of *Knemiceras attenuatum* Hyatt.

Locality: Celendin, Peru.

Age: Upper Cretaceous.

Roemeroceras subplanum n. sp. Hyatt.

Pl. II, figs. 4–6.

This specimen is a cast, whole diameter 55 mm The lateral zones are flatter than in *R. syriaciforme* and *denticulatum*, and the outer nodes are smaller, more acute, and have slight ridges or orad continuations in some cases. The inner nodes are also smaller in the young and increase very rapidly in size on the last volution and then suddenly disappear, the volution becoming at the same time contracted to a subquadrate outline. There are four small and three large nodes on the inner line, the place where the fifth node ought to be is vacant, and there are fifteen nodes on the outer line. The living chamber, which is probably very nearly complete, is less than one-half of a volution in length The last two large nodes of the inner line are on this chamber.

The sutures have very broad, short, simple saddles and very short lobes. They are similar to those of *R. denticulatum* but have not such complex outlines. The last six sutures are nearer together and become finally closely approximated, showing that the fossil is probably an outgrown shell. This cast having been cracked open, it was possible to study exactly the contact of incrusting ostreans with the surface. It was found, as in other cases described, that no shell layers were present, the ostrean having grown directly upon the surface of a fossil cast. The shell is present in the impressed zone where it is protected by the enveloping volutions, and it is there thick and well defined.

Locality: Cajamarca, Peru.

Age: Upper Cretaceous.

PSEUDOTISSOTIIDÆ Hyatt.

If the position here taken is correct, the genera assembled under this name are distinct from those heretofore included under the Tissotiidæ They include forms from the discoidal channeled and keeled *Pseudotissotia* in the Turonian to the highly involute compressed *Plesiotissotia* of the Senonian. The lobes have the same denticulated outlines as in Tissotidæ, but the saddles are more complex, being denticulated in all the genera except *Plesiotissotia*, in which they are all bifid, the first lateral saddles being quadrifid according to Peron's figure.

The relations of the genera in this family can only be estimated by their full-grown shells and sutures, and doubtless any arrangement that can now be made will be only provisional. So far as the facts go, *Pseudotissotia* is a flat-ventered, keeled, and channeled form until a late age, losing its keel in old age and having so close a resemblance to *Tissotia tissoti* that it seems to be the only form having any claims to be considered the ancestor of that species, as first pointed out by Peron.

Choffaticeras, until a late age, has a venter with keel and channels like those of *Pseudotissotia* in *C. meslei* but combined with an inflated volution and deep, abrupt umbilici and highly inclined, convergent sides. In other species the line of modifications indicated by the later stages of its ontogeny leads into forms having subacute venters at a comparatively early age, and possibly the keeled and channeled stage with its flat venter may have altogether disappeared in some of these. The highly involute, compressed-keeled forms of *Hemitissotia* follow these in the same line of modification and as their sutures also coincide and they occur in the Senonian, whereas all of the above-described genera are Turonian, Peron's idea that they are the direct descendants of *Pseudotissotia* seems to be well sustained.

That these are not transitional to true *Tissotia* becomes apparent when it is recognized that the type form of that genus has an ontogenetic history like that of *Pseudotissotia* and is probably, as stated in the description of the Tissotiidæ, the most primitive member of a series of forms distinguished by their differences of development as well as by their simpler and more retrogressive sutures.

Although the sutures differ decidedly, the forms of more primitive species like *Pseudotissotia galliennei* and their keels appear to place them provisionally nearer to the Buchiceratidæ than to the keelless forms. I have had no fossils for examination in this family, but the literature and the figures given by Grossouvre and Peron have been sufficient to enable me to arrange the forms provisionally and to make comments upon their probable relations that will, it is hoped, attract attention and lead those who have better opportunities to test the truth of the views presented below.

PSEUDOTISSOTIA Peron.

Peron's typical species, *Ps. galliennei*, is a discoidal form with keel and channels, having obviously, as observed by Peron, genetic affinities with true *Tissotia* as here defined, but it differs in the more complex outlines of the sutures, all of which have small marginal lobes and saddles. In my opinion, the genus should be limited, so far as known, to one species, the type described by Peron. The other species described under this name are obviously widely distinct in their forms and mode of development. The sutures resemble those of *Roemeroceras* on the lateral aspect. The ventral lobes are also alike, so far as can be seen on Peron's figure. Peron's suggestion that these are the ancestors of *Tissotia* and its allies in the Senonian appears to be supported by the facts so far as now known. They appear also to have been the immediate ancestors of *Hemitissotia* and its allies in the Senonian, but this last inference needs confirmation that can only be obtained through the study of the young of the latter.

Pseudotissotia galliennei (d'Orbigny).

Pseudotissotia galliennei Peron, 1896, Mém. Soc. géol. France, Paléontologie, Vol. VI, No. 17, pl. 2, fig. 3; pl. 3, fig. 1.

This is a moderately compressed but still comparatively discoidal form, with large umbilicus and involution enveloping something more than one-half of the sides, according to Peron's figures. The venter is flattened, with heavy, continuous keel and shallow channels bordered externally by thick continuous ridges. The sides have very broad fold-like costæ without tubercles. In extreme age all of these ornaments disappear. The entire aspect and genetic transformations of this fossil are so similar to those of *Tissotia tissoti* that it would have to be included in the same genus, if the sutures were unknown.

Locality: France.

Age: Turonian.

Pseudotissotia ? tunisiensis n. sp. Hyatt.

Tissotia cf. *fourneli* Peron, 1896. Mém. Soc. géol. France. Paléontologie, Vol. VI. No. 17, pl. 12, figs. 7, 8.

Tissotia fourneli Peron, 1890, Moll. Crét. de la Tunisie, pl. 17, figs. 11–13.

This remarkable fragment has a truncated venter, entire keel, and compressed volution, with moderately large umbilicus. The costæ are fold-like, with tubercles on the umbilical shoulders and a line of closely set elongated tubercles on the ventro-lateral angles. The first lateral saddles are trifid and rather peculiar, owing to the approximate equality of the three marginal saddles. The other saddles are very long and phylliform, and according to Peron's figures the third saddle is trifid or bifid. These sutures and the ventral lobe, with its steep denticulated sides and truncated siphonal saddle, are similar to the sutures of the old stage of *Roemeroceras syriaciforme*. The form and ornamentation also agree with this determination, but the keel is more prominent than is usual in this genus. It is possible to understand this form, if it is related to *Ps. galliennei*, because in that case the keel and lateral costæ are similar to those of that species. The differences in sutures lie largely, according to Peron's figure, in the second lateral saddles, which are entire. This may be due to retrogression.

Locality: North Africa.

Age: Santonian.

CHOFFATICERAS n. gen. Hyatt.

This genus has sutures similar to those of *Pseudotissotia*, but the form is distinct. The species are more or less stout gibbous forms with more or less open and deep umbilici. The sides are heavily costated and nodose along the umbilical shoulders, but there are no external tubercles according to Peron. He also describes the venter as having a continuous keel and two ventro-lateral ridges. The form is more involute and more compressed than *Pseudotissotia*, and the outer parts of the volutions have a tendency to become concave in the involute species with broad volutions.

The type is *C. meslei* (Peron).

Choffaticeras barjonai (Choffat).

Pseudotissotia barjonai Choffat, 1898, Faune Crét. du Portugal, Vol. I, 2d series, pl. 18, fig. 3; pl. 22, figs. 40–42.

This species is a close ally of *C. meslei* of North Africa, as has been stated by Choffat, but has a more prominent keel and has no signs of channels on the venter.

Locality: Portugal.

Age: Turonian.

Choffaticeras meslei (Peron).

Pseudotissotia meslei Peron (pars), 1896, Mém. Soc. géol. France, Paléontologie, Vol. VI, No. 17, pl. 1, fig. 1; pl. 2, fig. 1 (not pl. 2, fig. 2, nor pl. 3, fig. 2).

This species has a form which is sublenticular when seen from the front in Peron's figure, owing to the great prominence of the umbilical shoulders and the rapid slope of the lateral zones and subacute character of the venter. The costæ are linear and only slightly curved in the only well-preserved part of his type as figured. The involution covers about three-fifths of the next inner whorl, leaving a rather large open umbilicus showing the younger whorls.

The more discoidal form (pl. 2, fig. 2, and pl. 3, fig. 2) supposed to belong to this species, is certainly distinct specifically and may be nearer to *Pseudotissotia* than to any species of this genus, but it is too imperfect to give diagnostic characters.

Locality: North Africa.

Age: Turonian.

CHOFFATICERAS? DOUVILLEI (Peron).

Pseudotissotia douvillei Peron, 1896, Mém. Soc. géol. France, Paléontologie, Vol. VI, No. 17, pl. 2, figs. 4, 5, and pl. 3, figs. 3, 4.

This species, as figured and described by Peron, has the general form and aspect of *C. meslei*, but the heavy nodes on the umbilical shoulders and dichotomous costæ reaching to the sides of the prominent keel are quite different.

Locality: North Africa.

Age: Turonian.

HEMITISSOTIA Peron.

This genus seems to me to be more intimately related to *Choffaticeras* than to *Tissotia* and other genera having similar forms but having sutures with smooth saddles. Such questions can only be definitely settled when the younger stages become known. These involute and more or less compressed forms with trenchant keeled venters are apparently in the direct line of modifications indicated by the similar forms of Tissotidæ, but on the other hand their sutures correlate with the more complex outlines of those of *Pseudotissotia* and *Choffaticeras*, and this indicates that they are simply parallel as representative forms analogous to some of the Tissotidæ but really in the genetic line of *Choffaticeras*. They have retrogressive characters in the undivided outlines of their inner saddles, but this arrest of development has not affected the outer saddles that are completely digitated. They can not be placed anywhere in the genetic line between *Pseudotissotia* and *Subtissotia* on account of the absence of channels and ridges on either side of the keel, and this is the only position that could be claimed for them in view of their peculiar sutures. All of their characters accord best with the view that they are direct descendants of *Choffaticeras*. There is an interesting group of this or an allied genus from the Senonian, described by Choffat in his Céphalopodes de la Faune Crétacique du Portugal, Vol. I, 2d series, but the condition of the specimens did not permit him to describe them sufficiently to judge closely of their affinities.

Hemitissotia cazini Peron.

Hemitissotia cazini Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No 17, pl. 14, figs. 1–5; pl. 18, figs. 9, 10.

This species is a highly involute compressed form, and in the oldest specimen figured the first and second lateral saddles are completely denticulated, the third is equally divided by a median marginal lobe in the figure of the suture of the oldest specimen (pl. 18, fig. 9), but this is not described in the text.

Locality: North Africa.

Age: Senonian.

Hemitissotia? batnensis Peron.

Hemitissotia? batnensis Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 15, figs. 7, 8.

This species has the external aspect of this peculiar group and the sutures are similar as figured by Peron, but his question mark after the generic name is justified by the *Sphenodiscus*-like aspect of the first lateral saddles.

Locality: North Africa.

Age: Senonian.

Hemitissotia morreni (Coquand).

Hemitissotia morreni Peron (pars), 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 15, figs. 1 and 2 only, and pl. 18, fig. 11.
Hemitissotia morreni var. *præcipua*, ibid., p. 77.

This var. *præcipua* of Peron is a highly compressed form with acute venter. Pl. 15, fig. 8, may be the young of this species, and if so, it shows conclusively that it is distinct from the following.

Locality: North Africa.

Age: Senonian.

Hemitissotia tissotiæformis Peron.

Hemitissotia morreni var. *tissotiæformis* Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 15, figs. 3–5 only.

This is a much stouter form with stouter volutions, and as might be expected in such a species the young exhibits distinct ribs. *Hemitissotia morreni* var. *coquandi* (pl. 15, fig. 6) may be distinct, but no front view is given and the sutures shown in pl. 18, fig. 14, do not appear to be very different.

Locality: North Africa.

Age: Senonian.

Hemitissotia djelfensis (Peron).

Tissotia djelfensis Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 16, figs. 3, 4.

Buchiceras ewaldi (pars) Peron, 1890, Moll. Crét. de la Tunisie, pl. 15, figs. 7 and 9 (no others).

This is a compressed shell very closely allied to *Paratissotia ficheuri* in aspect, but differing in the sutures. These have the first lateral saddles narrow and bifid as in *Hemitissotia* and the first lateral lobe is large as in that genus. The figure of the highly compressed cast given by Peron as part of his *ewaldi* in the Mollusques Crétacé de la Tunisie has very similar sutures so far as the deep division of the first lateral saddles and lobes is concerned. It is better to quote it here, since it is undoubtedly not related to the other species on the same plate and has also a form similar to that of *djelfensis*.

Locality: North Africa.

Age: Lower Senonian.

Hemitissotia ceadouroensis Choffat.

Hemitissotia ceadouroensis Choffat, 1898, Faune Crét. du Portugal, Vol I, 2d series, pl. 20, figs. 7–10.

This species is apparently a member of this genus and is of interest in showing the old-age transformations, the rounding of the venter and contraction of the outer volution. If the last part of the last volution is perfectly natural, it shows an extraordinary senile scaphitoid deviation from the spiral.

Locality: Portugal.

Age: Senonian.

PLESIOTISSOTIA Peron.

This genus has been founded by Peron entirely upon the differences of the sutures as compared with *Hemitissotia.* The first lateral saddles are broad and very deeply divided by a median marginal lobe and each arm is phylliform and is also subdivided by a median marginal lobe; the remaining saddles are phylliform and equally subdivided by median marginal lobes. It is a question whether these peculiar sutures really represent another group or are simply retrogressive modifications in the genetic line of *Hemitissotia.* The compressed and costated form does not indicate affinities, but, as stated by Peron, the divided saddles are similar to those of *Hemitissotia præcipua*, except the first laterals, which are narrow and irregular in outline in the latter.

Plesiotissotia michaleti Peron.

Plesiotissotia michaleti Peron, 1897, Mém. Soc. géol. France, Paléontologie. Vol. VII. No. 17, pl. 16, figs. 7, 8.

A highly compressed keeled form with costæ having tubercles on the umbilical shoulders, as in some species of *Hemitissotia.* The sutures are described in the notice of the genus.

Locality: North Africa.

Age: Senonian.

TISSOTIIDÆ Hyatt.

This family name is here much narrowed in its application as compared with what it was in my chapter on Cephalopoda in Zittel's Text-book. It is now considered applicable to a series of genera that includes only *Tissotia* and its immediate allies, excluding *Pulchellia*, *Psilotissotia* and *Lopholobites.* The genera can be described as having keeled forms, with channels only in primitive genera. The keels have a crenulated or nodose stage in a number of primitive genera, but are continuous in the flattened forms. Costæ are present in the globose primitive forms and are usually tuberculated, and when they disappear the nodes are apt to persist. The venters lose their keels and become rounded or flattened in old age. One genus has a hollow keel (*Paratissotia*) and others may have hollow keels. So far, however, the only fact in favor of this is the presence of prominent keels on the shells that have no corresponding keel elevations on the casts. The sutures are characteristic, having simply digitated or phylliform, often entire or bifid saddles and narrow, often club-shaped, lobes digitated at their tops.

The first lateral saddles are usually bifid, but in some forms they become trifid. In these cases the additional saddles are added on the ventral side through the division of the outer arm of the first lateral saddle. The group as here defined is confined to the Lower Senonian in Europe, and the South American representatives are probably of about the same age.

TISSOTIA Douvillé.

The definitions heretofore given of this genus have been based upon the sutures which, according to the views here advanced, can not be accepted when not correlatable with external characters. The type of this genus, *T. tissoti*, so far as can be seen from the side view given by Bayle and the front view by Douvillé, is unique in having a considerably inflated form like some species of *Subtissotia*, but with keel and ventral channels bordered by continuous ridges, and in the extreme gerontic substage a truncated venter without either keel or channels. This certainly justifies the opinion of Grossouvre that this species is closely related to *Pseudotissotia gallienuei*. According to the views here advocated, this genus is a direct derivative of *gallienuei* of the Turonian, as has been previously suggested by Peron.

TISSOTIA TISSOTI (Bayle).

Buchiceras tissoti Bayle, 1878, Expl. de la Carte géol. France, Vol. IV, pl. 40, fig. 1.
Tissotia tissoti Douvillé, 1891, Bull. Soc. géol. France, 3d ser., Vol. XIX, p. 501, fig. 1.
Tissotia tissoti? Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 12, fig. 3.

The type of Bayle's species, which is also the type of his genus *Tissotia*, has been figured by him in side view and by Douvillé in front, from the same type in the École des Mines, Paris. Douvillé also describes the specimen. It is therefore plain that it is a stout form without any very marked nodes and is flat on the venter in its gerontic stage, having lost its keel on the last part of the outer volution according to Bayle's figure, which is natural size, and also Douvillé's figure. This shell also, according to Douvillé's figure, preserves an unusually depressed venter having keel and shallow channels on either side bordered by faint ridges or carinae throughout the adult stage. The loss of the keel is correlated with loss of the gibbosity of the sides, these becoming flatter and more convergent outwardly.

SUBTISSOTIA n. gen. Hyatt.

This group includes a number of the species heretofore associated with *Tissotia tissoti* on account of the sutures. These are unquestionably similar in the simplicity of their outlines, but, as has been argued above, this fact can not be considered as determinative in such peculiar retrogressive groups, unless correlatable with other characteristics and especially with the changes in the development both of the young and the gerontic stage.

The younger stages, so far as known, beginning with the neanic stage, have, as a rule, very globose forms with continuous keels, the sides are costated and terminate outwardly, with tubercles that form raised but discontinuous ridges on either side of the keel. The venter is much broader than the area included within these lines of nodes, except in the gerontic stage, when it narrows down to the same limits as are common in *Metatissotia*. The keel disappears in the gerontic stage and the lateral costæ and the nodes also in some species, according to Peron's figures, leaving the venter more or less rounded.

Type is *Subtissotia inflata* (Peron).

Subtissotia inflata (Peron).

Tissotia tissoti var. *inflata* Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 12, fig. 6.

The figures of this form, given by Peron, show an excessively stout shell, increasing rapidly in transverse diameters by growth, with an obtusely subacute venter, prominent keel, and slight channels on either side, bordered by ridges. Peron's figure at diameter of 68.5 mm. is 51 mm., while the figure of *intermedia*, which is 92 mm. in diameter, is 53 mm., only 3 mm. wider than the much smaller and younger specimen of *inflata*. Such differences of proportion do not occur in the same species of Ammonites.

Locality: North Africa.

Age: Base of Senonian.

Subtissotia intermedia (Peron).

Tissotia tissoti var. *intermedia* Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 12, figs. 4, 5.
Tissotia tissoti var. *lævigata* Peron, ibid., pl. 13, figs. 1, 2.

This form differs from *inflata* in having much less gibbous volutions at the same age and a more acute venter at all stages.

Locality: Northern Africa.

Age: Lower Senonian.

SUBTISSOTIA PERONI n. sp. Hyatt.

Buchiceras ewaldi Peron, 1890, Moll. Crét. de la Tunisie, pl. 15, figs. 1, 2 (no other).

Tissotia ewaldi Peron, 1897, Mém. Soc. géol. France, Paléontologie. Vol. VII, No. 17, p. 63.

This is based on a specimen from Tunis, of a diameter of 107 mm. It is figured by Peron as having an entire keel throughout, although the rounded tubercles on either side of the ventro-lateral angles have almost disappeared at a stage when in his *ewaldi* var. *africana* they would have become elongated and very coarse and the keel have been resolved into elongated tubercles. The venter is also entirely distinct in this species, in its sharper outline and more prominent keel. These features are also associated with peculiar sutures. The sutures of *Tissotia africana* have a long, well-defined ventral lobe, the sides of the first laterals being abrupt, whereas in this fossil there is a very short, ill-defined ventral lobe, with the sides of first lateral saddles denticulated and sloping. The first lateral saddles are deeply divided in *T. africana*, while in this the division is not so well marked. The resemblances in form and sutures between this and *T. lævigata* show that they are closely related.

Locality: North Africa.

Age: Base of Senonian.

SUBTISSOTIA AFRICANA (Peron).

Tissotia ewaldi var. *africana* Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 11, figs. 1–6.

At a diameter of 54 mm. the young figured by Peron is a very gibbous form, in which the broadest diameter of the last volution measures about 39 mm. The keel is continuous and prominent even on this cast, and there is a line of prominent tubercles on either side along the ventro-lateral angles. In the aged specimen, figured at diameter of 108 mm., these have become elongated, and the sides being less gibbous the venter is flatter, and on this volution the keel begins to disappear, becoming resolved into elongated nodes. There are no costæ figured on these casts. Peron considers this identical with *Tissotia robini*, as figured by Grossouvre, but *robini* is a costated compressed species with a continuous keel, even in extreme age, after the disappearance of the lines of tubercles, according to Grossouvre's figure. His *ewaldi* is similarly figured as a compressed shell, but not in extreme of age apparently. This species is evidently distinct from *T. ewaldi* figured by Peron in his Mollusques Crétacés de la Tunisie, which attains a large size, and at an advanced age still has an entire keel and rounded tubercles. The resemblance of the young of this species to the more mature stages of *Subtissotia inflata* and *intermedia* is apparent, if Grossouvre is correct in his assignment of the smaller casts figured to this species.

Locality: North Africa.

Age: Lower Senonian.

METATISSOTIA n. gen. Hyatt.

Following out the system adopted in these pages, it becomes obvious that species having the peculiar development of *Metatissotia fourneli* and *robini* can not be associated with either *Tissotia* or *Subtissotia.* The entire ontogeny, including the gerontic stage, of these highly compressed forms is distinct from *Tissotia* and *Subtissotia* on the one side and from the more accelerated development of *Paratissotia* on the other.

The typical ontogeny begins with a stage having a compressed smooth form and a continuous keel. In the next stage there is a more or less truncated venter having also a continuous keel, but with nodes at the termination of costæ that appear on the sides, and nodes also on the umbilical shoulders. In the gerontic stage, the costæ, keel, and channels finally disppear, leaving the sides smooth or ornamented only with large nodes, and the venter more or less angular.

Metatissotia fourneli (Bayle).

Buchiceras fourneli Bayle, 1878, Expl. de la Carte géol. France, Vol. IV, pl. 40, fig. 3 (not fig. 4).

Tissotia fourneli Peron, 1890, Moll. Crét. de la Tunisie, pl. 15, figs. 10–14.

Tissotia fourneli Peron, 1897, Mém. Soc. géol. France, Paléontologie. Vol. VII, No. 17, pl. 10.

The development has been determined by Peron in his Ammonites de l'Algérie, cited above. In the figures of his youngest specimen, which measures about 30 mm. in diameter, there are large dichotomous costæ with alternating short single costæ. In the oldest part of this specimen and in the stage represented by the next figure, the forks of the dichotomous costæ are becoming obsolete and being resolved into short costæ, so that there are two short nodose costæ between the larger ones. This is obviously, however, very irregular, since in the figured specimen, which has a diameter of 85 mm., there is still one dichotomous costation. It is obvious, too, that the costæ, being very heavy, become fold-like with age. The longer costæ have nodes on the outer ends along the ventro-lateral angles, and nodes along the umbilical shoulders, which persist throughout the ephebic stage and are present as very broad, low folds in the gerontic stage. According to Peron's description and figures, the short costæ disappear and are apparent only as simple nodes in large specimens.

This is a compressed form of this genus having an entire keel at an early stage, and a close ally of the European species *M. nodosa.* Peron has clearly shown that Bayle confounded two species under this name, but I doubt whether Bayle's *Tissotia fourneli*, figs. 4–5 of pl. 40, is identical with *ewaldi.*

Locality: North Africa.

Age: Base of Senonian.

Metatissotia robini (Thiollière).

Ammonites robini Thiollière, 1848, Ann. Soc. d'Agriculture de Lyon, Vol. XI, pl 1.

Buchiceras ewaldi Fallot, 1885, Ann. sci. géol., Vol. XVIII, pl. 3, figs. 1, 2.?

Ammonites cfr. *ewaldi* Redtenbacher, 1873, Abhandl. K.-k. geol. Reichsanstalt, Vol. V, pl. 22, figs. 5 a–i.

Tissotia robini Grossouvre, 1893, Ammonites Craie supérieure, pl. 4, fig. 1 (not fig. 2 b).

Tissotia ewaldi (pars) Grossouvre, ibid., pl. 9, fig. 5.

This shell has a compressed form, and the adult figured by Grossouvre at a diameter of about 50 mm. has a truncated venter with prominent elongated tubercles on the ventro-lateral angles and a prominent continuous keel. At the end of this volution, or say at a diameter of 55 mm., according to Grossouvre's figures, these tubercles begin to disappear, and at a diameter of 80 mm. they are absent, and the venter has consequently lost its truncated aspect and become subacute. This agrees also with Redtenbacher's figure of a specimen which is 83 mm. in diameter, and in which the old-age characteristics are similar. Grossouvre's fig. 2, also named *robini*, is apparently a distinct species. It has the subacute venter of the oldest gerontic substage of true *robini* when only 59 mm. in diameter, and this begins when the shell was about 40 mm. in diameter or earlier, according to this figure. This whole volution is also covered by dichotomous costæ having only very faint tubercles. This might be a dwarf of this species, but is apparently not a young specimen. Redtenbacher's figures (except perhaps 5, f and h) all appear to belong to this species, and fig. 5f may have been a worn specimen or a dwarf. At any rate, the latter has a suture with the first lateral saddles looking remarkably like an immature stage of those characteristic of *robini*. Grossouvre thinks this is the true *ewaldi* of Buch, but on the contrary it seems to me more likely that part of his *ewaldi* as given above belongs to *robini*. The peculiar ventral trend of the outer divisions of the first lateral saddles occurs apparently only in this species. Redtenbacher's figures are of value in that they give information with regard to the young, showing that at a diameter of about 18 mm. the keel is prominent and continuous, as it is in later stages, the costæ are well developed and dichotomous and have two rows of tubercles, one on each umbilical shoulder and a row on either side of the keel. It is also to be noted that the venter of this young specimen is more acute and the whole form more compressed than in the more mature stages.

Locality: France and Austria.

Age: Senonian.

Metatissotia nodosa n. sp. Hyatt.

Tissotia haplophylla (pars) Grossouvre, 1893, Ammonites Craie supérieure, pl. 4, figs. 3. 4 (not fig. 5).

The two specimens figured by Grossouvre have large nodes on the umbilical shoulders like those of *haplophylla*, but the costæ are well developed at an age when these are absent in true *haplophylla*, as shown in Redtenbacher's figure. The keel at the same stage is entire, whereas in *haplophylla* there is a row of tubercles.

Locality: France.

Age: Coniacian.

Metatissotia haplophylla (Redtenbacher).

Ammonites haplophylla Redtenbacher, 1873, Abhandl. K.-k. geol. Reichsanstalt, Vol. V, pl. 23.
Tissotia haplophylla (pars) Grossouvre, 1893, Ammonites Craie supérieure, pl. 4, fig. 5 (not figs. 3, 4).

This form is compressed, but has heavy fold-like costæ and very stout nodes on the umbilical shoulder and ventro-lateral angles, the venter being similar to that of *M. fourneli*, but with a line of nodes instead of a continuous keel. The French fossil quoted above may possibly be the same, but it has quite a distinct aspect, and the supposition of Grossouvre that the sutures will prove to be similar when those of the Austrian specimen are better known, is not sustained by the collateral evidence. Grossouvre's figs. 3 and 4 of the supposed neanic stage of his *haplophylla* are certainly quite distinct, having an entire keel and aspect allied closely to *Metatissotia fourneli* and *robini* and here treated as distinct under the name of *Meta. nodosa.*

Locality: Austria.

Age: Senonian.

Metatissotia ewaldi (von Buch).

Ammonites ewaldi von Buch, Abhandl. K. Akad. Wiss. zu Berlin, 1848, pl. 6, figs. 6, 7.
Tissotia ewaldi (pars) Grossouvre, 1893, Ammonites Craie supérieure, pl. 4, fig. 6 (not pl. 9, fig. 5).

This species is very similar to *Meta. robini*, but, so far as known by the figures of Grossouvre and others, these two species appear to be distinct in their sutures. Both species have the first lateral saddles deeply divided and the outer arms of these are shorter than the inner ones, but the outlines of these outer arms in this species are rounded, phylliform, undivided, and straight or parallel with the keel. In *robini* these outer arms are inclined toward the keel and the outlines are subdivided by marginal lobes in mature specimens.

Locality: France.

Age: Senonian.

Metatissotia auressensis (Peron).

Tissotia auressensis Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 13, figs. 4, 5.

This is a cast of what is apparently an old shell. The form is not unlike that of *Paratissotia grossouvrei*, with a similar large umbilicus, and it might be considered as perhaps the gerontic stage of this species, but the sutures are so distinct that this supposition is not tenable. These have extraordinarily large and long phylliform saddles, and the first lateral saddle has a conspicuously trifid base.

Locality: North Africa.

Age: Senonian.

Metatissotia slizewiczi (Fallot).

Buchiceras slizewiczi Fallot, 1885, Ann. sci. géol., Vol. XVIII, p. 240, pl. 2, fig. 2.
Tissotia slizewiczi Grossouvre, 1893, Ammonites Craie supérieure, p. 46, fig. 25; pl. 7, fig. 2.

This species, if correctly given by Grossouvre, has a young form which at a diameter of 41 mm. has a truncated venter, continuous keel, a line of small tubercles along each ventro-lateral angle beginning on the last volution at about this size, and also a line of nodes on the umbilical shoulders. The form at this stage is like that of *Tissotia* cf. *fourneli* Peron. The sutures are also similar in having trifid first lateral saddles and other saddles and lobes long and large. The three marginal saddles and lobes are much more completely developed, longer, and the first lateral saddles broader in consequence of this differentiation of the outlines. The nodes on both lines are much larger in the large shell figured and the keel persists. The umbilicus is also of good size, as in the species of Peron referred to above. Peron considers all of these forms to have occurred in the Senonian, and his evidence is very strong on this point.

Locality: France.

Age: Coniacian, base of Senonian.

PARATISSOTIA n. gen. Hyatt.

Highly compressed smooth forms like the type of this genus, *P. regularis* and *ficheuri*, omit the characteristic nodose stages and more or less obtuse or flattened keeled venters of *Metatissotia* or else pass through them at an early stage, becoming later highly acute and smooth or at least without prominent nodes in their mature stages. In the two species examined they never have channeled venters at any stage. The discovery of a hollow keel in the later stages of *P. regularis* would have caused me to separate that species from the other species referred to this group had their development been different and the structure of their keels also known.

Paratissotia grossouvrei (Peron).

Tissotia grossouvrei Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 16, figs. 1, 2.

This is similar in aspect to *P. ficheuri*, but is less involute, the umbilicus being much larger and the sutures distinct. The first lateral saddles have denticulated outlines instead of the smooth, phylliform arms of *P. ficheuri*. The young have not been examined, but the adult appears to belong to this genus.

Locality: North Africa.

Age: Lower Senonian.

Paratissotia ? thomasi (Peron).

Tissotia thomasi Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 13, fig. 3 (not pl. 16, figs. 5, 6).

The type of this form is a compressed shell with very involute whorls and the zone around the umbilicus depressed and flattened. The venter, at least in advanced age, has a simple, not very prominent keel, unaccompanied by tubercles of any kind and sides almost smooth.

The form is not sufficiently well known to be placed here without a query after the generic name.

Locality: North Africa.

Age: Base of Senonian.

Paratissotia ficheuri (Grossouvre).

Tissotia ficheuri Grossouvre. 1893, Ammonites Craie supérieure, p. 35, fig. 17.
Tissotia ficheuri Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 12, figs. 1, 2; pl. 18, fig. 2.
Buchiceras ewaldi (pars) Peron, 1890, Moll. Crét. de la Tunisie, pl. 15, figs. 3–6.
Buchiceras fourneli (pars) Bayle, 1878, Expl. de la Carte géol. France, Vol. IV, pl. 40, figs. 2 and 4 (not fig. 3).

This is a very much compressed shell, with no channels on either side and no tubercles on the costæ, which are simple and very slightly developed. The keel is prominent and acute, and the umbilicus is very small. The costæ are shown by Peron in the side views of a young specimen having a diameter of 55 mm. and in a very old shell with diameter exceeding 115 mm. In both the costæ are linear and straight, with only the outer half developed. A description of this last specimen, which is evidently very old, would have been of much interest, but it is not given. The very broad, low denticulated saddle occupying the extremity of the ventral lobe and the deeply divided denticulated first lateral saddles of this species, of which the outer one is bifid and the inner has a broad, phylliform base, are very peculiar, as are also the costæ. The very globose fossil figured on pl. 15, fig. 8, by Peron in his Mollusques Crétacés de la Tunisie as part of his *Buchiceras ewaldi* is undoubtedly a distinct species, but the information given is too limited to enable one to refer it to any known species. The reference of part of *B. fourneli* Bayle to this species is given on the authority of Grossouvre. Bayle's figures are handsome, but not very instructive.

Locality: North Africa.

Age: Base of Senonian.

Paratissotia serrata (Hyatt).

Pl. II, figs. 7–11.

Buchiceras serratum (pars) Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 370.

This is a fragmentary cast of more than one-half of an entire coil, without living chamber. The diameter without the shell is 37 mm. The outer volution measures 20 mm. at larger end, the umbilicus 4 mm., and opposite side of outer volution from line of involution to venter is 17 mm. The shell reduces the diameter of the umbilicus to 3 mm.

The cast of the outer volution is perfect only on one side. This is planoconvex and covered with regularly arranged costæ, of which there are eight to half of a volution on the inner part of the whorl. The costæ broaden and flatten outwardly, becoming sigmoidal in curvature and then bifurcate, the branches bending well forward and rising into elongated swellings on the cast. These are about 3 mm. from the outer edge of the keel, and there are very slight obsolescent ridges beyond them, which, however, do not cross the smooth bands on either side of the keel.

The venter on the first part of the outer volution, the third quarter, is subacute, but on the last quarter it is beginning to be rounded, the keel having disappeared. This shows that the shell was in the gerontic stage, and the approximation of the last two sutures also indicates the same stage. There is also the trace of a line, probably a line of involution, impressed upon this part of the outer volution, showing that the living chamber must have decreased very rapidly in the amount of involution, since it did not cover quite half of the sides on the third quarter and part of the fourth quarter of the now exposed volution. The length of the absent living chamber could not be determined, but that it was much rounded and depressed on the venter and in an extreme stage of gerontic degeneration is highly probable. The sutures are more like those of *Paratissotia fourneli*, as figured by Grossouvre in his Ammonites de la Craie supérieure. The ventral lobe is, however, very short, broad, and opens widely, with two small, short, entire arms. The siphonal saddle is broad, prominent, and entire, with a hardly perceptible median marginal lobe or depression, which seems inclined to disappear in the gerontic stage. The first lateral saddle is large, as in other species of this group. On the third quarter of the exposed volution it is plainly only one bifid saddle, but on the fourth quarter the dividing marginal is deeper, and there appear to be two distinct saddles, as in P. *djelfensis*. The outer arm of the saddle shows a hardly perceptible median marginal, as in P. *fourneli*. There are five other lateral saddles, all entire, and, like the first lateral, very short and extremely broad like those of P. *ficheuri*, as figured by Grossouvre.

The first lateral lobe is broad at the end and denticulated exactly as in *Tissotia tissoti* and *Metatissotia ewaldi* as figured by Douvillé, but it is very short and broad. The second laterals are smaller and also denticulated.

The remaining lateral lobes are like those of the same species, but very much narrower, and the second to the fifth hardly more than mere indentations.

The dorsal sutures were seen only from above. The antisiphonal lobe was obviously very narrow at the base, but its length could not be determined. There are seven pairs of entire zygous dorsal lobes and saddles, the latter much narrower than the external laterals. The first and second lateral saddles are connected across the septum by broad ridges, so that the septum observed was convex externally and internally along the mesal plane, but concave along the center. The saddles on the dorsum and the corresponding external saddles were connected only by very slight ridges, and the intermediate surface of the septum was convex.

The figures of sections show the broad globose, keelless form of the nepionic stages and perhaps of the earliest of the neanic stages. The siphuncle is certainly very small and the keel is solid when it first appears, as shown in figure. The disappearance of the siphuncle left me in doubt with reference to its structure in later stages.

Locality: Cachiyacu, west side of Huallagua River, Peru.

Age: Upper Cretaceous, probably Senonian.

Paratissotia regularis n. sp. Hyatt.

Pl. III., figs. 1–6.

Buchiceras serratum Hyatt (pars), 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 370.

This species has a broad volution with a rounded venter until the shell reaches a diameter of 6 mm. A broad, low keel next makes its appearance and the next volution becomes helmet-shaped in section. There is certainly one line of nodes on the umbilical shoulders at this time, and the umbilical zone is broad and at an angle of about 45° with the line of involution. This helmet-shaped section, with more or less gibbous sides, is retained through life, but becomes more compressed; the keel becomes subacute and prominent, and slight concave zones appear on either side of it. An outer line of tubercles appears on the edges of the elevated venter, and both lines increase steadily in size. The umbilical zone becomes rounded and is in the first ephebic substage at right angles to the plane of coiling. The two lines of tubercles are connected in the ephebic stage, and possibly earlier, by faint costæ, which bend forward onto the venter but do not cross the keel. These were observed on the cast alone, no shell being present on the parts observed.

The young were seen only in section, and the nepionic stage was completely destroyed, so that the earliest part actually seen was probably in the ananeanic stage. The sutures were developed on the ephebic volution, and there is no close similarity to those of any described species of this genus. They have a siphonal saddle, and first lateral saddles on both sides more like those of *Hemitissotia djelfensis* Peron than any other. The inner arm of this saddle is, however, bifurcated instead of being entire, and the outer arm is trifurcate instead of being bifurcate as in that species. The siphonal saddle has an inner rounded marginal like that so common in *Sphenodiscus.* There are five pairs of entire saddles on the sides, inside of the first pair. The lobes more than the saddles are like those of Peron's species, but they are more symmetrical in outline and longer and narrower in proportion. It is interesting, however, to note that its nearest affine in form is also an African species, *Paratissotia grossouvrei* of Peron. This is close enough in external aspect to have been considered identical but for the sutures, which are quite different. Peron's form also appears to have had a solid keel. The surfaces of the septa and the dorsal sutures differ from those of *Paratissotia serrata* in that there are only four broad zygous saddles and lobes on the dorsum, and the saddles are directly connected with the external saddles by broad ridges that flex the floor of the septa correspondingly. The internal wings of the septa are also straight. The antisiphonal lobe, so far as seen, seems to be much broader than in that species.

The young must have been similar to that of *Paratissotia serrata* in form, and keelless until the neanic stage was reached. The keel was at first solid and then became hollow.

Locality: Cachiyacu, Peru.

Age: Upper Cretaceous, probably Senonian.

Incertae sedis.

Tissotia cossoni Peron.

Tissotia cossoni Peron, 1890, Moll. Crét. de la Tunisie, pl. 16, figs. 1, 2.

This is a large fossil, 248 mm. in diameter, with acute venter exactly similar to *Sphenodiscus* in aspect and evidently extremely aged, as shown by the overlapping of the last sutures. These have low, broad, entire saddles and broad lobes, very different from any observed in that genus. The younger sutures resemble those of *Tissotia* more nearly than those of *Sphenodiscus*, the saddles being phylliform and entire. The ventral lobes as figured are quite different from those of any described species, so far as I know. How much of these peculiarities can be attributed to the metamorphoses of age remains unknown, but these ventral lobes have apparently no siphonal saddles except a minute point that seems to be becoming obsolete. Unluckily this important point is not mentioned in the description.

Locality: Bir Oum-el-Djof.

Age: Campanian.

Tissotia globosa n. sp. Hyatt.

Tissotia thomasi Peron (pars), 1890, Moll. Crét. de la Tunisie, pl. 16, figs. 5, 6 (not pl. 13, fig. 3).

This fossil, figured on pl. 16 by Peron, has a globose form with distinct proportions from the type of *thomasi*, and the umbilical shoulders are quite prominent. The sutures also are distinct according to the figure given. The aspect indicates affinity with *Metatissotia* rather than *Paratissotia*.

Locality: North Africa.

Age: Senonian.

HETEROTISSOTIA Peron.

If the type of this genus had been abraded so as to round off the venter, its sutures would have placed it near *Tissotia*, if not in the same genus. Nevertheless the flattened venter with keel, and the bifurcated, fold-like costæ ending in slight tubercles on the edges of the smooth ventral zone and gathered into a few large nodes on the prominent umbilical shoulders are similar to those of several species usually included in *Pulchellia*. The affinities of this fossil appear to be indeterminable without some knowledge of the young.

Heterotissotia neoceratites Peron.

Heterotissotia neoceratites Peron, 1897, Mém. Soc. géol. France, Paléontologie, Vol. VII, No. 17, pl. 16, figs. 9, 10.

Sufficiently described above, except that it is an involute compressed form with flat lateral zones and small but not very small umbilicus. The involution covers up entirely the sides of the last volution, but it is obvious that until a late stage preceding this, it is not so complete, leaving a large and more open umbilicus in the young.

Locality: North Africa.

Age: Senonian.

SPHENODISCIDÆ.

This is a provisional group to include genera having three principal lateral lobes and saddles and numerous auxiliary lobes and saddles which are more distinctly phylliform than is usual in the Tissotidæ, also having keeled venters.

There are three genera: *Indoceras*, *Libycoceras*, and *Sphenodiscus*. The development of the first and second genera, and whether they have a solid keel, is not known, but the third has an acute venter from an early stage and has also a solid keel. Nearly all specimens having hollow keels exhibit a truncated aspect on the venter of their internal casts which is not shown in any figures of *Indoceras* and *Libycoceras*

INDOCERAS Noetling.

Indoceras has been placed in the Sphenodiscidæ near to *Libycoceras* because of the external characteristics of the later stages of the type species described below, and because the sutures in both the species described by Noetling have resemblances to those of *Sphenodiscus*. As in many other published forms, there is no description of the earlier stages, and the dorsal sutures, which would also greatly assist in drawing correct inferences, are still unknown. The essential distinction between this and *Sphenodiscus* lies wholly in the fact that the saddles are entire in this genus instead of being divided or denticulated as in the former.

Indoceras baluchistanense Noetling.

Indoceras baluchistanensis Noetling, 1897, Pal. Indica, Series XVI, Vol. 1, pt. 3, pl. 21, fig. 2; pl. 22, figs. 1–3.

According to Noetling's figures and descriptions, this interesting species at a diameter of about 40 mm. has elongated forward-bent ridges on the outer part of the volution that are obviously the remnants of sigmoidal costæ. The venter at this stage is somewhat obtuse, but tending toward being subacute, with a keel bordered by smooth zones and obscure ridges on either side In later stages the venter becomes planoconvex, the keel and lateral ridges having disappeared. These characteristics are very similar to those of *Sphenodiscus pleurisepta.* The sutures have entire phylliform saddles that resemble those of *Sphenodiscus* more than those of Tissotidæ. The first lateral saddles are described by Noetling as being bifid in this species, and as becoming split up into separate saddles during development. There appear to be three principal lateral saddles in the fullgrown.

Locality: Mazar Drik.

Age: Upper Senonian.

INDOCERAS ACUTODORSATUM (Noetling).

Sphenodiscus acutodorsatus Noetling, 1897, Pal. Indica, Series XVI, Vol. I, pt. 3, pl. 21, fig. 3.

This shell has the usual acute volutions of *Sphenodiscus*, but the sutures have the entire saddles of *Indoceras.* In fact the only distinction appears to be that the first pair of saddles are not yet completely separated, but appear to be branches of a first lateral. It might be said, therefore, that this species had only two principal lateral saddles, the first and second, the first being deeply bifid. If we reckon the sutures as having three entire principal lateral saddles, two of which are not yet fully separated, the species passes into *Indoceras.*

LIBYCOCERAS Hyatt.[a]

This genus is founded upon a single species, which has, however, such a peculiar combination of characters that it can not be incorporated with other genera. Zittel recognizes the affinity of this form to *Sphenodiscus* and describes it as having three principal lateral saddles. The sutures have phylliform entire saddles and simply digitated lobes, and resemble those of the young of *S. lenticularis* after they have passed through the stage in which both saddles and lobes are entire. The median lateral line of tubercles and broad costæ connecting these with an outer line of nodes along the edge of the venter and distinct keel are, however, quite different from the tubercles and costæ and solid acute venter of *Sphenodiscus*, which has distinct sutures, and also different from *Indoceras*, which has similar sutures.

[a] *Λίβυκος*, Libyan.

Libycoceras ismaele (Zittel).

Sphenodiscus ismaelis Zittel, Handb. der Palæontologie, Vol. II, p. 451, fig. 631.
Libycoceras ismaeli Hyatt, 1900, Zittel's Text-book of Palaeontology, Vol. I, p. 585.

According to Zittel this has three principal lobes and saddles.

Locality: Libyan Desert.

Age: Upper Senonian.

SPHENODISCUS Meek.

This genus is apparently a close ally of *Engonoceras*, judging by its sutures and external characters, but the development shows it to be very distinct. In two species, *pleurisepta* and *lenticularis*, the young were examined, and in these there were no indications of a stage having a flat or concave venter. In the nepionic stage the species is rounded on the venter which in the neanic changes directly to a form with an acute venter and flattened side like that of the adult. There are three principal lateral saddles derived from the division of the primitive first lateral saddle.

The earliest stage described in *S. lenticularis* exhibits sutures like those of the adult of *Neolobites*, but they are also very similar to those of some species of *Engonoceras* having longer, narrower, and more phylliform saddles than usual, like *Engonoceras subjectum*. There is, however, in *Engonoceras* and in *Neolobites* also a very distinct persistent first lateral. These peculiarities in development of the sutures, as well as the acute venter, heighten the resemblances to the shell figured by Zittel as *S. ismaelis*. This is generically distinct and here described as *Libycoceras*, but *Sphenodiscus* might be a modified form of the same series in which the keel had become incorporated with the venter and with more complex sutures, whereas its development does not indicate descent from any of the genera having flat and tuberculated venters. The external characters of this genus are often so uniform that the sutures as a rule are the only means of distinguishing the species. The exceptions to this rule are to be found in the American forms *S. pleurisepta*, and perhaps *acutum*, and the European representative of the former, *S. binckhorsti*, which have lines of tubercles and faint costæ. The keel is solid, and the siphuncle being placed well within the sutures of the siphonal saddles, is protected by a ridge of the stony filling of the cameræ and is not, therefore, easily laid bare when the shell is removed from casts.

SPHENODISCUS PLEURISEPTA (Conrad).

Pl. III, figs. 7–15; Pl. IV; Pl. V, figs. 1–3; Pl. VI, fig. 6.

Ammonites pleurisepta Conrad, 1857, U. S. and Mex. Bound. Surv., Vol. 1, Pt. II, p. 159, pl. 15, figs. 1, a, b, c.
Ammonites pedernalis Binckhorst, 1873, Mon. Gast. et Céph. du Limbourg, p. 21, Pl. V a[1], fig. 1 (no others).
Sphenodiscus pleurisepta Böhm, 1898, Zeitschr. Deutsch. geol. Gesell, Vol. L, pl. 7.

Conrad's original specimens, preserved in the United States National Museum, show how erroneous and misleading are his descriptions and figures. The original of his figure has two distinct rows of lateral tubercles. Another specimen, 117 mm. in diameter, is the one cited as collected by Schott, "Yellow Stone." This has the same characteristics, but is in the gerontic stage, and the outer row of tubercles disappears on the last quarter of the outer volution. The condition of the specimen, however, made this somewhat doubtful.

A number of fine specimens were collected by Stanton and Vaughan near Eagle Pass, Tex. All of these have two rows of nodes on the sides, and one is a noble specimen 182 mm. in diameter (Pl. IV, fig. 1–2). What appears to be the abraded edge of the aperture is present on one side, and the living chamber is somewhat over one-half of a volution in length. The inner row of nodes is present, but the outer row is replaced on the last volution in the gerontic stage by broad arcuate folds. These are visible throughout the volution on the side opposite to the one figured. The venter broadens and becomes less acute on the third quarter of the outer volution and is rounded on the last quarter. It is obvious from this that the specimens described below were in some cases dwarfs, the range being considerable.

The interesting fact in this large specimen is that the lobes and saddles vary but slightly from those of smaller fossils. The three principal saddles and the lobes are longer; there may be one or two saddles more, making the total number fourteen, concealed under the shell of the umbilical zone; and the marginals are more numerous, but otherwise the sutures are just about the same as at younger stages. There are only five divided saddles, the first to the fifth, as in younger stages, and the remainder are entire. Another fact is that the amount of involution decreases so slightly, even in this large specimen, that it is hardly perceptible. There is, however, a broader umbilical zone in the paragerontic substage and a decided umbilical shoulder.

A small cast of this species, No. 19145b, U. S. National Museum (Pl. III, fig. 14), only 59 mm. in diameter, shows the ephebic stage. The diameter of last volution from line of involution to venter on cast is 32 mm., the same diameter on opposite part of volution is 22 mm., the umbilicus being 5 mm. without the shell. The fragments of the shell are not specially thick except on the crest of the venter, where it forms a solid keel, and in the umbilicus, where it is over a millimeter in thickness.

This cast is somewhat compressed, but judging from an accompanying older specimen it is a medium stout volution with, however, a very acute venter. There are two lines of distinct, transversely elongated, radiating nodes, about 8 mm. apart, the outer line occupying the centran surface, about 7 mm. from the venter. The inner line gradually increases its distance from the umbilical shoulder, but on the first part of the outer volution begins to be farther removed from the dorsum than the outer row is from the venter. The venter is blunted on the last part of the exposed volution and the parephebic substage had probably already begun in this specimen.

The ventral saddle is that of *Sphenodiscus*, with similar marginal saddles at the inner corners, but the aspect of the lobes and saddles is like those of older specimens, except that they are shorter and the sutures do not overlap anywhere, and do not even approach one another until near the umbilical shoulders. The lobes all have flaring tops and the saddles phylliform and rather broad bases, flattening out, however, as usual near the umbilical shoulders. Nevertheless, on the umbilical zone they are again slender and phylliform.

The first lateral saddles are trifid, narrow at the openings, with a few phylliform saddles; the second and third are bifid a trifle longer, but of nearly the same form; the third becomes trifid on the oldest part of this volution; the fourth is trifid and then becomes quadrifid. These form a bent outline, each being a little longer than its neighbor, beginning with the first lateral. The fifth is bifid and from thence to the umbilicus there is the usual row of entire saddles gradually shortening up and showing more and more primitive forms; but they become narrower again on the umbilical zone.

The branches of the ventral lobe are trifid and spreading as usual, but small, of course, in such a suture; the first laterals are shorter and broader and together with the longer second and third laterals form the usual arch. The fourth lateral is about half the length of the third and from this to the umbilicus there is the usual diminishing row. The type is bifid except the first and fourth laterals; these were uncertain. All are divided except, perhaps, the last and umbilical lobes; these were not seen.

There are twelve saddles and twelve lobes visible, and there may be a saddle on the line of involution on the left side; the sutures of the right side were not seen.

The older specimen of this species (Pl. III, fig. 13) is a cast from same locality and is very instructive. It is 90 mm. in diameter and the form is better preserved, not having been injured by pressure. The oldest part is 47 mm. in diameter, the umbilicus without the shell is about 8 mm., and the volution opposite is 35 mm. measuring from line of involution to venter. The greatest transverse diameter is carried farther out than the centran surface at this age and is 21 mm. between the tubercles, the greatest diameter opposite between tubercles and about centran of the lateral zones is 16 mm. No shell is present in any of these measurements.

The shell is excessively thick on the umbilical zones and is nearly a millimeter thick on the sides in the parephebic substage; it is considerably thicker on the venter, where it forms a solid keel. There are two lines of tubercles as in the smaller specimen, the age of the first part of this volution being the same as the age of the last part of exposed volution in the younger specimen, but the nodes are rounder or hardly perceptibly elongated. The inner line of nodes persists and retains its distance from the umbilicus, but the nodes are slightly nearer to the venter on the last part because of the gerontic decrease in the rate of growth of the dorsoventral diameter. The outer tubercles gradually decrease and disappear, but the fold-like short costæ between the tubercles persist. These costæ may have a bifurcated aspect when slightly better developed than in these specimens. The outer part of the whorl is decidedly convex, while the surface between the inner line and the umbilical shoulder is decidedly concave and the umbilical zone narrow and abrupt.

The earliest part of this volution has the venter bluntly acute, showing it to be in the parephebic substage, while on the second quarter the rounding of the venter and loss of tubercles shows anagerontic substage.

On the third quarter folds take the place of tubercles of outer row, and on the fourth quarter the venter becomes gradually rounded. This shifts the greatest transverse diameter from the central parts of the sides to nearer the venter. There is also a very slight decrease in the amount of involution internally.

The living chamber is only in part preserved. The younger sutures are like those of the same age in the smaller specimen, but are a trifle more complex in outline and the ventral lobe seemed to be shorter. This last, however, could not be made out clearly anywhere. The general character of the sutures is the same as in the younger specimen, so far as all of the remaining lobes and saddles are concerned, and there are five divided saddles. The first and second lateral saddles are probably bifid, in the young becoming trifid later and perhaps bifid again in extreme age.[a] The third is trifid, becoming quadrifid later. The fourth is trifid throughout. The remainder are same as in younger specimen. Lobes appear to be about the same as in that specimen. The last two sutures are so close together that they overlap more or less throughout, and the third suture approaches nearer to the second than in younger parts of this volution. This specimen had, therefore, in all its characters probably completed its cycle of development and was in the paragerontic substage. There are constantly five divided saddles on both sides of specimens of this species so far as seen by me.

A perfect cast (Pl. III, figs. 7–12), labeled Rio Pecos,[b] in collection of Columbia University, is 60 mm. in diameter. The outer volution measures 32 mm., transverse diameter is 13 mm., the umbilicus 3.5 mm., the opposite 24.5 mm., and the transverse diameter between tubercles of inner row 9 mm. The outer volution has already begun to show a blunted or rounded venter, and the two rows of elongated nodes are more distinct than in other specimens described. These also begin to become rounded on the last part of the outer volution. This is as much altered in the form of the volution (i. e., venter is as blunt) at this size as a second specimen from same locality (Pl. III, fig. 1 (suture), and Pl. V, fig. 3) at diameter of 86 mm

[a] The condition of the sutures of the paragerontic stage made this observation somewhat doubtful, because when slightly worn away the saddles lose their secondary divisions and become bifid, the central marginal lobe being always more persistent on account of its greater penetration into the interior than the more recently acquired marginal lobes on either side of it.

[b] See Mr. Stanton's note, p. 65.

The first specimen is the only one with perfect young that I have seen, and is, therefore, a very instructive example (Pl. III, figs. 9–12). In ananepionic stage the innermost volution next to the large protoconch is rounded and followed by a volution still in the nepionic stage. This acquires an elevated venter and becomes more compressed and helmet shaped, but has nowhere a flattened or concave venter. The sutures were simpler than those of later age. The sutures on both sides had five divided saddles. The first lateral saddles were bifid on both sides, the second just beginning to be quadrifid, the third and fourth symmetrically trifid, and the fifth only bifid on the right: whereas on the left side the second to the fifth, like the first, were all bifid. The volutions in section were similar in outline to the adult, having the same highly involute and almost pear-shaped section and acute venters. Neither of these specimens showed the living chamber.

One specimen (Loc. 582, U. S. Geol. Survey, Pl. V, figs. 1, 2), when compared with more typical forms, shows, in what is probably the metephebic substage, the outer fold-like costæ as in the gerontic stage of others. The diameter of the cast, without the shell, is about 118 mm., partly estimated. The last of the outer volution measures 60.5 mm., the umbilicus, 8 mm., and the opposite volution from line of involution to venter measures about 49.5 mm.

The acuteness of the venter decreases on last part of this volution, but does not become blunted and rounded as it does at the corresponding size in the typical form.

The sutures of the last five septa show gradual approximation, and in the closer approach of the last two there are indications that the specimen was beginning its gerontic stage. The living chamber was broken away, but the marks of the umbilical parts showed that this had extended at least one-fourth of a volution farther on the sides. The inner line of tubercles was becoming wider apart, and together with the venter and sutures, also indicated that the gerontic stage was begun or was about to begin, and had been perhaps nearly completed in the now absent living chamber. The sutures, it will be understood, always represent a later stage than the parts of the shell on the inner surface of which they are found. The sutures have short phylliform saddles and broad lobes, and are well separated from each other and approximate only near the umbilical shoulders. They were more perfect on the side opposite to the one figured. The first lateral saddles are trifid, the second, third, fourth, and fifth are bifid and phylliform; the remainder are similar to those of the inner columns of others of this species, but are perhaps somewhat simpler in outlines. The exact number was not ascertained. On a fragment of what appeared to be the same species from the same locality, there were thirteen saddles at a diameter of 60 mm. from line of involution to venter. This was a cast, and slightly abraded on the venter. The ventral saddles were much worn and the first lateral saddles were entire, except for a faint median marginal in two sutures. The remaining lobes and saddles exactly agreed with those of the ephebic stage of the first specimen described, except in being a trifle longer. There were five divided saddles, as in other specimens.

One of the figures of *Amm. pedernalis* given by Binckhorst in the monograph quoted above was taken from a Texas specimen supposed to be identical with von Buch's species. The specimen was in the Museum of Stuttgart, and was said to have come from Rio Bravo del Norte, Texas, and to have been collected by Schott. This figure is identical with the larger varieties of this species which retain the acute venter until a late stage of development. This same specimen was refigured by Böhm, as above quoted, and properly named by him. Except in being somewhat older and large, it is identical with the fossil figured on Pl. III, fig. 15 (septum), and Pl. V, fig. 3. The first lateral saddles are, however, bifid, the second trifid, the third to fifth bifid, whereas all the saddles in sutures on Pl. III are bifid, and this holds in all the sutures on this volution in this fossil. Even in the close approximation of the sutures this is similar to Böhm's figure and also in the way in which the inner line of nodes trend outward on the latter part of the volution.

A fragment in the collection of Frederick Braun, of Brooklyn, N. Y., is labeled as from rotten limestone grit, Brooksville, Noxubee County, Miss. The diameter of side is 55 mm. The inner line of nodes still remains somewhat elongated; the outer line is superseded by broad folds. The fine surface of this cast shows that the shell had sigmoidal, and sometimes dichotomous, costæ and ridges on the outer convex half of the volution, but that it was smooth and decidedly concave on the inner half. The first lateral saddles were trifid, then four bifid and nine entire. There were ten entire dorsal saddles at the same age, with lobes like those of the exposed sides. Unluckily the antisiphonal lobe was not exposed by excavation, and therefore it was not considered necessary to draw these curves. This species is very instructive, since its external characteristics are well marked and they show that the amount of involution, the general outlines of the lobes and saddles, and the number of divided saddles remain very constant, while the trifid or bifid outlines of the larger saddles are variable. These minor details of the saddles, and of the lobes also, depend on the relative growth of marginals and may vary at different stages of growth or on the opposite sides in some individuals or in different individuals. The number of septa may also greatly vary, thus in Böhm's and the fossil figured on Pls. III and V they are 5 mm. apart near the center; in Braun's they are 9 mm. distant at about the same age and the saddles are much longer.

Another specimen from the same collection is given on Pl. VI, fig. 6, and this although closely associated with *S. lobatus*, and apparently at first sight the young of that species, has all the external characters and the sutures of *pleurisepta*. The fossilization is in the peculiar yellow limestone, with iron incrustations of the specimens of *lobatus* from the same locality. It is of course possible that this specimen may be the young of *lobatus*, which I have never seen of as small size, but in any case it is identical with *pleurisepta* of the same age, which has an acute venter on the outer volution and sutures like those of Pl. III, fig. 15. There are five bifid saddles on the right side at the point where that side is about 30 mm. broad, and on the left side, where 20 mm. broad, the fifth saddle shows the faintest possible beginning of a median marginal division.

Locality: Near Laredo, Rio Pecos, and near Eagle Pass, Tex.; Brooksville, Noxubee County, Miss.[a]

Age: Eagle Pass beds, Upper Cretaceous.

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[a] The following note was contributed by Mr. Stanton:

"It is pretty well established that Conrad's specimens were not collected near Laredo. It is probable that they came from the neighborhood of Eagle Pass, where the species is abundant. It has been collected by Geological Survey parties from localities from 1½ to 18½ miles southeast of Eagle Pass.

"I doubt whether the species has been found on the Rio Pecos. There are certainly no beds that could have yielded it near the mouth of that stream."

Sphenodiscus lobatus (Tuomey).

Pl. VI, figs. 1, 2; Pl. VII, figs 1, 2; Pl. IX, figs. 11–13.

Ammonites lobata Tuomey, 1856, Proc. Acad. Nat. Sci. Philadelphia, Vol. VII, p. 168.

The description given by Tuomey of his *Amm. lobata* may of course apply to another species, but this is the only one I have seen to which the following words could have applied, and it comes from the same State although from another county: "Shell discoidal, smooth, thin toward the circumference;" "dorsal (ventral) lobe finely serrate." These words and his reference to the large bilobed saddles as characteristic seems to make this name applicable to this species, which is so widely different from *Sphenodiscus lenticularis* and its nearest affines that no discussion is necessary.

A fine specimen (Pl. VI, figs. **1**, 2) in Coll. Nat. Museum, labeled *S. lenticularis*, No. 20577, from Ripley group, Lander's mill, Tippah County, Miss., is **111** mm. in diameter. The last volution at what appears to be the aperture measures 59 mm. and the volution immediately opposite in same diameter from line of involution to venter is 46 mm. The greatest transverse diameter is about the middle of the lateral zone and is 21.5 mm. and for the smaller part of the volution **15.5** mm. The cast is naked except a fragment that shows that it did not have a very thick shell. The inner volutions are not entirely covered and the umbilicus is larger proportionally than in the large specimen, supposed to be the adult of the same species, from Pontotoc County, Miss. There are obscure fold-like costæ indicated outside of the greatest transverse diameter, which is nearly central: internally the surface is slightly concave. There are no umbilical shoulders and no flat umbilical zone and the umbilical openings are shallow. The shell must have been very thick between the volutions and may have much contracted the opening of the umbilicus. There were twelve lobes and thirteen saddles on the oldest part of the volution. The flat siphonal saddle has a minute saddle in the center and a couple of inflections or marginal lobes on either side of this and then at the ends two small round saddles. The ventral lobe is very broad and the two arms also broad and obscurely trilobate, each lobe being subdivided by a minute saddle. The first, second, and third lobes are broad at top and have an unequal number of small short branches, as if they were derived from the trifid type. They are all probably, however, derived from a bifid type, unless exception may be made for the branches of the ventral lobe.

The remaining lobes have one large median saddle and an equal number of small lobes as if derived from the bifid type There is a series from a primitive bifid lobe, the eleventh, and only the twelfth lobe is single. On the right side the twelfth lobe is on the line of involution, whereas on the left side that line is occupied by a saddle. The lobes are very short and broad.

The first six saddles have broad phylliform bases and the first five are bifid on both sides, being equally divided by a small median lobe, the sixth is transitional and entire; the remaining saddles are of the same type but so short and broad that they appear to be flattened at the base, and in fact are approximations to that type.

The most remarkable fact about this cast is what appears to be the living chamber. The evidences of the existence of a perfect living chamber on this cast seem undeniable and there is every mark of an aperture with an entire reflected lip. And what is still more remarkable, the last four sutures on the left side are shortened as if absorbed by pressure after they had been built. The fourth has lost the three inner rows of lobes and saddles, the third has lost seven, and the eighth saddle is partly gone; the second has only four saddles left and faint traces of fifth lateral lobe and outer side of the saddle, and the basal septum is represented by hardly perceptible traces of first, second, and third lateral saddles, no ventral or any other lobes.

On the right side the pressure of the body has shortened up five of the sutures. The fifth has lost all the inner entire saddles and their lobes except one-half of the last outer one, the sixth row from the umbilicus and the seventh from the venter. The fourth has lost this remaining half and part of the next saddle, the third has not been absorbed quite so far and has the sixth saddle from the venter and part of the next inner lobe, the second has first four lobes and saddles, but only one-half of the suture of the fifth saddle The tracings of the sutures of the basal septum are slighter than on the other side and includes as on that side only the faintest possible traces of the bases of the first three saddles. The interval between the fifth suture on the right side, the last perfect one, and the apparent aperture on the line of involution is only 6 mm. The interval between the same and the half absorbed sixth saddle (from the venter) of the second suture is only 4 mm. The rostrum of the aperture is incomplete, but the distance from the last ventral siphonal saddle to the broken edge is 22 mm.[a] The almost obsolescent traces of sutures of the basal septum are only about 5 to 7 mm. from the edge of the aperture on the sides, and may have been about 26–30 mm. from the end of the completed rostrum on the venter.

The only explanation that I am able to suggest is that the animal lost the power to build shell after it had constructed this aperture, but still continued to live and build the sutures until finally the pressure of the base upon the last sutures put a stop to their construction near the lines of involution, but allowed it to go on with decreasing completeness externally. This obliges one to suppose that a futile attempt was made to construct the outer three saddles and lobes of the basal septum, and that the animal slipped back upon the second septum after failing to do this. There are no lines connecting the broken sutures with each other that I could detect. The reflected rim of the cast of the aperture near the umbilicus in some measure supports the opinion that the animal, failing in having a proper shell wall to the living chamber, spread out laterally and the reflected extensions of the aperture were built by the lateral parts of the body wall that bulged out on either side. In that case the animal might have had an abnormally thin-shelled living chamber which was destroyed after its death. The questions that such suggestions create are far more difficult than I can answer with merely a single cast in hand, and an entirely satisfactory solution must be relegated to future investigations.

A large cast (Pl. VII, figs. 1, 2; Pl. IX, fig. 13) in Coll. Nat. Museum, No 2403, from Pontotoc County, Miss., is somewhat over 265 mm. in diameter. The diameter of outer volution from line of involution to venter at the beginning of last quarter where venter was complete is 136 mm.; same diameter opposite this one-half of a volution distant is 92 mm.; smallest diameter 79 mm., one-quarter of a volution younger than the last.

The transverse diameter through the center of sides corresponding to first diameter is 57 mm. and for second 39 mm.; the third could not be measured. The right side is a little worn away, so that these transverse diameters are less than they should be.

[a] These sutures are not like the imperfect septa occurring in *Bathmoceras* and some Orthoceratites, since in those cases the animal still continued to have a distinct living chamber. They are in some measure similar to those occurring rarely in very old shells.

The form, surface, etc., are the same as in smaller specimen above described. The sutures, however, being much more mature, are quite distinct in details of outline, although the general aspects were similar. The saddles have the swollen phylliform outlines of the bases and the lobes the same spreading tops. The first and second lateral saddles on the youngest part of the outer volution are trifid, the third, fourth, and fifth are bifid, the remainder are entire and rounded, becoming gradually flattened and more depressed toward the lines of involution. This was on the side figured, but on the right side there are six columns of divided saddles, the sixth having only, however, a very small median marginal. The first lateral on this side is bifid, the second trifid, and the four other divided saddles are bifid. The first, second, and third lateral lobes present irregularities that obscure their origin, but are probably from the trifid type; the remainder are all distinctly bifid. There are about fourteen saddles beyond the fourth, and probably two rows more on the outer part of same volution, since the spiral arrangement is well marked and the sharp umbilical sides are transformed into flat zones on the last half of this volution. The saddles and lobes are more complicated and the first more deeply undercut near the end of this volution, but there is no other marked difference produced by the development of the shell, except that the saddles are all markedly longer in proportion and more slender. The rotund, phylliform aspect of the bases of the saddles is maintained because of the slow development of the dividing marginal saddles. The sutures are easily separable except near the umbilicus. The ventral is a trifle longer than the first lateral, and there is a descent from the last to the third lateral, and beyond this a decided break owing to the sudden decrease in the fourth lateral, which is only one-half the length of the third lateral. The remaining lobes and saddles slowly decrease in length. The differences between the third and fourth laterals decrease in the older parts of this volution and the sutures approximate somewhat, showing the approach of old age. The fragment figured by Whitfield[a] may perhaps be a specimen of this species or some related form. Such broad internal saddles and digitate short lobes occur in *lobatus*. They are simpler in outline although belonging to a larger specimen than that here described as variety *beecheri*. There are two very large specimens in American Museum of Natural History in New York

[a] Mon. U. S. Geol. Survey, Vol. XVIII, pl. 41.

City.[a] One has no living chamber, but is 290 mm. in diameter. This when complete must have been much larger than the second, which is over 362 mm. in diameter. The living chamber was probably complete and was about one-half of a volution in length. The shell existed near the venter and showed a completely rounded venter; the first half of this outer volution was still obtusely subacute, the tendency to roundness being present only on the last half. Hardly perceptible broad low folds, like those of smaller specimens, exist on the sides of the outer volution of both these fossils. The sutures are more complex than in younger specimens, but still have about the same elongated phylliform marginals. There is also in the Academy of Natural Sciences in Philadelphia a large fragment of this species having smooth sides, but the specimen was not in hand for my final revision. The concavo-convex sides of the casts of this species and the broad outer forward curved folds are similar to the older stages of *S. pleurisepta*, but no tubercles were observed. The young, so far as I know, have not been described.

A very interesting variation from Buncombe Hills, Pontotoc County, Miss., in the collection of Frederick Braun, of Brooklyn, N. Y., is shown on Pl. IX, fig. 11. This has on the right side sutures quite different from those of other specimens figured. The diameter is about 155 mm. and the breadth of the side where suture is shown in Pl. IX, fig. 11, is about 85 mm. The first three saddles of the left side are given on Pl. IX, fig. 12, for comparison with those on the left side of *lobatus* when the volution was about the same breadth. There were five divided saddles on both sides of this fossil.

Locality: New Jersey, Mississippi.

Age: Ripley group, Upper Cretaceous.

Sphenodiscus stantoni n. sp. Hyatt.

Pl. V, fig. 4; Pl. VI, fig 5.

This is founded upon two casts from locality No. 1473 (Coll. U. S. Geological Survey). There is no distinction, so far as could be seen, to separate this from *S. lenticularis* except the sutures. These have, however, so much broader and shorter saddles than any specimen of that species I have ever seen, that, if there is any specific distinction in such peculiarities, these forms can not be included in *lenticularis*. The same peculiarities, as

[a] Not having had this fossil before me for revision, this opinion may be erroneous.

well as the fact that the sides are smooth and entirely without tubercles, also separate it from *pleurisepta*.

The diameter is not far from 114 mm. The partly preserved living chamber of the largest cast is not less than one-half of a volution in length. About midway the diameter from line of involution to venter is 68 mm., that of the same volution opposite this, partly estimated, is 44 mm., the umbilicus being only 2 mm. The keel was solid in the ephebic stage. The basal suture and the next or second one are apparently incomplete on the right side, but on the left they are both present but depressed toward the umbilical shoulders. The last three sutures are more closely approximated than others, as if the shell were in the gerontic stage.

The sutures have minute marginal lobes on the saddles and lobes. The first lateral saddles are very short and broad and quadrifid, the marginal saddles are small, but still distinctly subphylliform, as are also the second, third, and fourth; the fifth is distinctly phylliform and bifid, the sixth just beginning to be bifid on the left side, while on the right side it is still entire.[a] The remaining saddles form the usual series, flattening out on the bases near the umbilicus. On account of the short saddles the sutures are as widely separated on the venter as in *lobatus*, but a slight overlapping begins at the third ventrals and continues to the umbilicus, in so far as the sutures were seen in this direction. The smaller specimen has even broader and stouter saddles, but the umbilicus is not so much contracted. There were five divided saddles on the left side of this specimen and six on the right side, just the reverse of the larger fossil.

Locality: Eighteen and one-half miles southeast of Eagle Pass, Texas

Age: Eagle Pass beds, Upper Cretaceous.

Sphenodiscus lenticularis (Owen).

Pl. VIII, figs. 1, 2; Pl. IX, figs. 1–6.

Ammonites lenticularis Owen, 1852, Rept. Geol. Surv. Wisconsin, Iowa, and Minnesota, p. 579, pl. 8, fig. 5.

Placenticeras lenticulare Meek (pars), 1876, Mon. U. S. Geol. Surv. Territories, Vol. IX, fig. 66 on p. 473 and pl. 34.

Meek's original specimen, from which his figures were taken, shows that these are accurate with exception of certain minutiæ. Figure on page

[a] The sixth column of saddles was entire on the left side throughout; on the right it was just beginning to show a dividing marginal, the diameter of the side along this line being about 53 mm.

473 of the work cited shows acute wings to the siphonal saddle; these are phylliform in the specimen, as is usual in this species. The marginal lobes of the ventral lobe are too pointed in this figure. The auxiliary saddles have not the acute corners as figured. The entire saddle in fifth column of lowest suture is a mistake; it is bifid like the others above. The siphonal saddle is not perfectly entire: there is a minute marginal depression on either side of the center, which is elongated, forming a very minute-pointed but narrow saddle on the keel. The umbilicus is present and plugged with dark matrix, and the shell is present all around and is very thick. This was entirely overlooked in the drawing. The figure on pl. 34 was taken from the same specimen before it had lost the very friable shell that once covered the sides, or else the shell was in large part restored. In this figure the umbilicus is too large. The fold-like costæ as figured are visible only on the outer half of the outer volution, but are slightly curved, not straight, and are more decided than in the figure The inner half of this volution and the outer part are smooth zones with no elevations perceptible to the eye or touch.

A fine young one of this species (Pl. VIII, figs. 1, 2) (Coll. National Museum, Morean River, South Dakota), has the living chamber only partly preserved. The septa and sutures are straight and closely approximated even at this stage, but the overlapping in consequence of this is more decided near the umbilicus, the two outer saddles and first lateral lobes being free on account of a slight bend orad in this part and the greater space at the periphery. According to Meek's figure the increase in size and length of these saddles in the later stages brings them into contact. The lobes and saddles of this specimen are similar to the style of Meek's woodcut on page 473, differing only in certain details.

There are six columns of divided saddles on the left, the only side visible; the first and second are just passing from the bifid to the trifid type, the third and fourth are also passing from the bifid to the quadrifid type, the fifth is bifid, and the sixth passes on the first and second quarters of this volution from an entire outline into a bifid condition. The five inner columns are entire and the fifth column is seen coming in on this volution. The spiral arrangement of these inner entire saddles is prettily shown in the umbilicus.

The lobes all belong to the trifid type except the three inner ones which are entire. There is a steady series of gradations in complexity beginning with the fourth columns of saddles and lobes, both becoming simpler toward the umbilicus. This is parallel to the development of any row taken in the ontogeny, as explained in the general description. There are eleven lobes and twelve saddles, besides the arm of the ventral lobe on each side in the oldest part of this volution, and at least one, perhaps two, rows of lobes and one row of saddles less on the very earliest part of this volution when the shell was 26 mm. in diameter, and from venter to line of involution about 9 mm. The saddles, when a little older than the suture figured, had the phylliform outlines of Meek's figure and were plainly growing to be more like his figure on pl. 34. Fold-like costæ about 1 mm. apart occur, but these are elevated above the general surface only along the median surface of the sides. They are obsolete outwardly, and inwardly they are mere elevated lines. The involution almost completely covers the volution even at this stage, and the umbilical opening is only about 2 mm. in diameter.

The venter is acute on the youngest part of this volution, and the shell is thin. the inner coat brilliantly nacreous; the keel is solid. This is probably the young of the same species figured by Meek on pl. 34, since some of the first lateral saddles already show the tendency to attenuation and the phylliform outlines of the marginal saddles common in that form. The siphonal saddle also has the same form as in that species, and the dependent marginal saddles on either side have the peculiar rounded aspect of the same parts as figured by him. The arms of the ventral lobe are long and directed laterally, and distinctly trifid. The whole diameter is 42 mm., diameter at last septum is 30.5 mm., broadest volution from line of involution to venter 19.5, umbilicus 1.5 mm., and smaller part of same volution opposite 9.5 mm.

Fragments of one or two specimens of the same species (Pl. IX, figs. 1–6) as the above, from Rock Creek, Wyoming (Coll. Yale Museum, No. 1697), show similar sutures and characters The age and size of this are about the same as of the one described above. There are seven narrow phylliform dorsal saddles in the zone of involution. The next to the youngest fragment of a volution was 4.5 mm. from venter to line of involution, with a transverse diameter of 2 mm. Even at this early neanic substage the form of the venter was like that of the adult and the involution almost completely concealed the next inner volution, which was paranepionic and quite distinct in form. The diameter of the youngest volution is about 1 mm. from venter to line of involution. The transverse section is stouter than in second volution, the outline being helmet-shaped, and the venter elevated and beginning to be subacute. At this stage there is one large trifid saddle and one large lateral lobe, and the large inner saddle has two marginal saddles and one on the line of involution. This enabled me to see that the first to third saddles and first to second lateral lobes of succeeding stages were made by division of the first nepionic saddles. The third lobe of the adult consequently represents the primitive lateral nepionic lobe, and the remainder of the saddles and lobes were derived from the division of the outlines of the magnosellarian or second lateral nepionic saddles. In the zone of involution there is a deep antisiphonal lobe and a pair of large saddles with a pair of broad lobes and small saddles at the lines of involution The specimen has the color and transparency of amber and the enlarged drawing (Pl. IX, fig. 2) represents what was seen. There was a decidedly swollen joint at each septum of the three seen. A collar was dimly seen, and there appeared to be but one long funnel reaching across the chamber. This seemed to be the fact, and yet I do not think it was clear enough to be considered certain. Such a long funnel would be a remarkable case of arrested development, especially when a collar was present. It may be that the appearances were due to the entire absence of any true funnel. This last view would entirely reverse the statement and show a high degree of acceleration, since the disappearance of the funnel usually takes place later in life in most Jurassic and Cretaceous forms. In the neanic substage, perhaps in the ananeanic, above mentioned, the first three saddles still show the curvature of the great first lateral nepionic saddle. The ventral lobe is broad, as in the adult. The siphonal saddle is prominent and broad, but as yet shows no digitation, only a few faint indentations. The arms of the lobe are just passing from the entire hastate to the trifid type. The first two lateral lobes are in the same condition, but the saddle remains entire and club-shaped. In fact, at the stage immediately preceding this, the three principal derivative saddles and lobes must have been almost exact repetitions of those of *Prolecanites* among Goniatitinæ. The fourth saddles are entire, but rather short, and beyond are three saddles still very primitive in outline. The dorsal has an entire antisiphonal, more club-shaped than in the younger stage, and there are four other pairs of zygous entire saddles and three pairs of similar lobes. The globular first stage had been lost out of this fragment before it came into my hands. The sutures have five columns of bifid saddles on the right side and six on the left side when the volution is about 10 mm. broad. The suture figured was taken from a volution about 12 mm. broad transversely (Pl. IX, fig 5). The dorsal sutures are of the same age, but were drawn on a larger scale by mistake and have been separated as a distinct figure on that account.

There is an interesting small specimen in the Academy of Natural Sciences, Philadelphia, said to be from near Santa Fe, N. Mex. In this museum and in the United States National Museum there are fragments of volutions of large size having very broad, coarse, low folds on the outer half of the sides; these may belong to this species. The largest is 102 mm. from line of involution, which was not wholly complete. The sides are rather gibbous, the venter still subacute, although not so sharp as in earlier stages. Through the thickest part about 34 mm. from keel the transverse diameter is 51 mm The absence of tubercles at all ages was completely demonstrated in this species. The concave zone found along the inner half of the older volutions in *S. pleurisepta* and *lobatus* was not present in this species, although low, fold-like, arcuate costæ were found as figured by Meek in older stages on the outer parts of the whorls.

Locality: Moreau River, South Dakota; Rock Creek, Wyoming; Santa Fe, N. Mex.

Age: Fox Hills group, Upper Cretaceous.

Sphenodiscus lenticularis variety splendens Hyatt.

Pl. VIII, figs. 3–7.

A young fragment broken out of an older volution is in the form of a cast, but with the sutures and septal partings beautifully marked. It has the usual ax-like venter of its congeneric forms, with fold-like, arcuate, very obscure costæ showing on the outer parts of the sides. The extreme acuteness of the venter shows that this species had a solid keel. The first to the sixth saddles on the right side and the first to the fifth on the left side in the smaller cast and also in the larger are bifid. An observer seeing the young on one side and the older fragment on the other would be apt to consider this lateral difference as a distinction due to age. The basal parts of the saddles have marginal lobes like those of *lobatus*, but these are longer and divide up the body of the saddle more completely, making a more complicated outline, with long, phylliform, marginal saddles on the first three saddles. The lobes and saddles of the inner part are very closely similar to the older ones of the typical specimens described above, having similar phylliform branches and deeply cut outlines.

At a diameter from line of involution to venter of 43 mm. in the younger fragment the sutures are closely approximate, the outlines overlap slightly on the third, fourth, and fifth columns and then separate toward the centran surface, but remain close and become overlapped again near the umbilicus. The lobes and saddles are comparatively long and with highly complex outlines even at this stage, and the phylliform marginal saddles remind one strongly of *Phylloceras*. These are shorter and stouter than the same parts in the older stage, but even at this stage the first lateral saddles are more complex than the sutures of var. *magnificus* and the whole aspect is more phylliform. The first lateral saddles are trifid, but obviously modified from the bifid type; the second, third, and fourth are quadrifid, modified from the bifid type; the fifth is bifid; the sixth is beginning to show the bifid division on the right side, but on the left is entire. There are twelve saddles in all, but the remainder are entire and tend as usual to become shorter and flatter. The ventral saddle is similar to that of var. *magnificus* and *S. lobatus*, with large, rounded, marginal saddles at the corners. The ventral lobe is broad with broad and short branches, belonging to the trifid type. The remaining lobes are complicated with marginal branches, but are of the bifid type, although this is not so noticeable in the first five lobes as in the smaller and less complex ones of the sixth to the twelfth column. There may have been one more pair of lobes inside of these which were broken away.

From line of involution to venter the large fragment had a diameter of 103 mm. with the same surface features as on the smaller cast, but with the venter not so acute. The sutures are older and more complex, as noted above, and there were the same differences between the two sides.

There are twelve lobes and thirteen saddles, and there was certainly one row of lobes broken away and probably another of saddles gone from the umbilical edge. The inner three saddles are considerably flattened; the next four rows are rotund, as in the younger stage described above; and the other rows to the venter have the elongated aspect of the ephebic sutures of this variety. The outer or first laterals are slightly more distant from the lobes than in the ephebic substage, but the second, third, fourth, fifth, and sixth laterals overlap the lobes more than in that stage. The contour of the venter and aspect of the sutures do not indicate advanced age. The largest fragment was probably only in the parephebic or anagerontic substage and must have belonged to a much larger shell.

Mr. Stanton has kindly sent me a tracing of a suture from a large specimen which he supposes is the one that furnished the suture figured by Meek on pl 34., This suture has attenuated saddles and lobes more like those of var. *splendens* than the typical *lenticularis*.

Locality: South Dakota.

Age: Fox Hills group, Upper Cretaceous.

SPHENODISCUS LENTICULARIS variety MISSISSIPPIENSIS Hyatt.

Pl. IX, figs. 7–9.

There are two more or less crushed specimens in the National Museum from friable marls on Owl Creek, 3 miles northeast of Ripley, Miss., No 20863. These have smooth shells, except for well-defined bands of growth, and evenly convex sides and sutures that are more like those of *lenticularis* than those of any other species. The lobes and saddles are remarkably long and similar, and although the ventral saddles are different, they are not widely different. The largest fragment, belonging to a fossil probably about 200 mm. in diameter, has only five columns of divided saddles on the right side (Pl. IX, figs. 7, 8). The actual breadth of the side where this suture was studied is 111 mm. The dorsal saddles are remarkably unsymmetrical, and these and the antisiphonal lobes are different from those of the western variety *splendens*, and further investigations may show these to be distinct, but the materials do not seem at present to justify a separation. The suture of the smaller specimen (Pl. IX, fig. 9), taken where the side was about 78 mm. broad, agrees, considering the difference of age, nearly enough with that of the preceding to be placed in the same variety, but the dorsals were not seen. This cast is identical with that shell in external aspect and has the shell partly preserved on one side. This has the usual brilliantly nacreous layers, and what seems to be the external layer is also nacreous. The growth ridges certainly give the aspect of an external shell, but this may be due to the fact that the second or middle layer takes the lines as impressions from the outer layer, which is absent in this and in the larger fossil also. This last has a very distinct nonnacreous or only faintly nacreous inner layer; the middle layer is brilliantly nacreous, as usual, but the lines of growth, although present, are not so well marked as in the smaller specimen. In both specimens these lines indicate a well-marked rostrum with broad lateral sinuses, median lateral, broad crests—similar broad sinuses internally rising toward the umbilical shoulders. The diameter was partly estimated at 157 mm.; the diameter of living chamber, which is nearly complete and one-half of a volution in length, is about 90 mm. at aperture.

A cast from South Carolina (Coll. American Museum of Natural History, New York), is 151 mm. in diameter. The living chamber is a trifle over one-half of a volution in length where complete on the umbilical shoulder. The form and other characters are like those of *lenticularis* and the saddles have exactly the attenuated outlines given in Meek's pl. 34, but are much shorter, and are also quite distinct from those of Meek's other figures of this species. The auxiliary saddles have the peculiar phylliform bases given in that figure. The inner edge of aperture is present on one side and shows that internally the living chamber was about one-half of a volution in length. The venter was solid. Steinmann, in his Elemente der Palaeontologie, Vol. II, p. 415, figures a specimen said to be from upper Missouri, with the typical suture line of this species, but having a line of median lateral nodes. He gives four derivative lateral saddles, but there are, in my opinion, only three, the remainder belonging to the auxiliary system. The nodes may be the inner termini of the costæ, perhaps slightly more prominent than usual. True nodes are not present in any specimen I have seen.

SPHENODISCUS BEECHERI n. sp. Hyatt.

Pl. VI, figs. 3, 4; Pl. IX, fig. 10.

The type of this species is a large specimen in Collection of the Museum of Comparative Zoology, labeled "Central City, Colorado,"[a] but the real

[a] Mr. Stanton has most kindly corrected this as follows: "This locality is an error. Central City is in the midst of a granitic region and 30 or 40 miles from the nearest Cretaceous outcrops."

locality is probably Fox Hills, Dakota. It is 263 mm. in diameter without the shell, which was not present on the venter. The shell would have increased the measurement to about 267.5 mm., judging by the shell preserved on the venter of the next inner volution.

The living chamber is complete and about one-half of a volution in length, and the diameter, from line of involution to venter, is 150 mm. The outlines of the aperture are sufficiently well preserved to show that it has in this old stage very low, broad crests on the sides, slight sinuses between these and the rostrum: this last being also obtuse and not much extended, the outlines being the same as the lines of growth described elsewhere. Even at this large size the venter is still acute. The inner volution is covered and the umbilicus is only about 1.5 mm. It is as near as possible to being completely closed by the thick shell, although in casts it is obviously much wider open. The shell is about 3 mm. in thickness near the lines of involution. It is also quite thick over the entire last volution, whenever present, and consists of the usual outer opaque, middle iridescent, and inner pearly layers. The keel was solid, so far as seen, at all stages.

There are fold-like obscure costæ, very broad on the oldest part and visible only on the outer part of the volution, as in the casts of *S. lenticularis* var. *splendens*. The venter has the same form as in the young, namely, an ax-like solid edge with biconvex sides to the edge, forming obscure smooth zones on either side. There are no tubercles on any parts visible, but the bands of growth, as in other species, are very well marked on the outer shell. The sutures (Pl. IX, fig. 10) have broader saddles than those of Meek's figure on pl. 34, but they are quite similar to those of *S. lenticularis* variety *splendens*, except that they are more complex and have a larger number of divided saddles.

The branches of the ventral lobe are similar to those of *S. lenticularis*, but longer and narrower. The first lateral is much shorter than the ventral branch and the second lateral lobe, and the second lateral is shorter than the third lateral, so that this part of the suture is decidedly convex and has not the flat aspect of the same part in Meek's figure. The lobes are also of the trifid type, a difference not accounted for by the difference of age, as is the fact also that they are more complicated in outline. The fourth to the eighth are quadrifid, as are the second, third, and fourth in

Meek's figure and also sixth, seventh, eighth, and ninth, while the fourth and fifth are trifid. The ninth lobe is of the primitive trifid type: those interior to this were not seen. The first lateral saddle is unsymmetrically trifid, the second to the fourth more symmetrical but rather irregularly quadrifid, the fifth and sixth trifid, the seventh, eighth, and ninth bifid, with broad phylliform bases, the tenth entire. The remainder, probably at least two more, were not seen.

The lines of the sutures are quite distinct and are separated by a considerable interval to the third lateral saddle in the older septa, and in the younger septa this separation is maintained until the innermost lines of bifurcated saddles are reached.

A fragment from Fox Hills, collection Museum Comparative Zoology, No. 397, shows that this species must have attained a much larger size than the specimen described above. The sutures are visible on this fossil, the partly estimated breadth of the sides being 180 mm, the transverse diameter through the zone of involution at the fifth pair of dorsal and eighth pair of lateral saddles being 65 mm. There are seven pairs of divided saddles. The first laterals are quadrifid on right side and bifid on the left side, the second to the fourth are quadrifid on both sides, and the fifth to the seventh, bifid on both sides. The next or eighth pair are entire. The volution was absent beyond this line. The outlines are obviously similar to those of *S. lenticularis* var. *splendens*, and the dorsal including the antisiphonal lobe also resemble that variety and are more cross-shaped than in Pl. IX, fig. 8, which gives the dorsals of *S. lenticularis* variety *mississippiensis*. There are three layers present in the shell.

A fragment of a cast (Pl. VI, figs. 3, 4), collection Yale Museum, No. 200, from Birmingham, N. J., from the Lower or Middle Greensand Marls, Upper Cretaceous, evidently in its ephebic stage, shows sutures that are quite different from those of any other form. The venter is destroyed except in one spot, but this is sufficient to show it to be solid and acute. The volution is stouter than in typical *lobatus* or *lenticularis*. The actual diameter from line of involution to venter is 61 mm., and it was probably a few millimeters deeper; the transverse diameter here is 25 mm., this being also a few millimeters shorter than the actual diameter.

The ventral lobe is broad, and it is also evident that the siphonal saddles are not bordered internally by prominent marginal saddles. There are twelve saddles on the side and there may have been one more. The first four lateral saddles are similar to those of *lenticularis*, but are succeeded internally by more pairs of divided saddles, and the dorsal lobes and saddles differ. The first to the third are quadrifid; the fourth is of same type, but has three marginals on the outer arm; the fifth to the seventh are simply bifid; the eighth is entire; the ninth is bifid; the tenth and eleventh are entire and phylliform. The lobes are all symmetrically bifid, the branches subdivided and serrated, but the bases between saddles are entire on both sides; even the eleventh lobe is bifid and has minute serrations, and all the smaller internal lobes are short and broad. There are ten narrow phylliform dorsal saddles with entire bases in the zone of involution, and probably there were originally eleven. The lobes are broad, bifid, and digitated like the opposite external ones; the saddles alone are quite different. The first dorsals are very narrow, almost linear, and the dorsal lobes are bifid, narrow, and long, overlapping as in other species of this genus. I hesitate to describe this as a distinct species, because it is a fragment, but its sutures can not be reconciled with those of any other species.

The side, as shown in Pl. VI, fig. 4, is evenly convex as in *S. stantoni*.

A specimen from the friable marls 3 miles northeast of Ripley, Miss., accompanied a specimen described above as *S. lenticularis* var. *mississippiensis*. It was from 75 to 80 mm. in diameter probably when complete. It is covered with nacre, but the sutures can be seen sufficiently. At a stage when the side is 35 mm. in breadth the sutures have the complex aspect of this species in the first four saddles and lobes, the fifth to the seventh are bifid on both sides, and there are about eight more entire saddles. This specimen appears at first to be identical with the var. *mississippiensis* from the same locality, but while the external aspect is the same the suture line, even at this comparatively early age, is like that of *beecheri*

A very fine cast from Mount Wahallak, Kemper County, Miss., collected by Frederick Braun, of Brooklyn, in arenaceous rock in lower part of the Rotten limestone, shows the sutures perfectly and also the inner part of the living chamber. The latter is one-half of a volution in length.

The suture shows eight divided saddles on each side and the form and aspect are like those of this species. This fossil has folds on the outer half of the outer volution, the inner part being smooth and the sides evenly convex. Whole diameter, partly estimated, is 145 mm.; the diameter at base of living chamber is 120 mm.; breadth of side at this line 67 mm., to the shoulder: umbilicus (no shell present) 8 mm. Greatest transverse diameter, 23 mm., is along the median line in the same plane; no shell present.

Locality: Fox Hills, South Dakota.

Age: Fox Hills group.

SPHENODISCUS KONINCKI n. sp. Hyatt.

Pl. XII, fig. 8.

This is a cast in fragmentary condition with one side abraded, but the right side in excellent condition. The whole diameter was about 150 mm. The side is smooth near the umbilical shoulder and has the usual obsolescent folds on the outer part of the lateral zone. The suture figured shows the very large siphonal saddle. While the other saddles and lobes are similar to those of *S. lenticularis*, they are not identical. There are six divided saddles on the right side. Those of the left side were obliterated.

Locality: Near Maestricht.

Age: Senonian.

SPHENODISCUS BINCKHORSTI Böhm.

Ammonites pedernalis Binckhorst, 1873, Mon. Gast. et Céph. du Limbourg, pl. 5a[1], fig. 2 and 5d, fig. 1 (no others).

Sphenodiscus binckhorsti Böhm, 1898, Zeitschr. Deutsch. geol Gesell., Vol. L, p. 197.

This species from Limbourg as figured by Binckhorst is a close ally of our American *S. pleurisepta*, but has only one line of nodes, with costæ arising from these and radiating outwardly; apparently there is no outer line of nodes. It is said to have been compared with Roemer's originals. This leads one to think that these must include more than one species.

SPHENODISCUS UBAGSHI Grossouvre.

Sphenodiscus ubagshi Grossouvre, 1893, Ammonites Craie supérieure, p. 141, pl. 9, fig. 4–6.

This French species is more like our *S. lobatus* than any other species, but the principal lateral saddles have less lobate phylliform outlines. The sutures have the small first lateral saddles common in this genus and five divided saddles.

Age: Upper Campanian (uppermost Cretaceous).

SPHENODISCUS RUTOTI Grossouvre.

Sphenodiscus rutoti Grossouvre, 1893, Ammonites Craie supérieure, p. 143.

This French species is obviously closely allied to *S. ubaghsi*, but the three principal laterals are very distinct from that and from any of our species.

Age: Upper Campanian (uppermost Cretaceous.)

SPHENODISCUS SIVA (Forbes).

Ammonites siva Forbes, 1845, Trans. Geol. Soc. London, 2d series, Vol. VII, p. 110, pl. 7, fig. 6.

Sphenodiscus siva Kossmat, 1895, Beitr. Pal. und Geol. Oesterreich-Ungarns und des Orients, Vol. IX, pl. 22, fig. 2.

This species, as figured by Forbes, is completely involute, smooth, and probably has an entire keel. It is extremely acute on the venter and highly compressed. There are three complex, narrow, deeply cut derivative saddles, with phylliform marginals. The venter has a prominent pointed siphonal saddle according to the figure.

Age: Valudayur beds, Upper Senonian.

EULOPHOCERATIDÆ Hyatt.[a]

This group appears to be necessary in order to separate the remarkable series of forms included under this title from the Coilopoceratidæ. The forms include *Tegoceras*, which was, according to d'Orbigny's figure, a form with a remarkably rounded volution in the gerontic stage, but having a venter like that of *Styracoceras* in the ephebic stage, and a second genus, which is exactly similar to *Coilopoceras* in form, compressed, and with an acute venter. All of these have peculiarly solid, low, broad saddles and short lobes, the marginals being simple and not usually branching, but often long, narrow, and tongue shaped. The first two saddles may be reckoned either as one very broad saddle or as two, the dividing lobe being small. The auxiliaries are also very peculiar, and in *Coilopoceras* the innermost is a long sweeping curve. So far as the evidence goes, *Eulophoceras* appears to have had a different origin from *Sphenodiscus* and *Coilopoceras*, as, indeed, is quite clearly indicated by the sutures. *Tegoceras* probably had a solid keel, but no direct observations have been made upon this part of its shell.

[a] See note on p. 84.

The development of *Eulophoceras* indicates quite clearly derivation from the same common stock as *Buchiceras* and the Tissotidæ, and it should be noted that the sutures are more like those of *Buchiceras*, in having very large, broad first and second lateral saddles. The form indicated for the ephebic stage of *Tegoceras* in d'Orbigny's figure suggests that here, as in the Tissotidæ and Coilopoceratidæ, the more primitive species had truncated venters with keels and lateral tubercles.

TEGOCERAS[a] n. gen. Hyatt.

The curious form figured by d'Orbigny as *Ammonites mosensis* is obviously entirely distinct from any species heretofore described, so far as I know. The external outline in the gerontic stage in section is oval, with rounded venter and only slight involution. There were obviously large alternating nodes on the venter of the inner ephebic volution and a somewhat elevated and bluntly subangular venter. These characters are combined with sutures having in the gerontic stage a large first lateral saddle divided as in *gevrilianus*, so that it is probably really two principal laterals. The auxiliaries are irregular and pseudoceratitic in outline. The peculiar crowded, tongue-like, elongated, marginal saddles and lobes are similar to those of *Eulophoceras*, and it is mentioned in this paper on that account The only species known is the following:

Tegoceras mosense (d'Orbigny).

Ammonites mosensis d'Orbigny, 1840, Terr. Crétacé, pl. 67.

Age: Albian.

LENTICERAS Gerhardt.[b]

This genus, described by Gerhardt in his Kreideformation in Venezuela and[c] Peru, had for its type *Lenticeras* (*Amm.*) *andii* (Gabb). Being unable to compare this with Gabb's types that have apparently disappeared, it is

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[a] Τέγος, roof.

[b] In Zittel's Text-book of Palaeontology, Vol. I, p. 590, Professor Hyatt refers this genus, together with *Paralenticeras* and *Platylenticeras*, to the family of Lenticeratidæ. Although the statement is not directly made that the family is abandoned, it may be inferred from the reference of *Platylenticeras* to Coilopoceratidæ, the remark under *Paralenticeras* about its affinity for *Eulophoceras*, and the fact that the manuscript was arranged as now published with *Lenticeras* and *Paralenticeras* between *Tegoceras* and *Eulophoceras*.—T. W. S.

[c] Neues Jahrbuch für Min., Geol., und Pal., Beil.-Bd. XI, 1897–98, p. 81, pl. 1, fig. 9.

not practicable to say that these species are identical, as supposed by Gerhardt. The drawings certainly differ materially. The sutures are more like those of *Paralenticeras* than those of any other genus that I know. The siphonal saddle is very large, the first lateral saddle has three long arms, the outer one the shortest and the inner one the longest. The first lateral lobe is narrow and trifid with long bifid arms. The outer lobes are narrow also, whereas the saddles are very broad and solid and have short rounded marginals.

The volutions are depressed, helmet shaped in section, and very broad, without keels, but have smooth shells with broad fold-like knobs on the umbilical shoulders.

PARALENTICERAS Hyatt.

This is a highly compressed involute smooth shell with sutures unlike those of any other known genus except *Lenticeras*. Although so compressed and smooth that it resembles *Platylenticeras*, it is obviously a member of the same genetic series as *Lenticeras*. The excessively elongated and club-shaped marginals also indicate affinity for *Eulophoceras*.

The genus was mentioned in Zittel's Text-book, Cephalopoda, page 590, and placed in its proper relationship to *Lenticeras*.

The sutures have the same broad first lateral saddle with three arms, the shortest next the venter, as in *Lenticeras*, and similar second and third laterals. All the outlines are also of the general outline according to Gerhardt's figures.

I fail to recognize any special resemblances to the sutures of *Ammonites clypeiformis* d'Orb., which has a type of suture found in *Coilopoceras* and its allies.

Only one species is known to me, *P.* (*Amaltheus*) *sieversi* Gerhardt.[a]

EULOPHOCERAS[b] n. gen. Hyatt.

This genus is proposed for shells similar to *Platylenticeras*, but the sutures obviously have only two principal laterals, derived from the primitive first lateral saddle, and only a few broad auxiliary saddles, the inner most being extremely broad.

Only one species is positively known at present to be in this genus.

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[a] Neues Jahrbuch für Min., Geol., und Pal., Beil.-Bd. XI, 1897–98, p. 79, pl. 1, fig. 5.

[b] Εὔλοφος, handsome crest.

Eulophoceras natalense n. sp. Hyatt.

Pl. XI. figs. 2–6.

This species is founded upon a fragment in the collection of the Yale Museum. It is a bare cast on one side with the shell preserved on the opposite, right side, and on venter. Diameter, partly estimated, is 164 mm. (actual diameter 155 mm.). There is no umbilicus, this being practically sealed up by the growth of shell on one side, and is of course very small, where cleaned out on the other side. There are faint folds on both shell and cast. The folds occupy the sides and are not confined to the outer or inner parts of the lateral surfaces, although more prominent along the centran lateral lines.

The keel is solid in the younger stages (Pl. XI, figs. 5, 6) and then becomes apparently hollow. The proof of this is not absolutely clear, but in each volution of the section there is a partition of shell outside of the siphuncle. In the upper tip of the section of the volution next to the last a partition was also present, but this is apparently a section of the septum itself, and what seemed to be the siphuncle is represented on the right and above this partition. If this be correct the keel is solid at this age and remains in this condition in the last volution. The siphuncle is not present in this last volution, but as in the section of the next younger volution above described the common matrix fills the interior completely and on the outer exposed edge the sutures run against the solid interior of the thick deposits of the keel. In the younger whorls the space between the partition above the siphuncle and the keel is filled, as in the interior of the siphuncle, by dark transparent calcspar. There is, however, no black layer present above the siphuncle, as in the Jurassic forms, that have hollow keels

The sutures are extraordinary. They are so excessively overlapped that there are two second lateral lobes telescoped into every third one, so that one has to disentangle the lines of three consecutive sutures in marking out this lobe. It becomes necessary, in fact, to infer outlines that can not be seen, the sutures having in some parts necessarily passed along the same lines and can not be separated by the eye. The first to third lateral saddles are broad and have numerous long tongue-shaped marginal saddles. The fourth lateral saddle is also broad, deeply bifid, the outer arm entire, the inner bifid. About half of a volution earlier this saddle is much narrower, and is probably still smaller at younger stages. The fifth is also a broad saddle, but shorter than the fourth and has two arms, the outer bifid, the inner trifid. The sixth is a long entire remnant of the primitive second lateral saddles of the nepionic stage occupying the umbilicus. The inner part of the outline of this saddle is faintly concave, especially where it crosses the shoulder, but no definite lobe is formed. The lateral lobes are cut up by marginals on their entire outlines. The first laterals are about as long as the short narrow arms of the ventral; the second laterals are about a third longer and fully twice as broad; the third laterals are about the same size and length as the first laterals; the fourth are shorter and about the same breadth; the fifth is narrow and divided by two minute tongue-like saddles. These form a column near the umbilical shoulder of the cast.

On the right side the third lateral or first auxiliary saddle is very much smaller at the same age, and apparently subdivided with at least one dividing lobe, giving one more lobe and one more saddle on this side. The fifth is also narrower and has a simple trifid outline. The remaining saddles and lobes also differ, and in fact this side of this specimen might be described as belonging to a distinct species. The first and second laterals are larger and the marginals fewer in number, but the principal difference lies in the second or primitive lateral lobe. This is bifid, divided by one very large median marginal saddle. There are, however, but two principal lateral saddles on both sides.

The outlines of these sutures are entirely distinct from those of any species of *Sphenodiscus.* The bodies of the saddles are solid and the complicated outlines are made by the outgrowth of long tongue-like marginals, the lobes being divided in the same way. The only suture so far figured having a similar outline is that of *Tegoceras mosense.*

The ventral lobe is very broad, the outline sinuous, the center occupied by a small lobe divided by a sharp minute saddle. There are two arms to the ventral lobe, short, narrow, and bifid, and parallel with the venter. These are quite different from the usual spreading arms of this lobe in *Sphenodiscus* and *Coilopoceras.* The auxiliary saddles are even more distinct as described above and together with the number of the principal lateral saddles show that we are dealing with a species that can not be included in *Sphenodiscus* nor in *Coilopoceras.*

Locality: Port Natal, South Africa.

Age: Upper Cretaceous.

COILOPOCERATIDÆ Hyatt.

This includes genera having the primitive first lateral saddles far more variable in development than in Sphenodiscidæ. *Aconeceras* has only one long deeply divided first lateral. *Platylenticeras* and *Coilopoceras* have three according to the method of reckoning adopted below, but the elements are the same as in *Aconeceras*. *Aconeceras*, *Styracoceras*, and *Platylenticeras* probably have solid keels, although there are no observations on this point that can be quoted.

The development and adult form of *Styracoceras* indicate that the more primitive forms of this family had truncated venters with keels and lateral tubercles, and were similar in external aspect to *Buchiceras*.

Coilopoceras has a hollow keel. The sutures and development at first seem to place it in the same group with *Sphenodiscus*, but the two principal lateral saddles, the median lateral lobe (second lateral lobe) with long tongue-shaped marginal saddles, and the aspect of the auxiliaries in the young indicate association in the same family with *Aconeceras*.

These remarks show that while these genera are sufficiently distinct, their association in a group together is made more to call attention to certain suggestive similarities than with any idea that they really belong together exactly as described below.

The evidence that this family was directly derived from *Phylloceras* or some similar form rests upon the general outlines of the saddles, which are phylliform, especially in the neighborhood of the umbilici, and the widely spreading and peculiar lobes. The dorsal sutures are as usual less changed than the external inflections and these have almost exclusively phylliform outlines like those of Phylloceratida. The antisiphonal has a long narrow form with a bifid end and although it is serrated or slightly branching and not so simple as in *Phylloceras*, it has a similar form.

As mentioned in the generic description of *Aconeceras* the sutures of *A. nisum* make a nearer approach to those of *Phylloceras* than any other genera of this group or any others except the Sphenodiscidæ.[a]

PLATYLENTICERAS Hyatt.

This genus was mentioned in Zittel's Text-book, page 590, by the author and the type given was the same species cited below. The sutures are

[a] The manuscript of this last paragraph bears an interrogation mark on the margin.—T. W. S.

similar to those of *Coilopoceras* but are still more like those *Styracoceras balduri*. The siphonal saddles are small and bifid in these two genera. The small first lateral lobes may be reckoned either as mere marginals in this genus dividing the first lateral saddles equally or as true first laterals. The two small saddles coming next to these resemble the corresponding saddles in *Coilopoceras*. Uhlig in his Die Cephalopodenfauna der Teschener und Grodischter Schichten[a] figures several species mentioned below, one of which has a rounded venter with the usual smooth sides and characteristic sutures of this genus. Uhlig takes the same position that has been here independently assumed, namely, that the sutures are similar to those of *Styr. balduri* (Keyserling), and that the affinity of this genus for *Mojsisovicsia* is shown by the development of one of his species which has a rounded venter until a late stage. The sutures and the affinities of this fossil for *P. heteropleurum* show that this is a prolonged, immature, or arrested condition of ontogenic development, and therefore an indication of remote rather than proximate derivation from *Mojsisovicsia*, whose sutures are widely different. The section of *P. heteropleurum* given by Struckmann[b] shows that the transition from a rounded to an acute venter probably takes place directly at a comparatively early stage, as might be imagined after studying the ontogeny of *P. pseudograsianum*. This fact shows that the resemblances of the sutures with those of *Styracoceras* have no genetic significance because the extraordinary and complex ontogeny of that genus indicates very distinct affinities.

PLATYLENTICERAS HETEROPLEURUM (Neumayr and Uhlig).

Oxynoticeras heteropleurum Neumayr and Uhlig, 1881, Palæontogr., Vol. XXVII, pl. 15, figs. 1, 2.

This species has smooth compressed volutions but the involution is not sufficient to cover the sides and the umbilici are quite large. The keel is acute and so far as can be seen in the figures is apparently solid. The sutures as drawn by the authors cited are not at all like those of true *Oxynoticeras*, which have only one first lateral saddle, but are similar to those of *Styracoceras balduri*, as stated above. It is not practicable to determine

[a] Denksch. K. Akad. Wiss., Wien, Vol. LXXII, 1901.

[b] Jahrb. K. preuss. geol. Landesanstalt, 1889, p. 71, pl. 11.

whether *Ammonites heteropleurus* Struckmann[a] and *Amm. gevrilianus* Dunker,[b] which were found partly in the same localities in north Germany, are identical or not, but they are probably the same.

Locality: Near Springe, Hanover.

Age: Neocomian.

PLATYLENTICERAS PSEUDOGRASIANUM (Uhlig).

Oxynoticeras pseudograsianum Uhlig, 1901, Denksch. K. Akad. Wiss., Wien, Vol. LXXII, p. 25, pl. 2.

This is a really discoidal shell with a much larger umbilicus than other species of this genus, and therefore making a nearer approach to the radical form of *Mojsisovicsia*, but it has on the other hand the characteristic sutures of the *P. heteropleurum* type; that it should have a rounder venter until a late stage is quite consistent with its noninvolute discoidal aspect.[c]

Locality: Nieder-Lischna.

Age: Valangian (Lower Neocomian).

PLATYLENTICERAS GEVRILIANUM (d'Orbigny).

Ammonites gevrilianus d'Orbigny, 1840, Terr. Crétacé, pl. 43.

This species was noted by Neumayr and Uhlig, in their Ammonitiden aus den Hilsbildungen, as having similar sutures and similar external characters to *Platylenticeras heteropleurum*, which is, however, in my opinion quite distinct. *Aconeceras nisum* was also cited by them as an ally, but this has only one principal first lateral and the resemblances exist only in the external characters. *Amm. marcousanus*, also cited by them as an ally, has only one large bifid first lateral and has a depressed rounded volution and tubercles like *Pachydiscus*.

Age: Aptian.

[a] Jahrb. K. preuss. geol. Landesanstalt, 1889, p. 71, pl. 11, figs. 3, 4.

[b] Palæontogr., Vol. I, 1851, p. 324, pl. 41, figs. 21-24.

[c] The other species mentioned and figured by Uhlig are not named. They are closer to the involute character of *P. heteropleurum*, but one of these, *Oxyn.* cf. *heteropleurum*, pl. 2, fig. 2, has three principal saddles instead of two and is considerably less involute than that species.

COILOPOCERAS[a] n. gen. Hyatt.

This genus includes species formerly associated with *Sphenodiscus*, which, however, differ so that they are easily separated. The development and form are closely similar; that is to say, the shell develops directly from the rounded nepionic volutions into a helmet-shaped whorl in section having subacute venter which becomes more acute with age. In the three forms described below in the neanic and adult stages, the volutions are somewhat less compressed than in species of *Sphenodiscus*, but this is probably only a specific character.

The sutures differ in having broad first lateral saddles with a peculiar large internal arm or marginal saddle, and the first and second laterals, when the second are present, are narrow and very distinct from the first laterals on the outer side and the first large auxiliary saddles on the inner side. There are but two secondary lateral saddles, the first and second, derived from the division of the primitive first laterals in *C. colleti*, the type of the genus, but this form is in an early ephebic substage and the aspect of *C. novimexicanum* at a somewhat older stage shows that there is an approximation to the trisellate condition. This trisellate or placenticeran aspect of the principal or first outer saddles, derived from the division of the primitive first lateral saddles, is still more marked in *C. springeri*. The hollow keel is remarkably distinct. When the shell is removed, the siphuncle is covered only with a very thin layer of the fossilizing sediment, and this organ is apt to be exposed on the casts and is often absent in more or less worn specimens, leaving the venter deeply channeled. This last accident is of rare occurrence among forms with solid keels. The siphuncle is also larger and thicker walled than in *Sphenodiscus*.

Coilopoceras colleti n. sp. Hyatt.

Pl. X, figs. 5–21; Pl. XI, fig. 1.

This species is easily distinguished by comparison with its nearest affine, *Coilopoceras novimexicanum*. It has stouter volutions, a more open umbilicus, the venter is blunter, and in the young, at any rate, it has larger, stouter fold-like costæ, one long one reaching to the umbilical shoulder,

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[a] Κοιλωπός, hollow.

and an alternating shorter one. This last series disappears in the last part of the outer volution of the specimen described, leaving a series of single costæ. These may perhaps be obsolete or obsolescent in older specimens. There is a decided aspect of bifurcation in the earliest stage observed when from line of involution to venter the cast of the volution is 15 to 20 mm., but there are no tubercles. The whole diameter of this cast is 67 mm. The outer volution at largest end from line of involution to venter is 37 mm.; without the shell the umbilicus is 7 mm. on one side and 8 mm. on the other side; with the shell it would be 5 mm. on one side and 6 mm. on the other. The greatest transverse diameter is about one-third of lateral zone distant from umbilicus and is for thickest part 18 mm., and opposite, corresponding to ventro-dorsal diameter above given, it is 11 mm., both measurements being between the costæ. The costæ are more prominent on the middle and inner parts of the sides than on the outer, and broaden out toward the venter, disappearing near the solid edge somewhat abruptly on the younger parts and more gradually along the older part of this volution.

The first lateral saddles are broad and short trifid on the right side, with a small outer marginal saddle and quadrifid on the side figured (Pl. X, fig. 7), with an inner accessory large marginal saddle dependent on the first laterals. The second laterals are single, short, but slender saddles, with phylliform bases, which are only slightly indented at the age observed. The third laterals are only about a third longer than these, and, although overlapping, are easily separated. The outlines are irregular and deeply indented by two marginal lobes and other accessory lobes. The fourth and fifth laterals are phylliform, with the bases indented by a number of marginal lobes, apparently entire and small. The sixth and seventh laterals are faintly trifid. The almost entire aspect of these saddles is due to slight abrasion. On the youngest part of this volution (Pl. X, fig. 9) all of the saddles are entire except first to third, the cast here being 16.5 mm. in breadth from line of involution to venter; the outlines are perfect.

The ventral saddles are more like those of *Sphenodiscus* than in *novimexicanum*, and have rounded marginal saddles at the inner angles. The first lateral lobes are of about the same length as the arms of the ventral lobe, both of them trifid and with accessory marginal lobes orad of these. The second laterals are the deepest lobes, and represent the primitive lateral. They are bifid and about twice as long as the third, the arms and sides being cut up by marginals. The remaining lobes are narrow as compared with the saddles, and irregularly denticulated. I could not tell whether they were of the trifid or bifid type, or both mixed. There were eight lobes, the line of involution being occupied by a saddle.

The venter is capped by a hollow keel, as in *novimexicanum*, and in this species there is the plug, the dark layer, and an inner-shell layer, upon which the ventral saddles and lobes abut.

The sutures are more like those of *novimexicanum* than any other species, and I at first considered this to be the young of that species; but the difference in these and in the external characters at the same age are far too marked.

The saddles and lobes are all shorter than in *novimexicanum* and overlap a trifle only from the fourth lateral to the umbilicus. They are also much less complicated in outline or less cut into by marginal lobes, and less distinctly phylliform.

The young in section, so far as seen, showed the same general development as in *Sphenodiscus*, but the division of the primitive first laterals took place early in the neanic stage.

The figures (Pl. X, figs. 10–21) give the stages as far as these could be studied. The protoconch is stout and slightly scaphitoid or irregular in shape, like many other Cretaceous forms The second suture had a minute siphonal saddle that was distinctly seen by a side light. Fig. 11 shows the deepening of the antisiphonal and the beginning of the two first dorsal saddles on the first quarter of the second volution. Fig. 11a shows the lengthening of the antisiphonal, the incoming of two saddles and the beginning of a third on the dorsum, the incipient stages of division of the primitive second lateral into four saddles of the auxiliary system and the arising of the second lateral saddle on the inner side of the primitive first lateral saddle. Fig. 12 shows the progressive lengthening of the antisiphonal, the presence of a third pair of fully developed saddles on the dorsum, the division of the primitive second lateral into four, the definite separation of the second lateral saddle, and the incipient stage of the great inner branch of the first lateral saddle; also the first appearance of the smaller marginals on the outer side of the base of the same

This specimen, therefore, affords clear ideas of the mode of development of the full-grown sutures in this form and also in the group to which it belongs.

Locality: Near Carthage, N. Mex.

Age: Colorado group, Upper Cretaceous.

COILOPOCERAS NOVIMEXICANUM n. sp. Hyatt.

Pl. X, figs. 1–4.

This species appears to be more like *Sphenodiscus lenticularis* Meek than any other at first sight, but the sutures and other characters are so dissimilar that this impression is easily corrected.

The cast in hand is 93 mm. in diameter and, allowing for siphuncle on one side and crests on both sides, it would be, when perfect, about 96 mm. The transverse diameter of the outer volution is 56 mm., the umbilicus is about 1.5 mm., and the outer volution below on same line is 34 mm. without siphuncle and crest, which would make it with both about 35.5 mm. The transverse diameter, about the middle of the lateral zone, is 23 mm. for the largest, oldest part of the volution and 15 mm. for the smaller, younger part opposite this. The latter had the shell on both sides, and deducting this it would be 14 mm.

While the form and aspect were the same as in most other species of this genus, it has very faint fold-like costæ on the outer part of the last half of the outer volution and more decided and more fold-like costations upon the younger portion and on first quarter of the exposed volution; these last reach to the umbilical shoulder.

The venter is subacute, with blunted, narrow crest, and on either side of this lateral zones are slightly concave on the entire outer volution. The shell vaulted over a clear space above the siphuncle, the hollow keel, and this was filled by clear, crystalline limestone different from the matrix, and there was a black layer over the siphuncle. Farther out a part of the black layer was found to consist of black dendritic oxide of iron. The sutures are equally peculiar. Upon closer examination it is seen that the resemblances to *Placenticeras* are due to the small size of marginal saddles, the solidity of the fourth lateral saddles and the greater complication of the smaller saddles than in *Sphenodiscus*. There are, however, but two secondary lateral saddles, although the deep division and length of the inner branch of the first laterals make apparently three saddles. The outer branch of the first lateral saddles is narrow, long, much cut up by marginal lobes, bifid, and has phylliform elongated marginal saddles. They slightly overlap the branches of the ventral lobe, except in the two sutures figured. A large marginal springs from their orad parts inward, forming a narrow saddle with phylliform single base, undivided on the younger parts of the volution and beginning to have a small lobe on outer side in older parts of same. These are much longer than in *colleti*, are attenuated and cut into by marginal lobes, and would usually be counted as the second laterals. They do not reach to the next sutures and are separated by bare spaces from the outlines of the second lateral lobes. The pointed aspect of the marginals is noted in Pl. X, fig. 4, but the slightest abrasion would obliterate such marks and make all the marginals appear to be rounded, as they did to me at first.

The second laterals are nearly all on a level with these inner branches of the first and have solid elongated bases, which are cut into only by small pointed marginal lobes and consequently subphylliform, but apicad of these there are on each saddle two projecting phylliform branches. The third laterals, first auxiliaries, are fully one-third longer than the second and broad and solid throughout; the apical openings are not contracted, their marginal saddles and lobes being small and short. The extraordinary length of these saddles causes them to overlap the inner outlines of the third lateral lobe so much that one is apt, unless aware of this, to confuse two sutures and consider this saddle short and broad. The remaining saddles decrease in length to the umbilicus. The fourth are like the third in aspect; the fifth are slender, phylliform, and bifid; the sixth are slender, single, and phylliform; the seventh less elongated, less slender, but phylliform, and near the umbilical shoulders. On the umbilical zone there are two rows of saddles visible on the last part of the outer volution, having still the rounded phylliform bases of the *Sphenodiscus* type. The siphonal saddles are quite distinct, larger and more prominent and unlike those of any other allied species.

The ventral lobe is similar to that of *Sphenodiscus lenticularis*, but has spreading trifid arms. The first and second lateral lobes are narrow. The first is decidedly bifid, the second is but a shade longer than the first, and the sutures have to be perfect to see this clearly. The third is about one-half the length of the second, and from this one the decrease in length is gradual to the lines of involution. The third, fourth, and fifth lateral lobes are broader in proportion and correlate with the forms of the accompanying saddles. There are eight lobes and nine saddles on the oldest parts of this volution, the seventh lobe being on the umbilical shoulder.

The septa are concave along the median plane, being convex only at the ventral and antisiphonal lobes. The large third saddles, the first of the auxiliary series, correspond to the first pair of dorsals and are connected with them so that the number of saddles on the dorsum is the same as the number of lateral saddles, or six, exclusive of the saddle on the line of involution. The details of their curves could not be seen.

Locality: Near Carthage, N. Mex.

Age: Colorado group, Upper Cretaceous.

Coilopoceras springeri n. sp. Hyatt.

Pl. XII, figs. 1–3.

This superb specimen, presented to the Museum of Comparative Zoology by Frank Springer, of Las Vegas, the well-known student of crinoids, appears to have characters so distinct that they can not be accounted for by the extreme size and age of this specimen. It is 400 mm. in diameter. The last part of outer volution from lines of involution to venter, which is slightly truncated by abrasion, is 225 mm., and half of a volution younger it is 196 mm. This, judging from thickness of the shell on younger part (5 mm.) and siphuncle at this part 7 mm. in diameter, has lost 12 to 15 mm., and to this must be added shell in the umbilicus, which was 5 mm. At the last part of the second quarter of this volution, where sutures were studied, the volution was 195 mm. in breadth; the allowance of 5 mm. for shell on venter and of 3 mm. for shell in umbilicus makes the volution when complete 203 mm. The actual measure of same diameter near beginning of first quarter, which was entirely covered by shell, was 149 mm. The inner layer of the shell was not present in umbilicus and probably added 2 mm. to this measurement.

There is only a small part of the living chamber left on this large specimen, and its original length is not clearly indicated by any marks on the exposed volution. The shell is only partly preserved, but it is sufficient to enable one to state that there are no tubercles nor distinct costæ on either shell or cast.

The venter is subacute and appeared at first to be solid, but close examination showed a small core of light-colored filling and a fine darker layer between this and the large siphuncle. The small size of the core was due to the great age of the specimen, and probably at a still older age the keel was entirely solid. The last part of exposed volution is obviously in the extreme gerontic stage, since the line of involution has retreated considerably from the previous normal line of involution, beginning its departure on the first quarter and thus greatly enlarging the diameter of the umbilical opening. The diameter of widest part is 40 mm. without the shell; with the shell it was 8 mm. less, whereas that of the opening in next inner volution was only 10 mm. with the shell on. The oldest sutures were closer together, and, like the decrease of involution, indicated that the specimen was outgrown; but these did not show the extreme degeneration sometimes found at the end of the parageronti substage. The sutures on last half of the exposed volution were not in good condition and those described below were about the middle of the volution, or in what I took to be the metagerontic substage. The sutures were at this time separated by a good interval, the first overlapping being between the fourth saddles and the inner side of the third lobes. The next overlapping was between the seventh saddles and continued thence to umbilicus. The first lateral saddle on left side is very broad and of the trifid type, and the marginal saddles elongated and phylliform in outline. It has an inner branch which is phylliform, and although it might be reckoned as the second lateral, is only a marginal, as in other forms of this genus. The corresponding marginal in *novimexicanum* is smaller, and is not at all likely to be mistaken for a second lateral saddle.

The second is somewhat larger and less phylliform than this branch of the first lateral, but has similar characters. The third is still longer and larger and has lost more of its phylliform aspect through the development of the long marginal lobes. The fourth saddle is very long and large, rising above the level of the first laterals, and is deeply cut and unsymmetrically trifid, each branch being subdivided except the central one. The remaining saddles are very short, broad, and more or less phylliform. The fifth is entire with exception of minute marginals; the sixth is trifid without secondary marginals; the seventh and eighth are unsymmetrically bifid; the ninth and tenth are entire and phylliform. The eleventh saddle passes across the lines of involution and forms the seventh saddle of the dorsum. The corresponding saddles on the right side are quite distinct in detail, but of the same number and similar in general aspect. However, the fifth and sixth laterals are unsymmetrically trifid with secondary marginals, showing that they were on the road to the quadrifid type,[a] and the seventh is bifid. The remaining saddles are shown on the same side at an older stage. The eighth, ninth, and tenth were phylliform and entire; the eleventh was entire, and situated on the line of involution. The lobes on the left side were as follows: The first laterals were merely marginals on the first lateral saddles, the first corresponding to the first saddle, as reckoned above, the second and third progressively deeper. The third, although it was apparently trifid in type, was subdivided by a very long, slender, and peculiar marginal saddle coming from opening of fifth lateral saddles. The fourth, fifth, sixth, and seventh laterals were broad at the tops and had pointed small marginals as in some other more primitive species. The eighth, ninth, and tenth had more unequal serrations and were narrow at the tops.

The adult sutures were exposed on an inner volution and exhibited, as I anticipated, more overlapping than in the gerontic stage, owing to the greater length and development of the second and third lateral saddles. This is an instructive case because, as a rule, the overlapping is greater in the gerontic stage than in the ephebic. In the extreme gerontic stage, when the decrease in length of the saddles and lobes is greatest, the approximation of sutures causes overlapping, notwithstanding this decrease. But in a prolonged gerontic stage the relative decrease in length of lobes and saddles may sometimes, as in this case, where septa are not much closer, cause sutures to appear wider apart than in the ephebic stage.

The adult sutures had very much the same outlines as in the gerontic stage described above, but there was a slight overlapping along the entire suture.

[a] This shows a variation between the two sides that is interesting, and it must also be noted that there is a slight overlapping on this side, owing to the greater length of the fifth and sixth saddles.

There were three principal lateral lobes and the third was the remnant of the primitive lateral lobe.

The dorsal sutures were seen in the gerontic stage and a partly restored outline of the antisiphonal is given in Pl. XII, fig. 3. The right outline and the end of the lobe are restored. The extreme bifid end of this lobe was, however, seen from below. The first dorsal saddle was clearly seen but was apparently abraded like the antisiphonal, and the remaining saddles were seen, but not in such connection as to make a drawing desirable. They correspond in outlines to the opposite lobes and saddles of the auxiliary series, being entire and phylliform near the lines of involution and trifid near the first pair of dorsals. The lobes also are digitated like their opposite companions of the auxiliary series. There are six pairs of saddles, with a seventh continuous with the eleventh outer saddles, and six pairs of lobes, the antisiphonal making the thirteenth lobe on the dorsum.

Locality: Rit du Plain, Colfax County, N. Mex.

Age: Colorado group, Upper Cretaceous.

COILOPOCERAS REQUIENIANUM (d'Orbigny).

Ammonites requienianus d'Orbigny, 1840, Terr. Crétacé, pl. 93.

The suture given by d'Orbigny has a large first lateral, but it is narrow, long, and bifid, with a third arm on the external side. The two next saddles have the relations common in this genus, the second being hardly distinguishable as an independent saddle, narrow, phylliform and bifid, while the third, which is large enough to be ranked as an independent saddle, is narrow, phylliform, and trifid. The auxiliary series has the broad complex saddle to begin with, reckoned in these descriptions as the fourth lateral, and the remaining saddles have the usual phylliform bases, all that are drawn, four in number, being bifid.

The outlines approximate more nearly to those of the phylloceran group like *Aconeceras nisum*. The siphonal saddle, if correctly drawn, is intermediate in aspect between the broad ventrals of other species of this genus and those of such forms as *Platylenticeras heteropleurum*, with narrower siphonals.

Locality: Uchaux, France.

Age: Turonian.

COILOPOCERAS? GROSSOUVREI n. sp. Hyatt.

Pl. XII, fig. 7.

Sphenodiscus requieni Grossouvre, 1893. Ammonites Craie supérieure, p. 141, fig. 59.

The suture and description given by Grossouvre of his French species and the one figured by d'Orbigny as *Ammonites requienianus*, although quoted as identical by him, are very different. There are distinctly three principal lateral saddles in Grossouvre's figure, but the first is large, long, and trifid instead of being narrow, long, and bifid; the second is really an enlarged branch of the first saddle and still entire, while the third is bifid and much larger than in true *requieni*, according to d'Orbigny's figure. This species may be one of the hollow-keeled group, a suggestion that is further supported by the aspect of the auxiliary saddles and lobes. In order to call attention to these points I have placed a question after the generic name.

Locality: Near Tours, France.

Age: Turonian.

ACONECERAS[a] n. gen. Hyatt.

The single species here referred to this genus has sutures more like those of Cretaceous forms of Phylloceratida than any others of this group. These are combined with a highly involute compressed shell having an ax-like acute venter like a species of *Eulophoceras*. The ventral saddle, as figured by d'Orbigny, is broad and similar to that of *Coilopoceras;* the first lateral and the other saddles are deeply divided and broader than in the Phylloceratida and certainly show approximation to those of the Coilopoceratidæ. I have therefore referred the form to this family, and it appears to strengthen the opinion that the Coilopoceratidæ were derived from the Phylloceratidæ.

ACONECERAS NISUM (d'Orbigny).

Pl. XII, figs. 4–6.

Ammonites nisus d'Orbigny, 1840. Terr. Crétacé, pl. 55.

This figure is copied from d'Orbigny because it gives what appears to be an important link in the evidence that the group to which it is referred is correctly referred to the Phylloceratida.[b]

Age: Neocomian.

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[a] *Ἀκόνη*, a whetstone.

[b] The two pages of manuscript bearing these notes on *Aconeceras* were out of place, lying at the top of one of the two bundles of manuscript, and just before the generic name is the penciled note,

COSMOCERATIDA.

VASCOCERAS Choffat.[a]

This genus, thanks to the researches of Choffat,[b] can now perhaps be assigned to its proper group. In my chapter on Cephalopods in Zittel's Text-book I placed it with a question mark in the Acanthoceratidæ. It is apparently a group of very broad coronate shells having in the young adolescent stage of some primitive forms (ex. *V. subconciliatum*, Choffat) three rows of tubercles, which are often large nodes on casts. The section is essentially helmet shaped at this age, the umbilical zones very abrupt, and the diameter through the umbilical shoulders much greater than that through the ventro-lateral angles. The absence of a keel and the rounded ventral zone, interrupted by costæ in some forms, are characteristics that, together with the lateral nodes and section, are similar to the young stages of *Coronites* and the discoidal forms of *Hoplites* that have similar coronate young with a line of large nodes. The sutures have remarkably broad first lateral saddles and ventral lobes that are similar to those of some species of *Heinzia* and *Metoicoceras*. These and the other characters indicate that this genus may have had relations to typical Pulchelliidæ similar to those that

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"Belongs with the *Desmoceras* group." It seems probable, therefore, that Professor Hyatt had changed his opinion concerning the relationship of the genus, but as he had arranged figures of it on the plate in connection with figures of *Coilopoceras*, it is thought best to print the manuscript as written. The statement that "the group * * * is correctly referred to the Phylloceratida" is evidently in conflict with the general note on the Mammitida, which is made to include the Coilopoceratidæ and many other families. I have not been able to determine which of these views was last held by Professor Hyatt, but the arrangement of the manuscript gave the impression that *Acompsoceras* was removed from Coilopoceratidæ as the result of later studies and that much of the evidence for the relationship of the family with Phylloceratida was thus removed.—T. W. S.

[a] In the manuscript a sheet is inserted just before *Vascoceras* with the heading "Cosmoceratida," followed by "In family description notice resemblance of form to Aspidoc. of Jura as more remote than to *Cheloniceras* of the Cretacic." Another memorandum bears pencil-sketch copies of d'Orbigny's figures of *Ammonites royerianus* (Pal. Fr. Terr. Crét., 1, pl. 112, figs. 3, 4) labeled *Cheloniceras royerianus*, indicating that he had probably selected this species as the type of a new genus. It is inferred from this that he had referred *Vascoceras* to the Cosmoceratida, and that he intended to name and describe a new family to include this genus and possibly *Tolypeceras*. But did he also intend to put Coilopoceratidæ, Pulchelliidæ, and all the families that follow in the Cosmoceratida? I can see no evidence of it, except in the arrangement of the manuscript and the absence from it of other super-family names. Certainly no justification for it can be found in the definition given by Professor Hyatt in Zittel's Text-book. In the plates *Vascoceras* follows Coilopoceratidæ, and I have changed the arrangement of the manuscript sheets as found so that the descriptions follow in the same order, believing that this is a more natural order and that it represents Professor Hyatt's latest views, as the last work he did was the mounting of these drawings in plates.—T. W. S.

[b] Faune Crét. du Portugal.

highly coronate forms like *Erymnoceras* in the Inferior Oolite have to true *Stepheoceras*, but until the young are known there can be no certainty in such conclusions.

The similarity of this genus to *Olcostephanus* is very close indeed. The costæ on the venter of that genus are, however, not so fold-like, and the nodes on the umbilical shoulders are correspondingly smaller and more numerous. The sutures in *Olcostephanus* are much more complex in outline, and there are fewer saddles and lobes.

The coronate form of the volutions and deep open umbilici retained in some untuberculated shells have a certain remote resemblance to some forms of *Pachydiscus*, but, so far as I know, none of these, nor any species of Cretaceous Ammonitinæ, have volutions so excessively depressed and so similar to the Stepheoceratidæ of the Jura and some Goniatitinæ of the Carboniferous.

The living chamber is full three-fourths of a volution in length. Lateral zones do not exist, the umbilical zones being abrupt and the umbilical shoulders on the lateral edges of the venter.

The only form in the Cretaceous that is similar to this is in the young of *Gabbioceras batesi* (Gabb). This last has a similar coronate form without any lateral zones throughout the neanic stage, but the sutures show this to belong to a different suborder, the Leptocampyli, with which it also agrees in the aspect of the shell and the characters of the adults.

The sutures have very peculiar broad, short ventral lobes and first lateral lobes. There is but one broad principal lateral saddle, with coarse marginal saddles; the lobes and saddles are ammonitic—that is, completely margined by small lobes and saddles. White's figure has the sutures very imperfect and much worn away, but shows the orad trend of the auxiliaries. It is also defective in regard to the first auxiliary saddle. This is a well-defined and very broad saddle, smaller than the first lateral, but otherwise resembling it. The sutures are considerably worn away in the specimen figured, but the preservation is better than in White's fossil. The differences in the sutures and form from its assumed congeneric associates in the Pulchellidæ can be accounted for if it is assumed that this genus is in its principal characteristics an arrested development of the coronate form of the early stages, as stated in the introduction to this paper.

Vascoceras hartti (Hyatt)

Pl. XIV, fig. 16.

Ceratites harttii Hyatt, 1870, Geol. and Phys. Geog. Brazil, p. 386.
Buchiceras harttii Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 370.
Ammonites harttii White, 1888, Arch. Mus. Nac. Brazil, Vol. VII, pl. 19.
Vascoceras? harttii Choffat, 1898, Faune Crét. du Port., Vol. I, 2d series, pl. 13.

This fine fossil was received from Prof. J. C. Branner, and was collected by him not far from the locality of White's fossil of the same species. It is a cast, the diameter of the whole is 175 mm., the transverse diameter of the last volution is 124 mm. The form and general aspect is about the same as in White's figure; living chamber of the same length—three-fourths of a volution—and also other external characters and sutures are as described in remarks upon the genus; the inner volutions could not be exposed. There is not the slightest fragment of shell upon this cast, but there are the remains of the cemented valves of two or three ostreans. With reference to these I again reiterate the opinions expressed with reference to Hartt's and White's specimens. This cast must, like these, have been a fossil at the time the ostreans were building their shells, since their valves are attached to the surface of the cast and fit into the irregularities produced by abrasion before they began to grow on its exposed surface. It was not a member of the fauna in which they were found, but came from some earlier strata.

Locality: Province Sergipe, Brazil.

Age: Cenomanian?

TOLYPECERAS[a] n. gen. Hyatt.

The curious species upon which this is founded, *Tolypeceras* (*Amm.*) *marcousanum*, described and figured by Pictet and Campiche in their Terrains Crétacés de St. Croix, is represented in the collections of Museum of Comparative Zoology by a fragment collected by Jules Marcou, near Nozervy, in Switzerland. This is, however, sufficient to enable me to see that the sutures of a somewhat younger stage than those figured by Pictet and Campiche are of the same type as those of *Lenticeras*, but with shorter marginals. The first lateral saddle is broad and solid and the other saddles are also broad and not deeply cut into. The outer volution is 22 mm. in

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[a] *Τολύπη*, a lump.

diameter through the mesal plane and 20 mm. at the broadest part between the nodes. The next youngest volution is 9 mm. in ventrodorsal diameter and 9 mm. broad.

BARROISICERAS Grossouvre.[a]

According to Grossouvre's and Redtenbacher's figures this genus evidently has smooth, compressed young, with a continuous keel. Grossouvre shows some forms intermediate between those of his involute *haberfellneri* and the very discoidal ones figured by Redtenbacher. It is very obvious that these have no affinities with *Tissotia*, unless it may be through the similarity of the young. The young in this and in *Tissotia* suggests affinity with the so-called *Oxynoticeras* of the Cretaceous figured by Neumayer. Apparently the young figured by Redtenbacher is more involute than at later ages.

The metamorphoses seem to be (1) entire keel, sides smooth, venter acute, and form involute; (2) costated with entire keel; (3) tuberculated and costated and keel broken up into tubercles by crossing of venter by costæ; (4) continuous keel again. (See Redtenbacher, Am. Päon., Abhandl. K.-k. geol. Reichsanstalt, Vol. V, 1873, pl. 23, fig. 3 *b, d.*)

This group, so fully described by Grossouvre, contains an excellent series of forms which he largely includes under the single name of *B. haberfellneri*. According to the mode of classification followed in these pages, the great differences in form and other characters, including corresponding differences of development between his *B. haberfellneri* var. *harlei* and var. *desmoulinsi*, indicate distinct species widely removed from each other. It makes no difference in following out this method whether these are obviously connected by intermediate forms or not, the sole criterion being whether the species differ in their form, involution, and other characters sufficiently to be arranged in a natural series which can be shown to be parallel or partly parallel with other generic groups about which there is more complete information.

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[a] This genus is referred to Mammitidæ in Hyatt's chapter in Zittel's Text-book, while in the original copy of the present manuscript, prepared in 1897, it appears among the Pulchelliidæ. The notes on the Pulchelliidæ then written are entirely superseded by the pages in Professor Hyatt's handwriting published here, in which the family is much restricted and does not contain *Barroisiceras*, *Stoliczkaia*, *Tissotia*, nor *Neolobites*, all of which were included in the original manuscript. These remarks on *Barroisiceras* are inserted in the revised manuscript just before Pulchelliidæ.—T. W. S.

BARROISICERAS DESMOULINSI Grossouvre.

Barroisiceras haberfellneri var. *desmoulinsi* Grossouvre, 1893, Ammonites Craie supérieure, pl. 2, fig. 6.

A very stout form, with huge nodes and having the continuous keel until a later stage.

Locality: Near Périgueux (Dordogne).

Age: Coniacian.

BARROISICERAS HAUERI n. sp. Hyatt.

Barroisiceras haberfellneri var. Grossouvre, 1893, Ammonites Craie supérieure, pl. 2, fig. 1 only.

This is more compressed than *B. desmoulinsi*, the nodes are smaller and more numerous at the same age, and the keel is broken up into tubercles.

Locality: Same as above.

Age: Same as above.

MANTELLICERATIDA.

MANTELLICERATIDÆ.

This group was described in Zittel's Text-book, Cephalopoda, page 587, as the Pedioceratidæ, and included only the genera *Pedioceras*, *Douvilleiceras*, *Steuroceras* (*Odontoceras*) Cossmann, and *Diadochoceras*. Of these, *Steuroceras* should be removed to the Hoplitidæ. In the young, or throughout life in primitive forms, there is close parallelism with *Phricodoceras* and other discoidal tuberculated forms of the Cosmoceratidæ, but in later stages the large single or imperfectly bifurcated costæ cross the venter. All traces of tubercles may be lost at this or a later age in some forms, but in most species there are at least two rows, one on each of the ventro-lateral angles. There is never at any stage a row of median ventran tubercles nor a keel,[a] nor are the ventral costæ ever cut through by a narrow ventral channel, as in Hoplitidæ.

[a] *Acompsoceras* appears to be an exception in the figure given by Schlüter, but that author distinctly states that no true keel is formed.

METASIGALOCERAS n. gen. Hyatt.

The type of this genus, *Metasigaloceras rusticum* (Sow.), has been figured by several authors.[a] All of these figures, including Sowerby's, show a form in section like that of *Sigaloceras taylori* and two rows of large tubercles. These are, however, not truncated on the casts as in that genus, but are apparently hollow spines arranged in two outer lines. There is no inner line of tubercles. There are the same number of lobes and saddles on the sides as in *Sigaloceras*, viz., three broad and rather deep, solid saddles with corresponding large lobes. The sutures, as figured by Sharpe, are sufficiently similar to those of other genera in the family Mantelliceratidæ to show that it can readily be placed in this group. The first lateral saddles have three long branches, the second lateral is rather narrow and, although well divided, is club shaped, and the third is broad and deeply bifid. This outline is more like that of *Douvilleiceras* than any other genus. The dorsal sutures could not be compared. The alternating costæ are tuberculated on the venter of *Pseudaspidoceras* and smooth in *Sigaloceras*. The general resemblances to *Aspidoceras* are apparently close, but as this genus has no inner line of tubercles and perhaps no strongly developed lateral costations at any stage, the comparison fails. It is obviously a more primitive form than that of *Pseudaspidoceras* or *Diadochoceras*.

PSEUDASPIDOCERAS n. gen. Hyatt.

This genus is instituted for some Indian fossils which in the adult forms and ornaments of some species show close parallels with Jurassic Aspidoceratidæ, but the development and sutures place them in the same family with *Diadochoceras*. Their forms are discoidal with quadrate volutions, broad concave venters, flat lateral zones or sides, prominent umbilical shoulders, and distinct convex, smooth umbilical zones. The costæ are wide apart, cross the venter and have two ventral and at least four lateral rows of tubercles, two on either side. The young have in the type form *Pseudaspidoceras footeanum* (Stoliczka),[b] stage similar to that of *Diadochoceras nodosocostatum* with, however, more prominent alternating costæ and more quadragonal form of whorl.

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[a] Amm. rusticus Sowerby, Min. Conch., p. 177; Amm. rusticus d'Orbigny, 1840, Terr. Crétacé, pl. 111; Amm. rusticus Sharpe, 1856, Foss. Moll. of Chalk of England, pl. 20.

[b] Foss. Ceph. Cret. Southern India, pl. 52.

Other species of this genus are as follows: *Pseudaspidoceras* (*Amm.*) *conciliatum*, *cunliffi*, and perhaps *crassitesta* Stoliczka;[a] also *Pseudasp.* (*Amm.*) *euomphalum* Sharpe,[b] and *deciduum*, equal *Amm. rotomagensis* d'Orbigny.[c] There is also a stouter species from the same locality as the last, Rouen, which has the ventral tubercles in close approximation and a much more aspidoceran aspect than in the usual form. This is *Pseudasp. schlüteri* n. sp. Hyatt (*Amm. rotomagensis* Schlüter).[d]

The fact that this species and *Metacanthoplites rhotomagensis* (Defrance) which has a line of median ventran tubercles and a distinct mode of development, have been so often published under the same specific name is very interesting. It shows how close is the parallelism of form between two widely separated genera, one in the group Cosmoceratida and the other in the Mammitida.

DIADOCHOCERAS Hyatt.[e]

The young of this genus, first cited in Zittel's Text-book, page 587, has in its youngest stages a more cylindrical volution and more discoidal form and slower growth than in *Douvilleiceras*. The paranepionic stage has a coronate form with large tubercles and smooth sides, as seen from the umbilical aspect. At this stage the venter could not be seen. Later lateral costæ appear and a line of very small tubercles at their inner ends. In the neanic stage there are ventral tubercles situated on the larger costæ and a broad depression occurs between them on the continuous costæ that cross the venter. This depression is not at first present in the intermediate untuberculated costæ, which are continuous laterally and ventrally. Later in the ephebic stage the intermediate costæ disappear on the sides but remain on the venter and become dichotomous from the lateral row of tubercles of the larger costations. This may be a matter of individual variation or it may be characteristic of different species, since in d'Orbigny's figure (Terrain Crétacé, pl. 75) it is not present in the adult, and two specimens that I have handled of the type species, *Diad. nodosocostatum* d'Orb., differ, the costæ remaining single in one and becoming dichotomous in the other. There is also a third row of tubercles developed in this genus on the umbilical shoulders that is not present in *Douvilleiceras* until a later age, when the associated characters are quite distinct.

[a] Foss. Ceph. Cret. Southern India, pls. 50–52.
[b] Foss. Moll. of Chalk of England, pl. 13.
[c] Terr. Crétacé, pl. 106.
[d] Palæontogr., Vol. XXI, pl. 6.
[e] Διάδοχος, a successor.

PEDIOCERAS Gerhardt

Type *Ped. cundinamarcæ*, Gerhardt Kreideformation in Columbien, etc. Neues Jahrb. für Min., Geol., und Pal., Beil.-Bd. 11, 1897–98, p. 172, pl. 4, fig. 7. Age Aptian. A stout, quadragonal, very discoidal shell, with two lines of outer tubercles and one on the umbilical shoulders, all very slight, costæ linear, but prominent on the sides and crossing the venter, which is broad and concave. The dorsal side barely covers the outer line of tubercles. No sutures given. Includes *caquesensis* and *ubaquensis* Karst.

DOUVILLEICERAS Grossouvre.

The type of this genus is the fossil figured first by Walch in the Naturforscher, Vol. I, 1774, p. 196, pl. 2, fig. 3. This was cited by Schlotheim in his Beitrage zur Naturgeschichte der Versteinerungen in Taschenbuch für Mineralogie, Jahr. 7, I, p. 111, as the type of *Amm. mammillatus.* The figure given by Walch seems to apply to the young of the form usually cited by authors as *mammillaris* and figured by d'Orbigny under this revised name. *Mammillaris* is cited by Grossouvre, without an authority after the name, as the type of his genus *Douvilleiceras* in his Ammonites de la Craie Supérieure, page 26, and the suture alone is given on page 23.

The young of the shells in the genus have after the smooth nepionic stage highly coronate depressed volutions with broad smooth venter and a line of spines on the ventro-lateral angles. These are at this time coincident with the umbilical shoulders, the true sides of lateral zones being of later age. The umbilical zones at this time are broad and smooth and convex, reaching from the tubercles to the lines of involution. Faint costæ are developed from the tubercles in both directions, completely crossing the venter, and shorter ones on the sides. They appear also to be dichotomous at the tubercles. Later these large tubercles separate more widely and intermediate costæ begin to appear, apparently through arrested development of some of the tuberculated costæ already existing. These have the same form and tubercles, but are less prominent than those on either side of them, and sometimes this is carried to the extent of suppressing entirely the alternate pairs of tubercles. During this stage the lines of ventral tubercles appear, and those may be, but are not always, smaller on the alternating costæ. Subsequently at some stage the smaller costæ and tubercles become of equal size with the others. The stage with four lines of tubercles may persist until the shell is one-half to five-eighths of an inch in diameter, but usually another line of minute tubercles appears on what are to become the umbilical shoulders, and lateral costæ and a lateral zone begin to appear. This occurs before or contemporaneously with the appearance of another line of tubercles on the ventral costæ close to the already existing ventral lines. In the next stage a third line appears on the venter next to the last developed, and usually nearer to them than to the ventro-lateral line of primitive tubercles. At or about the same time still another line of tubercles appears on the lateral costæ midway between the two lateral lines. This stage of twelve tubercles is succeeded by a fourteen-tuberculated stage, and in some cases by a sixteen-tuberculated stage, through the generation of additional lines of tubercles on the venter. During these later stages the form of the volution changes, losing entirely its coronate aspect. The venter becomes more and more elevated and rounded, the costæ more prominent, and the tubercles are apt to become more and more equal in size, so that eventually in some species it is difficult to pick out the primitive lateral tubercles. The stage of neanic age, in which there are six lines of prominent spines, is exactly similar to the young of *Pseudaspidoceras footeanum* as figured by Stoliezka in his Fossil Cephalopods of the Cretaceous Rocks of Southern India (pl. 52).

This genus includes the species described below.

Douvilleiceras mammillare (d'Orbigny).

Ammonites mammillaris d'Orbigny (pars).

Assuming that the young of d'Orbigny's species on pl. 72 represents the *mammillatus* of Schlotheim, it is evident from the collections in the Museum of Comparative Zoology that his supposed *mammillaris* given on pl. 73 is a distinct species. The young have the same crowded costæ and aspect of this species only throughout the neanic stage. In this species this crowded condition of the costæ and the development of additional rows of crest-like tubercles on the venter seem to continue indefinitely. In some specimens that can hardly be considered as anything more than sporadic varieties, there are one or two additional lines of tubercles generated within the ventral channel, and in our shell a line of faint tubercles finally appear in the middle of this channel, thus imitating transiently the ornamentation of a distinct family, viz, the Mammitidæ.

Locality: Cherbourg, St. Croix, etc.

Age: Albian.

DOUVILLEICERAS ORBIGNYI n. sp. Hyatt.

Ammonites mammillaris d'Orbigny (pars), 1840, Terr. Crétacé, pl. 73 (not pl. 72).

Through the neanic stage this species is not separable from *mammillare* except by its slightly more discoidal form and more prominent tubercles on the venter, but later than this the costæ separate as given in d'Orbigny's figure, through the nondevelopment of intermediate costæ. This gives an entirely distinct character to the ornamentation. One fragment from Cherbourg, in the Koninck collection in the Museum of Comparative Zoology, shows perhaps a third species, since this change is much more pronounced than in the type cited above and occurs at an earlier age.

This genus is represented in North America by *Douv.* (*Acanth.*) *spiniferum* (Whiteaves), found in Canada, and there seem to be two species, the first described in Mesozoic Fossils, Vol. I, pt. 1, pl. 4, and the second in the same, pt. 4, pl. 35. The differences appear to lie in the costations and tubercles of the older stages.

Localities: Numerous, western Europe.

Age: Albian.

SCHLUETERICERAS n. gen. Hyatt.

This group has in its type species *Schlueterieeras nodosoides*, described and figured in Schlüter's Cephalopoden der oberen deutschen Kreide (p. 18, pl. 8, figs. 1–4) a neanic stage with compressed, flat-sided, moderately involute shell that resembles the neanic shells of *Metoicoceras* and *Mantelliceras* in aspect and in the possession of six rows of tubercles and a concave, keelless venter. In the next stage, however, the ventral lines of tubercles are lost, thus reducing the shell to a quadri-tuberculate stage and much larger and longer nodes and more prominent single lateral costæ are developed, while at the same time the venter becomes flatter. This is a degenerative, obviously gerontic change, but it is so distinct from the similar stages of other genera that it is quite sufficient to characterize the group. It is from the Lower Turonian according to Schlüter.

Other species of this genus are as follows: *Schlueterieeras vielbanci* of the Turonian, described and figured by d'Orbigny in Terrain Crétacé (pl. 108) as *woolgari*, but changed in his Prodrome (Pt. II, p. 189) to this name. The reference to this genus accounts for the retention of two lines of obsolescent tubercles on the flat venter between the large ventro-lateral spines. *Schlueterieeras laubei*, described by Laube and Bruder in Ammoniten der Böhmischen Kreide[a] as *nodosoides* of Schlüter, and *Schlueterieeras michelobense* occur in the Upper Turonian and are distinct in their forms, especially their large nodes and costæ, and in their tendency to form definite channels on the venter, from either *vielbanci* or *nodosoides*

SHARPEICERAS n. gen. Hyatt.

This genus in its full-grown condition has very nearly the same form and characteristics as the neanic stage of *Mantelliceras mantelli*. There are eight lines of tubercles and the volution is compressed quadrate in section. The costæ, are however, more evenly developed and do not bifurcate in the figures given by Sharpe. These characters are so marked and it is so plainly a phyloneanic form that it can not be placed in the same genus with *Mantelliceras*. Its characters in old age are unknown, but in the young, according to Sharpe, the costæ are dichotomous from the line of tubercles on the umbilical shoulders.

Type is *Sharpeiceras laticlavium* (Sharpe), figured on pl. 14 of his Fossil Mollusca of the Chalk of England (Pt. I, pl. 14).

Sharp. schlueteri n. sp. Hyatt, described as *Ammonites laticlavius* by Schlüter in Cephalopoden der oberen deutschen Kreide[b] is a Cenomanian species with less rapidly growing and less compressed volutions than in the English shell. *Sharp. inconstans* (Schlüter) is a more involute species of the same genus, having in its old age, if correctly defined by Schlüter, a volution precisely similar to that of the genus *Acompsoceras*. All of these belong to the Cenomanian

ACOMPSOCERAS[c] n. gen. Hyatt.

The type of this genus, *Acompsoceras bochumense*, was described by Schlüter in his Cephalopoden der oberen deutschen Kreide,[d] from the Cenomanian. In the adult stage, as described and figured, it has large fold-like costæ on the lateral zones, with two rows of tubercles, one on the edges of a flattened venter and the other on the dorsal shoulders. These

[a] Palæontogr., Vol. XXXIII, 1887, p. 229, pl. 25.
[b] Palæontogr., Vol. XXI, pl. 7.
[c] Ἄκομψος, unadorned.
[d] Palæontogr., Vol. XXI, pls. 1, 2.

are exactly like those of *Pulchellia.* In the aspect of these ornaments and in the convex venter with its nascent keel or raised line there is also a close resemblance to *Roemeroceras* and even to *Buchiceras.* But Schlüter distinctly states that this is not a keel "und der Sipho drückt die Mittellinie des Bauches etwas in die Höhe, ohne dass jedoch ein eigentlicher Kiel entstände." In old age the sides become smooth and the venter rounded, and all traces of tubercles and costæ are lost. The sutures have a decided similarity to those of *Sharpeiceras inconstans*, and, as stated in noticing that species, the older stages of this species are similar to those of *bochumense*, while the younger ones, including the ephebic stage, have the characteristics of *Sharpeiceras.* This implies genetic connection with that genus, and if confirmed by further observation, settles the origin of the group. The young are not known, and until these are known it is, of course, questionable whether the affinities for *Sharpeiceras* are as close as is assumed here.

Acompsoceras essendense (Schlüter), described in the work quoted above, and also from the Cenomanian, is another species of the same genus.

Acompsoceras renevieri (Sharpe).

Ammonites renevieri Sharpe, 1856, Foss. Moll. of Chalk of England, pl. 20.

This species is from the Gray Chalk (Cenomanian) of England and has been referred to as similar to *essendense.* It is a more compressed form than either *Acompsoceras bochumense* or *essendense*, but has a nascent keel and two rows of large tubercles, one on the ventral edge and the other on the umbilical shoulders which are similar. The tubercles are connected by broad fold-like costæ with intermediate shorter costations that sometimes bifurcate from the longer ones.

The sutures have a large, deep, and rather narrow ventral lobe divided by an entire siphonal saddle. The first lateral saddle has three large marginals, the first lateral lobe is long, rather narrow, and bifid. There are but three lateral saddles, the innermost of good size and bifid. If this suture is correctly drawn by Sharpe, it is more like that of *Barroisiceras* as figured by Grossouvre than that of *Acompsoceras.* But until the young is known, the generic name should be considered uncertain. The sutures also are not unlike those of some species of the keeled and tuberculated forms like *coupei*, etc

MANTELLICERAS n. gen. Hyatt.

At first sight the type of this group, *Mantelliceras mantelli*, appears to belong to the same genus as *Metoicoceras*, but a slight examination of the development shows them to be generically separable. The tuberculated young *Mantelliceras* approximates to the type of development exhibited by *Douvilleiceras*, and is a compressed tachygenic form of the same family. The adult characteristics also show no close affinities for the Pulchellian group to which *Metoicoceras* probably belongs.

The type species can not frequently be separated from *Calycoceras*[a] *navicularis*, owing to the similarities caused by the continuity of the costæ across the venter and the presence of similar lines of ventral and lateral tubercles. The development, however, and the forms in well-preserved fossils are both distinct and their variations lead in different directions. *C. navicularis* has the coronate form prolonged in its early stages and the costæ prominent on the venter and a median ventran line of tubercles during its neanic stage and sometimes later. The furrowing of costæ on the venter is of later development, and if Sharpe's figures and descriptions in Fossil Mollusca of the Chalk of England, page 39, pl. 18, are correct, it is due to the disappearance of this line of tubercles. I have not been able to get the young of this species for study, but that this line of tubercles is sometimes retained until later is obvious in some specimens that I have had in hand.

The relations of the young to those of *Douvilleiceras* are obvious during the stage in which the volutions have a very broad ventral channel, with costæ crossing the venter and six rows of tubercles, and before the innermost and eighth rows arise on the inner ends of the costæ. In the octotuberculate stage they are like the full-grown form of *Sharpeiceras laticlarium*. The shell of *M. mantelli* is at that time, a middle neanic substage, very closely similar to *Douvilleiceras mammillatum* in its sexituberculate stage. No additional lines of tubercles are added in this genus. On the other hand, the tendency is toward complete suppression of all except the two ventral rows. These disappear also in extreme age. The sutures are obviously of the same type as in other genera of this family and are closer to those of *Douvilleiceras* than any other genus.

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[a] Κάλυξ, calyx. Noted in Zittel's Text-book, Cephalopoda, p. 589.

MANTELLICERAS MANTELLI (Sowerby).

Ammonites mantelli Sowerby, 1814, Min. Conch., pl. 55.
Ammonites mantelli Sharpe (pars.), 1856, Foss. Moll. of Chalk of England, pl. 18, figs. 6, 7 (not fig. 4).
Ammonites mantelli Schlüter, 1872, Palæontogr., Vol. XXI, pl. 5 (not pl. 6).

The compressed form, with broad venter, and presenting clearly three facets, with four rows of tubercles, more or less well defined, is obviously the shell that more nearly than others answers to Sowerby's description and figures. This is obviously the form that in the young is the least involute and has the most decidedly quadragonal volutions, becoming compressed in later stages. This is the var. (a) of Sharpe, as quoted above.

MANTELLICERAS COULONI (d'Orbigny).

Ammonites mantelli d'Orbigny, 1840, Terr. Crétacé, pl. 104 (not pl. 103).
Ammonites couloni d'Orbigny, 1850, Prodrome de Paléontologie, II, p. 147.
Ammonites mantelli Sharpe, 1856, Foss. Moll. of Chalk of England, pl. 18, fig. 4 (not figs. 6, 7).
Ammonites mantelli Schlüter, 1872, Palæontogr., Vol. XXI, pl. 6 (not pl. 5).

This is a highly compressed shell, separable even in the neanic stage from *mantelli*. The young are much more compressed than in *mantelli*, sides flatter, and the form resembling that of the full grown of that species when the shell is not over three-fourths of an inch, or about 18 mm., in diameter. The tubercles are present, but much less prominent in the young than in *mantelli* at the same age.

MANTELLICERAS PICTETI n. sp. Hyatt.

Ammonites mantelli Pictet et Campiche, 1859, Terr. Crét. de St. Croix, p. 200, pl. 26.

The neanic stage, with its more compressed form, but otherwise like the young of *mantelli*, and all stages are finely illustrated by the authors quoted above. The volutions are more compressed than in *mantelli* and somewhat less involute in all stages later than the neanic, and the venter narrower. The octotuberculate stage is more prolonged and the umbilicus wider than in *M. couloni*. In extreme old age the tubercles are all lost and costæ are prominent where they cross the narrow rounded venter. There are a number of this species and casts of some of Pictet's originals in the Museum of Comparative Zoology.

Locality: St Croix.
Age: Cenomanian.

MANTELLICERAS VICINALE (Stoliczka).

Ammonites vicinalis Stoliczka, 1865, Foss. Ceph. Cret. Southern India, pl. 44.

Locality: India.

MANTELLICERAS USHAS (Stoliczka).

Ammonites ushas Stoliczka, 1865, op. cit., pl. 51.

Locality: India.

MANTELLICERAS INDIANENSE Hyatt.

Ammonites mantelli Stoliczka, 1865, op. cit., pl. 41, 42.

This species is similar to true *mantelli*, but the shell retains the eight rows of tubercles and the facetted form until a much later age. It finally loses these larval characters and takes on the usual aspect, with only two rows of ventral tubercles and compressed volutions. There are probably two species under this name. The type of this is fig. 1, pl. 42, a more ornate shell than any variety of *mantelli*, with larger tubercles and deeper depressions on the venter.

MANTELLICERAS DOMEYKANUM (Bayle and Coquand).

Ammonites domeykanus Bayle and Coquand, Foss. sécondaires rec. dans le Chili, etc., p. 10, pl. 2, figs. 2–5.

Retains the tuberculate stage until quite large, and in the full-grown shell, which is of great size, the last volution being 80 and 90 mm. in diameter in one specimen, there are still six lines of well-developed tubercles and the subquadrate form of the volution is but little modified This is by far the most primitive form of this group.

METOICOCERATIDÆ Hyatt.

This family is necessarily instituted for a peculiar group of species whose development does not admit them within the pale of either Heinzidæ or Pulchellidæ, but whose later stages show that they belong in the same group with the latter. The family and generic and to some extent specific characters are necessarily mingled in the following descriptions:

METOICOCERAS[a] n. gen. Hyatt.

The young, although distinct from those of *Heinzia*, enable us to connect *Heinzia* and its more modified allies with what I have misnamed in Zittel's Text-book the Pedioceratidæ,[b] here corrected to Mantelliceratidæ.

The type species, if the full-grown shells were the sole evidence, would necessarily fall into the same genus with *Heinzia matura* on account of the resemblance of the compressed later stages. But the following description of the young shows this to be a case of morphic equivalence based on entirely distinct modes of development.

The earliest stage observed has a coronate form with large lateral tubercles. This stage is of short duration and appears on what seemed to be still the nepionic stage at about 2 to 2.5 mm. in diameter. The venter at this time is broadly rounded and without costæ on the cast. Subsequently at diameter of about 3 mm. the ventral rows of tubercles begin to appear upon fine costæ that pass across the venter and connect the rows of tubercles, and the costæ also begin to spread inward on the sides. The terminations of these at 4 mm. diameter were without tubercles. The costæ are partially bifurcated at the outer row of ventro-lateral nodes, but only one of each pair passes across the venter. The two rows of ventral tubercles are borne upon this costation, and in front of each one is a depression or transverse furrow exactly like those that are so peculiar and characteristic of *Cheloniceras royerianum*. Intermediate costæ begin to appear a little later and at first are without tubercles and are single. In this stage there is an evident modification of a late neanic substage of *Cheloniceras*, which has similar costæ but a more coronate form. These costæ subsequently form a branch of the dichotomous lateral costations or may remain single and short. Though the resemblance to *Aspidoceras* is apparent, the general form and aspect at this age can be accounted for as a parallelism with *Pseudaspidoceras* of India, which is one of the same stock, and arises as the result of the assumption of the subquadrate form after the coronate stage in related organisms. It is of course very likely that this Aspidoceran aspect may have some genetic significance, but the connections that would prove this are not as yet clearly made out. One can not accept all of the characteristics that appear in larval forms as of unquestionable genetic significance. They are safe guides only when carefully compared and

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[a] Μέτοικος, an emigrant.

[b] See Mantelliceratidæ.

systematically handled with due regard to the collateral evidences, deducible from the later stages of development and the obvious relations of the adult and even senile stages. Thus in the present case, while the young would place this genus entirely outside the pale of the Heinziidæ, the later neanic and the ephebic stages and old age and sutures show them to belong near that group. The peculiar elongated crestlike tubercles, the costæ, and finally the sutures are of the Pulchellian type. When these later stages are allowed their full weight, it is then seen that the development shows *Metoicoceras* to be the descendant of some common form from which *Carstenia tuberculata* and *Heinzia provincialis* are also descended. It is also apparent that this must have been either similar to or identical with some species of the coronate genus described here as *Cheloniceras*. The coronate young of *Metoicoceras* are not reconcilable with the young of *Heinzia* nor any other form of this family, so far as known. The development of *Heinzia* differs in the suppression of the coronate stage and of the sextuberculate stage and the appearance of the approximated lines of tubercles on the venter of the Heinzian type by a tachygenic mode of development common in this group. The difficulty of reconciling the development lies in the fact that the outer rows of tubercles appear later than the ventrals and are not developed, like those of *Metoicoceras*, from a primitive row preceding the ventrals in development. This may be a case of what Cope has called retardation of development, but if this is so, the effect is really to accelerate the appearance of the Heinzian characteristics of the venter.

The sutures of the entire groups of Cheloniceratidæ and Mantelliceratidæ are of the same type. The number of lobes and saddles is much more limited than in Heinziidæ or Pulchelliidæ, both on the dorsum and externally. The outlines also are excessively complex, with a certain ragged look due to their long, subdivided marginals, and also apt to be asymmetrical or trifid rather than bifid. There is also a noticeable absence of simple entire saddles and lobes in the umbilical region. Comparison of the sutures of *Metoicoceras* with those of *Heinzia* or *Pulchellia* shows at once resemblances that are quite close enough to place *swallovi* in the same group with *Heinzia*, and the sutures of *Metoicoceras* are especially close to those of *Carstenia? tuberculata*. The development, being irreconcilable with that of any form of Heinziidæ or Pulchelliidæ, shows that the genus can not be placed in either of these families without confusing the picture of their systematic and genetic relations, so far as now known.

Metoicoceras swallovi (Shumard).

Pl. XI, figs. 7–24; Pl. XIII, figs. 1, 2; Pl. XV, figs. 1–4.

Ammonites swallovi Shumard, 1859, Trans. St. Louis Acad. Sci., Vol. I, p. 591.

So far as I have been able to see, this species has not been previously figured, but that described below as *whitei* has been the one selected as the typical form of *swallovi*.

The following quotation from Shumard's description shows that while he had in hand perhaps both of the species here described his remarks seem to apply more decidedly to the one selected as *swallovi* rather than to its less prominently nodose and more complex companion. Shumard states "dorsum [venter] flattened, transversely ribbed, nodose-bicarinate: * * * umbilicus deep, exhibiting about one-third of each of the inner volutions and about as wide as one-half of the width of the last volution." If he had in hand such a specimen as the one he mentions as being 6 inches in diameter, and it was a representative of *whitei*, this large umbilicus would be just about in this proportion, but it would be inapplicable to an ephebic stage as a young specimen of this species. If he had had a specimen of *M. swallovi*, the large umbilicus would have been found in the neanic and ephebic stages in about this proportion. Shumard's other remarks apply also about equally well to either species, but the sutures, as described by him, point out quite clearly the typical form. "Dorsal saddle almost double the width of the superior lateral lobe and divided into two unequal branches by a short subconical auxiliary lobe; the dorsal [outer] branch having three small notches, while the inner one is rounded and has usually only a single small notch at its internal border." Such simple outlines as these occur only in the forms here referred to as *swallovi*, and one of the specimens (Pl. XIII, fig. 2) came from Grayson County, Tex., the typical locality quoted by Shumard.

The young figured (Pl. XI, figs. 7–15) and the sutures (Pl. XI, figs. 18–23) were taken from a specimen found in a piece of the matrix cracked off from the specimen shown in fig. 16 and are quite likely the young of this species, but it is probable that at this age the differences are slight between this species and *whitei*. Three specimens were obtained from this piece of matrix. That to which figs. 12, 13 belonged reached an older stage than figs. 14, 15, and the last node near the umbilicus on this was considerably larger than the preceding nodes, indicating that this young one belonged to this species. The breadth of side at this age was about 9 mm., the transverse diameter about 6 mm. The breadth of the side at the base of the living chamber, which was badly crushed farther on, in fig. 16 is 20 mm., while the diameter between the tubercles is 16 mm. The young volution was quadrate in form, the sides parallel, whereas in the specimen represented by fig. 16, as may be seen in fig. 17, the lateral zones are highly inclined and the venter much narrower than in the young. In the fossil shown on Pl. XII, fig. 2, the breadth of the side at the third suture is about 33 mm., the transverse diameter between the costæ being 23 mm. The outward inclination of the sides in this specimen was not so great as in the fossil represented by Pl. XI, figs. 16, 17, even at the same stage, and the nodes near the umbilicus were apparently not quite so prominent. Besides the marked prominence of the nodes and their dichotomous costæ, the living chamber in the young (figs. 14, 15) is clearly nearly three-fourths of a volution in length, while in the later stage it appears to be in part complete and to be one-half of a volution in length. It is obvious that this species becomes more compressed with increasing age, and has a much narrower venter and less transverse diameter in proportion to the ventro-dorsal than in the young. The protoconch has an arcuate venter (Pl. XI, figs. 7–10) and rounded dorsum, with subangular bend as the outline approaches the opening of the conch. This opening, doubtless once the aperture of the protoconch, is much depressed or broad transversely and continues to have this form throughout the ananepionic and metanepionic substages. The elevation of the venter begins in the second volution, fig. 10, but the form remains smooth and the sutures goniatitic until about the fourth volution.[a] Then nodes begin to appear on the ventro-lateral angles and the venter becomes broader in consequence. The venter is smooth at this substage, the first of the neanic substages. In the next substage, about one-half of a volution later, fig. 14, the costæ become more prominent near the umbilici and wrinkles appear on the venter, each accompanied by a pair of tubercles. In the next substage, which was not seen, it is probable that these ventral costæ become connected with the lateral ones and equal in number to them, and nodes appear on the inner

[a] This was guessed at.

ends of the lateral costæ and there fuse into more or less dichotomous forms. This fusion is not as complete in the fossil shown in fig. 16 as it is in the one shown in Pl. XIII, fig. 2, at a later age.

The sutures seem to follow about the same steps in progress of development as the external characters. Fig. 11 gives an enlarged sketch of cæcum, which seems small in this specimen and which opens into a large siphuncle, whose parts could not be studied any further than is visible in the drawing. Although every effort was made, and this specimen was remarkably clear and transparent, nothing definite could be made out beyond the cæcum. It is certain that the dark color of the wall of this body has no posterior prolongation or prosiphonal continuation. The second septum, beginning the sutures of the metanepionic substage, had unquestionably a divided ventral lobe, as given in fig. 10. This was established by many repeated observations. There were, as usual, but two broad goniatitic saddles of the Tornoceran type on either side and one broad lateral lobe on each side, with a distinct saddle at the line of involution. I was not able to detect any depression, such as I have previously described in other forms as an embryonal umbilicus, occurring at the beginning of the true conch. In the paranepionic substage the suture becomes distinctly divided on the sides into two broad saddles, with a lateral lobe and a lobe at the line of involution on either side, and during this substage the dorsal suture assumes finally the aspect given in fig. 21. The sutures (figs. 18–20, 22) belong to the neanic stage, represented in figs. 12–15. They show the usual mode of division common in Ammonoids of the Jura and Cretaceous, the incoming of auxiliary inflections on the primitive second lateral saddle and the primary bifid division of the first lateral saddle and first lateral lobe, the entire aspect of the siphonal saddle and its subsequent bifidity. Fig. 22 of Pl. XI shows the peculiar prolecanitean aspect of the dorsal inflections before the end of the neanic stage, and illustrates my previous statements with regard to the retention of ancestral characters by these internal sutures. Fig. 23 of Pl. XI and fig. 1 of Pl. XIII are of very nearly the same age, and give the beginning of the ephebic substages. The latter show that the primitive median marginal lobe of the primitive dorsal saddle becomes the large marginal dividing the full-grown first lateral saddles. This suture also shows that the second lateral saddle has a trifid termination in some specimens of this species.

The sutures in the two specimens here described as *swallovi* are somewhat abraded, but their details of outline are sufficiently well preserved in different sutures to enable one to see how much simpler they are than in *M. whitei*. This simplicity of the marginals is not so great in some specimens as it is in fig. 2 of Pl. XIII, since in the suture (Pl. XIII, fig. 1) the second lateral is trifid and in fig. 13 the fourth lateral saddle is bifid. The number of inflections on the sides appears to be less in this species than in *whitei*, five only being present on both sides, with saddles at the lines of involution; and in the fossil shown in Pl XI, fig. 16, there is the same number, with a lobe at the line of involution.

Locality: Grayson County, Tex.; Utah.

Age: Colorado epoch.

METOICOCERAS GIBBOSUM n. sp. Hyatt.

Pl. XV, figs. 5–8.

The single fossil upon which this species is founded could not be placed in any of the species here described under the same genus. It has stouter, broader volutions than any of these, and, instead of becoming more compressed as it grows older, continues the same rate of increase in the transverse diameters The involution is about the same as in *M. swallovi*, but there are no nodes on the umbilical shoulders at any stage, although the alternating longer costæ reach to the umbilical shoulders. Their greatest prominence is at a short distance ventrad of the umbilical shoulder. The costations are like those of the oldest stage of *whitei*, i. e., regularly long, prominent costæ alternating with short ones. The two outer lines of tubercles do not differ from those of other species. The sutures are intermediate between the simpler character of those of *M. swallovi* and the more complex outlines of those of *M. whitei*. The first lateral saddles and lobes have about the same general aspect as those of *M whitei*, but the auxiliaries are similar to those of *M. swallovi*, except that the second lateral saddle shows small marginals and a tendency to division on its outer side, which has not been observed elsewhere. The third lateral saddle shows in some sutures of the left side a tendency to become divided, which is necessarily exaggerated in the drawing and which is entirely absent in many sutures, both younger and older than the one drawn. The dorsal sutures could be seen only from above and in a fragment of the cast of the last camera, which is not included in the figures given. It was evident that the antisiphonal lobes resembled those of *M. swallovi* and *Heinzia* in being elongated and considerably telescoped into each other. The saddles also were similar, especially the first dorsals, which were narrow, long, phylliform, and deeply cut into by the marginals, as in *Heinzia matura*. There was also a similar broad pair of second lateral dorsal saddles; these certainly had one marginal lobe and perhaps two, being perhaps trifid, but very flat on their bases. The remaining saddles were entire. There were apparently five saddles and four lobes on the right side and six saddles and five lobes on the left side, corresponding to the differences in number of the external auxiliaries on the same sides. The overlapping of the sutures is noticeable in this specimen, but whether it can be considered characteristic of the species is doubtful. The whole diameter is 85 mm. The last volution on the face of the septum from the center of the venter to the line of involution is 50 mm.; the ventro-dorsal diameter is 35 mm. The amount of involution at this point is two-thirds of the breadth of the side of the next inner volution, being 17 to 27 mm. The umbilicus, in consequence of the smoothness of umbilical zones and the nonextension of the costæ internally, has a smooth, funnel-like aspect, entirely distinct from that of *M. swallovi*, although it is nearly of the same size and differs therefore from that of *whitei* in being much larger as well as smoother.

Locality: Texas.

Age: Colorado epoch.

Metoicoceras whitei n. sp. Hyatt.

Pl. XIII, figs. 3–5; Pl. XIV, figs 1–10, 15.

Buchiceras swallovi White, 1875, Geog. and Geol. Expl. and Surv. West of 100th Meridian, Vol. IV, p. 202, pl. 20, figs. 1 a–c.

Buchiceras swallovi Stanton, 1894, Bull. U. S. Geol. Survey No. 106, p. 168, pl. 37; pl. 38, figs. 1–3.

The external characteristics of this species, in comparison with *M. swallovi*, consist in more compressed volutions without such prominent nodes on the umbilical shoulders. They have nodes, but these are more a part of the costæ and less prominent, the sides are consequently flatter than in *swallovi*. There is a decided tendency in the Texas specimens to have the umbilicus smaller and the inner row of the two outer lines of tubercles elongated longitudinally and parallel with the outer rows. The sutures are more complex at an earlier stage and remain more complex throughout life as regards their marginal digitations. The first lateral lobes are also narrower and longer in proportion in the later stages than in *swallovi*, and the inflections are more numerous at the same age, being from six to seven, instead of five or six as in *swallovi*. The youngest stage seen (Pl. XIV, figs. 1, 2) had a living chamber complete near the umbilicus and not quite three-fourths of a volution in length. Several specimens showed a completed living chamber near the umbilical shoulders and on the sides, and in adults it is much shorter, invariably one-half of a volution in length. The sides were smooth and flat at the beginning of the outer volution in this specimen. The costæ appeared as shown in the figure and nodal termini were developed on the last costation near the aperture. These were also present in the specimen shown in fig. 4, but, as may be seen in figs. 2 and 5, these were not prominent as in *swallovi*. The same is true of all of the seventeen specimens examined besides Pl. XIII, fig. 4 The elongated second row of lateral tubercles found in fig. 4 is also perceptible to some slight extent in the specimen fig. 7, but is absent in younger stages and is not present at any stage in some specimens. This second row of tubercles may be very slightly developed in some specimens, and the costæ are also much less pronounced and the venters narrower than in those figured. The other two specimens show a much stouter form with broader venters and more prominent costæ. These can only be separated from true *swallovi* by their costæ, flatter sides, and less prominent umbilical nodes.

An old suture of this species is shown on Pl. XIII, fig. 5. This was the basal suture of a fragment of the living chamber of a fossil of about the same size, probably, and age as the one shown on Pl. XIII, fig. 4. The differences of this suture appear to be considerable when compared with Pl. XIV, fig. 8. The external characters of this fossil are equally decided, but the absence of the internal volutions and the variability of the sutures in this species does not justify the separation of this as distinct from *whitei*. The latter part of this living chamber and the whole of another larger fragment has huge fold-like costæ that cross the venter, cutting it into waves. The costæ are flat on the venter with abrupt forward edges. The ventro-lateral tubercles and the second lateral row disappear on these costæ. The decrease of the involution through shrinkage of the later diameters is greater in this than in the old age of the specimen shown on Pl. XIII, fig. 4. Breadth of the side from line of involution to the siphonal saddle at the suture figured is 65 mm. The length of the living chamber on the outside or venter is 190 mm. and apparently complete, and the breadth 75 mm. In the specimen shown in Pl. XIV, fig. 7, the normal rate of increase is from 50 to 70 mm. in the same distance measured along the venter, and in the living chamber of the fossil shown on Pl. XIII, fig. 4, which is of the same length on the venter it is from 70 at the base to 80 mm. near the end. In both of these old specimens the length of the living chamber and decrease in the rate of growth was therefore about the same and about one-half of what it was in the fossil shown on Pl XIV, fig. 7, which was also an old specimen but was measured along the septate and therefore younger portion of the outer volution. The increase by growth previous to this must have been greater still. The broadening of the venter noticeable near the aperture (figs. 3 and 4), the spreading of the costæ across the venter, and the loss of nodes are the same in all three of these specimens and show them to have entered upon the last or paragerontic substage or decline. The youngest suture examined in this species is shown in Pl. XIV, fig. 3, from the left side, and this has fully entered the ephebic stage and is already more complex than those of *swallovi* at a much later age. The corresponding suture on right side of the same specimen is similar, but the third lateral saddle was quadrifid instead of bifid and the fourth lateral was more distinctly bifid and phylliform. The matrix of this fossil from Elm Fork, Tex., was a gray limestone, whereas that of the specimen shown (fig. 9) was a red clayey limestone, but from the same locality. The suture was much older, but nevertheless had simpler third and fourth saddles on both sides of the outer volution. The position of the suture of the specimen shown in fig. 7, given in fig. 8, is indicated in fig. 7 by a straight line near the venter, but the sutures throughout this volution have the same outlines. This and fig. 10 are the most complex of the full-grown sutures observed in this species.

Fig. 10 was taken from the left side of Pl. XIII, fig. 4, and shows the outlines of about the same age as in Pl. XIII, fig. 8. The shell was stripped from a part of the fossil shown in Pl. XIII, fig. 4, also, and the corresponding suture on that side also observed. In this way it was found that the sutures on the two sides differed considerably. They were alike in their first and second lateral lobes and saddles, but the third lateral saddles were simpler on the right side, the side given in Pl. XIII, fig. 4, in having the marginals less distinct and the fourth lateral was entire instead of being bifid. The outlines internally were the same and there were seven saddles and seven lobes on each side, and saddles at the lines of involution. The differences between the more fully developed sutures on the left side, those of the right, and the oldest suture showed similar degenerations, the saddles becoming much shorter and broader in proportion and the marginals less distinct.

The table on page 126 gives an account of the variations observed in the sutures. It will be observed that the first lateral lobe is quite generally bifid, but in the largest specimen (Pl. XIV, fig. 8) from Elm Fork, Tex., it is sometimes trifid. It is very obvious that this characteristic may be capable of two translations, some of the first lateral lobes in this specimen being made trifid by a slight enlargement and extension of the main terminal marginal lobe.

The second lateral lobe varies from simple primitive form of bifidity to trifid without regard to age, but in most specimens it is bifid. The third lateral saddle is bifid or trifid without regard to age, but tends to become quadrifid in older stages. The fourth varies from entire to bifid or trifid, but in most cases is bifid or trifid. The fifth varies from entire to bifid or trifid, but is in most cases entire, sometimes bifid but rarely trifid. The number of lobes and saddles on the sides varies from 11 to 14 in the early ephebic substages and from 13 to 16 in the full grown.

No. 6 is taken from a fossil with a notably stouter volution, more prominent coarser costæ, and larger tubercles than any of its companions of the same size from the same locality, Elm Fork, Tex The whole diameter of this fossil when complete was probably not less than 63 mm. and the living chamber of the usual length, a little over half of a volution. Unluckily, like all others of this species, the aperture has been badly broken and the rostrum could not be observed. I at first thought this exceptionally stout and more coarsely ornamented specimen must be a different species, but the sutures, when laid bare, were identical with others here described as *M. whitei*, especially close to that given on Pl XIV, fig. 10.

Variations observed in sutures of Metoicoceras whitei.

[The number of saddles and lobes represents one side only. All except Nos. 11, 12, and 15 are from Elm Fork, Hortons mill, Dallas County, Tex.; No. 15 is from Utah; no locality is given for Nos. 11 and 12.]

Specimen.	Side observed.	Length of suture line or breadth of side.	First lateral lobe.	Second lateral lobe.	Third lateral saddle.	Fourth lateral saddle.	Fifth lateral saddle.	Number of saddles and lobes on sides.	Number of saddles and lobes on dorsum.	Figured.
		mm.								
1	Left	10	Bifid	Trifid	Trifid	Bifid	Entire.	11	(?)	Pl. XIV, figs. 1-3.
	Right		do	do	do.[a]	do	(?)	11		
2	Left	13	Bifid?	(?)	do	Entire?	(?)	(?)	(?)	
	Right		(?)	(?)	do	do.?	(?)	(?)		
3	Left	17	Bifid	(?)	do	Trifid	Entire.	14	(?)	Pl. XIV, figs. 4-6.
	Right		(?)	(?)	(?)	(?)	(?)	(?)		
4	Left	17	(?)	(?)	(?)	(?)	(?)	(?)	(?)	
	Right		(?)	(?)	Trifid.[a]	Trifid	Trifid	11		
5	Left	23	(?)	(?)	(?)	(?)	(?)	(?)	(?)	
	Right		(?)	Bifid	Trifid	Bifid	Entire.	(?)		
6	Left	23	Bifid	do	Bifid[g]	do	do	13	(?)	
	Right		(?)	(?)	(?)	(?)	(?)	(?)		
7	Left	28	(?)	(?)	Bifid	Trifid?	Entire.	11	(?)	
	Right		(?)	(?)	(?)	(?)	(?)	(?)		
8	Left	31	(?)	(?)	(?)	(?)	(?)	(?)	10	Pl. XV, fig. 15.
	Right		Bifid	Trifid	Bifid[b]	Trifid	Bifid	13		
9	Left	34	(?)	(?)	Trifid[a]	(?)	(?)	(?)	(?)	
	Right		(?)	(?)	do.[a]	Entire.	Entire.	13?		
10	Left	35	Bifid	Bifid	Bifid	do	do	16	(?)	Pl. XIV, fig. 9.
	Right		do	do	do	do	do	16		
11	Left	39	do	do	Trifid	do	do	13	(?)	
	Right		do	do	do.[a]	do	do	13?		
12	Left	45	do	(?)	do	do	do	13?	(?)	
	Right		(?)	(?)	do	(?)	(?)	13?		
13	Left	55	Bifid	Bifid	do.[d]	Bifid	Entire.	15	(?)	Pl. XIII, figs. 3, 4, and Pl. XIV, fig. 10.
	Right		do	do	do.[e]	Variable.[f]	do	15		
14	Left	65	do	do	Bifid[c]	Trifid	Bifid	15	(?)	Pl. XIII, fig. 5.
	Right		(?)	(?)	(?)	(?)	(?)	(?)		
15	Left	70	Bifid	Bifid	4-fid	Trifid	(?)	13?	(?)	Pl. XIV, figs. 7, 8.
	Right		do	do	do.[g]	Bifid	Entire.	13		

[a] Beginning to become quadrifid, i. e., having four minute marginal saddles by division of one of the bifid marginals.
[b] With a few minute digitations beginning to appear.
[c] With three other very minute lobes, five marginal lobes in all.
[d] Distinctly trifid.
[e] Obscurely trifid.
[f] Some entire, others obscurely trifid.
[g] With a number of small marginals just beginning.

In all of these specimens the first lateral saddles were of very nearly the same general character, decidedly deeply bifid, even in the youngest stages recorded, and with both arms subdivided by one or more marginal lobes; the second lateral saddles were also complex at all stages observed, and one small specimen not recorded in the table, with suture lines on the last volution running from 12 to 18 mm., showed the same facts. This has bifid first and trifid second lateral lobes, with quadrifid third lateral saddles on both sides. A bifid fourth is visible on the right side when the volution is less than 12 mm. This same saddle with a bifid base is the only one visible in another fossil with a suture line of about 8 mm. It is evident that the law of variation in the sutures is that lobes and saddles increase in variability of outlines and in number progressively from the venter toward the dorsal lines of involution, the so-called auxiliaries or derivatives of the primitive second lateral saddles of the young being far more variable than the first lateral saddle.

Locality: Kanab Valley, Utah; Elm Fork, Dallas County, Tex.

Age: Colorado epoch.

Metoicoceras acceleratum n. sp. Hyatt.

Pl. XIV, figs. 11–14.

I at first thought this to be the young of the species described by Whiteaves as *Placenticeras liardense*, but the figures given by him merely indicate that the venter had continuous costæ across it. The condition of his fossils was, however, such that he did not see the venter, and this can only be inferred from the lateral aspect as given in his drawings. Apparently there were no tubercles on the sides in the full-grown specimen, and the umbilicus was about the size of that of *M. whitei* and not so small as in this species. There were no nodes nor prominent costæ near the umbilical shoulder in this fossil, and the two outer rows of tubercles were much less prominent than in the preceding species. The venter in the first half of the outer volution resembled that of *M. whitei* at an earlier age on the first quarter of the outer volution of the specimen shown in Pl. XIV, fig. 1, but with less decided tubercles, and on the latter half of this volution it is changed as the venter is in the old age of *M. whitei*. That is to say, the costæ that cross it are prominent and flat, but not channeled nor concave. The costæ on the sides are not so prominent and coarse as in *whitei*. There are more of them, and only the last begin to reach entirely across the sides. There is a sigmoidal channel on either side that does not reach across the venter. This is a characteristic occurring also in *M. liardense*, but not in other species. This occurs close to what must have been the edge of the aperture, since the living chamber is considerably over three-fourths of a volution in length and was probably a little longer when complete. The black line shows the position of the basal septum of the living chamber shown on the opposite side of the fossil figured.

Locality: Elm Fork, Horton's mill, Dallas County, Tex.

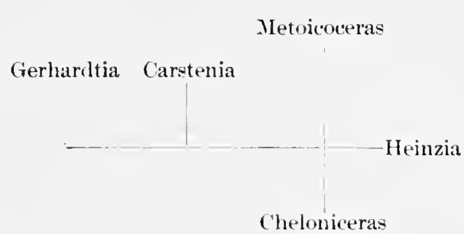
Age: Colorado epoch.

HEINZIIDÆ.

The members of this family are easily distinguishable from the typical Pulchelliidæ by the possession at some stage of elongated, usually double, but more or less connected tubercular terminations on the ventral ends of the lateral costæ. All of the forms so far known have coarser and more complete lateral costæ than are usual in Pulchelliidæ, and there is, especially in primitive forms, a tendency to the development of stouter volutions, with less involution and consequently wider umbilici. The average size is larger, and the development is very distinct in all forms, so far as known. The young are stouter, less involute, and have costæ continuous across the venter. The tubercles appear upon these costæ in two lines of single tubercles, and then subsequently two rows are developed upon the outer sides of these that remain more or less closely connected. The lateral costæ are similar to those of Pulchelliidæ, but sometimes a median or an inner row of tubercles or both appear in the later stages. The ventral channels are apt to be real channels furrowing both the costæ and the intercostal spaces on the venter, and in the young and in primitive forms are apt to be narrow and smooth. The sutures are similar to those of Pulchelliidæ, but as a rule have fewer and larger saddles and lobes, and the outlines more complex at the same comparative age, judging from the size of the casts.

The development is so distinct from that of Pulchelliidæ in some species of *Heinzia* that if it were not for the fortunate accident that placed one specimen of *Heinzia matura* in my way, I could not have offered any rational suggestion as to the true relations of this family. The development of *Heinzia matura*, however, shows, as stated below, a form that in the young is involute, smooth, and compressed with a rounded venter as in the young of Pulchelliidæ. Then it has a faint line of ventral tubercles and flat venter followed by a true Pulchellian stage with channeled venter bordered by single tubercles. In other words, at this age the species is like *Pulchellia* except that the tubercles are not elongated crests. The ephebic stage shows the usual terminal double row of tubercles of the Heinziidæ. The conclusion from this evidence is that the Pulchelliidæ probably arose from *Heinzia* or some very similar form through the increase of compression and involution and from the prolongation of the smooth larval stages, the suppression of the preliminary lines of ventral tubercles in the young and the tendency in later stages to suppress the second lateral lines of tubercles. This inference acquires some support also from the fact of the earlier appearance of Heinziidæ in the Neocomian. We can in this way account for the communal resemblances of these two families in their adult forms, costæ and sutures, but it must be borne in mind that the evidence upon which this inference is based is not by any means complete.

The evidence with regard to the connection and genesis of forms is less complete than in the Pulchelliidæ, but the following diagram gives the apparent relations of the genera so far as the ontogeny at present known indicates these:



HEINZIA Sayn.

Sayn[a] defines this genus in the following terms: "Les espèces qui se rattachent aux *Pulchellia subcaicedi* et *provincialis* sont nettement caractérisées par une ornementation vigoureuse, visible dès les tours embryonnaires, un accroissement en général moins rapide, des sutures le plus souvent très éloignées les unes des autres et remarquables par le grand développement en largeur des selles et l'amoindrissement des lobes très étroits et peu découpés." The group described by Sayn under this name is obviously a

[a]Amm. du Barrémien du Djebel-Ouach près Constantine: Ann. Soc. d'Agriculture de Lyon, 6th series, Vol. III, 1890, p. 151.

composite of several genera distinct in their development and in their sutures from any form of true Pulchelliidæ and also differing decidedly from each other. The species here mentioned as *H. sayni* is assumed to be the type because it is one of the first two species mentioned by this author and is the first one of these figured. His *Pulchellia subcaicedi* appears to me to belong with *Pulchellia caicedi* (Karsten) in the genus *Carstenia.*

HEINZIA SAYNI Hyatt.

Pulchellia provincialis Sayn, 1890, Ann. Soc. d'Agriculture de Lyon, 6th series, Vol. III, pp. 165, 166; pl. 1, fig. 16; pl. 2, fig. 7.

This is neither the species figured by d'Orbigny nor that given by Nicklès, but a dwarfed, compressed form with fine tubercles and fine costæ developed at a comparatively early stage. It is similar to true *H. provincialis* in being less involute than *corioli.*

Locality: Djebel-Ouach, North Africa.

Age: Barremien.

HEINZIA CORIOLI Nicklès.

Pulchellia (Heinzia) corioli Nicklès, 1890, Mém. Soc. géol. France, Paléontologie, No. 4, p. 53, pls. 6, 7.

This species and another, supposed to be allied to *sayni*, are both larger, have coarser ornaments and more complex sutures than the African forms, and broad channels like *Gerhardtia.*

Locality: Spain.

Age: Barremian.

HEINZIA HEINZI Coquand [a]

Pulchellia heinzi Sayn, 1890, Ann. Soc. d'Agriculture de Lyon, 6th series, Vol. III, pl. 2, fig. 5.

This species has similar ornamentation, but much coarser than in *H. sayni.* The sutures are given, and these are not similar to those of Pulchellidæ.

Locality: North Africa.

Age: Barremian.

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[a] Coronites is represented in North Africa by a small group of dwarfed forms having the development and general aspect of the more discoidal forms of *Hoplites.* The type is *Cor.* (*Heinzia*) *coronatoides* (Sayn). This form has a ventral channel, beginning at a comparatively early stage while the young are still highly coronate and the costæ dichotomous on the venter. These spring from single nodes on the latero-ventral angles, which are coincident with the umbilical shoulder. These subsequently

HEINZIA HISPANICA n. sp. Hyatt.

Pulchellia (Heinzia) cf. provincialis Nicklès, Mém. Soc. géol. France, Paléontologie, No. 4, pls. 6, 7.

Nicklès's figures give a species with smaller umbilicus and a shallower, wider channel furrowing the costæ only, as in *Pulchellia.* The costæ have more prominent nodes and are more prominent on the venter, which is crossed by them and cut up into waves as in *Pulchellia.*

There is one specimen in the Museum of Comparative Zoology, probably from Escragnolles, that I have labeled *Heinzia* aff. *hispanica.* It differs from this species only in having more involute whorls and perhaps somewhat coarser costæ and possibly the sutures a little more complex.

HEINZIA PULCHELLIFORMIS n. sp. Hyatt.

This species, from the collection in the Museum of Comparative Zoology, has exactly the form and aspect of some of the typical species of *Pulchellia,* except that the costæ are more prominent and cross the inner parts of the sides, and the outer row of tubercles has the broad, double character of those of the *Heinzia* group. This has no inner line of tubercles and has been considered similar to *didayanus,* which is a species of *Nicklesia.*

Locality: Escragnolles, France.

Age: Barrémian.

HEINZIA PROVINCIALIS (d'Orbigny).

Pl. XV, figs. 19, 20; Pl. XVI, figs. 1–3.

Ammonites provincialis d'Orbigny, 1850, Prodrome de Paléontologie, Vol. II, p. 99.
Pulchellia provincialis Uhlig, 1883, Denksch. K. Akad. Wiss., Wien, Vol. XLVI, pl. 20, fig. 2.

Assuming Uhlig's figure to be taken from a species identical with d'Orbigny's, the specimen here figured is a true representation of this

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extend internally into lateral single costæ and the nodes disappear. The costæ become single on the sides or may remain dichotomous. The result is a form in some species that is almost an exact parallel with some forms of the Hoplitidæ. The sutures are simple and have an immature aspect. The ventral is rather narrow and is divided by a small truncated siphonal saddle. The first lateral saddles are very broad, bifid on one side in *H. hoplitiformis* and trifid and still broader on the other. The first lateral lobes are narrow and trifid or bifid. The second lateral saddles belong to the auxiliary series, and are much smaller than the first and only slightly dentated, while the third and fourth saddles are entire. The second lateral lobe is very short and entire, and two other similar smaller lobes complete the lateral line.

This description is taken from Sayn's figures.

species. It has the narrow, deep, smooth ventral channel, which is also shown in Uhlig's figure, with the same peculiar abrupt ventral terminations to the costæ with forward bend on the edge of the channel. The venter is not cut up into waves by the crossing of the costæ as in *H. pulchelliformis.* The channel, in fact, is deeper than the depressions between the costæ, and the ridges that guard it on either ridge give a pointed aspect to the forward terminations of the costæ. This is also observable in Uhlig's figure.

On splitting this specimen I succeeded in exposing three substages of neanic age. The first substage showed faint costæ that crossed the rounded venter, the form being at this time rounded, with gibbous sides and open umbilicus. Then faint tubercles appeared, the venter still remaining rounded between them. These tubercles in the next substage became more prominent, and the venter between them became flattened. The costæ became more prominent at the same time on the outer half of the side and made a slight forward bend on to the venter. Soon after this a very faint, narrow, linear depression indicated the beginning of the ventral channel. I was not able to discover at what age the second range of tubercles began to come in nor their exact position. The volution is gibbous on the sides throughout these early stages and is a rather stout young form with an open umbilicus.

Locality: Escragnolles, France.

Age: Barremian.

HEINZIA MATURA n. sp. Hyatt.

Pl. XV, figs. 12–18.

This species is allied to that described above by Sayn. It is similar in its compressed form, in the amount of involution and in the broad ventral channel, and in having a row of tubercles on the umbilical shoulders. The costæ are, however, much broader and have the double external termination of the group of *Heinzia.* This termination is, however, not distinguishable on the earliest part of the outer volution, but is well developed on the third quarter of this volution. This termination is seen in this specimen to be a modification of the ends of the costæ, and it is not due to the approximation and coalescence of an inner row of tubercles with the outer row. The shell is preserved on one side of this specimen and shows the same markings as on the cast. The young is much flatter and increases faster in the abdomino-dorsal diameters than in other species of *Heinzia* and remains smooth until a later age. The tubercles appear also later on the venter, and there is a flat ventral zone for a more prolonged stage than in *H. provincialis*, and the ventral channel appears later. The umbilical tubercles appear on the last volution figured and are at first single. Then they probably become [double] by the development of two other rows of tubercles near the ventral lines, but this was not actually seen on the specimen.

Locality: Escragnolles, France.

Age: Barremian.

Heinzia ouachensis (Coquand).

Pulchellia ouachensis Sayn, 1890, Ann. Soc. d'Agriculture de Lyon, 6th series, Vol. III, p. 157, pl. 1, fig. 15 (not fig. 14).

This species, described as a *Pulchellia* by Sayn, is an involute compressed form probably in the same genetic group with *H. matura.* This is shown by the ventral channel and costæ and tubercles on the umbilical shoulders. It has not the broad double terminations of the costæ observed in *H. matura.* Fig. 15 is probably a true *Pulchellia,* and is cited under that generic name as *P. kiliani.*

Locality: Djebel-Ouach, North Africa.

Age: Barremian.

CARSTENIA n. gen. Hyatt.

This remarkable group has, as shown by Karsten's figure of *Carstenia lindigi* in the latest neanic or early ephebic stage, coarse costæ with double terminations becoming dichotomous at the middle lateral line and having a line of nodes at their junctions. These are continued later on the single costæ when these appear. The arising of the double line of outer tubercles close together on the ventral line is also shown in this figure. The form is stout in the type mentioned above and similar to that of *Heinzia provincialis,* but in the *Carstenia* (*Amm.*) *caicedi* Karsten it is more involute and compressed. The ventral furrow in *Carstenia lindigi* in the young is narrow and similar to that of *Heinzia,* but later it broadens and becomes similar to that of *Gerhardtia.* This occurs in an earlier age in *Carstenia caicedi.* Descriptions are wholly taken from Karsten's figures.[a]

CARSTENIA SUBCAICEDI (Karsten).

C. subcaicedi (Karsten) is described by that author as having heavy coarse costæ bifurcating like those of *caicedi* and, if his small figure represents the young or a primitive dwarfed form of this group, it shows how very distinct its development must be as compared with that of other genera.

CARSTENIA ? TUBERCULATA n. sp. Hyatt.

C.? tuberculata (*Pul. provincialis* Gerhardt)[b] is described by that author as identical with *lindigi* Karsten. It is, however, less involute, and, although having similar quadragonal volutions, has costæ like those of *Gerhardtia* and there is no median lateral line of tubercles. The sutures are more like those of *Metoicoceras* than of *Heinzia provincialis.* It is possible that the development of this species may show it to be more nearly related to *Metoicoceras* than to *Carstenia.* It has, however, the peculiar channeled bases of the second row of tubercles on either side that have been found so far only in this last-named genus. All of these have been supposed to be of Barremian age. Its characteristics seem also to ally it decidedly with such forms as *Heinzia provincialis,* and to indicate a common origin for all of these genera in some primitive form with similar but more tuberculose volutions. It is obviously a more primitive form than *Heinzia,* which has more compressed and often more involute shells and retains in its latest stage the form and aspect of the young of *H. provincialis* and of the earlier neanic stage of *Metoicoceras swallovi.* The resemblances to *Gerhardtia* are also close, as may be seen on Gerhardt's plates, and its form is similar to the young of *Carstenia caicedi* as figured by Karsten.

These affinities and its obviously primitive larval characteristics show it to be the nearest approach yet found of the probable genetic ancestor of the Heinziidæ.

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[a] Géol. de l'ancienne Colomb. Venez. Nouv. Gren. et Ecuador. Berlin, 1886.

[b] Kreidef. in Columbien: Neues Jahrbuch für Min., Geol., und Pal., Beil.-Bd. XI, 1897–98, p. 152, pl. 2, fig. 8.

Carstenia galeata (d'Orbigny).

Ammonites galeatus d'Orbigny, 1842, Voyage dans l'Amérique méridionale, Vol. III, pl. 17, figs. 3–5 (not figs. 6, 7).
Pulchellia caicedi Gerhardt, 1897, Neues Jahrb. für Min., Geol., und Pal., Beil.-Bd. XI, p. 151. pl. 3, fig. 7.

This species has a form, costæ, ventral channel, and outer tubercles similar to those of *C. caicedi* Karsten, but having the single costæ appearing later, the double outer line of tubercles disappearing at the same time, and no median lateral line of tubercles apparent in d'Orbigny's figures. The double outer tubercles are observable in figures given by d'Orbigny at the beginning of the outer volution and are quite plain upon an excellent cast of this fossil from Chile in De Koninck's collection in the Museum of Comparative Zoology. Figs. 6 and 7 of d'Orbigny are true *Pulchellia*, not the young of this species. *Pul. caicedi* Gerhardt has exactly the form and aspect of the next younger parts of the volution figured by d'Orbigny and observable on the last mentioned.

GERHARDTIA n. gen. Hyatt.

The near alliance of this genus with *Heinzia* becomes apparent upon comparison of the type *Gerhardtia galeatoides* (Karsten) with *Heinzia provincialis* (d'Orb.) and *Heinzia ? tuberculata*. The umbilical characters are similar so far as the amount of involution and the general aspect is concerned, but the umbilical shoulders are more prominent, the umbilical zone is sometimes concave, broader, and the umbilicus deeper. The shell in the neanic and adult stage is more compressed and more involute than it is in *Heinzia* at the same age and also more involute than its own ephebic stage. The extreme decrease of involution in old specimens may also be noticed in these forms. The costæ in the neanic stage are much finer and more closely crowded than in any genus of this group. The costæ are similar, but the outer row of double nodes are absent or only very faintly expressed. The sutures are more complex in outline, but of the same general type.

The form is more compressed, the venter more contracted, and practically bounded by the elongated single nodal termini of the costæ. The furrows between the costæ cross the venter, cutting it up into flexures, and the ventral channel is very broad and affects the flexures only, not descending to the level of the ventral furrows.

Besides the type mentioned above, this group contains *Ger. galeatus* (Karsten) (von Buch's figure of this species is too poor for comparison), and *Ger. veleziensis* n. sp. Hyatt (*Pul. didayi* Gerh., op. cit., pl. 3, fig. 4). *Amm. didayanus* d'Orb. belongs to genus *Nicklesia*. *Amm. didayanus* Karsten is probably a younger stage of the species figured by Gerhardt, and it came from the same locality, Velez.

Similar species have been cited from other countries by Gerhardt, but these are unknown to me.

All species are of Barremian age and found in Colombia or Chile.

The sutures have been well figured by Gerhardt and are quite different from those of *C. tuberculata* and *H. provincialis*.

PULCHELLIIDÆ.

This family has highly involute compressed shells. The costæ, when these are present, are acquired at a comparatively late age, and the tubercles, when present, are single elongated crests on the ventro-lateral angles of the costæ. The costæ usually cross the venter even when there is a channel on their outer surfaces. The sunken intercostal furrows that cross the venter also are not as a rule affected by the channeling of the costæ.

The sutures are of the same type as in *Heinzia*, but with somewhat more complex outlines. I have had no opportunity to examine the dorsal sutures.

The primitive form is *Psilopulchellia*,[a] which retains the smooth keelless condition of its own young throughout life. This stage is transient in the development of other genera. In *Nicklesia* it is followed by a stage with a flat venter, and this is then followed by the development of lateral costæ that cross the venter without tubercles or channels, or the latter may be developed directly from the previous stage.

Subpulchellia has similar stages followed by a channeled venter due to the development of two slight ridges.

Pulchellia develops lateral costæ that cross the venter, but these are concave on the venter and have lateral tubercular crests in place of the ridges of *Subpulchellia*. The intercostal furrows also cross the venter, but are usually convex on the venter between the costæ. The tubercles have been universally but erroneously spoken of as keels. They are really not

[a] The author failed to describe or cite any species belonging to Psilopulchellia.—T. W. S.

continuous at any stage and can not even be accurately described as ridges. The term carina or keel should be confined entirely to the continuous azygous ventral elevation. The term bicarinate is confusing and might be especially troublesome if occasion should arise to describe a form having a really double or split keel. A further modification of the development takes place when a keel arises upon the smooth rounded venter of the earlier stages as in *Psilotissotia*. This form is apparently transitional to true Tissotidæ, but these affinities disappear upon comparing the ontogeny with that of Tissotiidæ, and especially when the relations of these to the flat ventered and keeled and channeled forms of *Pseudotissotia* are recognized. The sutures of *Psilotissotia* are also decidedly Pulchellian and there are also transitional forms connecting it with *Psilopulchellia*. *Lopholobites*, so far as known, appears to be adequately accounted for as a retrogressive modification of *Psilotissotia* or some of the smooth forms with which it agrees in external characters. This suggestion requires, of course, to be tested by the comparative study of its development and that of the similar forms of this family.[a] The natural arrangement of these genera upon the basis of their ontogeny seems therefore to be as follows:

```
                 Pulchellia
                     |
Nicklesia    Subpulchellia    Psilotissotia
   |                 |              |
   |_______Psilopulchellia ---------|----- Lopholobites
                     |
                  Heinzia
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It seems obvious from the development of the young of most genera and the apparently full-grown *Subpulchellia*, and from the evidence of the sutures, that this group is closely related to Engonoceratidæ. If this be so, the latter can be explained as a retrogressive form evolved from *Subpulchellia* as its most probable Neocomian ancestor. The supposed relations of some of the genera to *Stoliczkaia* are discussed under the head of *Pulchellia*. The parallelism between some of these forms of *Pulchellia* and the Hoplitidæ is so close that it requires the evidence of their younger stages for their separation. It is closer than between this genus and any one of the Heinziidæ, because of the presence of the line of double elongated tubercles in the latter.

[a] The Pulchelliidæ were not mentioned in my Cephalopod chapter in Zittel's Text-book, owing to the accidental omission in copying of a page of the manuscript.

NICKLESIA n. gen. Hyatt.

This genus has a prolonged smooth stage, followed by a costated stage, in which the costæ are without tubercles and cross the more or less rounded convex venter without becoming concave. In some species, as in the type [*N. dumasiana*], the venter does not become decidedly flattened at any stage and the costæ are very slightly developed. The following species, described and fully figured by Nicklès in his Paléontologie du sud-est de l'Espagne,[a] can be referred to this section of the genus: *Nick. moltoi, levyi, nolani, lapparenti.*

In other species the venter becomes markedly flattened during the latter part of the smooth stage, and the following species, described by the same author, are referable to this section: *Nick. zeilleri, malladæ, bertrandi.*

Nicklesia alicantensis n. sp. Hyatt.

Pulchellia (*Stol.?*) *pulchella* Nicklès, 1890, Mém. Soc. géol. France, Paléontologie, No. 4, p. 13, pl. 1, figs. 10, 11.

This differs from d'Orbigny's species in having regularly dichotomous, more or less sigmoidal costæ, a wider umbilicus, less compressed form, and broader venter.

The following species can also be included under this head: *Nick. karsteni* (Uhlig)[b] (*pulchellus* of Karsten).

Nicklesia lenticulata n. sp. Hyatt.

Pulchellia aff. *pulchella* Gerhardt, 1897, Neues Jahrb. für Min., Geol., und Pal., Beil.-Bd. XI, p. 154, pl. 3, fig. 9.

D'Orbigny's species has several short costæ between the longer ones, and the internal sections between the longer costations are smooth, whereas in both of the above the costæ are crowded together and cover the sides of the shells.

Nicklesia didayana (d'Orbigny).

Nick. didayana (d'Orbigny), another species of this group, has been often misapplied to species having channels on the venter and lateral tubercles.

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[a] Mém. Soc. géol. France, Paléontologie, No. 4, 1890.
[b] Wernsdorfer Schichten, Denkschr. K. Akad. Wiss., Wien, Vol. XLVI, 1883.

Nicklesia dumasiana (d'Orbigny).

Pl. XVII, figs. 6–8.

Ammonites dumasianus d'Orbigny, 1842, Voyage dans l'Amérique méridionale, Vol. III, p. 69, pl. 17.

This species is fully figured by d'Orbigny, and easily recognizable in case of large specimens. The French specimens that usually bear this name have been retained here with a question mark. The three examples that are in the Museum of Comparative Zoology are much smaller than the figures of the South American species, but are otherwise identical, and there are no young forms of the latter for comparison. The young specimen figured shows the development of the generic costæ directly from a form with a rounded venter, without the intervention of a flat or concave venter.

Locality: Colombia, South America; Escragnolles, France.

Age: Neocomian.

SUBPULCHELLIA n. gen. Hyatt.

This becomes a distinct generic group, consistently with the principles advocated in this and other papers, because it represents a distinct grade in the evolution of the Pulchelliidæ. Its permanent adult characteristics correspond to those of the transient condition of the neanic stage in the young of *Pulchellia*. *Subpulchellia oehlerti* (Nicklès) has a smooth involute shell, with a concave ventral area bordered by two ridges. The venter on casts is usually flat and has no definite ridges.

The genus includes also *Subp. fouquei* (Nicklès), and *Subp. sauvageaui* (Nicklès.)

Subp. sauvageaui (Sayn) has lobes and saddles quite different from the Spanish form as figured by Nicklès, but whether it or Nicklès's species is identical with Hermite's it is not possible to state. Hermite's original description and figure give no sutures. The shell as described in correction of the figure[a] has slight costations, present also in Sayn's, as described but not as figured, and not mentioned at all in Nicklès's description. The sutures of Nicklès's specimens, one from near Constantine, Africa, and the other from Spain, are similar, but entirely distinct from those of Sayn's figure. Until the suture of Hermite's original or of a specimen from the

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[a] Hermite, Etudes géol. sur les Iles Baléares, Vol. I, 1879, p. 315, pl. 4, figs. 4, 5.

same locality has been investigated, it can not be stated whether Sayn's or Nicklès's species are really the same as Hermite's. In these smooth forms the shells can not be relied on to show specific differences.

Subpulchellia castellanensis n. sp. Hyatt.

Pl. XVII. figs. 1–5.

The two specimens in the Museum of Comparative Zoology here described as the types of the genus and species are both smooth, compressed, highly involute shells similar to *sauvageaui* and others in aspect, but with denticulations on the auxiliary saddles not found in those species. The largest specimen is a cast 28 mm. in whole diameter, probably when complete about 40 mm. The inner edge of the living chamber shows on one side and this was about one-half of a volution in length. The suture figured was taken from the oldest stage of this specimen. The venter in this cast is plano-convex, and there are ridges on the ventro-lateral angles, but these are ridges because the lateral zones are faintly concave, consequently they are ridge-like toward the lateral aspects and not on the venter. The center of the venter has a raised line or pseudo-keel such as is figured by Sayn in his *Pul. sauvageaui*, and is not uncommon in species of *Placenticeras*. When the shell is present the venter is slightly concave and it has the usual ventro-lateral ridges. The specimen figured (Pl. XVII, figs. 1–4) is somewhat younger, but shows a partially completed living chamber a little longer than one-half of a volution.

Locality: Castellanes, France.

Age: Neocomian.

PULCHELLIA Uhlig.

Uhlig designated three groups when he described this genus, the so-called bicarinated or true *Pulchellia*, the group with costæ crossing the venter, equal to my *Nicklesia*, and those with a keel on the venter, the equivalents of the genus *Psilotissotia*. Nicklès recapitulates these facts and the observations of Douvillé, and joins him in referring the first group to *Pulchellia*, and also in thinking it possible that *P. pulchella* and some others may be referred to *Stoliczkaia*. Nicklès, however, retains these forms under the general name *Pulchellia*, and places the other generic names in brackets.

He has also traced some differences between the sutures of the different groups, but these are of such a nature that one does not get clear impressions from drawings, although those of Nicklès are remarkable for their excellence and full of instructive details. I unfortunately can not agree with these gentlemen with regard to *Stoliczkaia*.

Neumayr[a] states "sehe ich mich genöthigt, eine Gattung für eine merkwürdige kleine Gruppe von Ammoneen aufzustellen, nämlich, für die eigentümlichen Formen der indischen Kreide, welche Stoliczka * * * beschrieben und mit den Hällstatter Arcesten verglichen hat." He then goes on to establish new names for the two Indian species considered by him to be distinct from *Ammonites dispar* d'Orbigny, and the first of these, *Stoliczkaia tetragona* Neumayr or *Amm. dispar* Stoliczka,[b] thus becomes the type of this genus. D'Orbigny's figure and description of *Amm. dispar* shows a compressed involute shell with a volution in section like that of *Nicklesia pulchella* (d'Orbigny), but the costæ are narrow, and although they cross the venter they are quite distinct from those of this family. D'Orbigny's species is an old shell of some other group, but is related neither to *Pulchellia* nor *Stoliczkaia*.

Stol. tetragona has a quadragonal volution in section when full grown, venter depressed and slightly convex, sides same, umbilical zone abrupt and narrow. Ribs very prominent and sharp, reaching across the venter and side and having alternating shorter costæ across the venter. Only one row of tubercles along the ventro-lateral angles in the young until in the neanic stage. These disappear in the adult. This is precisely the form and general aspect of some of the Mantelliceratidæ. For example, *Amm. mantelli* is either a member of this genus or a very similar parallel form. But none of these have costæ or ornaments or channels like those of Mantelliceratidæ. Probably also the young are more or less distinct in development.

Whether this last be true or not, the agreements of the adult sutures are not close enough to place such widely different structured shells as *Stol. tetragona*, and *Pulchellia pulchella* in the same group, especially when there is close agreement between the latter and the younger stages of the typical *P. compressissima* and the suture lines are also similar.

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[a] Zeitschr. Deutsch. geol. Gesell., Vol. XXVII, 1875, p. 931.
[b] Foss. Ceph. Cret. Southern India, pl. 45, f. 2.

The keeled smooth forms were also referred by Douvillé and Nicklès and by myself in Cephalopods of Zittel's Text-book under the name of *Psilotissotia* to Tissotidæ, but I am now satisfied that this is an erroneous view of their true affinities, and they are here retained in the Pulchelliidæ.

PULCHELLIA NICKLESI n. sp. Hyatt,

Pulchellia compressissima Nicklès, 1890, Mém. Soc. géol. France, Paléontologie, No. 4, p. 8, pls. 1 and 3.

This species is now, thanks to the drawings and descriptions of Nicklès, sufficiently well known so far as the neanic and ephebic stages are concerned, and it is not venturesome to say that in the still younger stages the venter must have been rounded and smooth like that of the group here named *Psilopulchellia*. The true *P. compressissima* d'Orbigny is a much thinner shell, with broader costæ and narrower venter, the costal folds on the venter narrower and less deeply channeled. Doubtless the young are correspondingly distinct. The umbilicus is also narrower. *Pulchellia schlumbergeri* Nicklès, Mém. Soc. géol. France, Paléontologie, No. 4, p. 38, pls. 7 and 8; *Pul. columbiana* (*compressissima* Gerhardt), also figured by d'Orbigny as the young of his *Amm. galeatus* in the Voyage dans l'Amérique méridionale, *Pul. selecta*, and *Pul. hettneri* also belong to this genus.

Age: Barremian.

There are two species described from Djebel-Ouach by Sayn, *Pul. changarnieri* Sayn and *Pul. kiliani* n. sp. (*Pul.* (*Heinzia*) *ouachensis*, Sayn,[a] pars). This last is distinct from *Heinzia ouachensis* Sayn in not having an inner line of tubercles and in its narrower ventral channels as well as in its sutures as described by Sayn.

PULCHELLIA COMPRESSISSIMA (d'Orbigny).

Pl. XVII, figs. 9–12.

Ammonites compressissimus d'Orbigny, 1840, Terr. Crétacé, pl. 61.

This species is very peculiar and altogether distinct from the forms usually placed under the same name by authors generally. D'Orbigny's figure is very similar to a specimen of the Krantz collection from Escragnolles, the same locality as the shell figured by d'Orbigny. The form of this cast is quite as much compressed and involute, the costæ are present

[a] Ann. Soc. d'Agriculture de Lyon, 6th series, Vol. III, 1890, p. 155, pl. 2, fig. 15, not fig. 14.

only on the outer half of the sides, the spaces between are narrow sulcations that cross the venter. The costæ cross the venter with undiminished breadth and are channeled, but this channel is so shallow that I at first thought this must be the young of another species with very broad costæ, *Amm. catillus* d'Orbigny. The specimen described is just a little older than the shell figured as *compressissimus* by d'Orbigny and ribs begin suddenly to bend forward on the last part of the outer volution. *Amm. catillus* d'Orbigny may also belong to this genus, but the characters of the young, which alone can determine this question, are not known.

Locality: Escragnolles, France.

Age: Neocomian.

PSILOTISSOTIA Hyatt.

This genus was unluckily considered by me when mentioned for the first time [a] as a member of the Tissotiidæ. In this I was not led by the opinions of Douvillé and Nicklès, but by what I then considered to be its true affinities. It has become obvious in studying *Paratissotia*, which approaches it nearest in form and in agreement of the development, that this is not a natural association. Nicklès's plates also show that the sutures are similar to those of true Pulchelliidæ. They are involute forms, smooth, and compressed in the earlier stages and having at this time or all through the neanic stage a smooth keel that may in older stages become tuberculated. Costæ may be represented by fine folds as in *Psil. mariolæ* Nicklès, until a late age, but when they do appear they are heavy, fold-like, and sigmoidal. In this species also a median lateral line of nodes appears. If their real affinities are with this family, as they certainly appear to be now, they can be accounted for as direct derivations of *Psilopulchellia* which has evolved a keel. The intermediate aspect of species like *Pul. defforgesi* and *haugi* indicates that the shell did not have a flat ventral area at any stage, but was the direct outcome of the evolution of *Psilopulchellia.*

This includes besides the type, *Psil. chalmasi* (Nicklès), the following species: *Psil. mariolæ, defforgesi, reigi, haugi,* Nicklès; *Pul. defforgesi* Nicklès is described by him as having simply a sharp venter, but its affinity with *mariolae* would bring it into the group and the sharp venter may be merely due to the age of the example figured.

[a] Zittel's Text-book, p. 590.

LOPHOLOBITES Hyatt.

Lopholobites cotteaui (Picklès).

Neolobites ? cotteaui Picklès, 1890, Mém. Soc. géol. France, Paleontologie, No. 4, p. 54, figs. 36, 37; pl. 5, fig. 9.
Lopholobites cotteaui Hyatt, 1900, Ceph. Zittel's Text-book Pal., p. 590.

This is a small, very involute, compressed, smooth form, with minute umbilicus and subacute venter. The external characteristics and sutures indicate this to be a retrogressive but more involute shell, allied to such species as *Psilotissotia haugi*, figured on the same plate by Picklès. The sutures are entirely distinct from those of *Neolobites*, especially in the bifid character of the first lateral saddles and the greater differentiation of the inner saddles and lobes, which are more distinct from those of the outer part of the same sutures than in *Neolobites*. All of these discrepancies can be accounted for on the supposition that this is a retrograde form of *Pulchellia*. This also accounts for its small size when nearly outgrown, as in this specimen. Picklès recognized the great differences between this shell and *Neolobites*, but hesitated to describe it as a different genus because of the great difference in its size. This fear was unfounded, since *Neolobites* could not have had a similar set of sutures at any age.

Age: Barremian.

KNEMICERATIDÆ.

The external aspect of the species of this group places them apparently close to the Buchiceratidæ, but the sutures and the absence of a keel at all stages separate them widely. The first lateral saddles exhibit tendencies to division into several distinct branches, as in the Engonoceratidæ, and the outlines of the other saddles and lobes also are similar. The division of the first lateral saddles is not carried so far as it is in Engonoceratidæ. The principal first lateral resulting from the secondary division of the primitive first lateral is consequently a broad solid saddle instead of the narrow first lateral of that family.

Unluckily, the dorsal sutures were in no case exposed, and the conditions of fossilization in every specimen made excavation impracticable.

The forms, both by their ornamentation and general development, are apparently more specialized and more complex than those of the Engonoceratidæ, and although the young was seen in only one example in a section the appearances were the same as in sections of species of the

Engonoceratidæ. It has been therefore assumed that they had a similar stage in which the venter was concave and had continuous ridges on the ventro-lateral angles.

KNEMICERAS Böhm.[a]

There are but two lines of nodes on the sides and straight broad costæ, bifurcating between them. The venter is broad and concave, the costæ and nodes are opposite, and the venter is often transversely ridged between the nodes. The ventral lobes have the same shape as in *Buchiceras* and *Roemeroceras* and have similar truncated siphonal saddles. The ornamentation and form resemble these genera, but there is no keel at any age and the development is quite distinct. The young are not compressed as in *Buchiceras*, and the ventral zone is concave in an early neanic substage and remains concave throughout life. This shows similarity to *Engonoceras* and *Placenticeras*. The lateral lobes and saddles are similar to those of *Engonoceras*, but the inner laterals are fewer in number and the first lateral saddles are more complicated. The divisions of the first may be counted as four or even five lateral saddles derived from a primitive first lateral. Until some one ontogeny is studied the correct enumeration can not be given.

The young were seen in section. The rounded venter of the nepionic stage is succeeded in the neanic stage by a flat-ventered volution with quadragonal outline, and the concave venter appears in the earliest part of the ephebic stage. At this time the venter is very broad, the sides flat and obviously costated and tuberculated on the umbilical shoulders. Whether there were tubercles on the edges of the venter was not determinable.

At an early neanic substage the umbilicus was open, the venter flat and broad, but narrower than the dorsal diameter through the umbilical shoulders, the lateral zones flat and convergent, the umbilical zones well developed. These characters and the broad costæ and nodes of the later stages and the venter are similar to those of Pulchelliidæ, but the division of the first lateral saddles in full-grown specimens and other sutural characters are dissimilar. The species discovered in the Cenomanian of Portugal appears to indicate that the real age of the fossils found at Mount Lebanon is Cenomanian, although, as may be seen by the context, I have doubts whether any of the latter belong to the fauna of the rocks in which they have been found.

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[a] Zeitschr. Deutsch. geol. Gesell., Vol. L, 1898, p. 200.

KNEMICERAS SYRIACUM (von Buch).

Pl. XVI, figs. 4–8.

Amm. syriacus von Buch, Abhandl. K. Akad. Wiss. zu Berlin, 1848, pl. 6.
Knemiceras syriacum Böhm, 1898, Zeitschr. Deutsch. geol. Gesell., Vol. L, p. 200.

Von Buch's figures of this species on his pl. 6 are excellent in all characters, but his suture line on pl. 7 is either erroneous or belongs to another form.

One gerontic specimen is about 55 mm. in whole diameter, with living chamber nearly one-half of a volution in length. A smaller specimen, 45 mm. in diameter, has also reached into an extreme gerontic substage and has living chamber of same length. Von Buch's specimen, according to his figures, was also in gerontic stage, but evidently somewhat larger, perhaps 70 mm., or thereabouts, when living chamber was present.

This stage is indicated in one specimen as in von Buch's figure by the approximation of septa in pairs as if the individual were only temporarily affected by weakness and then resumed the usual rate of increase. In one specimen the last sutures are irregularly spaced. The last three next to the living chamber are approximate. A slightly greater interval occurs between these, and there is a pair closely approximated, and apicad of this is a broader chamber and again a pair of approximated sutures. Apicad of this last pair there is a chamber broad on the venter but so narrow near the lines of involution that the sutures are crowded together on the umbilical shoulder. Apicad of this is the ephebic stage, with all sutures regularly spaced. The gerontic sutures are not always so irregular, and there may be as many as eight sutures showing more or less inequality in spacing, ending with a series gradually becoming closer and eventually overlapping. The whole duration of the gerontic stage, including the living chamber, consists of about three-fourths of a volution. The lobes and saddles become shorter and the outlines simpler in this stage. Temporary approximation of sutures occurs often in the growth of these shells, and it is not always a sign that the gerontic stage has been reached, but when it is continued for some time, as in von Buch's figure, and after a period of prolonged regularity in the width of the living chambers, it is obviously due to senility. There are no signs of a row of tubercles on the median aspect of the sides, and there are obviously only two rows of nodes with heavy fold-like bifurcated costæ between.

The nodes continue to increase in length and size throughout life until in the latter half of the gerontic living chamber, when they show a decided and rapid decrease on the venter but persistently increase on the umbilical shoulders until near the end of this chamber. The living chamber was incomplete on the venter in all of these specimens, although in several it was complete near the umbilicus and somewhat over one-fourth of a volution in length.

The first lateral saddles are bifid, having two broad arms, and both of these are again faintly bifurcated, these subdivisions being minutely denticulated on the edges in perfectly unworn sutures, which can be found best by removing encrusting ostreans. In some specimens the second lateral saddle does not split up completely from the first, and instead of three principal lateral saddles there are but two, as shown in Pl. XVI, fig. 5. In others the division is complete, as it probably is in the later stage of the specimen shown in Pl. XVI, fig. 8. No specimen so far seen carries out the complete division of the remaining first lateral, although in some the median marginal lobe is quite long. It is a curious fact that all of these specimens—eleven in number and collected from five different sources—should have encrusting bryozoa and ostreans on the exterior of the cast and all more or less worn on all other parts of the surface. The lobes and saddles nowhere exhibit, and it is not likely that this species ever exhibited, the peculiar lobes and saddles figured by von Buch on his pl. 7. The entire suture seems to be incorrect for this species, whereas those given in pl. 6 are right so far as they go, although taken from the usual worn surfaces, of casts. Böhm's figure, quoted below, is accurate, but belongs to an older stage than that figured in this work. The second and sixth lateral saddles are bifid, the seventh and eighth broad, flattened, and entire. There are marks upon unworn sutures indicating the presence of slight denticles on the edges of the principal saddles, but no such divisions and prominent marginals as in von Buch's figure, pl. 7. The ventral lobe has two arms as in *Engonoceras;* the dividing siphonal saddle is apparently flat, but when clearly defined it has a diminishing base divided by a minute siphonal lobe. Faint denticulations are present on both this saddle and the sides of the arms of the ventral lobe. The lateral lobes are club shaped, denticulated on the top, but entire on the sides near their base between the phylliform bases of the saddle. There are irregular trifid outlines such as appear in Böhm's figure,[a] but there are also regular trifid bases to the first lateral saddles. The former arise from the irregular growth of the marginal saddles of the first or outer (originally bifid) arm of the first lateral saddle, making sometimes a simple triple division, and sometimes this outer arm itself becomes trifid, equally or more or less unequally, as in Böhm's figure. The variation of the sutures is very considerable in this species, but there seems to be, so far as my material reaches, no sufficient grounds for the separation of specimens having trifid first lateral saddles from those having this part bifid. In fact one specimen shows early in the ephebic stage a bifid first lateral on one side and a trifid saddle on the other side of the venter, i. e., the two arms of the first lateral on one side are regularly bifid and on the other the inner arm is trifid and the outer arm bifid. Occasionally this outer arm may have four marginals. In one specimen the inner arm is bifid and the outer arm has three minute marginals. In one specimen again (Pl. XVI, fig. 5) there are three arms, each regularly subdivided by a median marginal lobe. This saddle can perhaps be best described in general terms as having three arms derived from an original bifid form and usually preserving a record of this original form in the shortness of the outer marginal lobe as compared with the second marginal and also in the usually bifid outline of the base of the third or innermost arm. Often, as in Pl. XVI, fig. 8, the inner arm is sufficiently separated to be counted as a second lateral saddle.

The specimen described by Hamlin in Syrian Fossils[b] is fine only on one side and the supposed shell "the thin test almost entire" does not exist. Hamlin was misled by the smooth surface and the presence of a thin brown layer. That this is not the shell is shown by the sutures, which are somewhat worn, not showing the denticulations plainly. The living chamber is obviously nearly complete and is a trifle less than one-half of a volution in length. I have examined twenty-two specimens of this species and not a single one had even fragments of the shell preserved and many were incrusted with ostreans and bryozoa. There is no positive proof that these ammonites were living members of the fauna in which they were found, but there are obvious reasons in their aspect

[a] Ueber Amm. pedernalis: Zeitsch. Deutsch. geol. Gesell., Vol. L, 1898, p. 199.
[b] Mem. Mus. Comp. Zool., Vol. X, No. 3, 1884, p. 11.

and in the presence of these incrusting growths on the casts for considering them as having been fossil casts when the incrusting animals grew upon them.

Locality: Mount Lebanon, Syria.

Age: Cenomanian.

KNEMICERAS COMPRESSUM n. sp. Hyatt.

Pl. XVI, figs. 9, 10, 15–18.

Ammonites vibrayeanus Hamlin, 1884, Mem. Mus. Comp. Zool., Vol. X, No. 3, p. 12.

The typical form of this species is separable from the variety *subcompressum* in full-grown specimens by the greater compression of the volutions, narrower venter, and less development of the nodes on the umbilical shoulders. The proportionate increase by growth of the ventro-dorsal diameters is also greater with relation to the transverse than in the stouter variety described below, and in all these respects it differs still more from *Knem. syriacum.* The shell, however, until 45 to 50 mm. in diameter is not distinguishable from the shell of that species. As stated by Fraas and Hamlin, the sutures in the worn casts are similar to *syriacum*, but in a large specimen of the same size as the type of this species (Pl. XVI, fig. 15) in the Museum of Comparative Zoology these are less worn than usual and full grown. These sutures (Pl. XVI, figs. 17, 18) show the large ventral lobes, which occupy nearly the entire breadth of the venter instead of only the central part, as in the stouter variety and in *syriacum.* The lateral saddles and lobes are very long and narrow and the bases of the saddles swollen, rounded, and phylliform, resembling those of *Sphenodiscus.* The apical ends of the saddles are also similarly shaped, broad, denticulated, and cutting deeply into the saddles. In the gerontic stage the lobes and saddles become shorter again, as in the younger stages, and more like those of *syriacum.* The most perfect cast (Pl. XVI, figs. 15, 16) is 70 mm. in diameter, without living chamber, the outer volution 38 mm., the umbilicus 10 mm., and same volution opposite 22 mm., the thickness of the last being 13 mm. between costæ.

The largest specimen is from Beirut, No. 10902G in the collection of Columbia University. This has no living chamber, and the actual diameter is 85 mm., estimated diameter about 90 mm. Diameter when living chamber was present could not have been less than 130 mm.

Sutures are considerably worn, except in one place at diameter of 75 mm., the volution being 23 mm. ventro-dorsal diameter. These were similar to those of the typical specimens, except the first lateral saddles, which were narrower and distinctly bifid; the innermost inflections were not seen.

The nodes were present on the umbilical shoulders, but apparently disappear on the last half of the outer volution, but this could not be proved on account of the state of this fossil.

The venter remained concave to the end. The ventral tubercles became, however, much finer and more closely set than in the ephebic stage, and I should think more perfect specimens might show the correlative disappearance or obsolescence of the costations. I doubt if the costæ are ever so broad in this species as in *syriacum.* The state of these fossil casts tends to confirm the opinion that they were not living members of the fauna with which they were found.

Out of the eight casts in the Museum of Comparative Zoology only three were suitable for observation, and all of the three more or less imperfect, and there was not even the minutest piece of a shell on any of them. The same is also true of the large specimen from the collection of Columbia University.

Knemiceras compressum var. subcompressum Hyatt.

Pl. XVI. figs. 11–14, 19.

Amm. syriacus (pars) von Buch, Abhandl. K. Acad. Wiss. zu Berlin, 1848 (not figured).

Amm. syriacus (pars) Conrad, Lynch's Exp. Dead Sea and Jordan, 1852, pl. 14, fig. 74, two upper figures (not fig. 6).

This variety has heretofore been confounded with *Knem. syriacum,* from which it is, however, easily separated. The form even in extreme age is more compressed, the nodes on the umbilical shoulders are not so prominent, and the venter and transverse diameters do not broaden out in the later ephebic and gerontic substages, as in that species; the nodes also on the edges of the venter are longer and narrower than in that species. The sutures are very similar in these two forms.

A specimen from Mukhtara, Syria, in the American Museum of Natural History, New York, reaches 97 mm. diameter without living chamber, and shows that the shell sometimes reaches a larger size than 115 mm. in diameter.

A specimen in the Museum of Comparative Zoology is 50 mm. in diameter. This retained its flatter sides and proportionally broad venter to the end of the last volution. The living chamber is incomplete and somewhat less than half of a volution in length. A specimen from Abeih, Mount Lebanon, in the Museum of Comparative Zoology, 53 mm. in diameter, has a living chamber obviously very nearly complete and somewhat less than half a volution in length. This is therefore approximately the length of this part. One of the specimens in the Krantz collection in the Museum of Comparative Zoology shows thick shell on venter where it has been covered and protected by outer volution. Outside of this the cast is worn more or less, and there are absolutely no remnants of shell under the encrusting ostreans that occur on the exposed parts. The condition, in other words, proves that this and probably other fossils mentioned above were not living members of the Syrian fauna as heretofore described, but came from some earlier epoch and were already in the condition of fossil casts when the incrusting ostreans grew upon them.

Locality: Gilead Mountains east of Jordan, Mount Lebanon, Syria.

Age: Cenomanian.

Knemiceras attenuatum (Hyatt).

Pl. XVII, figs. 13–15.

Buchiceras attenuatum Hyatt, 1875, Proc. Boston Soc. Nat. Hist., Vol. XVII, p. 372.
Glottoceras attenuatum Hyatt, ibid, note.

The sutures agree quite closely with those of *Knemiceras compressum*, but the alternating tubercles on the edges of the venter and the form of this part are essentially Engonoceran.

The original specimen is 65 mm. in diameter; it is a cast without any vestiges of the shell. The ventral lobe is deep and narrow and like that of *Knemiceras*. The first lateral saddle is also Knemiceran in outline. It is unequally divided into three parts. The outer arm is trifid, but with such slight marginals that they are merely sinuosities. The central part is a minute saddle, and the inner has a trifid base. The second lateral is phylliform and so faintly bifid that I was not sure of the fact. All the remaining saddles are subphylliform, with broad bases and symmetrically bifid, except the seventh and eighth, the last on the line of involution. These are entire. The first to the sixth lobes are simple and denticulated; the seventh and eighth are entire.

This species was named erroneously *Glottoceras* in a note quoted above and accidentally left uncorrected in the proof.

The great regularity of the outlines of the bifid saddles and the small dividing marginal lobes are probably characteristic, as well as the fineness and number of the tubercles of the outer lines and the presence of a third line beginning, apparently, on the latter part of the outer volution.

Locality: Celendin, Peru.

Age: Cenomanian?

KNEMICERAS GABBI n. sp. Hyatt.

Pl. XVIII, figs. 1–3.

Ammonites attenuatus Gabb, 1877, Jour. Acad. Nat. Sci. Philadelphia, 2d series, Vol. VIII. p. 264, pl. 36, fig. 1 *a* and *b*.

The originals of Gabb's figures have not been found in the collections of the Academy of Sciences of Philadelphia and I could not obtain them for comparison, but the suture line figured by Gabb is distinct from that given on Pl. XVII of this work, and Gabb's form is much stouter at the same age, has larger nodes and a broader venter. The old age with a rounded broad venter is probably not particularly distinctive, although it may perhaps be that this change never occurs to such excess in true *attenuatum* as it does in *gabbi*.

Locality: Quebrada de Huari, Peru.

Age: Cenomanian?

KNEMICERAS UHLIGI (Choffat).

Placenticeras uhligi Choffat, 1898, Faune Crét. du Portugal, Vol. I, 2d series, pp. 4 and 77, pl. 2, figs. 3–5: pl. 4, fig. 2; and pl. 22, figs. 44–46.

This is a compressed species similar to *Kn. compressum*, but differing in the sutures. The saddles are very broad and have flat bases with more denticulations. The lobes are more like those of *compressum*, but the inner ones are quite different. The marginal divisions are less complete than in *compressum*.

Locality: Portugal.

Age: Lower Bellasian (Cenomanian.)

ENGONOCERATIDÆ.

Shells apt to be involute. The venter is concave and is occupied for its entire breadth by a smooth zone. The sutures are variable in the different genera and approximate in some forms to those of *Sphenodiscus.* There is a similar tendency in most of the species to have broad saddles with phylliform bases, which are either entire or bifid, while the lobes have narrow bases and are more or less expanded apicad and apt to have trifid terminations. The simplicity and shortness of the saddles and lobes is correlated with the tendency to produce a much larger number of inflections and great variability in the outlines in the same species and sometimes even on different sides of the same specimen. The ventral lobes are short, spreading apically, and have usually pointed short and entire siphonal saddles.

PROTENGONOCERAS Hyatt.

The ephebic form is compressed and involute, as in *Engonoceras* and *Metengonoceras* of the same subfamily group, and it is also similar to the neanic stages of *Engonoceras, Sphenodiscus,* and *Placenticeras.*

The shell is smooth, except in the gerontic stage, where folds appear. The venter is moderately broad and decidedly concave, bordered by sharp, smooth ridges. These are exactly the external characters of the young during neanic stages of the species of the different genera mentioned.

The sutures have the same ventral lobes as in *Engonoceras* and *Metengonoceras,* and similar lateral sutures, but the saddles are very broad and short and the lobes have fewer marginals.

Type, *Prot. gabbi* (Böhm), Whitney collection, in Museum of Comparative Zoology.

The septa follow internally the curvatures of the sutures, concave along the mesal plane and convex only on the areas on each side of the zone of involution.

Protengonoceras gabbi (Böhm).

Pl. XVII, figs. 16–20.

Ammonites pedernalis Gabb, 1869, Pal. California, Vol. II, pl. 35, figs. 1, 1a.
Engonoceras gabbi Böhm, 1898, Zeitschr. Deutsch. geol. Gesell., Vol. L, p. 197.

A cast of one-half of a volution in Museum of Comparative Zoology from Professor Whitney shows ephebic stage. The whole diameter, partly estimated, is 69.5 mm., the outer portion of this volution, partly estimated, is 42.5 mm., the umbilicus is 5 mm. and the opposite part of same volution is 22 mm. The shell is present on the venter but not on the line of involution. Greatest transverse diameter of outer volution is 25 mm., the inner part is 11 mm., both through the umbilical shoulders, shell on one side and not on the other side. Probably shell would have made the difference of 5 mm. in each case.

This is a compressed shell, closely similar in aspect to *Engonoceras uddeni* and the ephebic smooth stage of *Protengonoceras ? emarginatum*, but the involution is greater; the costations in this stage are fainter, but can be plainly enough seen both on cast and on the shell in a cross light. They are less than in Gabb's figure, but the form of venter and aspect of shell, including amount of involution, shows that we are dealing with Gabb's species. There are also no tubercles on the umbilical shoulders. The first large fold is partly present on the broken edge of the outer volution in the small fragment figured, showing the beginning of the gerontic stage. The venter is decidedly concave with slight ridges on either side. This form of venter is found in the neanic stage and the whorls, although stouter, are similarly compressed when the whole diameter is only 13 mm. At diameter of +4 mm. this venter, although almost as broad as the transverse diameter, is already like that of the adult, but may be a little flatter.

Other details could not be seen. It is obvious that the young acquire the concavity and sharp lateral ridges of the venter in an early neanic substage at a time when the volution becomes flattened on the lateral zones. The form is then obviously like some stouter and less involute forms of this genus not yet discovered.

The sutures are very slightly flexed apicad; the saddles and lobes closely similar to those of *Metengonoceras.*

The venter is slightly asymmetrical; the first pair of saddles on the right are divided by a very slight marginal lobe. There are nine saddles and eight lobes on the right side, the seventh saddle alone being bifid. The marginal lobe dividing this saddle appears on the earliest suture of this volution. Lobes on the left side of a more advanced stage show that this simplicity is due to age.

A larger specimen, same locality, in the gerontic stage, is 108.5 mm. in diameter and has the shell preserved. Outer part is 57.5 mm., umbilicus

7.5 mm., and opposite side same volution 46.5 mm., no shell present. The greatest transverse diameter of the volution is 30 mm., and of thesmaller part opposite is 22 mm.

The shell is marked by bands of growth and fold-like obscure costæ which appear in the gerontic stage. These terminate at the umbilical shoulders, and along the centran surface of the lateral aspect have very broad swellings and then subside into the flat general surface toward the periphery. The venter is slightly broader than in the ephebic stage above described and the volution stouter, owing to the development of lateral swellings and the slight decrease in the involution due to old age. The umbilical shoulders and the umbilical zones are abrupt instead of being rounded and sloping as in the adults. The living chamber is complete near the line of involution and is about one-half of a volution long internally and apparently about the same externally when restored. The concavity of the venter is maintained for one-half of the length of the living chamber. Beyond this it could not be followed, but there are some indications of the possible rounding of the venter in extreme age.

The sutures are quite distinct from those of the ephebic stage in the specimen above described. There were eight saddles and seven lobes to the umbilical shoulders, remainder on the umbilical zones being concealed. The interesting fact, however, can be noted that in this gerontic stage new saddles and lobes were not added as the sides broadened. The increase of the sides was met by the broadening out of the saddles. The first laterals were very broad, the second and third had not changed much, but beginning with the fourth they became irregularly broader toward the umbilicus, and the seventh was 6 mm. in breadth, whereas the sixth lobe was only about 1 mm. long. The lobes remained about the same as in the adult stage.

The form of the volutions, smooth concave venter, slightly costated sides, with large folds only in gerontic stage, and primitive sutures all show that this is a species like the similar stages in the development of tuberculated forms in *Metengonoceras* and also similar to the young of *Placenticeras*. It is, however, a deeply involute shell and is not therefore by any means the most primitive form of its own subseries. It indicates the existence of a distinct subseries having similar smooth concave venters and less involute or more discoidal shells, which in the gerontic stage become stouter with gibbous sides and have also comparatively flattened or rounded and much wider venters.

Having been loaned through the kindness of Dr. Pilsbry another specimen of this species from the collection of the Academy of Sciences, Philadelphia (Pl. XVII, fig. 20), I can state the following additional particulars: The diameter is about 82 mm., partly estimated. The living chamber is one-half of a volution in length on the periphery, but is much shorter on the line of involution, owing to the great apical trend of the aperture. This has a broad but very slight sinus on either side and apparently no lateral crests on the sides that could be separated from the rostrum. This last, however, was broken and could not be decisively determined. The specimen is in its gerontic stage and upon the inner parts of each side has four heavy folds which disappear near the venter. The bifidity of the internal saddles is variable, since in another specimen in the collection of the Museum of Comparative Zoology the sixth saddles were bifid.

Locality: Arivechi, Sonora, Mexico.

Age: Fredericksburg group, Comanche series.

PROTENGONOCERAS PLANUM n. sp. Hyatt.

Pl. XVIII, figs. 6–9.

This species is described from a fragment which would be ordinarily insufficient for diagnostic work. The greatest length of this piece is only 22.5 mm., the ventro-dorsal diameter of the volution 14 mm., the greatest diameter at umbilical shoulders 5.5 mm. Nevertheless, the cast is perfectly smooth, the sides flat, and the venter, which is only 1 mm. in width, is also smooth, concave, and bicarinate. These characteristics, especially the attenuated venter and smooth sides, distinguish it quite sufficiently from the preceding species to justify specific separation. There are ten saddles, all narrow, the first symmetrically bifurcated, as in other forms of this genus and *Engonoceras.* They are entire and from second to eighth more or less club shaped, but the ninth is broader and bifid. The tenth and eleventh are entire, occupying the umbilical zone. The dorsal zone of impression has six saddles, counting the outermost one above mentioned (Pl. XVIII, fig. 9). There are ten narrow zygous external lobes (Pl. XVIII, fig. 8) on the right side. The first is club shaped and entire, the second to the fifth similar, but faintly trifid. The sixth to the tenth are shorter and decrease in length to the line of involution and are entire. On the opposite or left side there are ten saddles and eleven lobes. The tenth saddle is completed, and there is a small lobe on the line of involution. The first saddle is narrower and the eighth and ninth saddles broad, and both similar to the ninth on the right side in being bifid. On both sides the first five lobes are long, and the same change occurs in the shortness of the sixth and remaining lobes and saddles. The matrix is similar to that which occurs in the Colorado formation at Horton's mill, Dallas County, Tex.

Locality: Texas.

Age: Stanton suggests Upper Cretaceous from the matrix.

Protengonoceras ? emarginatum (Cragin).[a]

Sphenodiscus emarginatus ? Cragin, 1893. Geol. Surv. Texas, Fourth Ann. Rept., p. 245.

This species is described as having straight distinct ventral channel at the diameter of 90 mm. and also as having two rows of feeble tubercles, one on the umbilical shoulders and the other midway on the lateral aspect. The bilobed saddles mentioned by Cragin indicate a more complicated suture line than occurs in *Protengonoceras* as far as known, but the condition of the venter indicates that genus.

Not having seen any specimens of the species, I can not say positively that it is a member of this genus.

Locality: 2 miles south of Pleasant Point, Tex.

Age: Comanche series, Walnut beds.

ENGONOCERAS Neumayr.

Although the descriptions and figures of *Engonoceras pierdenale* led me to believe that this species had an acute venter, Böhm[b] has stated, after studying the fragmentary originals, that these had truncated concave venters, bordered by ventro-lateral ridges or elongated tubercles, and that the species upon which the genus *Engonoceras* was founded, *Amm. pierdenalis* v. Buch, closely resembles his *Eng stolleyi.* The two fragments figured by Böhm do not show conclusively that this is the fact, but it appears to be safest to follow him in the effort to give stability to von Buch's name and Neumayr's genus. Von Buch's and Roemer's descriptions lead to the belief that the

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[a] See p. 177, where this species is referred to *Engonoceras.*—T. W. S.

[b] Ueber Ammonites pedernalis v. Buch: Zeitschr. Deutsch. geol. Gesell., Vol. L, 1898, p. 183.

shell casts they described had acute venters, but this is probably an error. In studying this group of fossils such a mistake is easily made, owing to the simplicity of the sutures, the narrowness of the flattened venters, and smoothness and symmetrical aspect of the fossils, although considerably worn and altered by abrasion.

The presence of three distinct lines of nodes, the flatness and nodose edges of the venter throughout the earlier and ephebic stages, the broad and often zigzag outline of the venter in the gerontic stage, caused by the extra development of the outer line of alternating nodes, enable one to separate the species of this genus readily from those of *Metengonoceras*, notwithstanding the close similarity of the sutures. The young during the neanic stage are compressed, involute, and smooth, with concave venter and form like *Protengonoceras.* Von Buch and Neumayr both describe the principal saddles of *Engonoceras pierdenale* as bifid, and this occurs in the species here supposed to represent *Engonoceras*, but does not occur, so far as known, in *Metengonoceras.* All specimens so far seen have been casts, either entirely naked or with only the nacreous layer partly preserved.

The attention of collectors is called to the fact that some of the species bear no convincing marks of having been autochthonous members of the faunas in which they are habitually found.

This genus differs from *Neolobites* only in having denticulated lobes, if the figures of the sutures heretofore given correctly represent their outlines.

Engonoceras belviderense (Cragin).

Pl. XVIII, figs. 4, 5.

Ammonites belviderensis Cragin, 1894, 1895, Am. Geol., Vol. XIV, pl. 1, figs. 3–5; Vol. XVI, p. 369.

Buchiceras (*Sphenodiscus*) *belviderense* Cragin, 1900, Colorado Coll. Studies, Vol. VIII, p. 27.

Through the kindness of Professor Cragin I have seen some specimens of this species, and one of these has been given in the figure. This alone was not much crushed, but the sutures could not be made out. The aspect is similar to that of *Eng. uddeni*, but the sides and venter are flatter and smoother. There are similar nodes on the umbilical shoulders and those on the edges are alternate; there are nascent folds on the outer part of the sides. It reaches a larger size than other forms before it begins to acquire the usual gerontic characters—that is, before the venter becomes convex and more or less zigzag in outline. The type of Cragin's species is the small specimen referred to above. This has sutures with numerous small saddles closely set on the suture line, and, so far as could be seen, one of Cragin's fossils of the same lot with that figured had similar sutures. Cragin describes this species as having a row of tubercles that may be developed on the inner ends of the low folds or costæ occupying the outer half of the sides. There are some very obscure signs of the existence of such markings in these fossils also. These are doubtful even to the touch and are not visible to the eye. This may be owing to the condition of the fossils.

Locality: Belvidere, Kans.

Age: Champion bed and Kiowa shales, probably near base of Washita Comanche series, Lower Cretaceous.

Engonoceras uddeni (Cragin).

Pl. XIX, figs. 1–6.

Sphenodiscus belviderensis var. *uddeni* Cragin, 1900, Colorado Coll. Studies, Vol. VIII, p. 30, pl. 1, figs. 3, 4.

A fragmentary cast in iron pyrite, No. 23147 U. S. National Museum, Pl. XIX, fig. 4, 5, shows a few of the last sutures and a portion of the living chamber. The diameter, partly estimated, is about 82 mm., the outer volution is 44 mm., the umbilicus 8 mm., the same volution opposite from line of involution to venter 30 mm., no shell being present. The form is compressed and highly involute, but slightly stouter than in the more compressed *emarginatum.* There is only one line of nodes, those on the umbilical shoulders. The costæ are fine, and like elevated bands of growth gathered to a focus at these nodes. They are sigmoidal with single fine lines between the nodes, externally more pronounced folds appearing in the later gerontic substage, but no nodes are present on this part in this specimen. The venter is flattened until near the last part of the living chamber, which is distorted through compression.

The part of the living chamber preserved indicates that it was not less than half a volution on the umbilical side. The ten lobes and eleven saddles on both sides are very similar in outline to those of *emarginatum.* The seventh and eighth lobes on both sides are bifid.

The ventral and also the first lateral saddle are asymmetrical. These have the usual form but are rather narrow. The internal parts of the sutures are deflected orad toward the umbilical shoulders so that they rise materially, giving them a pecular aspect in this specimen. The lobes are similar to those of *emarginatum*, but are narrower and shorter and the saddles broader and shorter in proportion. The second to the sixth saddles are entire, the seventh to the ninth bifid, and the tenth saddle is on the line of involution. The sutures are the same on both sides of this specimen. The lobes are irregularly bifid.

There is a fragment of a larger size consisting of one-fourth of a volution with stouter proportions, labeled "Locality 1490 U. S. Geological Survey, north of Pottsboro, Tex., Upper Comanche (Grayson)," that may belong to the same species, but the sutures and aspect are distinct enough to belong to a different species.[a]

The inner line of large nodes and the median lateral are present, but no outer line, and there are similar distinct costations.

The venter has a similar outline also, but the specimen being larger and older, the venter is more rounded.

The sutures are similar, except that the inner arm of the first lateral saddle is much narrower and entire, the outer arm is distinctly bifid, making the whole outline approximately trifid, the remaining saddles are longer and distinctly phylliform as in *Sphenodiscus*, and the lobes are correspondingly broader apically as in that genus. These effects may perhaps be due to the greater age of the specimen. There is apparently the same number of lobes and saddles. There are nine saddles visible on the broken end, right side, and there may be one more, making ten saddles and nine lobes.

A fragment obtained from Dr. F. A. Udden, locality northeast of Little River station, Rice County, Kans., is the original specimen used by Cragin and is figured below on Pl. XIX. It is in fine state of preservation, being fossilized with iron pyrite. The breadth of the side is 53 mm., the greatest transverse diameter is at about one-third of the breadth from the line of involution and is 20.5 mm. The venter is very narrow, about 3 mm. in breadth; it has no obvious nodes, but, as in the type, faint undulations may be felt with the finger on the ventro-lateral angles. The sutures are quite different, but have the same general character. The first lateral saddles are quite distinct on the two sides, owing to the asymmetry of the ventral lobe.

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[a] Figured as *Engonoceras retardum* n. sp. Hyatt, Pl. XV, figs. 15–17.

The sixth saddle on the left side is bifid; the seventh is broad and symmetrically and deeply bifid, looking like two entire saddles; the eighth has a large, slightly bifid, outer and a tongue-shaped inner arm; the tenth is bifid. The ninth and tenth can be reckoned in several different ways on account of the peculiar formation of the lobes, either as above, or the inner arm of the ninth be called the tenth and what is here named the tenth can be classed as the eleventh, or, on account of shortness of the lobes, the whole may be considered as a single broad saddle with three arms, the outer and inner arms bifid and central arm narrow and entire. The eleventh saddle is trifid and broad, the twelfth and thirteenth entire, and the last is on the line of involution. On the right side the first lateral saddles, on account of the asymmetry of the ventral lobe, are narrower and the second is much reduced. The second to the seventh are entire, the eighth and ninth are symmetrically bifid, the tenth to the thirteenth are entire. The twelfth and thirteenth saddles alone correspond or are symmetrical, bilateral on both sides of the body. The lobes have a tendency to become irregular at their terminations and are long and narrow on both sides and more alike than the saddles.

There is also a large fragment of an example of this species in its gerontic stage, or of an undescribed species, associated on same mount with *E. subjectum* (No. 10755 Collection Boston Society Natural History). The diameter from line of involution toward venter as far as fragment goes is 68 mm. There are only a few millimeters wanting externally, since part of the first saddle is present. There are apparently nine saddles only on the side, all entire except the seventh, eighth, and ninth, which are bifid. The first to fourth lobes are long and narrow and the saddles stout but phylliform. These sutures belong obviously to a very aged shell, since out of nine sutures visible the eighth is the first that does not slightly overlap and the last four overlap progressively more and more.

The absence or very slight development of the outer lines of nodes and the absence of distinct ridges on the ventro-lateral edges of the venter distinguish this species from *E. subjectum*. The sutures of these two run closely together, although the saddles and lobes of this form are somewhat stouter and broader at the same age than in *E. subjectum*.

Locality: McPherson County, Kans.

Age: Comanche series, Kiowa shales.

Engonoceras serpentinum (Cragin).

Pl. XIX, figs. 7–14; Pl. XX, figs. 1–5.

Sphenodiscus belviderensis var. *serpentinus* Cragin, 1900, Colorado Coll. Studies, Vol. VIII, p. 31, pl. 2, figs. 4–6.

Three casts of this species (Loc. No. 1489) are well preserved in a matrix of hematite. The diameter of one (1489 b) is 58 mm., the volution is 29 mm., the umbilicus 7 mm.: the same volution opposite, measured from lines of involution to venter, 22 mm., no shell being present.

The involution conveys the larger part of each outer whorl, but the internal volutions are plainly visible in the umbilicus and the involution is obviously much less in the younger stages than in adults. The volutions are much compressed. The venter is, however, flattened and slightly concave in the ephebic stage, and in the gerontic stage it becomes asymmetrical and sinuous through the development of the large tubercular terminations of the alternating costæ. In the ephebic stage the costæ are sigmoidal and only slightly developed; in the gerontic stage these become broad on the outer parts with an external and internal line of nodes, and become obscure internally or umbilicad of the second row of nodes, but they are obviously confluent to the internal or third line of smaller nodes on the umbilical shoulders. These nodes, like the costæ, come in on the casts at a late ephebic substage, the side of the younger whorls being smooth. The tubercles of the outer line in the one specimen (1489 b) are sharper and the costæ at the points convergent, whereas in the second specimen from the same locality the latter broaden out and the tubercular terminations are more elongated This, however, resembles those of the other specimen in the ephebic and anagerontic substage, the marked elongation coming in with the metagerontic substage.

A similar disposition to broadening out of costæ is also observed in the larger specimens in extreme age, but is not so marked and the venter also remains narrower. The living chamber is not complete, but it must have been about one-half of a volution in length on the line of involution. Other specimens show the same, but none give the outer margins. The inner lines of tubercles remain close to the umbilical shoulder, receding outwardly very slightly in extreme age.

The variation between different specimens in external aspect of the casts is not great except in the gerontic stage owing to the greater or less development of the nodose costations, but the variations in the sutures are such that no two specimens are alike.

The fourth suture on right side of figured specimen has eleven lobes and ten saddles, and is only slightly curved apicad. The arms of the ventral lobe are seen cutting deep into the lateral aspect. The inner branch of the first lateral saddle is broad, entire, and club-shaped, as are all other saddles, except the ninth and tenth, which are bifid. The depth and size of the lobe that divides what is here assumed to be the first lateral is so like other lobes that it is not always easy to determine whether it is a marginal or really the first lateral lobe. The lobes are all clubbed; that is, narrow orad and swelling-out apicad, and from first to seventh show very faint digitations or indications of from three to four very minute incipient marginal lobes, the fifth showing the equal and the remainder the unequal numbers of these.

Specimen 1489a has short lobes and corresponding saddles like the above, but narrow outer branches to the first lateral saddles and arms of ventral lobe hardly apparent on the lateral aspect. There are eleven lobes and ten saddles easily distinguishable, i. e., not overlapping and similar to those of the first specimen, but saddles narrower outwardly and broader inwardly, and, what is more remarkable, the seventh, ninth, and tenth are bifid, the eighth, which is bifid in the first specimen, being entire in this.

Specimen 1489c has such distinct sutures that one hesitates to place it in the same species with those marked 1489a and 1489b. The sutures are more deeply curved apicad, the outer five saddles and lobes longer and narrower, and the inner ones broader and flatter. There are, however, eleven lobes and ten saddles visible, as in the others, and the age is about the same. The sutures are, however, closely approximated, so that the lobes slightly overlap even in the ephebic stage and form columns except along the lines of the first to the second. The ninth saddle alone is bifid, all others being entire.

The discoidal aspect of the young in the umbilicus can be plainly seen in this specimen. The sutures on the left side have the same general character, but differ in details from those of the right side. The outer saddles are alike, but the inner ones are narrow and more numerous.

The fragments from Denison consist of an almost entire gerontic living chamber and one somewhat more imperfect one of the same age, a smaller fragment of part of ephebic living chamber and last suture. This last shows that in the ephebic stage the venter is smooth, narrow, concave, and has no tubercles, but is bordered by two smooth ridges. There are nine lobes and nine saddles, the seventh and eighth saddles being bifid. The line of involution is occupied by a minute lobe, as it is also in other specimens. There are five dorsal lobes between this and the antisiphonal lobe on each side. The first dorsal saddle next the antisiphonal is entire, the second and fifth are bifid, the rest are entire. The third dorsal lobe was bifid, the remainder on both sides of this were entire and narrower. The antisiphonal lobe was narrow and bifid. The sutures of an early ephebic or late neanic substage in one of these showed that the notation of the saddles in this group is correct, and that the first lateral has, as stated, two unequal arms, the inner being really an adventitious saddle derived from the inner side of the first lateral. The outer saddles and lobes are similar in outline to those of some specimens from northeast of Gainesville, but the inner saddles and lobes are shorter and broader.

A specimen from Denison, kindly lent me by Prof. F. W. Cragin [is also figured and is probably one of the types of his variety *serpentinus* now raised to specific rank].

This species is distinguishable from others by the extremely late stage to which the protengonoceran venter—i. e, the concave venter bordered by two ridges—is retained. Practically it lasts throughout the ephebic stage, and the engonoceran stage is passed through with great rapidity. In this the venter is flat and bordered by well-defined elongated tubercles, and consequently there is a quick appearance of the senile stage with elevated convex venter between large elongated nodes. It should be noticed that one of the varieties imitates the sutures of *E. subjectum* in the shape of the saddles and lobes, but these remain characteristically simple in outline (Pl. XIX, fig. 11). Some varieties have bifid saddles and some do not have them. The dividing marginals of the saddles enlarge by growth when they occur, until they often form lobes practically inseparable from others.

Locality: Four and one-half miles northeast of Gainesville and Denison, Tex.

Age: Upper part of Comanche series, Paw Paw beds, Washita group.

ENGONOCERAS PIERDENALE (von Buch).

Pl. XX, figs. 6–13.

Ammonites pierdenalis von Buch, Abhandl. K. Akad. Wiss. zu Berlin, 1848, pl. 6, figs. 8–10.
Ammonites pedernalis Roemer, 1852, Kreideb. v. Texas, Pl. I, fig. 3.
Engonoceras pedernalis Böhm, 1898, Zeitschr. Deutsch. geol. Gesell., Vol. L, p. 183.

I have placed this here with a query, because I find it impracticable to identify the young figured by von Buch with any form known to me. The ventral lobe and saddle and the other parts of the suture might belong to the young of a species a grade more complicated than any here described. There is a row of elongated nodes close to the venter in von Buch's figure, but the presence of such ornaments is denied in the text, and the nodes are said to be on one side and due to the exposure of the joints of the siphuncle. Roemer states that he had the originals in hand when making his description, and that the species was much larger than that described by him.

Neumayr mentioned this species as the type of his genus *Engonoceras*[a] and repeats the name "pierdenalis" instead of "pedernalis," the name given by Roemer, and also repeats von Buch's figure of the suture on Pl. 7 ot Über Ceratiten.

Von Buch and Neumayr also both describe the principal saddles as bifid, a condition that does not exist in any specimen of the genus that I have seen.

Locality: Texas.

Age: Fredericksburg group of Comanche series.

ENGONOCERAS PIERDENALE variety COMMUNE Hyatt.

Pl. XXI, fig. 1.

A fragment in U. S. National Museum, No. 8301b, from Bell County, Tex., is slightly crushed in the umbilical region, but has sutures and markings well preserved. At larger end the volution is 33 by 14 mm., at smaller end 24 by 11 mm.

The venter is flattened and narrow, bordered by small elongated tubercles rather numerous and closely set as in the adults of this species. There is an inner row of tubercles, hardly perceptible median row, and equally faint fold-like costations on the outer part of the volution, which can be felt better than seen on this cast.

[a] Amm. d. Hilsbild. Norddeutschlands, Palæontogr., Vol. XXVII, 1880–81, pp. 138, 141.

The ventral lobe is slightly asymmetrical to the left, giving rise to considerable differences in the first lateral saddles on either side. The first lateral on the right is bifid, the outer arm very broad and bifid, the inner subdivided asymmetrically by a very minute marginal lobe. Beyond this the inner arm is entire and quite large and phylliform. There are ten saddles and nine lobes on this side All the former are entire except the innermost, which is slightly bifid The lobes vary from trifid to six-pointed. On the left side the first lateral saddles have the usual bifid form without further subdivisions. All the saddles appear to have entire phylliform outlines, but this may be due to the worn sutures. The first to fourth lobes are slightly digitated, the fifth is faintly trifid, and beyond they are too much worn to show the minute serrations.

On the left side the first lateral saddles have the usual bifid form, the outer arm broad, pointed externally, and with only a slight indentation on the margin. The second to seventh lateral saddles are entire and phylliform; the eighth is broad and deeply bifid, but is apparently only one saddle; the ninth and tenth are entire.

The first to fourth lobes are faintly denticulated, the fifth and sixth narrow and trifid. The seventh is totally unlike any other lobe. It seems to be filed by a pointed saddle, the end bifid in one case.

There is also another specimen from the same locality, a cast with a part of a living chamber preserved. This is about one-half of a volution and in the gerontic stage, the last five sutures overlapping. The preceding sixth or eighth, being in the ephebic stage, do not overlap. The lobes and saddles are like those of the fragment just described, the sixth to the eighth saddle on the right side being bifid and the ninth entire. The saddles in old age, however, are flatter and the lobes become shorter.

The ornaments are the same as in other specimens, but the venter becomes broader in proportion to age; tubercles persistent. The living chamber is obviously nearly complete and must have been at least one-half of a volution in length.

Three small fragments from locality No. 1554, Seven Knobs, near Glenrose, Tex., have tubercles larger and more prominent, and although the sutures vary they are near enough to belong to the same species.

The largest specimen over one-half of a volution is 52 mm. in diameter. Probably, allowing for compression, this diameter is only 45 mm. The living chamber is about one-half of a volution and is nearly complete. The venter broadens out, and this specimen seems to be outgrown, judging from the approximation of the last three septa. The sutures are similar to those of the preceding, but the seventh saddles are bifid.

Specimen from locality 1545, Chalk Mountain, near Glenrose, diameter of volution 50 mm., partly estimated, has seventh saddle on the right side bifid: all others external to this entire and phylliform, except, of course, first lateral. This cast shows plainly that what is here counted as the second lateral is an adventitious saddle derived from division of the first lateral saddles, and the first lateral lobe is also an adventitious inflection arising from a primitive marginal of the first lateral saddle.

A fragment from the Goodland limestone, Choctaw Nation, about 100 miles east of Preston, Tex., is considerably worn, but apparently of this species. The volution is 33 mm. from line of involution to venter and is in gerontic stage, the last six sutures overlapping. The venter is also rapidly broadening, the gerontic tubercles and costæ are larger than usual, and the venter is more asymmetrical or zigzag in outline. There are nine saddles visible, and the seventh and eighth are bifid; the outlines of others are entire. The lobes, owing probably to attrition, are all entire.

A specimen in the United States National Museum, No. 22643, from locality No. 973, near Cerrogordo, Ark., has a combination of characters which appears to unite *serpentinum* with *pierdenale*. The sutures have the broad, short saddles with flat bases, like those of *serpentinum* from near Gainesville, but the size of specimen, nodes, and aspect are similar to the typical fossils of *pierdenale*. The surface is worn down somewhat in this cast, and probably these resemblances may be due to this cause. This cast is 91 mm. in whole diameter; transverse diameter estimated at 20 mm.

A cast in the Museum of Comparative Zoology from Towash, Hill County, Tex., is 56 mm. in diameter; the outer volution is 27 mm., the umbilicus 8 mm., and the opposite part of same volution from line of involution to venter 21 mm. This is an outgrown specimen, the last six sutures overlapping those preceding, while in ephebic stage they are separated by a distinct interval.

There are the usual lines of tubercles, and the costæ on the outer part of the volution become very decided, as in other aged specimens. The venter is at first narrow, but this becomes much broader at the same time that costæ increase in size in last part of the outer volution. The venter runs from 2 to 7 mm. in width on this one volution. The living chamber is complete internally and is somewhat less than one-half of a volution in length. The sutures resemble those of specimens described above except that there are only seven saddles, the fifth and sixth very broad and bifid, the seventh entire.

The first to third lobes are very slightly digitated; the rest are entire.

Böhm's studies of the originals of the descriptions of this species have been referred to in the generic description. Whatever doubts of Böhm's conclusions may remain in the mind, it is surely safer to follow such an investigator, who has worked over the original materials, than to indulge in speculations with regard to the exact meaning of von Buch's and Roemer's descriptions and figures, about which the most opposite opinions might be reasonably entertained.

Engonoceras subjectum n. sp. Hyatt.

Pl. XXI. figs. 2–6: Pl. XXII. figs. 1–5.

A good cast of this form (No. 431 in Museum of Comparative Zoology) is 101 mm. in diameter, the inner oldest part of the outer volution being partially destroyed, so that this could not be measured. The living chamber was probably, when perfect, not less than one-half of a volution in length. The whole diameter was about 102 mm.; the transverse diameter was decreased so by compression that the measurement near base of living chamber could not be relied on, but this was 18 mm., the ventro-dorsal breadth of side being at the same place 43 mm. The living chamber having been excavated, it was possible to measure the interior volution in the same line with the largest diameter given above. This was found to be 73 mm., the largest volution being 40 mm., the umbilicus 7 mm., the opposite part of same volution 26 mm. No shell was present on this cast. The involution covers up the entire side of inner volution at diameter of 86 mm. This is found in several specimens, but does not appear to be invariable. There are large nodes along the umbilical shoulders, very obscure nodose folds along the central surfaces of lateral zones, and prominent elongated alternating nodes along either border of the venter. These last are finer in the ephebic stage than in the gerontic substages. At diameter approaching 100 mm. the venter loses the flattened aspect of the ephebic stage, becomes broader and slightly rounded, but still retains the tubercles and asymmetrical aspect due to their prominence and alternation. The gerontic living chamber is about one-half of a volution in length on the ventral side, the dorsal side being absent.

The earliest suture in type No. 431 at diameter of 26 mm. from line of involution to venter has eight saddles and seven lobes to the umbilical shoulders. Beyond this they were not visible. The saddles are narrow and phylliform or club shaped; the lobes also are clubbed and have primitive denticulations. First lateral saddle is trifid and inner marginal lobe is digitated, the second to fourth entire, fifth to eighth bifid. The ventral lobe is longer than usual in this genus, but has the usual form, divided by entire broad siphonal saddle. The first, second, and third laterals have about five denticulations unequally divided, and the fourth is trifid. Later in the gerontic stage the second to fourth saddles become either bifid or have more digitations, and the digitations of the lobes increase to seven; the phylliform aspect also increases.

When the volution is about 37 mm. in diameter from line of involution to venter, there are apparently about the same number of saddles and lobes, Pl. XXI, fig. 5. The lobes have more denticulations and the third saddles are also faintly bifid. In another specimen, Pl. XXI, fig. 6, same locality at about the same age, all the saddles and lobes are shorter and broader in proportion, but decidedly phylliform, the lobes are more denticulated, the first lateral saddles deeply trifid, the second to fifth saddles entire, the sixth to the eighth (the last one visible) distinctly bifid.

A cast (No. 10755, Boston Society of Natural History) from Bell County, Tex., is 75 mm. in whole diameter. The entire volution is 39 mm. from venter to line of involution; the umbilicus is 10 mm.; the diameter opposite from line of involution to venter is 27 mm.

This is in the gerontic stage, the last five sutures overlapping. There are ten saddles and nine lobes on the left side. The second to the sixth are entire, the seventh to the ninth are bifid, and the tenth is entire. The saddles and lobes have the elongated phylliform character of this species.

Locality: Gabriel, Williamson County, Tex.

Age: Comanche series, Washita?

The remarkable and highly instructive specimen described below is a cast with an approximate diameter of 55 mm. It was received from Dr.

D. S. Martin and came from Grayson, Tex. The sutures on the right side possess a decidedly unique aspect, having a first lateral saddle entirely different from that of any specimen of this genus I have yet studied or seen figured. The whole aspect of these sutures indicates a new species, whereas the sutures on the other side, although considerably abraded, are perfect enough in places to show the ordinary form of first lateral saddle commonly found in *Metengonoceras*. The sutures of the right side are more like those of *E. subjectum* than those of *E. pierdenale*, but they are quite distinct from both in the aspects of the saddles. On the right side there are nine saddles and eight lobes. The first lateral saddle is broad and distinctly trifid. The inner arm is broad and has the usual shape of other species, being pointed externally and running well on to the venter. The central arm is a narrow, small marginal saddle between two small entire marginal lobes; the inner arm is narrower than the outer arm and phylliform. The second to the fourth saddle are entire and phylliform, the fifth and remaining saddles have flatter bases. The fifth is still entire and the remaining saddles also, except the sixth, which is broad and bifid. This bifid character can be detected only on the first part of the outer volution where the dividing lobes are not abraded, but even this is open to some doubt.

The ventral lobe has the usual outline and is symmetrical in position; nevertheless the first lateral saddles on the left side are quite distinct from those on the right side. They have the usual bifid character of specimens of other species, and there is nothing unusual in the outlines of the sutures on this side. The seventh and eighth saddles are bifid, and the sixth is entire. The ninth saddle is broader than on the right side. The condition of the sutures on this side did not admit of more minute observations. The first to the fourth lobes on the right side were of the usual form, but rather coarsely serrated and similar to those of specimens from Bell County, Tex., described above (collection of the Boston Society of Natural History, No. 10755). It agreed also with the last in the prominence of the middle line of tubercles.

Locality: Grayson, Tex.

Similar sutures occur in a cast of this species kindly loaned me by Prof. F. W. Cragin, and in this the eighth saddles are on the umbilical shoulders and the broad ninth reaches to the line of involution: the second to the sixth saddles are entire; the seventh to the ninth are bifid.

Locality: Tarrant County, Tex.

The venter in this species remains concave and has a sharp ridge on either side at the ventro-lateral angles, broken into waves by equally acute but elongated, nodes on the casts. Shells were not present. In old age these nodes persist, but the ridges disappear and the venter becomes flattened, and finally convex.

A cast from Denison, Tex., Duck Creek beds, United States Geological Survey, has very different sutures and is also somewhat different in general aspect. The living chamber is complete in the inner borders and is considerably less than one-fourth of a volution in length. It is in the gerontic stage; the inner tubercles are large, and the outer ones, terminating short, fold-like costæ, are also very large. The venter is completely rounded and much zigzagged in correlation with the large tuberculose alternating folds and nodes of the costæ.

The whole diameter is 92 mm.; the outer volution, which is somewhat reduced by gerontic contraction, is 42 mm.; the umbilicus is 14 mm., this being enlarged in proportion to reduction of gerontic part of volution, and opposite from line of involution to venter is 36 mm. The saddles are quite distinct from those of specimens described above, but have the same distinctly phylliform aspect; the lobes are more alike and with similar serrations. There are nine saddles on the right side. The first lateral has the same deeply bifid form as in specimens of this species. The second to seventh have rounded leaf-like bases; the eighth is still phylliform, but broadens out and is bifid; the ninth is entire. The first lateral lobe is evidently very slightly divided, but the second to the fifth are more richly denticulated than the sixth and seventh and are faintly trifid (?); the eighth is perhaps entire, but not plainly seen. The living chamber is shorter in this specimen than in any other example of this species and the nodes are more like those of *serpentinum*, while the sutures agree better with those of *subjectum*.

The principal distinction between this species and its allies of the same genus lies in the more elongated phylliform saddles and lobes.

Engonoceras gibbosum n. sp. Hyatt.

Pl. XXII. figs. 6–10; Pl. XXIII. figs. 1–6.

The best example of this species is an entire cast in my collection from Cook County, Tex. This has the median line of nodes along the central line of the lateral surface, the outer distinct and short and no perceptible costæ between these. This cast, the type of the species, shows no gerontic characters at the diameter of 93.5 mm. The greatest transverse diameter is at the umbilical shoulders and is 25 mm., the breadth of the side at the same point being 50 mm. The sutures are quite different from those specimens described below, but there is the same general character: the second lateral saddle and the fifth are bifid; the sixth is unequally trifid; the seventh is a compound saddle with two bifid arms; the eighth to the tenth are entire or flat. The more gibbous sides, the prolonged stage during which the nodes persist and are sharply defined, and the large number of bifid saddles characterize this species. The sutures are the most complex, with exception of *Eng. roemeri*, of any that have been so far descibed in the genus.

The largest fragment in the National Museum is about three-eighths of a volution. Widest diameter is 91 mm.: the distance from line of involution to venter is 50 mm. at the larger end and 38 mm. at the smaller end; and the transverse diameters are 20 mm. and 16 mm., respectively. This specimen was probably entirely uncompressed. The venter is narrow and flat and the sides are slightly gibbous and highly convergent outside of the middle row of obscure nodes. Between these and the umbilical shoulders, however, a flattened zone is developed, which may even slightly slope inward The usual row of nodes is present on the umbilical shoulders, and also the rows of alternating tubercles on each side of the venter. The latter are sharp and well formed, elongated, and sufficiently numerous to give a decidedly zigzag aspect to the narrow venter.

The venter is flat in the early part of the neanic stage and much broader in proportion to the volution than in later stages, as it is in most species of this genus. The volution has more flattened sides at this age, and the involution begins to cover up the volutions to the umbilical shoulders even at this early stage.

The sutures are well separated, as in other shells of this genus, and are very remarkable. There are on the right side ten lateral lobes and eleven saddles at the larger end of this fragment and the same number at the smaller end. These are more difficult to count and quite different on the left side. The ventral lobe is symmetrical and of the typical form.

On the right side the first lateral saddle is bifid, the outer arm short, broad, and spreading, the inner also broader than in most other forms; the outer is subdivided by a minute marginal or slightly and unequally bifid; the inner arm is slightly trifid in nearly all the sutures, and this becomes more apparent in the older sutures. The lateral saddles are broadly phylliform. The second laterals are obscurely and equally bifid in all the sutures: the third shows a faint tendency to become bifid only in the older sutures; the fourth seems to have a similar tendency, but this does not become demonstrable, and it must be described as narrower at the base and entire. The fifth is bifid in the younger sutures observed, and becomes more distinctly bifid with age; the sixth is narrower and entire; the seventh is equally bifid; the eighth is also equally bifid, but the inner arm is unequally subdivided by a minute marginal; the ninth is also equally bifid, and each arm is also bifid with a minute marginal lobe; in some sutures both are unequally divided and in others the outer is symmetrical, the inner asymmetrical; the tenth is small and entire, and the eleventh is very broad and is subdivided by a minute marginal lobe introduced on this volution, and the outer arm shows a tendency to broaden and become bifid in the older parts of the same. The saddles are phylliform but rather short and stumpy from second to sixth, then they become very broad and less phylliform; the lobes have the usual narrow bases between the expanded bases of the saddles and spread out apicad between the phylliform saddles. These are all apparently unequally subdivided, and the digitations and serrations are somewhat more numerous in the second to the fifth laterals than in most other species. The first and sixth are simply trifid, the seventh and eighth bifid, the ninth and tenth entire.

On the left side the first lateral saddles have a narrower outer arm, divided by a deeper marginal lobe, and the inner arm is not so broad and shows only a faint tendency to become bifid. The second lateral is more distinctly but unequally bifid: the third shows a faint tendency to a trifid undulation: the fourth is entire: the fifth is faintly bifid: the sixth is distinctly but asymmetrically bifid: the seventh is equally and deeply bifid: the eighth is very broad and also deeply bifid, the outer arm has the margin faintly undulated into four nearly equal marginal serrations, the inner arm is asymmetrically bifid: the ninth is also unsymmetrically divided, the outer part or arm is very broad, rather rounded basally and undulated into three minute serrations on the margin, the inner arm is a minute saddle; the tenth saddle is like that of the right side, but faintly bifid in the first sutures seen; the eleventh saddle is narrower than on the right side and entire. The lobes are all shorter, with broader ends apically and with less complex digitations than on the right side.

One small specimen, a cast from locality 1492, 15 miles west of Denison, Tex., has a diameter of 46 mm., outer part of volution, 23 mm.; transverse diameter, 11 mm.; umbilicus, 7 mm.; and opposite diameter from line of involution to venter, 16 mm.; transverse diameter, 7.5 mm. This has the same shape of venter and general aspect. The nodes of the inner line are present as elongated costæ, which are most prominent at the umbilical shoulders and much inclined orad. Very obscure nodes could be felt over the more perfect surface of the cast along the centran lateral area. The cast was too imperfect along the venter to observe nodes, but at the beginning of this volution on a small bit of the shell of the venter exposed by excavation there were smooth ridges at the ventro-lateral angles, and the venter was concave.

The sutures in this are crowded together unusually close for shells of this genus, the inner lobes and saddles overlapping slightly, beginning with the third lobes and fourth saddles. It is probably a dwarfed form of this species, since in the earlier part of same volution the sutures are well separated, as in other forms.

The ventral lobes are obliterated, but sufficient of the first lateral saddles remain to show that they were unequally bifid and that the outer arm was also bifid, the inner arm entire and quite large. The second to fourth saddles on the left side were broad and entire, the fifth to seventh symmetrically and deeply bifid, the eighth very broad and unequally bifid, the outer arm faintly bifid, the ninth alone entire. There is considerable variation on the right side, the sixth saddle is not deeply bifid, the seventh is unequally bifid, the eighth is like that of the left side, but the bifidity of the margin of the outer arm is more pronounced. The ventral lobe is symmetrical, but so much worn down that no observations were practicable except at two of the sutures, when it seemed to have the usual generic form. The living chamber was not present in either of the above-described specimens.

A small cast from Bell County, Tex., No. 8301a, about a fourth of a volution, is 23 mm. in diameter from line of involution to venter, transverse diameter 14 mm., two lines of tubercles and median line of elevations well defined, venter distinctly concave. The sutures appear to have more resemblances to those of the older stages of this species than to any others. The ventral lobe is narrow and slightly asymmetrical to the left, but the first lateral saddles on both sides are alike. They are both bifid, the outer arm is entire but is blunter than usual on the venter. The first to sixth saddles are otherwise like those of the specimen described above; the seventh to ninth saddles, seen only on the left side, are symmetrically bifid, the tenth is entire. This bifidity of the internal saddles agrees with those of *uddeni*, but the aspect of the volution and the general form of the saddles and lobes agree better with those of this species.

Locality: Cook County, Tex., 15 miles southwest of Gainesville and 15 miles west of Denison.

Age: Fredericksburg division of Comanche series.

Engonoceras stolleyi Böhm.

Pl. XXIII, figs. 7–9; Pl. XXIV, figs. 1–5.

Engonoceras stolleyi Böhm, 1898. Zeitschr. Deutsch. geol. Gesell., Vol. L, pl. 5.

This species has the flattened venter, becoming alternately nodose and zigzag in old age, as is characteristic of this genus. It is not distinguishable from *E. pierdenale* except in the sutures. The lateral saddles and lobes are smaller than in any other species of this genus, and the first lateral saddles are apt to have the inner marginal saddles tongue-shaped. This peculiarity is noticeable in Böhm's figure and in the large fossil (Pl. XXIV, fig. 5).

Age: Fredericksburg group [?], Comanche series, Lower Cretaceous.

Engonoceras complicatum n. sp. Hyatt.

Pl. XXIV, figs. 6–8.

This is founded upon a cast from near Austin, Tex. The whole diameter, partly estimated, is 73 mm., the outer volution is 39 mm., the umbilicus 9 mm., the volution opposite (estimated) 25 mm. By the cast alone this species could not be separated from *Engonoceras gibbosum*, but the sutures are nevertheless entirely different. A better preserved specimen might, however, show some external characteristic distinctions. There are fourteen sutures visible on the outer volution; then comes a gap between them and those on the first quarter of the same volution. The entire fourteen overlap, but the tenth, eleventh, and twelfth are nearer together than any others. The ephebic sutures on the first quarter of this same volution are well separated. There are eleven slender saddles and ten slender lobes on the left side. The first lateral is narrower than in any other species and bifid, with tongue-shaped entire arms; the second and third laterals are also entire and linguiform; the fourth to the ninth are phylliform and bifid; the tenth could not be seen; the eleventh was entire.

The ventral lobe is narrower, deeper in proportion than in other species. There is a smaller and contorted cast from Benbrook, Tex., with similar sutures so far as the bifidity of some of the principal saddles is concerned. It is very likely a variety of this species. The markings, so far as can be determined, are similar. The living chamber is about one-half of a volution, the last sutures overlap, and the shell was evidently in the gerontic stage. The third lateral saddles were bifid, the fourth was entire, the fifth to ninth were more or less phylliform and bifid, and beyond this none were visible.

It differs from *Protengonoceras emarginatum* (Cragin) in having pronounced lines of tubercles along the ventro-lateral angles and its greater number of lobes and saddles, judging from the descriptions of that species. The characteristics of the venter and the size as given by him indicate a larger species, with venter more like that of *Proten. gabbi*. A small specimen, a cast, from 15 miles west of Denison, Tex., has a diameter of 46 mm.; outer part of volution is 23 mm.; transverse diameter, 11 mm.; umbilicus, 7 mm., and opposite diameter from line of involution to venter, 16 mm.; transverse diameter, 7.5 mm. This has same shape of venter and general aspect. The nodes of the inner line are present as elongated costæ, most prominent at the umbilical shoulders and much inclined orad. These disappear as they pass the centran lateral surface. Nodes could not be seen nor felt over the perfect surface of the cast, and none were visible at the beginning of this volution on a small bit of the shell of the venter exposed by excavation.

The sutures in this specimen are crowded together unusually close for shells of this genus, the inner lobes and saddles overlapping slightly, beginning with the third lobes and fourth saddles. It is probably a dwarfed form of this species, since in the earlier parts of same volution the sutures are well separated, as in other forms.

The ventral lobes are obliterated, but sufficient of the first lateral saddles remain to show that they were equally bifid and that the outer arm was also bifid the inner arm entire and quite large. The second to fourth saddles were, on the left side, broad and entire, the fifth to seventh symmetrically and deeply bifid.

Locality: Near Austin and Benbrook, Tex.

Age: Fredericksburg group, Comanche series.

ENGONOCERAS EMARGINATUM (Cragin).[a]

Sphenodiscus emarginatus Cragin, 1893, Geol. Surv. Texas, Fourth Ann. Rept., p. 245.

According to Cragin's description, this species has the concave venter until a late stage, but has the tubercles and sutures of this genus.

ENGONOCERAS ROEMERI (Cragin).

Sphenodiscus roemeri Cragin, 1893, Geol. Surv. Texas, Fourth Ann. Rept., pl. 46, fig. 1.

Cragin describes this shell as having "venter narrowly truncate, the ventro-lateral angle at first sharp, becoming on the body-chamber subtuberculate-sinuous." This and the general outlines of the sutures, if they are supposed to be deprived of their marginal saddles, as they must have been in the young of this shell before these were developed, has caused me to refer the species provisionally to this genus The sutures are, however, obviously more complex as figured by Cragin than in any other known form of *Engonoceras.* The principal saddles are all bifid, trifid, or quadrifid, and the smaller saddles inside of what appears to be the fourth saddles are mostly bifid.

Mr. Stanton has written as follows regarding this form:

According to Cragin, this is from the "alternating beds"—that is, the Trinity division—not Fredericksburg, as given in your MS. If this be true (and Mr. Taff's stratigraphic data look all right), the form is probably the oldest one of this group that we have from the Comanche series.

Locality: Iredell, Bosque County, Tex.

Age: Comanche series, Glenrose beds.

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[a] See p. 157, where this species is doubtfully referred to Protengonoceras.—T. W. S.

NEOLOBITES Fischer.

The sutures of this genus have, perhaps, simpler outlines than those of any other Cretaceous ammonoid, and have been supposed to place the genus somewhere near *Tissotia.* They, however, differ decisively from those of any of this group in having long phylliform saddles and a very peculiar ventral lobe. The form, ornamentation, and old age of the species from Tunisia, described by Peron, would place it in the genus *Placenticeras,* if no sutures were visible. But the sutures and ornamentation agree with those of *Engonoceras,* and show that it is probably a member of the same family. Choffat's researches have placed this conclusion on a secure footing. His *Neolobites vibrayeanus* may not be identical with d'Orbigny's species, but it is surely a close ally, and he gives the sutures in full, and these show the ventral lobes and siphonal saddles and first laterals to be similar to those of *Engonoceras.* If the young, when seen, prove to have a similar development, the evidence will be complete.

NEOLOBITES VIBRAYEANUS (D'ORBIGNY).

Ammonites vibrayeanus d'Orbigny, 1840, Terr. Crét., pl. 96, figs. 1–3.
Neolobites vibrayeanus Choffat, 1898, Faune Crét. du Portugal, Vol. I, 2d series, pl. 5, figs. 2, 5 (not figs. 3, 4.)

This species as figured by d'Orbigny has led to great confusion, owing perhaps to the absence of a sufficient representation of the details. Choffat has figured a species from Portugal which, if not identical, is probably similar to d'Orbigny's species. All the characters coincide with the position here given to this form. A number of species are confused under this name, but the data given are not sufficient to separate them.

Locality: France and Portugal.

Age: Cenomanian.

NEOLOBITES CHOFFATI n. sp. Hyatt.

Pl. XXV, figs. 1–4.

Neolobites vibrayeanus Choffat, 1898, Faune Crét. du Portugal, Vol. I, 2d series, pl. 5, figs. 3, 4 (not figs. 2, 5.)

This is obviously distinct from *vibrayeanus,* as is shown by the broad venter and distinct sutures as well as the more gibbous form.

Locality: Portugal.

Age: Cenomanian.

Neolobites peroni n. sp. Hyatt.

Neolobites vibrayeanus Peron, 1890, Moll. Crét. de la Tunisie, pl. 18, figs. 1, 2.

A highly compressed shell with narrow flat venter bordered on either side by a line of small, closely set tubercles with numerous costæ on the flat sides, focussed into a very few large nodes near the umbilical shoulder. The involution is almost if not quite complete. The umbilicus is not figured in Peron's figure, but it must have been very small. In extreme age these nodes recede farther from their first position, the ventro-lateral lines of small tubercles disappear and the venter becomes elevated and is represented in the last stage as subacute. There are five or six lateral saddles in this species, according to Peron's drawing. Peron considered this form to be distinct, but did not describe it as a new species.

Locality: North Africa.

Age: Cenomanian.

METENGONOCERAS n. gen. Hyatt.

The shell is compressed as in *Engonoceras* and the involution covers the greater part of the sides of the internal volutions. Broad, fold-like sigmoidal costæ are present in some species and faint tubercles have been observed in rare cases on casts. No well-preserved shells have been so far seen nor described The venter in the neanic stage is comparatively broad and slightly concave; in the ephebic stage it becomes very narrow, but retains a linear concavity; in the full ephebic stage it becomes acute, and in gerontic stage subacute and then rounded. The sutures do not differ materially from those of *Engonoceras;* the distinction, so far as known, lies in the development of the venter and absence of nodes. The young were similar to the adults of *Protengonoceras*, as are those of other genera. The principal or outer lateral lobes and saddles are short, the lobes narrow and entire between the entire and more or less rounded, often phylliform bases of the principal saddles. The apical ends of the lobes are denticulated, but the marginals are entire, pointed, and the saddles blunter but also entire. The smaller inside of the principal outer saddles are often bifid. The ventral lobe is narrow orally, very short and broad apically, with two entire arms, and is divided by a depressed but more or less subacute entire siphonal saddle. The first lateral saddles in most species are broad and bifid, the outer arms more or less acute at the outer angles of the bases, and the inner arm narrower and tongue-like. One of the marked characters of this genus is the absence of differentiation between the parts of the suture at later stages of growth. The principal lateral saddles and lobes can not in many specimens be distinguished from the so-called auxiliary laterals, and I have not attempted to do this in my descriptions. In some specimens, on the other hand, especially young ones, there seem to be plainly only three principal lateral saddles or lobes, but in others there seem to be four or even five. The metaneanic substage in one species showed the primary division of the primitive first lateral saddle into three, and in several specimens in a late neanic substage it seemed obvious that this subdivision was maintained and that the first lateral of the derivative or principal series became bifid late in the life of the shell. First lateral saddles are therefore morphologically double, even when they are so fully divided that they have to be considered as two saddles, as in *Metengonoceras dumbli*. In most species there is no difficulty in seeing this, but in about all of them the line between the three principal laterals and the auxiliaries can not be drawn, nor between the principal lobes and the auxiliaries. Here, however, as in *Engonoceras*, there are but three principal laterals, if the first lateral is properly defined as double or bifid.

The subacute venters of the species in this genus have lead to confusion with *Sphenodiscus* and its allies. The ontogeny of the latter separates the two generically, but the latter might be considered an accelerated form of the same family, as stated above in the description of the family, but for the sutural characters which show that *Sphenodiscus* belongs in the Placenticeran stock.

Metengonoceras inscriptum n. sp. Hyatt.

Pl. XXV, figs. 5–9; Pl. XXVI, figs. 1–4.

One entire cast is 80 mm. in diameter. The diameter from line of involution to venter is 42 mm. at largest part, the transverse being 16 mm. Both measurements are a trifle short of what they would be in a more perfect cast. Opposite this the same diameter is 29 mm. without shell, the umbilicus being 9 mm.

A fragment somewhat younger from same locality was not compressed so as to destroy the shape. This had the same form, but was not so concave near the umbilicus and had no folds. The volutions were flat on the venter in the neanic stage, and were obviously similar to *Protengonoceras* in their young. The smaller fragment, nearly one-half of a volution, with center partly preserved, is 52 mm. in diameter, and the venter is worn, but in places where sutures are perfect the venter is narrowly rounded. In the largest cast, at about the same age, I was able to demonstrate by excavation that the shell, although very narrow, was thick and distinctly concave on the venter. There were apparently no large tubercles at any stage. The first lateral saddles in the small fragment, at a diameter of over 52 mm., were broad, very short, and had the inner angle furnished with a large marginal lobe and saddle.

The second to fifth saddles on the right side, and the second to sixth on the left side, are entire, the sixth on the right and seventh on the left being the first of the bifid saddles. The other saddles are all bifid, except, perhaps, the innermost pair, but this was not seen.

The lobes are too much worn down to show their minute digitations except in a general way. The ventral lobe and minute median saddle are present and the first lateral saddles are narrow. On the youngest and least-worn part of the larger specimen on the right side, the first lateral saddles show slight marginal lobes and saddles at each of the inner angles, but there are minute marginal lobes on the outer parts of these saddles. Several of them show this division, and one is distinctly trifid. On the older parts of the same specimen they are, however, distinctly entire as in the other fragment, and this I think is the normal character. The wearing to which it had been exposed caused me at first to count three entire saddles on the left side and four on the older parts of the same volution. It is obvious, however, that it is the sixth saddles that are bifid on both sides. The remaining saddles are bifid to the line of involution. In both of these specimens there are ten saddles and nine lobes, but there was probably in each a lobe on the line of involution. The youngest sutures were about 5 mm. distant, but the last nine lost distance rapidly and were more or less irregular, and in the last four the second lateral saddles overlapped slightly the second lateral lobes.

The larger cast has three much-worn fragments of the attached valves of an ostrean on the right side, which had evidently been exposed above the calcareous mud while in the same condition as at present, namely, a distorted fossil cast, and the ostreans grew upon the surface of the cast itself. That the cast had already suffered from attrition and compression was shown by the accurate fitting of the ostrean shells into the irregularities of the broken and worn surface. A few other lower valves were removed to study the sutures, but in no case could I find any remnants of the shell of *Engonoceras* between the bases of attachment of the lower valves of the ostrean and the surface of the cast. The specimens still left upon the cast show these facts also. The smaller specimen was much smoother and clean.

A much-distorted fragment from another locality, 9 miles from Austin on Beecaves road, of what seemed to be the gerontic stage of this species is 85 mm. from line of involution to venter and this is very near to the actual diameter in a perfect cast. The greatest transverse diameter is 35 mm. and is somewhat greater than in a perfect cast of the same age. This specimen, however, has the sutures well shown on the right side, and the differences, with one exception given below, when compared with the first specimen described, can be accounted for as probably due to greater age. The saddles and lobes are all much nearer together, the overlapping beginning between the third saddle and second lobe. The curvature was the same as in the smaller specimen.

The tenth saddle is the first bifid one and the remainder are bifid and near the umbilicus become very broad.

This difference can not be accounted for by supposing that the seventh and eighth saddles have become completely divided by the advance in development of the marginal lobes, thus adding two saddles to the series, but indicates some original variation in this shell.

The ventral lobe could not be defined and the condition of the other lobes only enabled an observer to see that they were digitated and near the umbilicus they were too much worn to say even this much. The lengthening out of the saddles by growth does not decrease the phylliform aspect of the bases and the lobes become narrower and longer without apparently altering much in general outline.

Locality: Twelve miles northeast of Decatur, Tex.

Age: Fredericksburg group, Comanche series, Lower Cretaceous.

METENGONOCERAS INSCRIPTUM var.?

This is a fragment of a volution of a large specimen, showing only a part of one side. It is, however, interesting, for the characteristics of the lobes and saddles given on Pl. XXV, fig. 8, show variations in the forms of these. A specimen from west of Walnut Springs, Tex., kindly loaned me by Professor Cragin, shows the subacute venter. The eighth saddles are bifid in this fragment and there are only ten on the right side, with large unequally bifid first laterals as in large fragment described above.

Locality: Fifteen miles west of Denison, Tex. Locality 1492, U. S. Geological Survey.

Age: Fredericksburg group of Comanche series.

One fragment is 55 mm. from line of involution to venter without the shell. The first lateral saddle is deeply bifid, and, counting this as one, there are only five entire saddles, some of which, probably owing to wear, appear to show a faint tendency to become bifid. The sixth to the ninth saddles are distinctly bifid; the tenth is a very broad saddle with three minute marginal lobes, and the eleventh is another broad saddle which is entire to the line of involution. On the opposite or right side the broad tenth saddle is divided into two bifid saddles, so that there are obviously twelve on that side.

Locality: Cow Creek, Travis County, Tex. No. 19105, U. S. National Museum.

METENGONOCERAS AMBIGUUM n. sp. Hyatt.

Pl. XXVI. figs. 5–7.

One nearly entire cast of this form is 79 mm. in diameter, the last volution 44 mm. from line of involution to venter, the umbilicus 6 mm., and the opposite part of volution 29 mm. The greatest transverse diameter through median surface is 17 mm. and is somewhat less than in a perfect specimen.

The sutures have smaller saddles than at the same age in *M. inscriptum*, are also less distant throughout, become still more approximate in later stages, and are straighter. There are thirty septa in this specimen to twenty-four in *inscriptum* at same diameter. The sixth saddles were bifid on both sides.

Fold-like costæ along the inner part of the volution are plainly visible and there are small nodes along the ventro-lateral angles, the venter being here faintly sinuous. The venter was much eroded, but in two places it showed a narrowly rounded area and on the end of this volution is subacute. Excavation was not very successful and I could only demonstrate that the venter was extremely narrow in the ephebic stage and perhaps not distinct from that of *Eng. inscriptum* at the same age.

This cast was considerably worn. The right side was free of encrusting ostreans; on the opposite (left) side there were a few, some of which were removed. No shell was found between these and the cast. They had evidently grown upon this cast and not upon a living or dead shell. This can also be seen by studying the remaining shells, one complete lower valve and part of another.

Locality: Nine miles from Austin, Tex., on the Beecaves road.

Age: Comanche Peak limestone, Fredericksburg group of Comanche series, Lower Cretaceous.

METENGONOCERAS ACUTUM n. sp. Hyatt.

Pl. XXVI, fig. 8; Pl. XXVII, figs. 1, 2.

The type specimen of this species in Boll collection in the Museum of Comparative Zoology is a fragment, but this shows the whole diameter to have been approximately 100 mm. The outer volution from line of involution to venter is 54 mm , the umbilicus 5 mm., and the same volution opposite must have been about 40 to 41 mm.

The form is much compressed and involute, with more acute venter than in *M. inscriptum.* The umbilical shoulders also in this species are more prominent and entire, and short but distinct, broad, fold-like costæ are present near the umbilical shoulders, but do not cross them. There are no tubercles on the fragments observed.

The marginal lobes of the first lateral saddles on both sides are narrow and divided by a minute marginal saddle or bifid. The first laterals are unsymmetrically trifid, the second to the fourth are symmetrical and quadrifid, the fifth is of the same type but not regularly divided. All of these are very narrow at the bases between the expanded bases of the saddles and spread out apicad into the marginal divisions. The sixth lobe is narrow and bifid, with a small marginal saddle, and the seventh similar, but with a larger tongue-like marginal saddle, and the minor lobes on either side of this are also subdivided or bifid. The eighth and ninth are distinctly but very faintly trifid, and much longer than the narrow marginal lobes described above as dividing the broad saddles of this part, which are faintly bifid. The tenth lobe was visible but not distinct enough for description.

Both specimens were too much crushed in the central parts to give any accurate data for the description of the younger stages. Nevertheless there are strong indications that the venter became acute in an early ephebic substage.

The matrix of these specimens is a red, apparently calcareous, clay stone, and indicates a distinct formation from that containing the species of *Placenticeras* cited from the same locality and also in the Boll collection in the Museum of Comparative Zoology. They have remnants of the nacreous layer and one has the shell still left in the umbilicus. The interior is so much crushed together that it is impossible to say that the venter was or was not concave in the internal volutions. Certainly, so far as the cast goes, the outer volution was unquestionably subacute.

Three fragments in Cragin's collection from the Grayson marl, one-half to three-fourths mile southeast of the Union Station, at Denison, Tex., have the phylloidal saddles and long complex lobes of this species and also subacute venters. The last volution of one of these fragments reaches ventro-dorsal diameter of 60 mm. while still septate, and has a transverse diameter of 24 mm. The sutures, however, are too much abraded for efficient observation.

The peculiar first lateral saddles of this species, the extremely phylliform saddles, narrow lobes with spreading and digitate extremities, and straightened sutures, separate this from *M. inscriptum.* The larger size of the lobes and saddles enables one, as well as the more persistent acuteness of the venter in the gerontic stage, to distinguish it from *M. dumbli.*

Mr. Stanton has written as follows with reference to this fossil: "I think this is certainly from the Upper Cretaceous and probably from the Eagle Ford shales, like the other specimens with the same locality label. Such brownish-red concretions are common in weathered portions of the Eagle Ford shales."

Locality: Elm Fork and West Fork (Horton's mill), Dallas County, Tex.

Age: Probably Eagle Ford shales, Colorado group, Upper Cretaceous.

METENGONOCERAS DUMBLI (Cragin.)

Pl. XXVII, figs. 3–14.

Sphenodiscus dumbli Cragin (pars), 1893, Geol. Surv. Texas, Fourth Ann. Rept., p. 243, pl. 44.

A superb specimen in collection United States Geological Survey, diameter 94 mm., although in three pieces and with nepionic stage and part of outer volution absent, is otherwise perfect and shows many essential facts with regard to the affinities of this genus. The last half of outer volution or greater part of living chamber is in the gerontic stage. This shows that the living chamber was at least one half of a volution in length. Cragin, who had this cast in hand as part of his materials, describes his specimens as being "very sharp in the young [my adult], becoming obtuse along the body-chamber of adult [my old age] specimens." The well preserved part of the gerontic venter in this cast is 23 mm. long and for a few millimeters is rounded, with two almost imperceptible ridges on the ventro-lateral angles, then a hollow occurs as if the shell had been injured, and this is continued to the end of the fragment by a very faint channel bordered by faint ridges.

The young in the nepionic stage has the usual rounded volution: the paraneanic substage was compressed with flat sides, deep involution, and broad concave venter, with entire, acute ridges on the borders. This stage is, in other words, like the ephebic stage of *Protengonoceras*, as has been already stated from examination of less perfect specimens. This substage was introduced gradually by the intervention of a metaneanic substage having a helmet-shaped section with a flattened venter and an ananeanic substage with transitional characters between this and the nepionic rounded volution, but not having the flattened zone on the venter. In the anephebic substage the compression and flattening continues to increase, the involution remains constant, and a very narrow channel still persists on the venter.

In the full ephebic condition this disappears and the venter becomes acute. In the paraephebic substage the venter is subacute, the sides a trifle more convex, and volution somewhat broader in proportion to the ventro-dorsal diameters, but these changes are slow until in extreme age, the paragerontic substage, when, as stated above, the venter becomes rounded. I have frequently alluded to the reinstatement by degeneration at the end of a cycle or in the adult of characters analogous to those of younger stages. In this specimen the rounded venter of the paragerontic substage has a faint concavity, and this, after what seems to have been some injury to the edge of the venter, becomes converted, as described above, into a faint channel with ridges on the outer borders. There are no marks of tubercles, nor costæ, nor folds at any stage so far as these could be seen.

The sutures have short broad saddles with narrow lobes, digitated only at the apical ends, and while the saddles remain about the same, the lobes increase somewhat in the number of their digitations and in length with age. They are quite different on the right and left sides. The siphuncle is eccentric to the right, and ventral lobe follows this organ, but there is no very marked difference between the first lateral saddles in consequence of this.

On the right side the first lateral has two branches so deeply divided by a bifid marginal lobe that it is really split into two distinct entire saddles, but these are more widely separated than in *Meteng. acutum*, and are more nearly equal in size and aspect. Counting these as two saddles, there are thirteen saddles—ten narrow, entire, and phylliform, and three broad and bifid, the eleventh very deeply bifid, and the twelfth and thirteenth successively less deeply divided. The first and second lobes are bifid, the third to sixth bifid, but with four to eight digitations; the seventh to tenth simply bifid; the eleventh and twelfth, especially the eleventh, are divided by longer tongue-shaped saddles.

On the left side the differences are as follows: The ninth to eleventh saddles are broad and bifid, the twelfth is broad and entire, the thirteenth is very broad and has a sinuous base, and inside of this a very minute lobe shows that there is a small fourteenth saddle. The eighth to the tenth lobes are simply bifid, the eleventh is unequally bifid, but has no long tongue-shaped marginal saddle; the twelfth is entire, and there is an excessively minute marginal thirteenth, as stated above.

In the adult stage from the fifth saddles inward on both sides the sutures overlap slightly and the outlines are easily separable, but in the last five sutures this overlapping spreads to the third saddles and lobes and the outlines are more compressed. This is accompanied by a shortening up of the saddles and lobes and a corresponding return of the younger proportions and aspect.

In the metaneamic substage the primitive first lateral is divided into three low broad saddles by simple indented marginal lobes, and the magnosellarian saddles are also divided, but the number of these was not ascertained. There were, however, only a few of these.

Locality: Four miles east of Whitesboro, Tex.

Age: Eagle Ford shales, Colorado group, Upper Cretaceous.

PLACENTICERATIDÆ Hyatt.

The young are similar to the adults of Engonoceratidæ, having concave venters bordered usually by continuous ridges with compressed volutions, the lateral zones converging outwardly. In later stages of genera the venters are either concave, flat, or rounded, but there is no true keel present, although the venter may become acute in some species at a late stage of growth. The volutions in the earlier stages subsequent to the nepionic are apt to be more or less compressed, the venters assuming early the characters described above, any further sharpening of the venter occurring in later stages. The principal lateral saddles are, so far as known, bifid in the young and show in most groups a tendency to become more or less trifid in later stages. The multiplication of inflections of the suture lines increases with the involution of the whorls by growth and they become very numerous in some genera.

PLACENTICERAS Meek.

The species of this genus could be readily distinguished if it were not for the great range of form in the gerontic stage, which occurs in dwarfed as well as in large specimens, and is continually mistaken for the ephebic stage.

The neanic shell is smooth, compressed, with at first a flat and then a concave venter bordered by smooth, entire ridges on the shell and on the casts, but has a stouter volution than later stages. It is, in other words, like the ephebic stage of *Protengonoceras* in external characters, but the sutures are of the Placenticeran type. Subsequently the ridges become tuberculated, the venter becomes much narrower and the sides also tuberculated and the volutions more compressed. These spines, nodes on the casts, are in three rows, but may be completely absent in some shells, as they are also in some old shells. In old age the venter again becomes flattened and smooth, and finally broader and rounded.

The species are all connected so closely by intermediate forms that distinct lines are difficult to draw between contiguous species.

The compressed and highly involute young show that those species, like *P. guadalupæ*, having depressed volutions with broad venters, are senile forms in the phylum, or what I have named phylogerontic. They are not scaphitoid, as stated by Munier Chalmas, except in the sense that *Scaphites* is an extreme case of the same tendency to reproduce senile characters early in the ontogeny and to such an extent that the ephebic form becomes more or less influenced by them. The species form a series, therefore, leading off from shells, like *P. syrtale* in one direction into *P. guadalupæ* and in the other into *whitfieldi*. The intermediate modifications connecting this genus with *Protengonoceras* are probably partly represented by *Diplacmoceras*, but this genus is not a primitive, although it seems to be a phyloneanic form.

The solution of the species problem appears to lie principally in the development of tubercles and the correlative stoutness of the volutions. Shells having heavy tubercles in three lines usually also have sutural peculiarities that enable one to distinguish them. The peculiarities of the gerontic stage are also distinct, as will be noticed in the descriptions. In some species the neanic stages are quite distinct in their sutures, although alike in their forms at the same age, and perhaps with more materials the study of these and the development of sutures may give good results. The most highly modified form as compared with its own neanic stage is certainly *guadalupæ*, but although the sutures are complicated in outline, they are not so complex as those of *whitfieldi*, and the modifications of form are distinctly in a phylogerontic direction. The varieties of each species and the development point to the most prevalent syrtaloid form as presenting more than any other purely progressive characters. This form has moderately compressed involute whorls, with three lines of nodes, narrow venter, and steadily complicating sutures. The same variations in the species and in the individual point consequently in one direction toward *guadalupæ* and in another toward *whitfieldi*. This last is reached through species like *stantoni* and *pseudoplacenta*, in which the median lines of tubercles become permanently obsolete and the outer and inner lines become less prominent and in many specimens of *whitfieldi* are absent. The interesting fact in this connection is that *whitfieldi*, which, as compared with its own young, is the least modified of all the forms, has the largest shells, the least affected by gerontic degeneration, and at all stages the most complex sutures.

These facts also show in a marked way the law of retardation of development. This was joined by Cope with acceleration, but so far as my experience goes they are quite distinct. Retardation occurs in cephalopods in phylogerontic forms. Thus in this phylogerontic genus the young is a highly modified, compressed involute shell in the neanic stage; the adult in some species like *guadalupæ* and the European *depressum* may have additional modifications ending with a paragerontic stage also tuberculated, but with peculiar broad venter and lateral nodes. In other species, obviously closely connected, like *pseudosyrtale*, *newberryi*, *planum*, and European congeners like *grossouvrei* and *milleri*, the first appearance of tubercles occurs later in the ontogeny and they are present in their full development only in the latest ephebic substage or gerontic stage. The same law holds also in the series leading from *syrtale* through *intercalare* and *stantoni* to *whitfieldi*. In some forms of *syrtale* and *intercalare* the three lines of tubercles appear earlier than in the typical forms of the same species and in *placenta*.

In *stantoni* and *pseudoplacenta* this later appearance of tubercles becomes invariable and correlates with the disappearance of the centran line and a tendency to decrease in size of these ornaments on the venter and umbilical shoulders.

In *whitfieldi* this tendency results in the total disappearance of the tubercles in a large number of shells, three lines of tubercles being present only in a very few shells and always of very small size, plainly individual reversions.

The sutures are simpler in outline and continue persistently to hold the syrtaloid outlines, and are easily separable, except in extreme age, in all of the guadalupan series, including not only the stouter forms like *guadalupæ*, but the highly compressed shells like *planum*. In the series leading up to *whitfieldi* there is a marked gain both in complexity of outline and in gerontic characters. This is apparent in *intercalare* and *placenta*, which still retain the three lines of tubercles, and is still more pronounced in *stantoni* and *pseudoplacenta* and culminates in *whitfieldi*. In these last the sutures are similar to *syrtale* only in the neanic stage, and in *whitfieldi* they become more rapidly complex in ontogeny than in other species and overlap to such an extent that it becomes more difficult to separate them throughout the ephebic and gerontic stages. This overlapping is a purely gerontic character, and the species that show it during the ephebic stage are therefore phylogerontic and to this extent degenerative in spite of the increase in complication of outlines of the lobes and saddles and their large size. This phylogerontic character is also accompanied, as stated above, by loss of ornamentation and retention throughout life of the compressed, involute, smooth volutions of the neanic stage.

The living chambers are persistently one-half of a volution in length, whether occurring in depressed or compressed shells or in dwarfs, and the apertures, so far as seen, have a short, blunt rostrum and low, broad lateral crests.

Grossouvre's careful descriptions and exceptionally fine figures of the different forms included under the name of *Placenticeras syrtale* show that while there exists in France and Germany a series closely parallel to that of *guadalupæ*, *sancarlosense*, *newberryi*, *pseudosyrtale*, and *planum* in this country, all of the European shells present differences showing that the evolution of the modifications was distinct in France. The gerontic stages show a greater tendency on the part of the inner lines of nodes to grow farther out on the lateral zones and approximate to the venter, and the venter not only flattens out to a plano-convex outline, as in some American species, but also in a subsequent gerontic substage, as in *P. grossouvrei* and *milleri*, becomes more or less concave. This is due to the increasing size of the tubercles of the median line on the borders of the venter after the disappearance of the ventral lines of earlier stages.

Kossmat[a] sums up the literature of the genus *Placenticeras* and its allies. The type of the genus *Buchiceras* is erroneously considered as a species of *Schloenbachia*. *Schloenbachia* is a genus with normal outlines to the sutures, a decisive keel with channels or smooth bands on either side, and more or less sigmoidal, prominent, well-developed costæ, the aperture having a long, pointed rostrum correlating with the keeled venter. The development is also very distinct from that of any of the Pseudoceratites of the Cretaceous. In preceding pages, *B. bilobatum* is joined with other related species, and the differences of the series to which it belongs can be more readily seen. Kossmat's strictures with regard to my own work on this group are just and most of his objections well founded. His reference to *balduri* Keyserling, as the probable radical of *Placenticeras* may be correct. At any rate there are some facts that favor this. The sutures are similar to those of *Placenticeras*. The young of this species certainly

[a] Südind. Kreidef.: Beitr. Pal. und Geol. Österreich-Ungarns und des Orients, Vol. IX, 1895, p. 171.

resembles that of some of this genus in having a channeled venter, but it is much too involute and compressed for a primitive type. The keel of *balduri* is developed in the center of a broad, concave venter of neanic age, as an obtuse raised area, but finally the entire venter becomes elevated with a subacute carina, like that of *Buchiceras* A raised nascent keel may be said to appear at a late age in some species of *Placenticeras*, but the venters in them are very narrow, and no such effect is produced as in *balduri*. The very narrow channel of the ananeanic stage in this species and the late development of the tubercles produce resemblances to *Diplacmoceras*, but in this genus the outer lines of tubercles are not on the ridges of the venter as they are in *balduri*. If this species is the ancestor of *Diplacmoceras*, we have still to account for this and the fact that the nepionic stages in *Placenticeras* exactly match those of *Protengonoceras* and *Knemiceras* and are never keeled as in *Buchiceras* and *Roemeroceras*. So far as Keyserling's drawings go, the nepionic form of *balduri* before the channel appears is like that of *Buchiceras* and *Tissotia serrata*.

The separation of the genus *Placenticeras* from the Hoplitidæ[a] demands a few words of explanation. Its association with *Hoplites* by Douvillé and Grossouvre depends upon the connection supposed to be shown by the large first lateral saddle of *Hoplites splendens*. This saddle, as figured by these two distinguished authorities, has the three large marginal lobes and three saddles which are supposed by them to be homologous with the three principal laterals of *Placenticeras*.

The author's position is quite distinct from this. If the three marginals of *H. splendens*, having undoubtedly, as stated by them, great similarity to the principal laterals (first to third) of *Placenticeras*, are intermediate gradations and not a case of parallelism, some similar stage ought to be present in the development of species having three principal laterals. This, so far as I know, is not the history of the development in any form of this kind.

[a] It is disappointing and much to be regretted that no direct mention is made of Prof. James Perrin Smith's paper on The Development and Phylogeny of *Placenticeras* (Proc. Cal. Acad. Sci., 3d series, Geol., Vol. I, pp. 181–240), although incidental reference to it is made in connection with the development of the sutures. If Professor Hyatt had completed the revision of his manuscript, he would doubtless have reviewed this paper and made some dispositon of the two species *P. pacificum* and *P. californicum*, treated in it. Professor Smith concludes that *Placenticeras* was derived directly from *Hoplites*, but the two species whose ontogeny he studied differ greatly from the typical forms of *Placenticeras*, and the results should be tested by a comparative study of some such forms as *P. placenta* or *whitfieldi*.—T. W. S.

In all genera having but one principal lateral (*Hoplites*, *Schloenbachia*, *Buchiceras*), this lateral is a direct and closely connected modification of the primitive lateral of the young. Also in genera having two or three saddles these are not preceded by an intermediate stage in which one large lateral arises like that of *Schloenbachia* and *Hoplites splendens*, but on the contrary, these principal laterals arise through the continuous growth of the two or three primitive and more or less tongue-shaped and at first entire marginals that develop in the top of the primitive first lateral lobe, as has lately been shown by J. Perrin Smith.

When these are arrested in development and do not increase in complexity and remain entire or become simply bifid or trifid, etc., the differentiation between them and the auxiliaries is lost and the sutures of the adult are similar to those of the Engonoceratidæ and the like. When, however, these do acquire more complex outlines and the development is duly progressive, its effect is invariably and naturally greater upon the saddles and lobes of the outer side, which have free growth and are most called upon to help hold the animal in the shell. These, either on this account or for some other reason as yet unknown, certainly during development as a rule become more complex than the inner laterals. This complexity is, as a rule, less in direct proportion to the distance of the saddle or lobe from the periphery if an allowance be made for the natural division due to the greater or less persistence and sometimes more or less independent development of the largest lateral lobe. This is the primitive first lateral in normal forms, but in retrogressive genera it may be, as in *Placenticeras*, the third marginal lobe of the primitive first lateral, as has also been shown by Smith. This greater development can be accounted for by the greater stress of the muscles at these median parts in balancing the shell while crawling. It interferes with the regularity of the gradations in size and complexity of the series, and marks the division between the principal or larger lateral lobes and saddles and the so-called auxiliaries.

In most groups of Ammonitinæ the first lateral becomes bifid and the centran marginal lobe is the first that appears. Usually the next saddle to become bifid is the first auxiliary. This occurs in *Placenticeras*, while the second and third laterals still have entire bases. In other words, similar laws govern the development of the two series of saddles, the principal laterals and the auxiliaries, so far as the development of the first saddle of each series is concerned. Subsequently, however, there is more irregularity. Thus the second auxiliary is not necessarily the next to become bifid, but it is apt to be the next, and the process passes inward, the innermost saddles being usually the last to become bifid, but there is great irregularity in the first appearance of bifidity or division among the auxiliaries.

As a rule, however, this irregularity does not occur in the innermost saddle, which is often broad and remains entire later than its neighbors and is the last to show complications of outline.

The second and third of the principal saddles in *Placenticeras* appear to reverse this law of progress inward. After the first has advanced to the trifid stage, it is the third which leads in complication of outline and the second which comes next. This same reversion is found also in the principal lobes In this genus the primitive lateral lobe is continuous in development with the third lateral, and it is this that first shows the trifid division, which is the incipient stage of complication; then the second follow, and after this the first. The last two, however, may progress in nearly equal ratio.

The second, third, and fourth auxiliary lobes are apt to follow the lead of the first auxiliary in regular succession, but there is variation in this respect, as among the saddles. The general law, however, is the same as among the saddles, the innermost being the last to modify their entire primitive outlines.

In the development of the sutures there are, however, two series to be considered, first the products of the development of the first primitive lateral saddle of the nepionic stage, and second the products of the inflections in outline of the second primitive lateral saddle. These form two series of lobes and saddles on either side of the primitive first lateral lobe and obey different laws of development. The complication in the lobes proceeds from the oldest lobe, the primitive first lateral, outward and inward; the complication in the saddles begins with the primitive first lateral and proceeds inward when that saddle is not divided in the neanic stage. When, however, that saddle is divided into three, there is more or less irregularity in the progression in complexity of the outlines of the second and third saddles. The outer division or principal first lateral is, however, apparently always the one that grows fastest and leads off in acquiring a more complex outline, as may be observed in about all of the genera noted below.

The tendency of the saddles to become bifid in their first stage of complication was noted by Branco and since by Nicklès, but in the lobes this varies. In these the first stage of complication is apt to be either bifid or trifid, according to the form of the entire lobe of the preceding stage. If these be pointed, the next step in complexity is the formation of a trifid top, if they be rounded or flattened, the next grade is usually a bifid termination.

In the genera described below there is a notable tendency toward the formation of trifid lobes in all of the outer lobes and in a number of the auxiliary series, the inner and last auxiliary lobes showing a tendency to become bifid.

The saddles and lobes in any one suture of the genera which have arrested development of the lobes and saddles, and even in some like *Sphenodiscus* and *Placenticeras* with very complex outlines, show a graded series of modifications from the line of involution outward. These have frequently such simple entire lobes and saddles near the umbilicus that one can see at a glance that they are like the entire outer lobes and saddles of the young. The suture, in fact, presents a series of modified forms that show in a general way the history of the development of any one of the outer lobes or saddles, if it be traced from its entire stage to the suture which is being observed. This is due to the fact noted above and also shown in Branco's observations and the author's on the young, viz, that new lobes and saddles as a rule are added from the line of involution so that these in any extended suture line are younger or later introductions. In some genera with arrested development these remain comparatively unmodified, but in most genera of Ammonitinæ and in *Placenticeras* these do become modified and have complex outlines in later stages, although never so complex as in the outer saddles and lobes. When this modification by development takes place these internal and younger lobes and saddles proceed or develop by repeating the stages passed through by their outer and more rapidly developed companions of the same sutures.

In other words, the lobes and sutures of Ammonitinæ exhibit the same law of repetition or parallelism in local development which was first discovered by Dr. R. T. Jackson among the Echinoids. He there showed that a newly introduced plate of the corona passed through stages of modification in the course of its subsequent growth which were parallel with those which had already been passed through by the surrounding plates of the corona during the stages of the ontogeny.

In other words, there is a local ontogeny in newly introduced lobes and saddles parallel with the developmental ontogeny of the same elements, and, in growing, each newly introduced internal lobe or saddle repeats locally the same stages of development. The arrest of development, which takes place habitually in all forms of Ammonitinæ, internally stops the progress of each lobe and saddle at different stages in proportion to the distance of the lobe or saddle of the auxiliary series from the line of involution. In genera like *Engonoceras*, however, the entire suture is arrested in development and presents therefore a certain resemblance to the young of other Ammonitinæ in the neanic stage and especially to the young of *Placenticeras* after the three entire principal lobes and saddles and the entire lobes and saddles of the auxiliary series have appeared. It may be objected that the division between the species is too minute and artificial, and it is admitted that this objection is in one sense well founded.

There is no real line between *P. guadalupæ*, *sancarlosense*, and *planum*, nor between *newberryi* and *guadalupæ*, nor between *guadalupæ*, *sancarlosense*, *syrtale*, *intercalare*, and *placenta*, nor between *intercalare*, *stantoni*, *pseudoplacenta*, and *whitfieldi*. As a matter of fact there is no real break, such as is usually supposed to establish a species, between *P. guadalupæ* and the extreme form of *whitfieldi*.

If, however, one admits that all American forms make up only one species, it becomes illogical to separate the European forms from each other or the American from them, and, consequently, all the forms of *Placenticeras* are one species.

I have not been able to find any middle ground between these two extremes, but have found that it is possible to diagnose species by describing the normal forms, meaning thereby the shells that are most distinct and usually most numerous in each species, and adding thereto the mention of intermediate forms.

When this is done, it is seen that in this genus the separable forms or species can be distinguished by their differences in development of the sutures, of identical ornaments, and of the sectional outlines of the volutions. The changes that take place in the aspect of the venter and of all characters in the senile or gerontic stage are included under the term development, which in the sense here used means all the modifications of the ontogeny.

Placenticeras guadalupæ[a] (Roemer).

Pl. XXIX, figs. 1–4.

Ammonites guadalupæ Roemer. 1852, Kreideb. v. Texas, pl. 2.

The best specimen I have seen has a diameter of about 145 mm. Outer volution on gerontic living chamber about halfway to the aperture is 63 mm. and transverse diameter 47 mm., the same volution opposite is 43 mm., the transverse being 34 mm., avoiding the tubercles. The umbilici are deeper, the umbilical zones being more rounded and the involution greater than in *pseudosyrtale.* The involution covers the inner volutions to the inner line of tubercles, whereas in *pseudosyrtale* these are not only completely uncovered but well inside of the line of involution. The venter is very broad, so that the second lines of tubercles are on its lateral angles and the first lateral saddles and lobes are on the ventral aspect. The alternating ventral tubercles and the flat ventral zone between them are retained on the venter throughout the ephebic stage. The inner row consists of large acute spines, solid at the tips only, which are large nodes on the cast, at the start when the umbilicus is only 25 mm. in diameter. These recede outwardly with age, but remain more prominent than in *pseudosyrtale* at the same age and the inner ridges are also much larger. The aperture is partly preserved and is apparently at the end of the metagerontic substage, judging by the last sutures, which are not closely approximated, and by the aspect of the last tubercles. The margin of the aperture has a sinus near the line of involution and broad lateral crest, but beyond this it could not be seen. The venter is convex and elevated in the gerontic stage and had a ventral zone as described above. The volutions are stouter at all stages than in *pseudosyrtale.* Having broken open this specimen, it was ascertained, as I had expected, that the young is more compressed and slender than the outer volutions, although in most Ammonitinæ the reverse of this is true. The rounded nepionic volutions were followed as in other

[a] Mr. T. W. Stanton has courteously commented as follows upon this species:

"The original spelling 'guadalupæ' should be restored. The name of the river is 'Guadalupe.' The type locality should be given 'Waterfall of the Guadalupe below New Braunfels' where the only horizons represented are the top of the Austin limestone and the lower part of the Taylor beds. The specimens from San Carlos are from beds probably of about the same age in a formation to which Mr. Hill has given the local name San Carlos beds. The Fort Worth locality [alluding to the specimen with that locality in my collection] must be inaccurate, as there are no Upper Cretaceous beds within several miles of that place."

species by the compressed and deeply involute volutions of the neanic stage, and these acquired first the flattened venter and helmet-shaped section and then, as the ventro-dorsal diameters lengthened, the hollow venter bordered by smooth ridges and general aspect of *Protengonoceras*. The facts were ascertained by excavation as well as by studying the section.

Unluckily the sutures were nowhere exposed in these inner volutions. The auxiliaries were visible later in the neanic stage after the volutions had become more compressed. They were then of the *syrtale* type, but their simple outlines showed that in the preceding *Protengonoceras* age they must have been very simple in outline and perhaps similar to those of *Engonoceras*. The nodes on the cast did not begin to appear on the umbilical shoulders until the shell was about 35 to 40 mm. in diameter and had entered upon the ephebic stage. The outer row of spines were not visible until later, and the age at which they appeared, except that it was later than the neanic stage, could not be ascertained. The ephebic stage has a stout volution with gibbous sides with proportions entirely different from those of the gerontic stage. At diameter of 26 mm. from line of involution to venter the transverse diameter at umbilical shoulders is 15 mm. and at 6 mm. distant from the venter the transverse diameter is 11 mm. The lateral zones are nearly flat and only slightly convergent and then converge rapidly but convexly to the venter which is broad, being here 5 mm. The last part of the neanic stage is 11.5 by 5 mm. at the umbilical shoulders and the convergence of the faintly convex lateral zones outwardly is constant to the venter, which is 1.5 mm. in breadth. The gerontic volution on same section is 45.5 by 35.5 mm. at the umbilical shoulders and between tubercles; the plano convex venter is 27. 5 mm., also between tubercles. The ventral line of tubercles and the concave area or ventral zone disappears in the gerontic stage, and the last measurements were taken after their disappearance near the basal sutures of the living chamber.

Roemer's figures are excellent, but they show a specimen much larger than mine, and but just entering the anagerontic substage. Roemer estimated that his shell, when complete, must have been a foot in diameter.

The living chamber of Roemer's specimen was broken away, or it would have shown similar gerontic characters. There is a centran trace on the venter of Roemer's figure which is present also on the venter of the ephebic stage in my cast. The trace is double, consisting of a faint depression between equally faint ridges. There is also a faint trace on the venter of the neanic stage, but it is then a single line sunk in the surface of the shell. It is too faint to be visible in any section, and is probably not present in the younger stages.

In the neanic stage the rather large siphuncle is at a perceptible distance from the shell of the venter, but in the ephebic stage it is directly against it, and the double trace may be due to this.

The sutures are more widely separated in Roemer's figure than in my specimen, but this may be due to more vigorous growth. There were eleven saddles and ten lobes on the older sutures, with less complicated outlines than in *pseudosyrtale*, but otherwise similar. The sutures are well separated at all stages, but the last two are nearer together than the preceding. The ventral lobes are deeper and narrower and the siphonal saddles more prominent and distinct than in other species, except that described by Choffat in Portugal as *P. uhligi*. It stands between this primitive form and *P. pseudosyrtale* and other American species, all of which have very broad ventral lobes and less prominent siphonal saddles.

A very fine suite of this species was collected by Stanton and Vaughan, locality 1467, United States Geological Survey, San Carlos, Presidio County, Tex. The largest specimen is 204 mm. in diameter; a part of the aperture at the umbilical zone shows on one side and the length of the living chamber is somewhat less than one-half of a volution. The gerontic stage is present and the involution is considerably decreased along the outer sides of the nodes on their retreat from the umbilicus. The venter becomes broader and rounded on the last part of outer volution. The outer nodes change from round spines to elongated costæ, dichotomous with the inner line of nodes that are nearly at the middle of the lateral zones at this age.

There are some more compressed specimens that still, however, have very stout volutions and a prolonged stage, during which the venter becomes broadened and occupies the space between the second rows of nodes, the outer ventral rows forming lines on either side of a zone occupying the center of the ventral surface. These features are still like those of typical *guadalupæ*, but in other cases it is impossible to say whether the specimens belong to typical *guadalupæ* or to the next described species.

Locality: San Carlos, Presidio County, Tex.

Age: San Carlos beds, Upper Cretaceous.

Placenticeras sancarlosense n. sp. Hyatt.

Pl. XXX, figs. 1–3; Pl. XXXI, figs. 1, 2.

This is represented by a series of specimens in collections made by Stanton and Vaughan that fade into true *guadalupæ*.

The typical forms differ in having smaller tubercles, the compressed stage is more prolonged and the ephebic volutions are never so stout nor the venter so broad as in *guadalupæ*. The stage in which the venter is broad and bounded by the second line of nodes and similar to that of *guadalupæ* is short and is often distinctly confined to the anagerontic substage. Some of the specimens of this form are very closely similar to *P. syrtale*. This last species has, however, so far as known, no stage in which the venter resembles that of *guadalupæ*, i. e., in which the venter becomes broadened out while the ventral lines of tubercles and the lateral nodes are still preserved in nearly their full development. This form is obviously an exact parallel with the *P. pseudosyrtale* said to be found at Fort Worth,[a] but from this it is separable by the involution which is more considerable and follows the inner line of tubercles. There are dwarfs belonging to this species which have more pronounced tuberculations than *Placenticeras newberryi*, but these approximate very closely to the specimens from Presidio del Norte, and show that these last are really another grade of modifications having the same general tendency.

Locality: San Carlos, Presidio County, Tex.

Age: San Carlos beds, Upper Cretaceous.

Placenticeras sancarlosense variety pseudosyrtale Hyatt.

Pl. XXXII; Pl. XXXIII, fig. 1.

The type of this variety is a well-preserved cast 200 mm. in whole diameter. The last volution from lines of involution to venter, although much affected by senile contraction, is 80 mm. and the same volution opposite is 65 mm. The ventro-dorsal diameter is 73 mm. about half way the length of the living chamber, and the transverse diameter is 53 mm., avoiding the tubercles. The same ventro-dorsal diameter at last septum, taken always from line of involution to venter, is 63 mm. and the transverse, avoiding the tubercles, is 43 mm. The tubercles of first inner row alternate

[a] See note on p. 202.

with those of the opposite side; the outer row is more numerous than the inner, and there are slight indications of bifurcated ridges of costæ connecting them on the cast. The ventral tubercles are irregularly alternate with the second row and there may have been ridges bifurcating more or less between these, but there are no indications of these on the cast.

It is very like Morton's species, but the gerontic stage begins later and the increase of the ventro-dorsal diameters is much more rapid. The width through the umbilical shoulders is greater at the same age and the lateral zones flatter and more convergent, owing to the greater prominence of the umbilical shoulders. The ventral lines of tubercles are more elongated, not so close together, and quite different, and the second inner line of tubercles is less prominent and nearer to the vertical lines. The inner lines of tubercles do not appear until the ephebic stage and are at first very minute but rapidly enlarge in the remainder of the ephebic and gerontic stage, disappearing suddenly before the outer ones at the beginning of the paragerontic substage. They recede from the umbilical shoulders outwardly in the parephebic and gerontic stages and have an inner costation or ridge inclined apicad.

The outer line of tubercles disappears in the paragerontic substage immediately after the inner line. The ventral lines of tubercles disappear on the cast in the metagerontic substage. These tubercles are present on a bit of the thick ventral shell in the ephebic stage. These are almost linear, alternating and widely separated, and border a slightly concave ventral zone, which is, however, flat upon the cast at the same age. The ventral zone continues well defined and flat upon this cast until quite close to the aperture in the extreme of the paragerontic substage. The contraction of the gerontic volution is very marked, beginning, even in the parephebic substage, before the gerontic septa appear and apicad of the base of the gerontic living chamber.

The sutures have the aspect of those of *syrtale*, but the outlines are more complex and the third lateral lobes longer and more pointed. This does not appear to be due to greater age, but correlates with the larger size and other differences in the form and development of this specimen. There are eleven lobes and twelve saddles on each side in anagerontic septa; the innermost saddle is narrow and apparently entire, all the remainder divided and bifurcate except the first laterals. In these the inner arm extends inwardly and, being itself bifurcated, gives a trifurcated aspect to each of these saddles. The inner lobes are bifurcated and broaden outwardly, being somewhat blunt or rounded except in the third lateral, which is pointed and apparently of the bifurcated type, as are also the other lobes. The last four sutures are more or less approximated, and the last two and part of the third interfere, as in *P. placenta*, except near and on the venter.

The living chamber is one-half of a volution in length. The outer part of the aperture is preserved, showing a blunt, broad, rounded ventral crest, or slight rostrum, ventro-lateral sinuses on the second line of tubercles, and the appearances indicate broad lateral crests, but the margins were broken away inside of this. The approximation to *P. sancarlosense* is so close that probably most paleontologists will prefer to consider them identical, but the lateral nodes are larger and more quickly developed and the ventral tubercles more elongated and more widely separated. The extremely thick shell is shown as well as the fact that the ventral tubercles are not more prominent on the thick shell than they are on the cast.

Locality: Fort Worth, Tex.[a]

Age: Probably same as *guadalupæ* and *sancarlosense.*

Placenticeras planum n. sp. Hyatt.

Pl. XXXIII, figs. 2–4; Pl. XXXIV.

This is also a part of the collection made by Stanton and Vaughan. This species also grades into *P. sancarlosense* although very distinct from *guadalupæ*. The sides are almost smooth, the tubercles being very small and obscure, except in the umbilicus. The affinities for *guadalupæ* and its allies are demonstrated by Mr. Stanton's care in collecting this fine series. The flat, compressed aspect of the young is maintained until the shells reach a diameter of 221 mm., and the venter does not show any broadening out until after the shell reaches the gerontic stage.

One of the specimens from Presidio del Norte, No. 21651, is 240 mm. in diameter. Four-fifths of the outer volution is in the gerontic stage, but the first part of the parephebic substage shows the venter still narrow, flat, and tuberculated. It then becomes rounded, but the volution still remains com-

[a] Mr. Stanton has commented as follows upon this alleged locality: "*P. sancarlosense* var. *pseudosyrtale*, labeled 'Fort Worth, Texas,' must have come from some other place, though possibly in that region." (See note on *P. guadalupæ.*)

pressed. There are small tubercles in the umbilicus but these disappear in the older stages, and almost the entire outer volution is smooth. The other specimen has similar characters, and the sutures are of the *guadalupæ* and *syrtale* type.

This species is not separable in some varieties from *P. newberryi*, except by the absence of large lateral nodes at all stages.

Locality: San Carlos, Presidio County, Tex.; Presidio del Norte, Mexico.

Age: San Carlos beds, Upper Cretaceous.

PLACENTICERAS NEWBERRYI n. sp. Hyatt.

Pl. XXXI. figs. 3–5.

The type is a cast with small patches of shell. Diameter is 120 mm., to which must be added perhaps 5 mm. for depression of outer volution. The diameter of the whole coil one-fourth of a volution younger and not altered by depression is 94 mm. The outer volution at aperture is 54 mm. and transverse is 39 mm., the umbilicus is 24 mm. and the opposite part of same volution is 42 mm. and transverse 28 mm. The last volution begins with transverse diameter of 19 mm., enlarges in the next quarter of a volution to 28 mm., and just beyond this the large gerontic tubercles begin. The transverse diameter continues to increase until the last quarter apicad of the aperture is reached, and then it diminishes between the two last tubercles, which are widely separated, and still further diminution takes place at the aperture. In another specimen there is no diminution in the rate of growth of the transverse diameter apparent to the eye, but this specimen has not a complete living chamber. The almost scaphitean aspect of the living chamber in some specimens is misleading and is in part due to depression. Nevertheless, this only exaggerates the gerontic metamorphoses of this interesting species. Small nodes are present in an early ephebic substage on the umbilical shoulders and continue to increase, becoming very large suddenly in the anagerontic substage. Elongated tubercles are present on either side of the venter in the ephebic stage, but the age of introduction was not ascertained; apparently it is later than that of the tubercles on the umbilical shoulders.

The latter are widely separated at all stages, but the ventral tubercles are close together. There are very obscure fold-like costæ, some of them dichotomous, on the outer part of the outer volution on the cast, but these have no perceptible middle row of tubercles in the ephebic stage. The venter increases in the gerontic stage from being 5 mm. wide between the lines of tubercles to 20 mm. on the first half of the outer volution, and this continues to grow broader and more convex until near the aperture, where there is an apparent diminution. As the venter broadens, the costæ are brought to the edges of the venter and their terminations become enlarged into rows of nodes as the gerontic stage progresses, but disappear in the paragerontic substage as the venter broadens and the surface of this becomes smooth on the casts.

The living chamber is somewhat less than one-half of a volution in length. It has very deep sinuses on the umbilical zones and prominent lateral crests. The form of the ventral margin was not seen. The umbilicus is deep, the internal volution visible, the umbilical shoulders are prominent, and the umbilical zones are steep and broad, as in other species of this genus, from a comparatively early age.

The sutures are of the guadalupæan *syrtale* type and well separated, becoming approximated only in extreme age. There is only one change, however, of considerable interest in the gerontic stage due to the broadening out of the venter. The ventral lobe does not broaden in the same proportion, and consequently in this stage the first pairs of saddles and finally first lateral lobes become included within the outer line of tubercles, thus becoming transferred to the venter, as in *P. guadalupæ*. Another specimen (No. 11975 a) from the same locality is more compressed, has somewhat less prominent tubercles, and not so deep umbilicus. In the interior of the type specimen the venter of the later part of neanic stage with shell on is exposed. This shows the usual compressed form of this stage in other species of this genus, the venter narrow, smooth, concave, as in *Protengonoceras*, and the volution also resembling that of that species, but at this time it is of course more discoidal. The largest specimen of the more compressed variety reaches a diameter of 134 mm. through the base of a living chamber and when complete must have been considerably larger.

I have separated *newberryi* from *P. planum* after some hesitation, because of the entire absence of the peculiar tuberculated zone of *guadalupæ* on the broadened venter of the gerontic stage, the more obscure tuberculations, and the more compressed young. The second row of nodes is more persistent in the type specimen than in other fossils, and this may be a specific character, although the condition of other casts does not enable me to determine this.

Locality: Presidio del Norte, Chihuahua, Mexico.

Age: Probably same as *guadalupæ.*

Placenticeras syrtale (Morton).

Pl. XXVII, figs. 15–17; Pl. XXVIII, figs. 1–6.

Ammonites syrtalis Morton. 1834. Synop. Organic Remains, pl. 16.

Morton's original specimen is probably a dwarf. At any rate, the shell is in its anagerontic substage, and the large nodes given in Morton's figure belong to this age. The diameter is 75 mm., and it is consequently smaller than the specimen of var. *halei* below described; nevertheless the gerontic stage has begun, as is shown by the great enlargement of the last pair of tubercles and the depression of the venter, and there is no living chamber. When this was present, the diameter was probably about the same as in the Alabama specimen. The tubercles appear earlier than in var. *halei* and are larger at the same age.

A specimen from Fort Worth, which shows the typical characters of the figure given by Morton, is 97 mm. in diameter. The outer volution is 42 mm. from line of involution to venter and the opposite is 31 mm. The large size of the umbilicus is due to the recession of the outer volution, which is in its metagerontic substage, and the shell consequently was almost wholly outgrown. It has the large inner nodes, and as these are not so numerous as the next outer row of smaller ones there is a distinct aspect of bifurcation in the fold-like costæ that here and there connect them throughout the ephebic and gerontic stages. The venter has a narrow, concave zone bordered by elongated tubercles forming a crenulated border on either side in the ephebic stage. These are more closely set than in var. *halei* from Alabama. The inner row of nodes, as in *P. intercalare*, does not hold to the line of the umbilical shoulder, but recedes outwardly in the gerontic stage, and this stage comes in much earlier than in *intercalare* in all of these specimens.

The venter has become rounded on the outer quarter of the last volution, the ventral line of tubercles being lost. The lateral nodes, however, remain prominent, showing that the last or paragerontic substage of senile development has not been reached. The outer row is nearer to the venter at all ages than in *P. intercalare*, and the volutions are stouter in all specimens of the latter that approximate in their markings to this species.

The sutures of *syrtale* at the same age as that given by Meek (Invert. Pal., p. 471) have the same broad first lateral saddles, but the other saddles are not so wide as those figured. There are, however, the same number, viz, 10. They are all minutely digitate except the tenth, which is entire. The living chamber is fully one-half of a volution in length, and part of the aperture preserved shows a broad, blunt lateral crest.

This form is obviously very similar to *P. intercalare* and may be, if one chooses, considered on one side to be identical with *P. sancarlosense* and on the other with *P. intercalare*. From the former it can be separated by the venter, which is not so broad at any stage, and by the early disappearance of the ventral tubercles in the gerontic stage, and the fact that the venter becomes rounded only in extreme age and is never flattened as in *newberryi* and its close ally, *sancarlosense*.

It can also be separated from *intercalare*, but the characters are more dubious It is certainly so close that the differences in the specimens so far known might be considered as due to the same causes that dwarfed the stature of the shells. The young, however, appear to be more compressed at the same age in *syrtale*.

Locality: Greene County, Ala.; Fort Worth, Tex.

Age: Probably Taylor marls or Austin limestone, Upper Cretaceous.[a]

Placenticeras syrtale var. halei Hyatt.

Pl. XXVII, figs. 16, 17; Pl. XXVIII, figs. 3–6.

This is found in the Hale collection (Boston Society Natural History, No. 8577), and approximates to *polyopsis* of Dujardin. It has, however, much heavier lateral nodes and costæ in the gerontic stage. The young in the later neanic stage, judging from the fragment studied, can hardly be

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[a] Mr. Stanton has most obligingly written as follows:

"Locality: 'Fort Worth, Tex.' It is not at all probable that the specimen came from Fort Worth, though it may have been found some miles east of there.

"Age: Upper Cretaceous, probably Taylor marls or Austin limestone.

"*Placenticeras syrtale* var. *halei* Hyatt.

"Locality: Greene County, Ala.

"Age: This specimen is probably from the Eutaw beds, which are probably very near the horizon of *P. guadalupæ*, in Texas."

separated from the young of *P. bolli*, although the tubercles of the inner line are less prominent at diameter of 45 mm., the volution being 23 mm. and greatest transverse diameter 11 mm. When the volution is 43 mm. from lines of involution to venter in same cast, the nodes in both lateral lines are very large and the ventral tubercles large, the ventral zone becoming sinuous on the cast in consequence of their size and arrangement. The venter also begins to show rotundity immediately after this, thus introducing the gerontic stage; the lateral zones begin to lose their flattened aspect, becoming more convex, the umbilical shoulders becoming correlatively rounded. The inner lines of nodes in this species are also apt to be elongated into ridges directed apically, as in *polyopsis* Dujardin. In the parephebic substage the volution from line of involution to venter in cast is 41 mm., transverse diameter between nodes, which are not close to umbilical lines of involution, as in earlier stages, but about 14 mm. distant, is 26 mm., and through the nodes, which are probably somewhat worn down, it is 30 mm. In a more complete cast of 90 mm. in whole diameter, which has lost a trifle on the venter by weathering, the same rounding of the venter begins when the volution reaches about 32 mm. in ventro-dorsal diameter from lines of involution to venter. The nodes enlarge rapidly in the parephebic and gerontic stage of these two specimens, and fold-like costæ appear which are obscurely bifurcated at the inner line of tubercles. The inner nodes are elongated, and have heavy, although not very prominent, folds on the umbilical zones which bend sharply apicad. The ventral zone gives place to a rounded area, as in the above, and the inner nodes are about 10 mm. distant from lines of involution instead of being only a few millimeters removed, as in earlier stages. They are, however, still on the umbilical shoulders, and, therefore, in same position as in the young with relation to the sides.

Locality: Greene County?, Alabama.

Age: Eutaw beds, Upper Cretaceous.

Placenticeras intercalare Meek.

Pls. XXXV–XXXVII; Pl. XXXVIII, fig. 1.

Placenticeras placenta var. *intercalare*, Meek, 1876, Mon. U. S. Geol. Surv. Terr., Vol. IX, pl. 23.

This was identified by Meek with *placenta*, but its characteristics were fully given by him and its relations to *Ammonites syrtalis* of Morton and the true *placenta* correctly defined. In some parts of his text he also speaks of this as "*Placenticeras intercalare*," so that he is the sole authority for the combined names as used in this description.

The ventral lobe as figured by Meek is very distinct from that of *P. whitfieldi*, as are also the entire sutures. This lobe is narrower, the branches are of the *syrtale* type, the siphonal saddle is more elevated, narrower, and is subdivided by a median marginal lobe with a minute bifid saddle; but these distinctions, except in a general sense, do not hold, since there are the same types of siphonal saddles in *whitfieldi*. The drawings by Meek, when compared with the originals, are accurate. The specimen on plate 23 is in the ephebic stage. The sutures overlap as much as in *whitfieldi*. A specimen having external shell in part preserved, from near Black Hills, South Dakota (purchased from Professor Ward), is 208 mm. in diameter. The last part of outer volution from lines of involution to venter is 112 mm., the first of the same being 50 mm. The greatest transverse diameter of the volution when it is 95 mm. is 44 mm., and when 50 mm. it is 29 mm. The volution is somewhat stouter than in *whitfieldi* and the involution somewhat less. The venter is a little broader and is bordered by two rows of tubercles of good size. These tubercles quite suddenly show decrease in size, and become much nearer at the same time on the last of third and on fourth quarter of this volution. They are present on both cast and shell. On the last part of outer volution they are almost obsolescent. On the first part of the living chamber they are opposite, then become again alternate, and as they decrease in size are again opposite. The ridges on the venter are slight, except in one short space, where they first become opposite. The shell has numerous bands of growth. The chevrons are particularly prominent on last part of this volution and run into and form several longitudinal ridges on the outer half of lateral zone, while the costæ are represented only by very broad, hardly perceptible, folds. The tubercles of the middle line are of good size and become obsolete on the last quarter, changing at the same time with ventral rows of tubercles. Large tubercles are present on the umbilical shoulders, which sensibly decrease at the same time and also recede gradually from the shoulders outwardly. These nodes are elongated, forming parts of the costæ that are more perceptible in their neighborhood. The outlines of the ventral zone are not sinuous between tubercles.

There is a thick, opaque, horn-colored outer layer, an intermediate crimson-red layer, and an inner nacreous layer of the usual color. These consist of a number of minor layers as in other shells of this genus. The sutures have broader lobes and narrower saddles than in *whitfieldi* and *placenta*, and the outlines of these are somewhat less complicated and not so overlapping. The ventral lobe has the same narrow character and *syrtale*-like branches, with large siphonal saddle, as in Meek's figure of *P. intercalare*, but the siphonal saddle is smooth and entire on the venter, as in *P. whitfieldi*, and also has the same minute marginal saddles on either side of this entire center. A fine young specimen of this species, from Sage Creek, South Dakota, No. 2104b in collection of Yale Museum, at diameter of 80 mm., shows the beginning of the large tubercles of umbilical shoulder, the ventral tubercles, and apparently those of the middle row to be on the first quarter of its outer volution. This shell must have been smooth and similar to *P. placenta*, perhaps, even in the sutures, when the diameter from line of involution to venter was about 15 mm. At later stages the sutures are distinct. Another specimen, same locality and collection, at diameter of 132 mm., shows three rows of tubercles distinctly visible on both cast and shell, No 2104a. The median lateral lines of tubercles disappear on the last quarter of the outer volution in this specimen, but the ventral inner rows persist. As long as the median rows of tubercles exist the shell has a transverse outline distinct from that of *whitfieldi* at any stage, but when these disappear it is difficult to separate this specimen from *whitfieldi*. I have not yet seen a specimen in which the ventral rows of tubercles disappear, but whether they do or not it must be impracticable in some specimens to separate them from *whitfieldi* var. *tuberculatum*, although most specimens are distinct on account of the size and persistence of all of the tubercles.

A fine specimen from same collection from Sage Creek, South Dakota, (No. 1863) at diameter 144 mm., has already passed well into its gerontic stage, whereas the specimen figured by Meek is not so far advanced in age. The first part of the last volution is considerably compressed, as in Meek's figure, but on the living chamber on the last half of this volution the whorl becomes stouter. This chamber is apparently nearer complete and about one-half of a volution in length. All three lines of tubercles persist and the ventral ones which are alternate in the ephebic stage are approximately opposite in old age and are sometimes connected by a ridge, so that the venter is serrated. The inner line of tubercles recedes in this stage, as in specimen figured by Meek.

The sutures have shorter, stouter saddles than those figured by Meek, and are more like those of *P. syrtale.* In the first lateral saddles especially they are more deeply cut into by the lobes that broaden out apicad, and the other lobes and saddles are like those of *intercalare*, as figured by Meek. The resemblances to *syrtale* occur more markedly in old age, when the body of the first lateral saddles loses the thread-like tenuity of the ephebic stage and becomes thicker. All the saddles do not show these changes equally. This last specimen has enabled me to make connections with No. 18975 U. S. National Museum, from the Upper Missouri, which is a nearer approach to *syrtale.* The inner nodes on this last are about the same, but are not partly buried by the involution and make their appearance somewhat earlier in the neanic stage. The outer line of tubercles are larger and the venter is broader. The sutures, however, and the proportions, etc., of the volutions are about the same. Lastly there is a fragment in same collection, locality No. 1720, 5 miles southeast of Harpers Station, Laramie Plains, Wyo., that no one would think of separating from *syrtale* by the external characters. The diameter is 94 mm., and the specimen has the same wide umbilicus, stout volutions, prominent nodes, and sharp ventral tubercles as that species. The sutures, however, although the specimen is so small, are almost as excessively complicated in outlines as in Meek's figure, although this was taken from a much larger volution.

One specimen, No. 9735, U. S. National Museum, from Ponil Canyon, New Mexico, has characters just intermediate between *P. intercalare* and *P. placenta.* The young and full ephebic stage has the form of the stouter specimens of *intercalare* with three rows of tubercles. The two outer rows are, however, more delicate than usual in *intercalare*, especially the median lateral ones, which are very small and widely separated as in *P. placenta.* Unfortunately the last of the ephebic and the first part of the gerontic stages are missing, but the parts left show similarity with the old age of *P. placenta* and *intercalare.* The venter does not broaden out except very slightly while becoming rounded as it does on the third quarter of the outer volution. The sides lose the abrupt elevated umbilical shoulders and become evenly convex, but the involution continues to follow the umbilical line of tubercles. The ventral lines of tubercles persist on the outer volution, but are very faint and finally disappear. The same is true of the other lines of tubercles, all of which finally disappear in the paragerontic stage. The shells of this species do not apparently have the gerontic enlargement of tubercles into heavy blunt nodes which is common in *guadalupæ* and its allies, *sancarlosense*, *planum*, and also *syrtale*. The sutures are like those of *syrtale* and less complicated than in *intercalare* at the same age, but this appearance is probably largely due to the fact that they are less crowded and do not overlap.

Locality: Black Hills region.

Age: Fort Pierre group, Upper Cretaceous.

Placenticeras placenta (Dekay).

Pl. XXXIX, figs. 3–6; Pl. XL, figs. 1, 2.

Ammonites placenta Dekay, 1828, Ann. New York Lyc. Nat. Hist., Vol. II, pl. 5, fig. 2, not fig. 3.

Placenticeras placenta Meek (pars), 1876, Mon. U. S. Geol. Surv. Terr., Vol. IX, p. 465.

Placenticeras placenta Whitfield (pars), 1892, Mon. U. S. Geol. Survey, Vol. XVIII, pls. 40, 41.

This species is represented in the Museum of Comparative Zoology by a large fragment from New Jersey 101 mm. in diameter from line of involution to venter at base of living chamber, and this last is about one-half of a volution in length. It is a cast and smooth on the sides, with the exception of a line of fold-like tubercles on the depressed umbilical shoulders. The ventral zone, even at this stage, obviously fully gerontic, is flat and 7.5 mm. broad as estimated.

The last sutures have not so highly complicated outlines as *whitfieldi*, but the lobes are long and narrow, the first and second laterals highly inclined apically. The fourth lateral is about two-thirds as long or only slightly shorter than the third lateral lobe. The saddles are not so deeply divided as in *whitfieldi* and broader and more solid. The last two sutures are approximated, but the third, although partly preserved, is at the usual distance and shows that this is not the same as the western form described by Meek as *placenta*. The sutures of this large specimen of *P. placenta* have exactly the outlines given by Whitfield in his figure, and a similar, although perhaps older, siphonal saddle has numerous denticles or marginal saddles. The median marginal lobe was not quite so plain as in Whitfield's figure, but this might have been owing to age or variation in sutures or the condition of the cast. Meek, as well as Whitfield, included under *placenta* several species which are separated in these descriptions, but Whitfield recognized and described the differences between the western and the New Jersey specimens and considered them as probably distinct. I have consequently named the western species *whitfieldi* in recognition of this fact.

The specimen described above enables me to add the following: The venter is not rounded on the smaller end of this cast, but flat, having the same form as *whitfieldi*, but broader than in that species; subsequently, although not well preserved, this part appears to become rounded. This specimen shows that in extreme age the volution is shorter and has more gibbous sides than in *whitfieldi* and shorter ventro-dorsal diameters. The decrease in involution due to senility is also more marked, and takes place at a smaller size. This species stands between *syrtale* and *whitfieldi* in this respect and in its sutures and other characters.

There are several fragments in the Hale collection of the Boston Society of Natural History, supposed to be from Greene County, Alabama, which have saddles with more solid bodies or basal parts, as in true *placenta* These indicate a species of larger size than the associated species of *P. syrtale*, having volutions with smooth flat sides and smooth venter, as in *placenta*. The sutures agree very closely with those given by Morton for *P. placenta* from the cut of the Delaware and Chesapeake Canal, and one specimen shows a rounded venter. The examination of the fine suite of original types and specimens in the Museum of the Academy of Sciences of Philadelphia gave the following results: The septum of this species is much flatter, having only a very slight double curvature in place of the very marked double curvature of *whitfieldi*, and this is less apparent on the suture line than on the surface of the septum. On a volution 63 mm. from line of involution to venter, transverse diameter is 22 mm. and there are three lines of tubercles. The lateral row is two-thirds of the breadth of the sides, nearer the venter than the dorsum, and very small and widely separated, but still quite distinct. The tubercles on the venter of *placenta* are large and elongated like those of *bolli* and much coarser and less numerous than in some specimens of *whitfieldi*. These disappear in the ephebic stage, together with the lateral line of tubercles, and in some specimens the latter may be entirely absent as in young specimens figured by Whitfield. The large originals of Morton's figure and of Whitfield's show these figures to be approximately correct. The venter is in all stages broader than in true *whitfieldi*, but remains flat only through a small part of the gerontic stage. In two specimens, 365 mm. and 425 mm. in diameter, one Morton's type, from cut of Delaware and Chesapeake Canal, the living chamber was practically complete and about one-half of a volution in length. The rounding of the venter begins in these on the still separate part of the second quarter of the outer volution. Near the aperture the venter is completely rounded and the decrease in the ventro-dorsal diameters between the lines of involution more marked than in *whitfieldi*, and the umbilici are consequently larger. The sutures vary from having very solid-looking saddles as in Whitfield's figure to those with the first to third saddles almost indistinguishable from those of some varieties of *whitfieldi*. Upon the whole, however, it is safe to say that while the saddles of *placenta* may be as deeply undercut and the necks as thin as in *whitfieldi*, the basal parts are, perhaps, always less completely cut up by the marginals. These and the auxiliary saddles have, however, as a rule, a bifid aspect with a large median marginal deeply dividing them, and this seems to be a distinction of more importance, especially in the aspect of the auxiliaries. The proportions of the diameters are also quite different. In the ephebic stage the transverse diameter may be more or less than one-third of the diameter from line of involution to venter and in old age it may be more or less than one-half of this same diameter. A young specimen of diameter of about 60 to 65 mm. is in collection of the Academy of Sciences of Philadelphia. In the neanic stage this cast had highly compressed smooth volutions as in *whitfieldi*, but the umbilicus is larger, the involution being somewhat less, apparently. The three lines of tubercles begin on the first part of the outer volution or just before, when the shell is about 45 mm. in diameter. At this stage the lobes and saddles are distinctly placenticeran. The saddles are all bifid, but the entire outlines have given place to completely denticulated outlines over both lobes and saddles, even on the innermost auxiliaries in the older parts of this cast. The sutures at this age are very similar to those of *syrtale* and *guadalupæ*.

Until a late age this shell is separable from *stantoni* or *pseudoplacenta* by the presence of the minute median lateral line of tubercles. The larger size and wider separation of the ventral tubercles separate the younger stages, in which the venter is often very narrow and the sutures similar to those of *whitfieldi*, from var. *tuberculatum* of that species. The sutures, however, as a rule, have less complex outlines and more solid-bodied saddles and less concave septa, as stated above.

Locality: New Jersey, Alabama.

Age: Matawan formation (clay marls), Upper Cretaceous.

PLACENTICERAS STANTONI n. sp. Hyatt.

Placenticeras placenta Stanton (pars.), 1894, Bull. U. S. Geol. Survey No. 106, pl. 39, figs. 2, 3, not fig 1.

Locality: Upper Kanab Valley, Utah.

Age: Colorado epoch, Upper Cretaceous.

PLACENTICERAS STANTONI variety BOLLI Hyatt.

Pl. XL, figs. 3–7; Pl. XLI; Pl. XLII; Pl. XLIII, figs. 1, 2.

Placenticeras intercalare Meek (pars.), 1876, Mon. U. S. Geol. Surv. Terr., Vol. IX, p. 471.

This species is very like *P. placenta* and *whitfieldi*, but has much stouter volutions with broader venters at the same age and is intermediate in character between *intercalare* and *whitfieldi*. The costæ are of the *syrtale* type, but are merely obscure folds on these casts. The tubercles are sparse and on the umbilical shoulders as in *placenta*. The costæ are occasionally bifid on the outer part of the side with single ones between them. The elongated ventral tubercles are alternate and each one has its costation. The sutures have much shorter lobes and stouter, shorter saddles than in *placenta*.

The young in the nepionic stage have a smooth volution with rounded venter. In the neanic stage this changes through the elevation of the venter. The ventral zone is at first quite broad comparatively and perfectly flat in the neanic stage. In the ephebic stage it becomes much narrower and concave and probably then acquires its tubercles. The tubercles on the umbilical shoulders do not appear until this stage begins.

The lateral angles of the single costæ, and still more the junctions of the dichotomous costæ, when these occur, tend to rise up more prominently than the rest of the costation as in other forms, but they do not in the specimens examined, as in *syrtale* and *intercalare*, become tuberculose. The specimens from which these descriptions were taken are in the Museum of Comparative Zoology.

This species is distinguished from *P. placenta* by the shorter and stouter lobes and saddles and the better separation of the sutures at all stages except, perhaps, the youngest. It stands apparently nearer to *P. syrtale* in its sutures than to *intercalare*, but this is due to the fact that in *intercalare* the sutures vary from those like *syrtale* to as complicated as in Meek's figures, and if the comparisons are made with the former, it is seen that the external characters and sutures place it between *intercalare* and *whitfieldi*, on account of the suppression in both of the lateral line of tubercles. A specimen from Dallas County, Tex., has similar markings and sutures so far as seen on the young volutions, and is probably the gerontic stage of this species. It is an incomplete living chamber about one-half of a volution in length, with the inner volutions attached but badly crushed. The latter shows the large inner row of nodes and the sutures in part, and these last agree closely with those of the specimen described above.

The volution from line of involution to venter at base of living chamber is 75 mm. in diameter, transverse diameter about 40 mm., and at one-fourth of a volution distant from this the diameter is 91 mm. The venter is broad, and the ventral zone convex on the cast at the two last septa. The tubercles are almost obsolete and the costæ completely gone, the cast being smooth with the exception of one obscure broad longitudinal ridge on the centran surface of the lateral zone. The remnants of tubercles are shown in obscure and very slight folds with a decided apical trend. This description shows that the gerontic stage is quite distinct from that of *placenta* or *whitfieldi*.

The basal suture is very complex in its outlines, but has the short saddles and lobes of this species. The next younger septum is, however, closely approximated to the last. The first and second lateral lobes are very narrow and the saddles approximate. The lateral lobe is also narrow. The remaining lobes and saddles are more like those of the younger stages, but also have narrower lobes and broader saddles. These sutures are quite distinct from those of other species and come nearer to those of the old whorl of *P. placenta* from New Jersey than any other form. They are, however, smaller, and the apical trend of the outer lobes is less, the third lateral being shorter, and the remaining lobes more abruptly separated through their extreme shortening up as compared with the third lateral.

Having received through Professor Martin the specimen described by Meek from Tarrant County, Tex.,[a] as belonging to *P. intercalare*, I am able to state that it is a good cast of this species. The diameter is 90 mm. The living chamber is incomplete but nearly half of a volution in length. The median lateral line of tubercles is absent, the inner line of small tubercles recedes from the umbilical shoulder, and the ventral tubercles are rather coarse and large, and the venter broad as in typical *bolli*. The sutures have the solid short saddles and short lobes of this form. The paraphebic substage is reached near the aperture.

Locality: Elm Fork and West Fork, Dallas County and Tarrant County, Tex.

Age: "Probably Eagle Ford shales" (Stanton)

PLACENTICERAS PSEUDOPLACENTA Hyatt.

Pl. XLIII, figs. 3–11; Pl. XLIV.

Placenticeras placenta (?) Stanton (pars), 1894, Bull. U. S. Geol. Survey No. 106, pl. 39, fig. 1 (not figs. 2, 3.)

The sutures are peculiar and unlike those of any of the forms of true *P. placenta* or *whitfieldi*. This fact was noticed by Stanton, who considered the Colorado species to be different from true *placenta*. In confirmation of these remarks I can add the following: A large fragment, U. S. National Museum, locality Upper Kanab, Utah, No. 22344, diameter from line of involution to venter 88 mm., greatest transverse about 35 mm., shows a wider venter 6 mm. and flatter than in *whitfieldi* at same age. The side which is unaffected by pressure is not so evenly convex as in that species, the outer part being very slightly concave, the centran part slightly gibbous. The sutures exhibit more complicated outlines than in the younger stage figured by Stanton, but they have similar ragged outlines and very broad lobes and are obviously the same. A specimen with diameter of 35 mm. has on the last volution sutures with same rugged

[a] Mon. U. S. Geol. Survey Terr., Vol. IX, p. 471.

aspect but very much simpler in outline than those of *P. whitfieldi* or even those of true *placenta* at the same age. The perfect venter at this stage is concave and it continues smooth and concave in this species until the shell is much larger, but then becomes flattened and apparently exactly similar to that of true *P. placenta*, but is broader at the same age and flatter than in *P. whitfieldi*. The sutures are more like those of *P. placenta* than those of *P. whitfieldi*. The casts do not show the shell except in the young stage and this has obscure sigmoidal bands of growth like those in *whitfieldi* but no costæ on the shell and none on the casts as is usual in that species. The youngest stage is more involute than in *P. placenta* and is like some specimens of *P. whitfieldi* in this respect.

Stanton's figure of the suture was taken from the ephebic volution of a specimen of the diameter of 173 mm The volutions were perfectly smooth on this cast, with a flat, broad venter, and at the diameter given on the third quarter of the outer volution the gerontic stage had begun and the last part of the volution was helmet-shaped in section with a rounded venter. This shows a paragerontic stage earlier than is usual in *placenta* or in *whitfieldi*.

The specimen alluded to by Stanton, from Ellis County, Tex., Eagle Ford shales or Fort Benton Group, is a cast 171 mm. in diameter, with form almost as much compressed, and with thin venter, as in *whitfieldi*, but the sutures are more like those of *stantoni*. They are, however, more deeply cut, being older than those figured and more like those of *whitfieldi*.

In fact, I do not see here nor elsewhere any possibility of drawing sharp lines, except between the genera; the species all run into one another.

Locality: Upper Kanab, Utah; Huerfano Park, Colorado.

Age: Colorado Epoch, Upper Cretaceous.

Placenticeras pseudoplacenta variety occidentale Hyatt.

Pl. XLV, figs. 1, 2.

The saddles and lobes have the elongated forms of those of *P. whitfieldi*, but are more solid; the ventral lobe has the same elongated arms, and the ventral saddle is also similar, but the lobes and saddles are simpler and more like *syrtale* until a later stage than in *P. whitfieldi*. The shells have a row of tubercles on the umbilical shoulders and fine tubercles on the venter. The principal distinction is, however, the breadth of the venter and its flatness in the ephebic stage, which is similar to *stantoni* and *placenta*. There are, however, some specimens with smooth venter, as in *whitfieldi*. A specimen in the collection of Columbia University, New York City, No. 10622G, from Upper Missouri River, has a diameter, partly estimated, of 150 mm. The last volution, with living chamber, is 76 mm., partly estimated; the umbilicus is 22 mm., and opposite the same volution, from line of involution to venter, is 52 mm. The volution is not so flattened or compressed, having slight ventral tubercles and slightly more gibbous sides than in *whitfieldi*, and volutions not so deeply involute, as is shown by the breadth of the umbilicus. The line of involution is outside the line ot internal tubercles, and this more open aspect of the umbilicus and the solid aspect of the saddles and forms of the lobes agree more closely with the smaller form of *placenta* figured by Whitfield and are quite distinct from true *whitfieldi* of the same size.

The living chamber is incomplete, but occupies about half a volution in length, and the aperture follows the bands of growth. The siphonal saddle has several minute denticulations even at this early age Sutures at diameter of 26 mm., from line of involution to venter, showed distinctly the *syrtale* type of outline which occurs in *whitfieldi*, only at a much earlier stage, short, broad saddles and corresponding lobes, with well-separated outlines and no appearance of bands free of sutures on either side of venter.

No. 8238, U. S. National Museum, from Cow Island, Upper Missouri River, Fort Pierre or Fox Hills Group, is a very interesting fragment of this form. It is a good-sized fragment, showing the inner and outer volutions, with broad venters and proportions stouter than in typical *pseudoplacenta* or *whitfieldi*. The tubercles on the venter are not large, but quite plain. They disappear on the last of the outer volution, while the inner line persist, and there is no median line. There is on the last part of the outer volution, in the beginning of the gerontic stage, a distinct elevation along the line usually occupied by the median lateral tubercles, which I have never seen in *whitfieldi*, and which usually occurs only in *syrtale*, *intercalare*, and the more heavily tuberculated forms. This is also apparent in the full ephebic stage, but is less marked. The sutures are very similar and, in fact, not distinguishable from those of *whitfieldi* in some varieties. I have, in consequence, placed this shell under name of *pseudopiacenta*, although in general aspect it really seems to agree better with *stantoni*.

One specimen, a fragment given by Dr. R. T. Jackson, said to have come from Bad Lands, near Black Hills, South Dakota, is 73 mm. from the lines of involution to the venter at small end, and 88 mm. at a distance of 110 mm., measured along the centran axis of the side, or somewhat more than one-fourth of a volution farther on, the whole length being 160 mm. This fragment is a living chamber, the last septum and the aperture being partly preserved. A restoration of the whole coil shows the diameter of the entire specimen to have been about 174 mm. The obsolescing costæ, sparse and small tubercles on umbilical shoulders, and small, more closely set tubercles on the edges of the venter, show that this is probably the parephebic stage of this species.

The venter has become rounded, or rather the previously concave zone has become convex, but the ventral tubercles, although faint, are clearly discernible at the oldest end of this fragment.

Thus the gerontic stage must have begun in this species at a size when the ephebic stage was not yet completed in *P. whitfieldi* or *placenta*. The saddles of the last septum show much less complex outlines than in *whitfieldi*. The third lateral lobe was not entirely preserved, but it was obviously not so long. The outlines resemble approximately those of *bolli*. Dissecting out a part of the ephebic volution contained in the zone of involution, the shell and the sutures also were found perfectly preserved. The probable diameter of the volution at this age from line of involution across side to venter was about 35 mm., and the whole diameter of coil perhaps 75 mm. The shell at the younger end of this fragment, which was about one-fourth of a volution, showed a decidedly concave venter; the cast was also slightly concave. At the other end, while the shell was still concave, the cast was flat on the venter. The tubercles on the younger end were well defined, but mere fine crenulations, as in *P. placenta* and *whitfieldi*. They were barely perceptible on the cast at this end of the fragment, and not visible at all on the cast at the other end, although, as stated above, present on the cast of the gerontic living chamber. The sutures showed somewhat more solid branches on the saddles than in *whitfieldi*, and ventral lobes and siphonal saddles like those of *P. intercalare*. Previous to cracking out this fragment the specimen was classified with variety *bolli*. The chevron markings on the nacreous layer were beautifully displayed and very instructive. At the younger end they had the normal orad direction for about an inch, then some accident had happened fracturing the edges of the aperture on both sides and causing a slight sinuous constriction on both sides when growth was resumed. Beyond this the direction of the chevron lines was reversed on the right side in a median depression and on the left along a slight corresponding elevation.

One fragment from Elm Fork, Dallas County, Tex., in the Museum of Comparative Zoology, not quite one-half of a volution in length and measuring 230 mm. in diameter, has these characters, but the umbilicus does not appear to be quite so large in proportion. The aspect of the saddles enables one to separate these from var. *tuberculatum* of *P. whitfieldi*, but it is probable that these two are connected. As I have repeatedly stated elsewhere, I consider this varietal connection no argument for uniting these obviously distinct species. This specimen has large marginal saddles on the siphonal saddle, and a distinct marginal median lobe, which becomes slightly trifid in later stages. On the left side of this are entire slightly phylliform saddles, and on the right a bifid marginal. These become subdivided later. The ventral lobe has the long arms of the *whitfieldi* type which are not similar to those of the same lobes in the *syrtale* type.

I propose, in following the indications of these observations, to confine this name to those forms of this genus having broad venters and more immature sutures than in *whitfieldi* at all stages of growth. The edges of the venter may be either finely tuberculated or smooth. The sides may be smooth or with a median line of very obscure elevations. The inner line of tubercles is developed, but does not appear at an early stage.

Locality: Elm Fork, Dallas County, Tex.; Upper Missouri, Bad Lands, South Dakota.

Age:[a] Probably Fort Pierre group, Upper Cretaceous.

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[a] The following note has been kindly added by Mr. Stanton:

"*Placenticeras pseudoplacenta* var. *occidentale* Hyatt.

"Locality: Upper Missouri. Bad Lands, South Dakota.

"Age: Fort Pierre group, Upper Cretaceous.

"The specimen from the Bad Lands is certainly from the Fort Pierre, and the one from the Upper Missouri probably is also.

"The specimen labeled '*P. pseudoplacenta* var. *occidentale*' and also 'var. *intermedium*' from Elm Fork and West Fork (Horton's mill), Dallas County, Tex., if the locality can be trusted, is probably from the Eagle Ford shales, which are about equivalent to the Fort Benton." (The locality referred to is trustworthy.—A. H.)

Placenticeras whitfieldi n. sp. Hyatt.

Pl. XLV, figs. 3–16; Pl. XLVI; Pl. XLVII, figs. 1–4.

Placenticeras placenta Meek (pars). 1876, Mon. U. S. Geol. Surv. Terr., Vol. IX, pl. 24, fig. 2.

This species can be distinguished from true *P. placenta* of New Jersey and the supposed western members of the same species by the following characters. The highly compressed volutions are more involute and the venter is narrower throughout life and less completely rounded in old age, and this change comes in only at a much larger size than in the shells of *P. placenta.* Owing also to the absence of the median lateral line of tubercles the volution has flatter sides. All tubercles are wanting in typical forms at all stages, but very fine tubercles are present on either border of the venter and larger ones on the umbilical shoulders in some shells. Sometimes minute tubercles are present on the median part of the lateral aspect, but these occur only in the neanic stage, disappearing with the ventral tubercles in the ephebic stage. The sutures are more complicated in the young and are more overlapping than in *placenta.* The saddles are almost linear because of the excessive development of the lobes, which are very long and narrow. These differences hold with the materials so far examined. It must be remembered, however, that as yet no examination of a large number of specimens of both species from the same locality has been made, and it is likely that there are intermediate shells. Certainly no one can distinguish these species unless familiar with both forms or having both for comparison. The same may be said of *P. intercalare*, between which and this species there are intermediate shells in *P. whitfieldi* var. *tuberculatum.*

I made special examination of the ventral lobes of *whitfieldi* in all available specimens. All had the peculiar very broad ventral lobes with long narrow branches on the lateral aspects except in rare cases in which *syrtale*-like or blunter arms were present. One specimen had the long narrow arm on the right side and a blunt *syrtale*-like arm on the left side. As a rule the ventral lobe is symmetrical, but the siphonal saddle is often unequally developed or out of place. This saddle is often entire and flat, so that one is apt to regard this as the normal form, but variations are so frequent that only large numbers of specimens could determine the facts.

This saddle may have a simple median marginal saddle or be trifid with three saddles, equal or unequal in size; or it may be bifid, with both marginals again subdivided, or of any shape between these and such irregular sinuous outlines that it is difficult to describe it. It is almost invariably sunken between two marginal saddles, one on either side, but occasionally even these blend with the central part of the siphonal saddle.

A specimen from Cheyenne River, South Dakota, in the collection of Columbia University, New York City, reaches 327 mm. in diameter and has the basal part of a living chamber present. The venter begins to be rounded on this living chambered part. There is a slight decrease in the amount of involution at the same time, showing that this is in its gerontic stage. In 11 other specimens, in collection of the Boston Society of Natural History, and sent me by Ward, ranging in size from 110 mm. in diameter to nearly the dimensions of the specimen last described, the typical form was observed. No tubercles were present, and the first lateral saddles were very narrow and very deeply cut by almost straight and very long marginal lobes and saddles.

In all of these there are chevron marks more or less shown, and the sutures are similar, with the exception first mentioned. The first three lateral lobes are not very steeply inclined apicad, and the fourth lateral is nearly or quite two-thirds as long as the third lateral.

Altogether I have seen perhaps 40 specimens.

A specimen from South Dakota, in collection of the Boston Society of Natural History, which is 113 mm. in diameter, shows the costæ and the chevrons, but the costæ are quite fold-like. There were no tubercles on the edges of the ventral zone nor on the umbilical shoulders. The smallest part of the outer volution was about 30 mm. and the widest part about 60 mm. from line of involution to venter.

Some of the fragments of volutions examined must have belonged to shells fully 15 inches in diameter, the size of the specimen from New Jersey figured by Morton as *P. placenta*, but none of these showed the gerontic degenerations in the rounding of the venter as in his figure. The wider separation and the simpler outlines of the sutures found in his figure also occur only at a comparatively early stage in this species. The ephebic stage has narrow concave venter on the thick shell and flattened zone on same area in the cast. The sides are perfectly smooth, with faint sigmoidal, almost obsolescent, costæ.

Meek figures a specimen just entering upon the ephebic stage, and these costæ are faintly indicated. It is, in fact, difficult to see them, and they can be felt better than seen in some specimens. The costæ are often quite linear and distinct on the shell in the neanic stage, but are not present before or after this stage. The divaricating ridges described and figured by Meek as lines have been described above as lateral chevrons with the apices pointing orad and occurring only on the outer thirds of the sides of the shell. They are very plain on the inner layers of shell and faintly indicated on the cast and entirely independent of the growth bands. At an older stage (probably the metephebic substage) than that figured by Meek they are quite broken or interrupted by the bands of growth on one side where the nacreous layers are preserved, and on the other, in which part of the outer layer covers them, they are not visible. They are apparently characteristic of the neanic and part of the ephebic stage. The venter retains its flatness until the shell is very large. The sutures are really at considerable distances from each other, but the saddles are so deep and the lobes so long and narrow that the external outlines are approximated except on and near the venter. The first lateral saddles are straight and narrow, and there is consequently a band on either side of the venter in casts which is not cut up by intermingling sutures. On breaking down a specimen sent me by Professor Ward the young at diameter of 11.13 mm. from line of involution to venter had the first four saddles even at this early stage more slender and more deeply cut by the marginal lobes than in the specimens supposed to be young of *P. placenta* of the west at diameter of 25 mm. The lobes and saddles were also longer and narrower in proportion, the sutures nearer together, and the branches of the ventral lobe larger and longer and the ventral saddle with larger marginal lobes at exactly corresponding ages. The ventral crenulations or tuberculations are not so persistent as in *placenta* of the west, since they disappear in all of these specimens in the ephebic stage.

The incomplete living chamber is about one-half of a volution in length.

The first volution of a specimen in the collection of the Museum of Comparative Zoology, from Clifford, Nebraska, has a depressed rounded goniatitic form with a single constriction in this specimen at the end of the first quarter. The lateral sutures along the sides have the broad lateral saddles; the others were covered and could not be seen. The only exposed suture immediately preceding the constriction has entire outlines. The ventral lobes are moderately deep and straight-sided, with large, undivided siphonal saddle. The first lateral saddle is rounded and broad, but entirely upon the venter, as is also the first lateral lobe. The latter is also rounded and wide at base and not so deep as the ventral lobe. The second lateral is magnosellarian in outline and reaches to the small lobe formed on the line of involution. It is interesting to note that in this highly degenerate form of the Cretaceous the sutures exactly resemble at this age the adults of the Primordialidæ, which have undivided siphonal saddles, and the volution on section has the semilunar anarcestian form of the nepionic stage in Ammonitinæ.[a]

Near the end of the first volution the first lateral saddles and also the magnosellarian saddles have begun to show minute dividing lobes. The form in section has at the same time changed to helmet shape through the elevation of the venter. The zone of involution at this age begins to increase and in the next volution extends over nearly the entire side of the first whorl. In consequence of the helmet shape and flatness of the sides the involution, which is about two-thirds, appears to be greater than at any subsequent stage, whereas it is proportionately less. The ananeanic substage begins on the second volution. The sides become flatter, more convergent, and the venter is narrowed and flattened on the cast and slightly concave on the shell. In the metaneanic this change is completed by the rapid increase of the dorso-ventral as compared with the transverse diameter. The venter still remains quite broad and does not attain the narrow aspect of the adult until in the latter part of the neanic stage on the fourth volution. The umbilical zone begins to develop in the ananeanic substage and steadily increases in breadth and steepness thereafter. The auxiliary lobes and saddles begin to appear in the paranepionic, and as the volution increases in the ventro-dorsal diameter more of them are introduced by the further division of the magnosellarian saddle, or rather what remains of this, in the umbilical zone. The process of division continues throughout the neanic stage, the additions being made internally on the umbilical shoulders and zone. They arise as simple indentations and grow deeper with age, the digitations being introduced gradually by

[a] The margin of the manuscript bears a large "?" opposite this sentence.—T. W. S.

minute inflections of the outlines. The saddles are not so long as to interfere with deciphering the outlines of the lobes until the fourth volution is reached and the anephebic substage begins. Before this the sutures resemble more those of *P. bolli*, having shorter saddles and probably at still earlier stages they are even more like those of this species, being proportionately shorter and with simpler digitations. There are nine lobes present on the last quarter of the third volution. The three principal lobes have their usual proportions, and the ventral lobe is nearly the same as in the adult, but the siphonal saddle is not so prominent, and the minor saddles on the sides of this are also much smaller and more nearly of the same size. There are six lobes on the lateral zone, a seventh on the shoulder, and two on the umbilical zone. The saddles are all distinctly bifid, except the tenth, which is not yet differentiated. The lobes are all of the trifurcate type, except the ninth, which is not fully developed and is single or unsymmetrical. The lobes and saddles greatly increase in complication of outline and become larger and larger, but the number remains stationary on the fifth volution. Meek[a] figures a very large suture with twelve lobes.

Tubercular elevations make their appearance on the edges of the ventral zone in the neanic stage, but they are more perceptible to the touch than to the eye. The widely separated sigmoidal costæ are more distinct, but the deep apical bend is only one-half developed and ends abruptly in some with a faint tubercle. The ventral part of the bend is apparently absent on the fourth volution, but subsequently appears more decidedly on the last quarter of this volution. Internally the oral bend of these costæ is also deficient in the neanic stage, appearing to be better developed in an ephebic substage. Nevertheless, when one looks at the volution, he is apt to see only the inner half of the deeper apical bend. The chevron-like folds are present on the shell in the later neanic substages and may come in earlier. A line of very faint, hardly perceptible, tubercles appears on the umbilical shoulder on the fifth volution in an ephebic substage.

I have been as minute in my descriptions as the specimen in hand permitted, because the presence of these indistinct tubercles and costæ in the neanic and early ephebic substages show, together with the more widely separated sutures and broader venter, that the young are quite similar to those of *placenta* and have also traces of their affinity with the more heavily

[a] Mon. U. S. Geol. Surv. Terr., Vol. IX, p. 466.

tuberculated and stouter forms *P. bolli*. The same characters also show that these species are not identical, since they are not so strongly developed at any stage as in other species, and are succeeded by distinct sutures in the nearly full-grown shells. This study suggests also that the western species was derived from the eastern form.

A specimen purchased from Professor Ward, locality Bad Lands, near Black Hills, South Dakota, shows the typical sutures and form of *whitfieldi*. The first lateral saddles in the ephebic stage have the usual three nearly equal marginal saddles and lobes, and there are no tubercles nor any costæ appreciable to the eye at diameter from lines of involution to venter of 101 mm. These sutures, however, have one peculiarity, probably of essential service to this investigation. In so far as the first two saddles and lobes are concerned, they are appreciably distinct, the first saddles being entirely free. The remaining parts of the sutures overlap more or less, as in almost all of this species. In the anephebic substage, or last of neanic stage, however, the diameter of volution being 33.5 mm., the costæ are apparent and have the usual form, but are very faint. The chevrons are especially well shown in the fossil, although not more prominent than in many other specimens. They were plainly seen on this fragment, broken out of the larger volution, and there appeared to be some connection between these at their line of convergence and the indistinct longitudinal ridge or trace, which is obviously the centran lateral ridge seen in some older shells. The sutures are similar to those of the adult at the diameter of 24 mm. from lines of involution to venter, but they are easily separable by the eye.

The earlier probably paraneanic substage dissected out from this was perfect and measured 26.5 mm. in diameter of the coil. The larger end of the volution in this was 15 mm. from line of involution to venter, and when the volution was about 11 mm. in same diameter the chevrons and costæ and excessively faint longitudinal ridges began to appear. There were as many as three of these along the centran lateral aspect of the volution and shorter but discontinuous ones arising from the chevrons. These could only be seen by careful and prolonged observation of the nacreous layer, which was preserved on one side. The sutures were less crowded than in the young one above described and favorable for observations at diameter just noted. There were ten lobes in all, including one on the line of involution. Six were on the lateral zone, one on the sharply defined umbilical shoulder, and three on the umbilical zone. The last saddle showed a distinct marginal lobe, the next saddle single, the succeeding saddles were also bifid and had entire outlines, the fourth had begun to show marginal digitations, and the remaining saddles were more or less deeply cut, having approximately the forms of the ephebic stage, but being, of course, much simpler. The outlines of all of them were free except those of third and fourth saddles and those of the third lateral lobe. The umbilical lobe is probably entire, as is the next lobe; the eighth is symmetrically trifid, the next from its position on the umbilical shoulder is unsymmetrically trifid, the next lobe on the side is symmetrically trifid again. The remaining lobes show ephebic division already defined but simpler than in the adult, and the same is true also of the ventral lobe and saddle, and the bare spaces on the cast on either side of the venter would be as conspicuous as in the later stages if the sutures were as close together. One thing is noticeable in this specimen; the slightly younger sutures on the same volution are for a time slightly closer than the succeeding ones, owing to a temporary decrease in the rate of growth of the shell. This specimen had sutures quite different from the sutures of the small specimen above described, in which at the same age there were approximating and even decidedly overlapping outlines, as in the adult. The outlines themselves, however, were about the same in both specimens, so that the differences were merely those of the slower, less vigorous growth of the forms as compared with that now being described.

At the beginning of this volution, when the diameter from lines of involution to venter is 7 mm., the umbilical zone is just beginning to be formed. The ventral saddle at this time is just beginning to show digitations on its sides, and is broad and large with flat concavity across the venter. The first lateral saddle is distinctly trifid, the second and third laterals with club-shaped bases and almost entire, showing only the faintest possible trace of the median marginal lobe that divides them in the succeeding sutures; the fourth lateral has this marginal lobe more distinct, but still very small, and the remaining saddles are entire with somewhat flattened basal lines.

The arms of the ventral lobe and the tops of the first and second and third laterals are unsymmetrically trifid, the fourth lateral is just beginning to have a median marginal division and is bifid, the remaining lobes being entire and very small and narrow. The trend of the sutures is about the same as in adults, but the bend at the fourth lateral saddle is more abrupt, the fourth lateral lobe being a scant one, about one-half the length of the third lateral. This proportion begins to alter soon after this, and approximates to that of the adult before the end of this volution. The number of lobes and saddles is the same; they are simply smaller in size and more primitive in outline. A very slight amount of exposure acts upon these sutures and alters the outlines, destroying the marginal lobes and saddles. At this time, i. e., 7 mm. in diameter, the sutures are somewhat more primitive on the left than on the right side of the volution, an irregularity that subsequently becomes less noticeable. There is probably nothing abnormal in this, as it is rare in any animal to find the two sides exactly similar. The costæ begin very early when the volution is about 7 mm. in diameter from lines of involution to venter.

In the ananeanic substage, when the volution is 4 to 5 mm. in diameter, the ventral zone is channeled, as in later stages, and sensibly broader in proportion. The form of the sutures, etc., is the same, but the digitations are less noticeable. The first lateral saddle on the most perfect side of this volution is faintly trifid, all the remaining saddles are entire and club-shaped except the smaller ones beyond the fourth, which are now plainly seen as mere inflections of the outlines of the magnosellarian saddles. The arms of the ventral lobe are single, the first and second laterals are beginning to show trifid tops, while the third is broader and more club shaped, and shows four nearly equal marginal lobes just beginning to appear. The ventral saddle is broad with concave base, the dependent marginal saddles being absent. There were nine lobes at this stage, but the ninth on the line of involution was very minute.

The next break exposed an earlier age in the ananeanic substage on the first quarter of the same volution. The venter had just become flattened and the edges of this zone are faintly crenulated on the cast, owing apparently to the presence of extremely fold-like costæ which cross the venter. These are so indefinite that they were perceived with difficulty.

The sutures are extremely instructive. The ventral lobe is as deep and as broad as the ventral zone; the ventral saddle is very small and divided by a siphonal lobe. The sides of the first lateral saddles are straight, and on the edges of the ventral zone the bases are entire and rounded. The first and second lateral lobes and the first, second, and third lateral saddles appear as inflections on the inner sides of the broad nepionic first lateral saddles. The third lateral lobes occupy the positions and are obviously the direct local representatives of the primitive primordialian lateral lobes. A large saddle, the primitive magnosellarian saddle, occupies the inner part of the sides and two minute marginal lobes and saddles are apparent on this. The first marginal saddle, the forerunner of the fourth and fifth saddles, is flat on the base and beginning to show an initial median marginal lobe; the future fourth lateral lobe, the inner saddle, has similar form but is still entire. This and the other specimens show that the great length of the third lateral lobes and the apical bend in the sutures and septa of adults are due to the retention of nepionic characters and that the great complication in the details of the outlines and the large number of lobes and saddles are based upon primitive nepionic outlines. This is also apparent in the internal double curvature of the septa, which are concave along the center and convex like those of most Ammonitinæ only at the dorsal and ventral lobes.

A fine young specimen, No. 18936, U. S. National Museum, Upper Missouri, enables me to add the following: Whole diameter is 55 mm., and the fourth volution is about completed. On the early part of this volution the sutures are the same as in the young specimen above described. The characteristic deeply cut saddles and lobes of the western form are already beginning to appear[a] and the first, second, and third lateral lobes have about the same proportions as in the adult, but the fourth lateral is only about half as long as the third lateral lobe. The sutures in this specimen are not so distinctly separated as in the young one at same age referred to, and are almost as closely intermingled as in the adult. The usual band free of sutures occurs on each side of the venter. On breaking down this specimen the sutures on the last quarter of the third volution were found to be more distinctly separated, the margins becoming simpler, but the peculiar bands free of sutures on either side of the venter are still present, and the species could hardly be mistaken even at this

[a] The external shell is preserved in the umbilicus, but there are no tubercles, and venter is smooth on the cast of this part. The outer layer of shell of the last quarter of fourth volution is preserved and shows same markings as above described at about same age in young specimen from Nebraska.

early stage on account of the much compressed wholly smooth volution and narrow concave venter with slightly elevated acute ridges on either side on the cast. At this age inner saddles assume a primitive rounded form with expanded base and one marginal central lobe; the inner lobes are trifid. Two specimens in the collection of the Boston Society of Natural History, collected by Prof. W. G. Crosby, have the typical characters and form of *P. whitfieldi* and are devoid of tubercles. The sutures were not very clearly made out. The matrix has the aspect of an arenaceous ? limestone, color light brown. The largest specimen from Fort Collins, Colo., is 185 mm. and the smaller one from El Paso County, Colo., 84 mm. in whole volution. One specimen in the collection of the Boston Society of Natural History reaches 265 mm. in diameter and has a concave ventral zone on both shell and cast at end of outer volution. There are excessively faint tubercles along the umbilical shoulders but no traces of them on the edges of the ventral zone, either on shell or cast.

The shell on this specimen and on several others is sufficiently perfect to show that there are the following parts. An outer opaque probably porcellaneous part of several layers, next a middle part with more or less of luminous red coloration, also of several layers, and an inner part, also of several layers, with the usual iridescence of nacreous shell

Two specimens from Loup Fork, Nebr., in the Museum of Comparative Zoology, show the typical large siphonal saddle with dependent marginal saddles of *whitfieldi*. One of them belongs to the parephebic stage of a shell having at the same time concave venter on both cast and shell with very faint tubercles, and the other and the two described next below represent the gerontic stage of a shell of very large size of the same species, with flattened venter on the cast and very faint concave zone on the shell, but no signs of tubercles on this part. The umbilical shoulders were destroyed. In both of these specimens from Kansas the ventral branches of first lateral saddles did not reach the edges of the venter and the same smooth band appeared on either side of this part as in other forms of this group. I can not at present separate them from *whitfieldi* upon the basis of their slight tuberculations, since faint tubercles are apt to be present at some stage even in typical forms of this species. A fine specimen from Nebraska, diameter 228 mm., and covered with beautiful nacre, shows chevron markings and has concave ventral zone and faint, rather uncertain indications of tubercles that may have existed on the outer shell, although the inner line on the umbilical shoulders is plainly shown on the nacre of the last volution. These last are obviously confined to this volution of the ephebic stage, since they are not present on the inner volutions, which are covered by the thick, opaque outer layer of the shell. This settles the fact that these tubercles may appear very late in the life of this species. They are small and wide apart on this specimen when the volution from line of involution to the venter is 60 mm., and are not present on the external shell in that part of the same volution which is about a centimeter apicad across a break in the fossil. There are fine transverse wrinkles on the nacreous layer in the ventral zone of this shell.

A large, much crushed fossil from Loup Fork, Nebr., also collected by Dr. Sternberg, is 215 mm. in diameter and has the external shell well preserved and as usual very thick, especially on the umbilical shoulders. Faint tubercles are present on the last volution and are also preserved on a remnant of shell belonging to a volution which has been broken away. Such small tubercles as these might be present on a shell and yet be absent on a cast.

A fine specimen in the National Museum, with nacreous layer, from southern Colorado, and having typical sutures of the western form and also identical in other respects, has a diameter of 136 mm. and shows faint tubercles on the nacreous layer. The volution is 65 mm. in diameter from line of involution to venter, when the first tubercle appears. This specimen makes it possible to say definitely that these appear in the ephebic stage, probably metephebic substage.

One specimen, from Black Hills region, in the collection of the Boston Society of Natural History, shows faint tubercles on umbilical shoulders when the diameter is less than 100 mm., and there are faint but perfectly defined minute tubercles on either side of the venter. Another specimen in the same collection and from the same locality has a diameter of 305 mm. It is without living chamber and has the nacreous layer in part preserved. There are faint tubercles on the umbilical shoulders of the next inner and part of the outer volution. The sides have three obscure broad longitudinal folds or ridges in the gerontic stage. There are no tubercles on the edges of the ventral zone. This zone continues to be very faintly concave, even on the last part of the outer volution. The gerontic stage begins with a slight transverse constriction, after which the transverse diameters increase considerably and the volution is stouter and larger.

The largest specimen so far recorded is in the University Museum in New Haven (locality, Bad Lands, South Dakota). This has been measured by Dr. C. E. Beecher, who also very courteously sent me a sketch and notes on its characteristics. The diameter of the entire fossil is 630 mm. ($24\frac{3}{4}$ inches). The ventro-dorsal diameter of aperture from line of involution to venter is 300 mm., and the transverse 150 mm., showing how much the volution has broadened in this extreme gerontic stage. The first quarter of outer volution has a flat venter 8 mm. wide, the edges rounded. The living chamber is perfect and occupies one-half of a volution, showing no decrease in length as compared with smaller specimens. There is, however, the usual decrease in the amount of involution of the whole of the outer volution. The venter loses its flatness entirely on the second quarter of the outer volution and on central parts of living chamber, becomes rounded, and the sides then become gibbous at a short distance inside the venter, as is not uncommon in old age. There is a tendency to resume the form of *syrtale* and of its own earlier stages. Near the aperture the gerontic flat zone noticed in other specimens returns upon the centran part of the venter, but the latter still remains rounded with the same gibbous outline to the outer parts of the sides. The aperture, as described in other specimens, has a short, broad rostrum and low, broad lateral crests.

Locality: Nebraska; South Dakota; Colorado.

Age: Fort Pierre group, Upper Cretaceous.

Placenticeras whitfieldi variety tuberculatum Hyatt.

Pl. XLVII, fig. 5.

I have so far seen only three shells from Bad Lands, South Dakota, having a very faint line of median lateral tubercles both on cast and shell, as well as minute denticles on the sides of the venter and tubercles on the umbilical shoulders. The two outer rows disappear at the end of the neanic stage, when the shell is about 80 mm. in diameter. These are obviously transitional to *P. pseudoplacenta*, but have much finer tuberculations and more complicated sutures.

Locality: Bad Lands, South Dakota.

Age: Fort Pierre group, Upper Cretaceous.

Placenticeras spillmani n. sp. Hyatt.

Pl. XLVII, figs. 6–8.

This species is founded upon a fragment, No. 4, in the collection of the Academy of Sciences of Philadelphia; but this is so distinct from any species of *Placenticeras* known to me that I venture to describe it here. This was in same tray with three fragments of *Sphenodiscus* labeled "Spillman Coll. Loc. Mississippi."

The estimated diameter of the volution is 80 mm.; the actual ventro-dorsal diameter measured along the exposed septum from dorsal lobe to ventral lobe is 48 mm.; and actual transverse diameter is about 40 mm. through the dorsal lobe. It has, therefore, a much stouter volution at the same age than its near allies, *placenta* or *stantoni*, and the venter is broad in proportion, being 9 mm in width, flat, and with low tubercles on either side about 14 mm. apart. The fragment is only the cast of the outer parts of two living chambers, and whether there were internal rows of tubercles could not be determined, but the sides have the flattened aspect of species that do not habitually have a median lateral row of tubercles. The sutures are closely similar to those of *syrtale;* they have broad, rather short, solid saddles, with short marginal saddles, the lobes narrow and broad, only at the apical ends. The outer part of the septum is more deeply concave than in *placenta* and the lobes and saddles are less complex in outline. There is a cast of one chamber in the collection of Yale University, said to be from Burlington, N. J., with a similar broad venter, that may be the young of this species. The dorso-ventral diameter measured in same way as above is 24 mm., and transverse diameter is about 18 mm. There is also a cast from Musselshell Creek, Idaho, having a very broad venter. This belonged to a much older and larger shell with very different sutures.

Locality: Burlington, N. J.; Mississippi.

Placenticeras ? telifer (Morton).

Ammonites telifer Morton, 1834, Synop. Organic Remains, pl. 2.

Ammonites (*Placenticeras*) *telifer* Whitfield, 1892, Mon. U. S. Geol. Survey, Vol. XVIII, pl. 41.

After examining the fragments of this species in the collection of the Academy of Sciences, Philadelphia, I am unable to determine with certainty whether this is a species of this genus or not, and the details of the sutures, so far as my hasty examination went, were too imperfect to enable me to make a reasonable guess with regard to their affinities.

Locality: New Jersey.

Age: Upper Cretaceous.

Placenticeras ? fallax Castillo and Aguilera

Placenticeras ? fallax Castillo and Aguilera, 1895, Bol. Com. geol. de México, No. I, p. 17, pl. 9.

This species is here mentioned because it is likely to be quoted as a species of this genus, whereas both the remarks of the authors and the figures show that it should be quoted as probably not a member of this genus. The authors consider the sutures as placenticeran, but very rightly regard the form as more like that of *Phylloceras.* I have not as yet seen a specimen of this genus that has such a rounded volution even in the gerontic stage, and this Mexican specimen was only 104 mm. in diameter.

Locality: Mexico.

Age: Lower Cretaceous ?.

Placenticeras ebrayi (de Loriol).

Amaltheus ebrayi de Loriol, 1882, Mém. Soc. Pal. Suisse, Vol. IX, Pl. I.

Placenticeras ebrayi Kossmat, 1895, Beitr. Pal. und Geol. Oesterreich-Ungarns und des Orients, Vol. IX, p. 170.

This figure shows a large and aged specimen of 250 mm. in diameter. The anagerontic substage is given upon the first part of the outer volution, and during this time the venter remains flattened and has large alternating tubercles of the usual elongated form on either side, but the edges of this zone are not sinuous. There are fold-like single costæ appearing in this substage, and these are prominent, but have no tubercles if the views are correct. These single folds are continued in the metagerontic substage when the ventral line of tubercles disappear and three lines of lateral tubercles appear for the first time on the costæ. In the paragerontic substage these tubercles disappear, first the outer, then the inner lines, and then the central line. The folds also tend to disappear and the venter is seen to be completely rounded and smooth in this substage and the involution has become considerably diminished, judging from the aspect of the umbilicus. The gerontic tubercles, together with the ventral line of tubercles, make up four rows, one more than appears in any other shell of this genus. The sutures were observed only in the anagerontic substage, but they are distinctly separated and have obviously not lost their ephebic characters.

There may be but two secondary laterals derived from the primitive first lateral saddle, or there may be three; one can not tell with exactitude from the drawings and descriptions. The general aspect of this shell is in favor of association with the species of *Placenticeras*, but the extra line of tubercles in the old, the fold-like, almost straight costæ, and the possibility that there are only two secondary saddles, the first and second laterals, make the generic reference doubtful. The outlines of these sutures remind one strongly of *P. warthi* Kossmat, and in this species there is also the same difficulty in making out whether the first lateral is single or double. The ventral lobe is deep and narrow, as in *P. uhligi*, but the siphonal saddle is small. The shell is apparently smooth in the ephebic stage, as in *warthi*, etc.

Age: Gault of Cosne.

Placenticeras warthi Kossmat.

Ammonites orbignyanus Stoliczka, 1866, Pal. Indica, Vol. I, pl. 48, fig. 2.
Placenticeras warthi Kossmat, 1895, Beitr. Pal. und Geol. Oesterreich-Ungarns und des Orients, Vol. IX, pl. 20, fig. 8.

This species is, as stated by Kossmat, quite distinct either from *orbignyanus* of Geinitz, or *syrtalis*, var. *orbignyanus* of Schlüter. Kossmat's text clearly states these distinctions, but he gives both of these names in his synonymy as in part belonging to this species, and on this fact we differ. The young as figured in section by Stoliczka has a very broad venter in the ananeanic substage and the broad venter is retained throughout the neanic stage.

The sutures are exceptional, the ventral saddle distinct from any other species of this genus, and there are so slight differences between the principal lateral saddles and the auxiliaries that one can not, according to Kossmat's figures, draw a definite line between the auxiliaries and the principal saddles. Kossmat counts the two arms of the first lateral as two saddles, but describes these as having arisen from division of the first lateral, and his figure shows this. He consequently considers the species as having four principal lateral saddles, whereas they should be counted as three. Stoliczka's figure of the older specimen in his Fossil Cephalopoda of Cretaceous Rocks of Southern India also shows distinctly the three principal saddles. Kossmat considers this identical with the American *P. syrtale*, but, as has been noted elsewhere, *P. tamulicum*, and especially *schlüteri*, are more like the former. The absence of all except the ventral line of tubercles and the broad, fold-like costæ, broad venter, and stout whorls are as peculiar as the sutures in *warthi*. In the ragged aspect of the sutures and broad, flat venter, this species has some resemblance to *P. stantoni* of the Colorado group. This favors the view that this species occurs in India somewhat earlier (in the lower Utatur group, which is placed by Kossmat in the Cenomanian) than its representative in this country. This evidence is in favor of the view stated by Stanton and others that the Colorado is the equivalent of the Turonian.

Age: Cenomanian.

Placenticeras memoria-schloenbachi Laube and Bruder.

Placenticeras memoria-schloenbachi Laube and Bruder, 1887, Palæontogr., Vol. XXXIII, pl. 23.

This species has a diameter of 198 mm.; it is smooth with the exception of a single inner row of small tubercles on the umbilical shoulder. The umbilical zone is well shown in figure, and the ventral zone very narrow and smooth on the cast. The parts of two sutures shown have very simple outlines and are wide apart even in what is evidently the parephebic or anagerontic stage of this species.

The outlines are probably more or less worn and have lost their digitations in part, but could not in any event probably have been as closely approximated as in species like *placenta* or *whitfieldi*. Laube and Bruder consider that the sutures are similar to those of *Placenticeras requienianum* (d'Orbigny, Terr. Jurass., pl. 93, fig. 4), but this species does not belong to this genus.

Age: Turonian.

PLACENTICERAS DEPRESSUM n. sp. Hyatt.

Placenticeras syrtale Grossouvre (pars), 1893, Ammonites Craie supérieure, p. 128, pl. 6, fig. 2 only, and pl. 7, fig. 1.
Ammonites syrtalis Schlüter (pars), 1871, Palæontogr., Vol. XXI, pl. 14, figs. 9 and 10 only.

This French and German species is undoubtedly a very close ally of *guadalupæ* and is called variety *guadalupæ* by both authors, who suppose it to be identical with the American species of the same name. The latter, however, has not the costæ in the young shown in the umbilicus as figured by Grossouvre on pl. 7, and the inner nodes in the American form are on the umbilical shoulder at all stages, the umbilici being deeper and the volution thicker or stouter in proportion This species also includes Grossouvre's variety *quadratum*. The saddles are more deeply undercut and outlines of both lobes and saddles more complex. They are, however, very closely representative species. Schlüter's figure shows the impression of a keel in the impressed zone of the fragment of an outer volution, but this is probably either accidental or a mistake in the figure, judging from the description. The obvious excellence of Grossouvre's work and figures enables one to see clearly the relations of these forms, and he describes them as varieties. We differ simply in our estimate of their relative importance, he preferring to call them varieties, and I to name them as distinct species in accordance with the methods adopted in this and other papers.

Age: Lower Senonian (Santonian).

PLACENTICERAS GROSSOUVREI n. sp. Hyatt.

Placenticeras syrtale (pars) Grossouvre, 1893, Ammonites Craie supérieure, pl. 5, fig. 32; p. 16, fig. 1 (no others).

The French form has no corresponding representative now known in this country. The young, if it be the young, figured on pl. 5, is costated like the gerontic stage of *polyopsis* of Dujardin, but it also has a prominent, closely set row of tubercles on either side of the narrow concave venter. The large fossil figured on pl. 6 has an umbilicus so very different that if it belonged to almost any other genus one would say at once it could not be the same. In this genus, however, the young are so compressed and distinct that no safe inference can be made from figures alone. This specimen is certainly in the gerontic stage, with the median lateral row of tubercles already on the borders of the venter. The ventral rows shown in fig. 3 of pl. 5 have disappeared entirely, and the venter is smooth and flat and very broad, the tubercles nearly opposite. The inner row of nodes begins to recede from the line of involution very early and gradually approximates to the outer row. On the last quarter these tubercles again begin to approach the umbilical shoulders, increasing their distance from the outer line—a movement not paralleled in any American form I have as yet seen.

Age: Lower Senonian (Santonian).

PLACENTICERAS INCISUM n. sp. Hyatt.

Placenticeras syrtale (pars) Grossouvre, 1893, Ammonites Craie supérieure, pl. 8, fig. 1 (no others).

In this form the volution is described and figured as compressed and smooth until a late stage. The specimen is in the parephebic substage on the first quarter of the outer volution; *i. e.*, the median lateral line of tubercles is close to the ventral line. The venter is, however, still concave, narrow, and tuberculated. On the second quarter the venter broadens to these lines of tubercles, the ventral ones disappear, the inner line of large nodes appears first at the center of the lateral zones and rapidly approximates to the outer lines, being joined to them by costæ. There are only five of these nodes, and while the third and fourth are nearest to the venter, the fifth is set somewhat farther away inwardly, thus indicating, as in *grossouvrei*, the same tendency of the nodes to return inwardly in extreme age. The peculiar broad, concave venter of the paragerontic substage is also akin to the aspect of the venter in an earlier substage in *grossouvrei*, but is a great exaggeration of this tendency, and occurs after the venter has become convex in the anagerontic substage, as is shown on the lower outline of fig. 1b. These figures are so fine that these observations are made upon their authority, and show a great difference between these and related American forms.

Grossouvre's reference of this variety to *P. milleri* of Hauer allows more latitude for variation than is given in this memoir. *Milleri* has only one row of tubercles, and the form of the venter is distinct.

Age: Senonian.

Placenticeras milleri (Hauer).

Ammonites milleri Hauer. 1866, Sitzungsber. K. Akad. Wiss., Wien, LIII, p. 304, pl. 2.

This species from Steirmark is quite distinct from any of the French forms described by Grossouvre, but it may be identical with some of the German forms already described having but one row of tubercles in an advanced stage of development. It has smooth sides, with only one row of tubercles on the outer volution, and apparently also in the earlier stages, as figured and described by Hauer. As stated by that author, it is very like *bidorsatus*, except that it has a convex and moderately broad venter. This last character also, as well as the peculiar form of the nodes on the edges of the venter and absence of inner lines of tubercles, separates it from Grossouvre's species. Hauer had specimens from 2 to 3½ inches in diameter.

Age: Senonian.

Placenticeras schlüteri n. sp. Hyatt.

Ammonites syrtalis var. *polyopsis* Schlüter, 1872, Palæontogr., Vol. XXI, pl. 14, figs. 1–2.

This species has ornaments very similar to those of *polyopsis* Dujardin, but these are quite distinct and peculiar in their ontogeny. The ephebic stage has two rows of large lateral tubercles, as well as ventral rows, and according to Schlüter's figures and descriptions the inner row in the anagerontic substage recedes outwardly, becoming approximate to the second outer row. The venter at the same time changes, becoming rounded and broader, but the ventral tubercles are still present. These figures are similar to the American *syrtale*, but differ in being less involute and in the wider removal of the inner row of tubercles from the umbilical shoulders and the elliptical section of the gerontic stage. In *syrtale* this section is distinctly subtriangular and more compressed in the same metagerontic substage.

Age: Lower Senonian.

Placenticeras orbignyanum (Geinitz).

Ammonites vibrayeanus Geinitz, 1843, Verst. v. Kieslingwalde, Pl. I, fig. 8.
Ammonites orbignyanus Geinitz, 1850, Quadersand. in Deutschl., pl. 14.
Ammonites orbignyanus Drescher, 1863, Zeitschr. Deutsch. geol. Gesell., Vol. XV, fig. 8.
Ammonites orbignyanus Fritsch and Schlönbach, 1872, Ceph. böhm. Kreide, pl. 10, figs. 4, 5.
Ammonites orbignyanus Geinitz, 1875, Elbthalgeb. in Sachsen, pl. 36.
Placent. fritschi Grossouvre, 1893, Ammonites Craie supérieure, pl. 5, figs. 1, 2.

This species has fold-like costæ and broad venters in the young, as figured by Fritsch and Schlönbach and by Geinitz in his Quadersandsteingebirge. One can not say anything definitely from the figure given in the first publication under name of *vibrayeanus*. The figure in Elbthalgebirge also appears to be the young of this same species; consequently Drescher's figure of the suture quoted above must also belong to this species and serves to correct the conventional figure given in Quadersandsteingebirge. There are three principal saddles, as in other species of this genus.

Grossouvre's figures are excellent and give clear ideas of this species. The broad, smooth, convex venter of what is probably the gerontic stage, and the young, both having costæ like the figures in the Quadersandsteingebirge, appear to show that the French and German forms are identical. The sutures as figured are different, but this may be due to the poor drafting of the figures in the Quadersandsteingebirge and in the Zeitschrift by Drescher.

Age: Lower Senonian.

Placenticeras polyopsis (Dujardin).

Ammonites polyopsis Dujardin, 1837, Mém. Soc. géol. France, No. 2, pl. 4.

This species has a form similar to *pseudorbignyanum*, but only in old age, the ephebic stage being smooth. The flattening of the venter in the gerontic stage is a transformation that may occur in any species of this and other genera at the same age and can not be considered to indicate specific identity. The ornaments are altogether different. The tubercles of the outer row are more or less connected with the inner row by indistinct, more or less bifurcated, costæ, and the inner row does not change place with age. The ventral tubercles are larger and more widely separated than in *schlüteri*, and all the tubercles and costæ occur only in old age, according to the figures, whereas in the latter they are present in adults as well as in the gerontic stage.

Age: Lower Senonian.

Placenticeras crassatum n. sp. Hyatt.

Ammonites syrtalis var. *orbignyanus* Schlüter (pars), 1872, Palæontogr., Vol. XXI, pl. 14, figs. 4–7, fig. 3? (no others).

This species differs from *schlüteri*, being more compressed. The recession outwardly on the inner row of tubercles does not take place. The inner row of tubercles disappears in what is probably the anagerontic substage, and in this also fold-like costæ are developed. The venter remains flattened, the sides flat, and the ventral tubercles are still well developed in this substage.

Age: Lower Senonian.

Placenticeras tamulicum (Blanford).

Ammonites tamulicus Blanford, 1863, Mem. Geol Surv. India, Vol. IV, p. 118.
Ammonites guadalupæ Stoliczka, 1866, Pal. Indica, Vol. I, pl. 47, and pl. 48, fig. 1.
Placenticeras tamulicum Kossmat, 1895, Beitr. Pal. und Geol. Oesterreich-Ungarns und des Orients, Vol. IX, pl. 22, figs. 1 a–c.

The neanic stage of this Indian species is figured by Kossmat, and this, together with the figures by Stoliczka, shows that this shell had a more compressed form, flatter sides, narrower ventral zone, and different sutures in the adult and less prominent and less distinct costations than the gibbous-sided form, also included in this species by Stoliczka in Paleontologia Indica and figured, pl. 47, fig. 2, sutures being also given, fig. 2a. There are considerable variations in the shapes of the saddles, between the last figure and those of *tamulicum* (*guadalupæ*) on pl. 48, fig 1, which can hardly be accounted for by differences of age in the specimens. It is difficult of course to say to which of the two forms the large specimen on pl. 47, fig. 1, may belong, and any attempt to separate them under different names would not be advisable. This last figure, 183 mm. in diameter, is in the gerontic stage and shows a second external row of nodes of large size and the inner row increasing greatly in size to blunt nodes on the last part of this volution. None of these authors mentions any rounding-off of the venter in old age, and apparently the venter retains its ephebic characters in this old specimen. I can not join Kossmat in considering *syrtale* of Schlüter as identical with this species. The American *syrtale* shows old age at a smaller size than in *tamulicum*, and the nodes and spines are much larger and last longer, especially the median lateral row, but it is much closer to this species than to any other European form except *schlüteri*. The more compressed form of pl. 48 has the external characters of the American *lenticulare* as figured by Meek, but the sutures are quite distinct.

Age: Lower Senonian.

PLACENTICERAS PSEUDORBIGNYANUM n. sp. Hyatt.

Ammonites syrtalis var. *orbignyanus* Schlüter (pars), 1871, Palæontogr., Vol. XXI, pl. 15, figs. 3–5, no others.

Schlüter's figure of a typical example of *orbignyanus* is not similar to that of Fritsch and Schloenbach, nor to Geinitz's species, nor does it agree with his var. *orbignyanus* given on pl. 14. It is a very distinct shell, having but one median lateral row of tubercles in the neanic stage. It is otherwise smooth and with narrow ventral zone.

Age: Lower Senonian.

PLACENTICERAS ? SUBTILISTRIATUM Jimbo.

Placenticeras ? subtilistriatum Jimbo, 1894, Palæon. Abhandl., new series, Vol. II, pt. 3, pl. 1, figs. 1, 1a.

This is merely mentioned here to call attention to the distribution of the genus. It is figured as a young, compressed shell and is certainly in aspect like a species of this genus. The figure has a centran trace or keel on the venter, although this part is described as being simply convex.

DIPLACMOCERAS[a] Hyatt.

This genus resembles *Engonoceras* quite closely in its involute compressed volutions and channeled venter bordered by continuous ridges, and in the tuberculation of the sides it is sufficiently near to be included in that genus if the sutures were unknown. These are, however, well known, thanks to Schlüter's fine figures, and they appear to be similar to those of

[a] Διπλόος, double; ἀκμή, edge. Misspelled Diplacomoceras in Zittel's Text-book, Ceph., p. 585.

Placenticeras. This genus therefore combines the external characters of Engonoceratidæ with the sutural lines of Placenticeratidæ, and perhaps ought to be placed in a separate family.

The young, however, are unknown, and it is perhaps better to wait until their development places their affinities on a firmer basis. It is also possible that they may be accounted for as members of the Placenticeratidæ that were arrested in their development, retaining the neanic condition of the venter and lateral zones in their later stages, but not arrested in their sutures, which approximate to those of *Placenticeras.*

Diplacmoceras bidorsatum (Roemer).

Ammonites bidorsatus Roemer, 1841, Verst. nord. Kreidegeb., p. 88, pl. 13, fig. 5.

This species has an outer row of lateral tubercles, according to Roemer's figures, with an inner row of folds or costæ directed apicad. The outer row of lateral tubercles are elongated continuations of the costæ and are bent orad, forming crest-like tubercles near and parallel to the edges of the venter. This last is a concave zone, bordered by two continuous ridges without tubercles. The outer volution is decidedly compressed, but is rather stout in proportion to its dorso-ventral diameter. This species is obviously, unless both the figures and description are erroneous, quite distinct from the *bidorsatum* of Schlüter, in having stouter volutions and broader venter and in the inner lines of narrow folds. There is, however, considerable resemblance between the two, and it is unlucky that Roemer did not figure the sutures.

Age: Lower Senonian.

Diplacmoceras canaliculatum n. sp. Hyatt.

Ammonites polyopsis Schlüter, 1867, Ammoneen norddeutsch. Senon., pl. 4.
Ammonites bidorsatus Schlüter, 1872, Palæontogr., Vol. XXI, pl. 15, figs. 6–8.

This species is very peculiar, having a well-defined gerontic stage with a row of lateral tubercles[a] set well out near the venter and becoming nodose or prominent. The shell in the ephebic stage is smooth and compressed, the venter is extremely narrow and channeled, and there are

[a] These are in no way comparable with ventral lines of tubercles as they occur in *Placenticeras*, being on the sides and near, but not on, the edges of the venter.

smooth continuous ridges on either side that can be compared with those of Engonoceratidæ. The differences between the shell figured by Schlüter and the *bidorsatum* of Roemer are so well shown in the drawing given by the latter that there can be but little doubt they are different species. The sutures are not distinct generically from those of *Placenticeras*, and would place the species in that genus if the characters of the shell were not so different.

Locality: Westphalia.

Age: Lower Senonian.

Incertæ sedis.

STYRACOCERAS[a] n. gen. Hyatt.

Ammonites balduri of Keyserling, the type and only known species of this genus, can not be associated with any species known to have same number of principal lateral saddles, because the external characters differ from those of any species known to me. The resemblances in the sutures are certainly closer to *Platylenticeras heteropleurum* than to any other species, if Keyserling's drawings and Neumayr's observations are correct. The suture has two broad principal lateral saddles, the first and second, or else these may be reckoned, as in others of this group, as one saddle divided into two branches. Until the young are known, this can not be definitely decided. (See *Platylenticeras*.)

Styracoceras balduri (Keyserling).

Ammonites balduri Keyserling, 1846, Petschora-Land, pl. 19, fig. 2.

The young, as figured by Keyserling, has a channel on the venter in the neanic stage after passing through a substage with an acute venter. This figure may have been taken from a partly crushed fossil. So far as known, the replacement of an acute condition of the venter by a furrow is exceptional and requires more proof than a single drawing. Neumayr obtained the originals of Keyserling's description and studied them, but his attention was not apparently attracted to this fact, and he did not break down any of the fossils to investigate the young. He redescribed, but, unluckily, did not have them redrawn, and did not state whether the

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[a] Στύραξ, spike on the inner end of a spear.

smallest fossil, about 10 mm. in diameter, was exactly represented in Keyserling's figure which shows the acute venter. Neumayr[a] does, however, state clearly that the venter becomes furrowed at 15 mm. in diameter, and that this furrow is succeeded by a stage with a rounded venter which preceded the incoming of a stage with a slightly convex venter and distinct ventro-lateral angles, and that this precedes a stage with distinct keel developed upon the elevated venter, and tubercles developed upon the costæ internally and at their terminations on the ventro-lateral angles. Such an extraordinary succession of transformations is irreconcilable with those of the ontogeny of any group known to the author. The resemblances of the sutures are, therefore, not sufficient to place the genus in the same group with *Platylenticeras*, from which it differs in every other respect.

Neumayr's view of the affinities of this genus for the Amaltheidæ is not sustained by anything except the general similarity of the external aspect of adults, which is probably due to parallelism, and the same is true of its supposed affinities for *Cardioceras*. The characteristics of form and ornamentation supposed to be so similar have obviously arisen from entirely distinct modes of development, and these genera are not even as closely related to each other as to *Styracoceras*.

Age: Neocomian.

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[a] Ueber Amalth. balduri Keyserl. u. d. Gattung Cardioceras. Neues Jahrb. für Min., Geol., and Pal., 1886, 1, p. 95.

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PLATES.

PLATE I.

PLATE I.

Mojsisovicsia, Buchiceras, Roemeroceras.

Page.

Figs. 1–3. *Mojsisovicsia durfeldi* Steinmann 25

Specimens from Pariatambo, Peru; Albian? (after Steinmann).

Figs. 4–9. *Buchiceras bilobatum* Hyatt 27

Figs. 4, 5. Natural size.

6. Enlarged, showing costæ and aspect of center.

7. Front view of center of fig. 6.

8. Suture from outer volution, part broken off in fig. 6, × 3.

9. Suture of young × 10 when the costæ begin to appear.

Cachiyacu, Peru; Upper Cretaceous; my collection.

Figs. 10–14. *Roemeroceras syriaciforme* Hyatt 31

Fig. 10. Aged specimen.

11. Suture of same.

12. Younger stage of another specimen, all natural size.

13. Suture of same, right side, × 3.

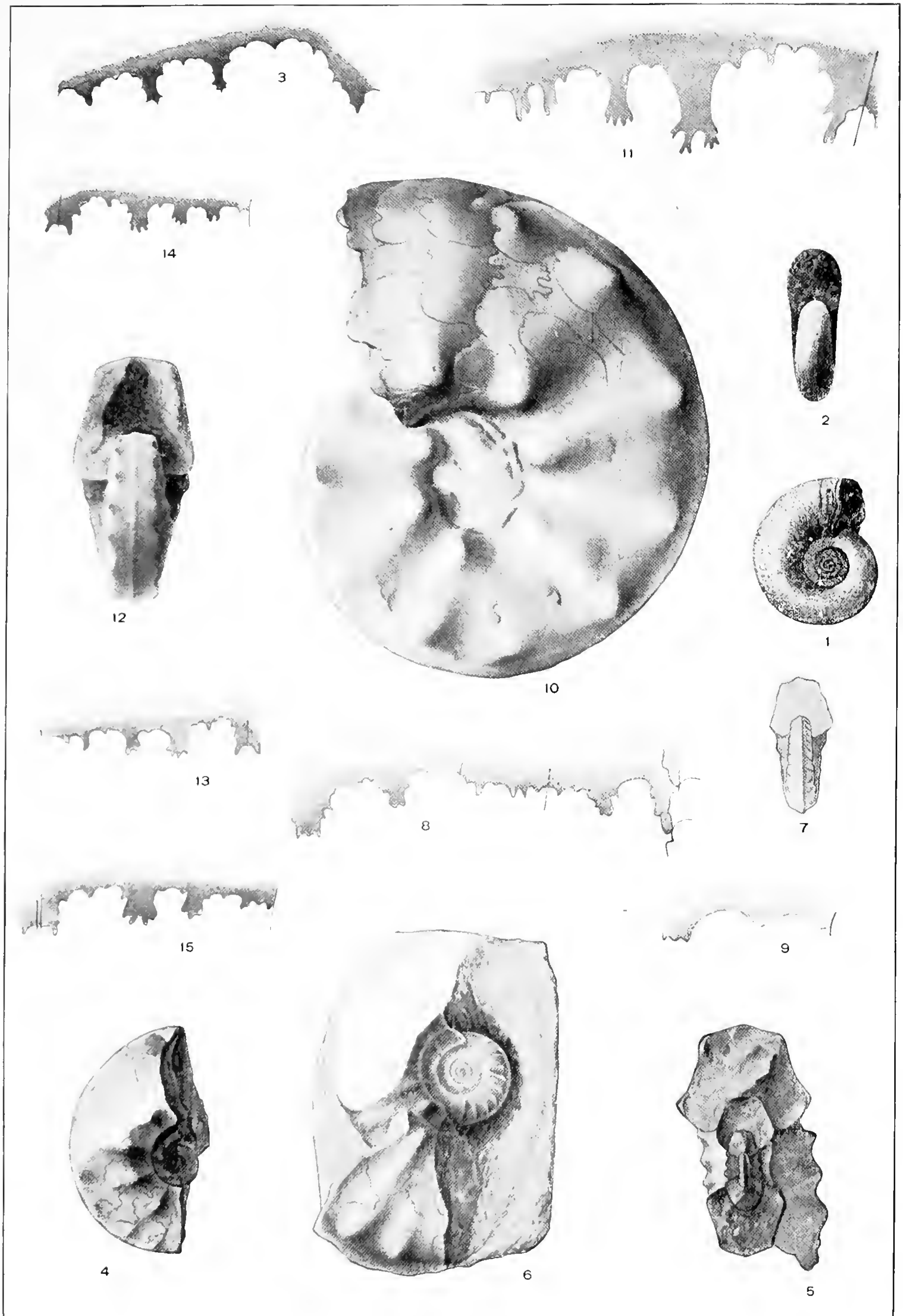
14. Suture of same, left side, × 3.

Cajamarca, Peru; Upper Cretaceous; my collection.

Fig. 15. *Roemeroceras attenuatum* (Hyatt) 33

Fig. 15. Suture, natural size. The second lateral saddle has, by an oversight on the author's part, been drawn too decidedly as trifid. It is really a bifid base with a prominent outer marginal and much like the same saddle in fig. 13.

Celendin, Peru; Upper Cretaceous; my collection.



MOJSISOVICSIA, BUCHICERAS, ROEMEROCERAS.

PLATE II.

PLATE II.

ROEMEROCERAS, PARATISSOTIA.

Page.

FIGS. 1–3. *Roemeroceras gabbi* Hyatt 30

Figs. 1, 2. Natural size.

3. Enlarged suture. Coll. Acad. Nat. Sci. Philadelphia.

Quebrada de Colpamayo, Peru; Upper Cretaceous; all after Gabb.

FIGS. 4–6. *Roemeroceras subplanum* Hyatt 34

Figs. 4, 5. Natural size.

6. Suture, × 2.

Cajamarca, Peru; Upper Cretaceous; my collection.

FIGS. 7–11. *Paratissotia serrata* (Hyatt) 51

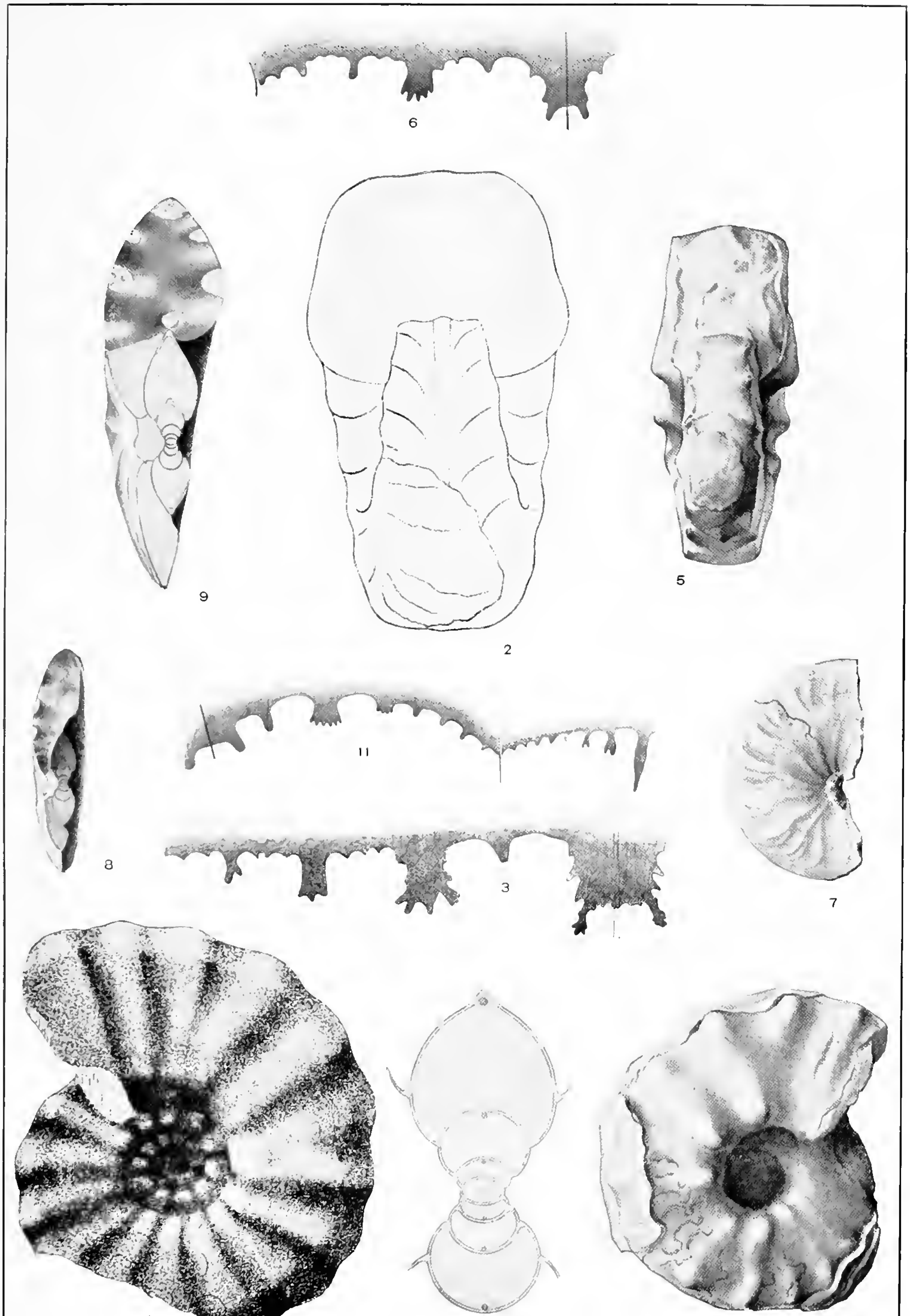
Figs. 7, 8. Natural size.

9. Fig. 8 enlarged.

10. Center of fig. 8 enlarged to show section of young and solid keel.

11. Lateral and dorsal suture of fig. 7 above the break.

Cachiyacu, Peru; Upper Cretaceous (Senonian?); my collection.



ROEMEROCERAS, PARATISSOTIA.

PLATE III.

PLATE III.

Paratissotia, Sphenodiscus.

Page.

Figs. 1–6. *Paratissotia regularis* Hyatt 53

Figs. 1–3. Natural size. The venter is restored in fig. 1, and in fig. 3 the hollow keel is restored except in lowest volution of section, which is as seen in fig 4.

4. Enlarged view of section of venter of lower whorl of fig. 3, showing hollow keel on its first appearance.

5. Suture of first quarter of outer volution of fig. 2; dorsal saddles merely indicated.

6. Much abraded sutures of last quarter of same, to show the number and general proportions of the curves; the ventral lobe is more deeply worn than the lateral.

Cachiyacu, Peru; Upper Cretaceous; my collection.

Figs. 7–15. *Sphenodiscus pleurisepta* (Conrad) 59

Figs. 7–9. Natural size. Rio Pecos, (?) Tex.; Upper Cretaceous; Coll. Columbia University, New York, No. 10881.

10. Enlarged center of fig. 9. The sutures in this were not so clearly seen as to make the observation in this and fig. 12 entirely reliable.

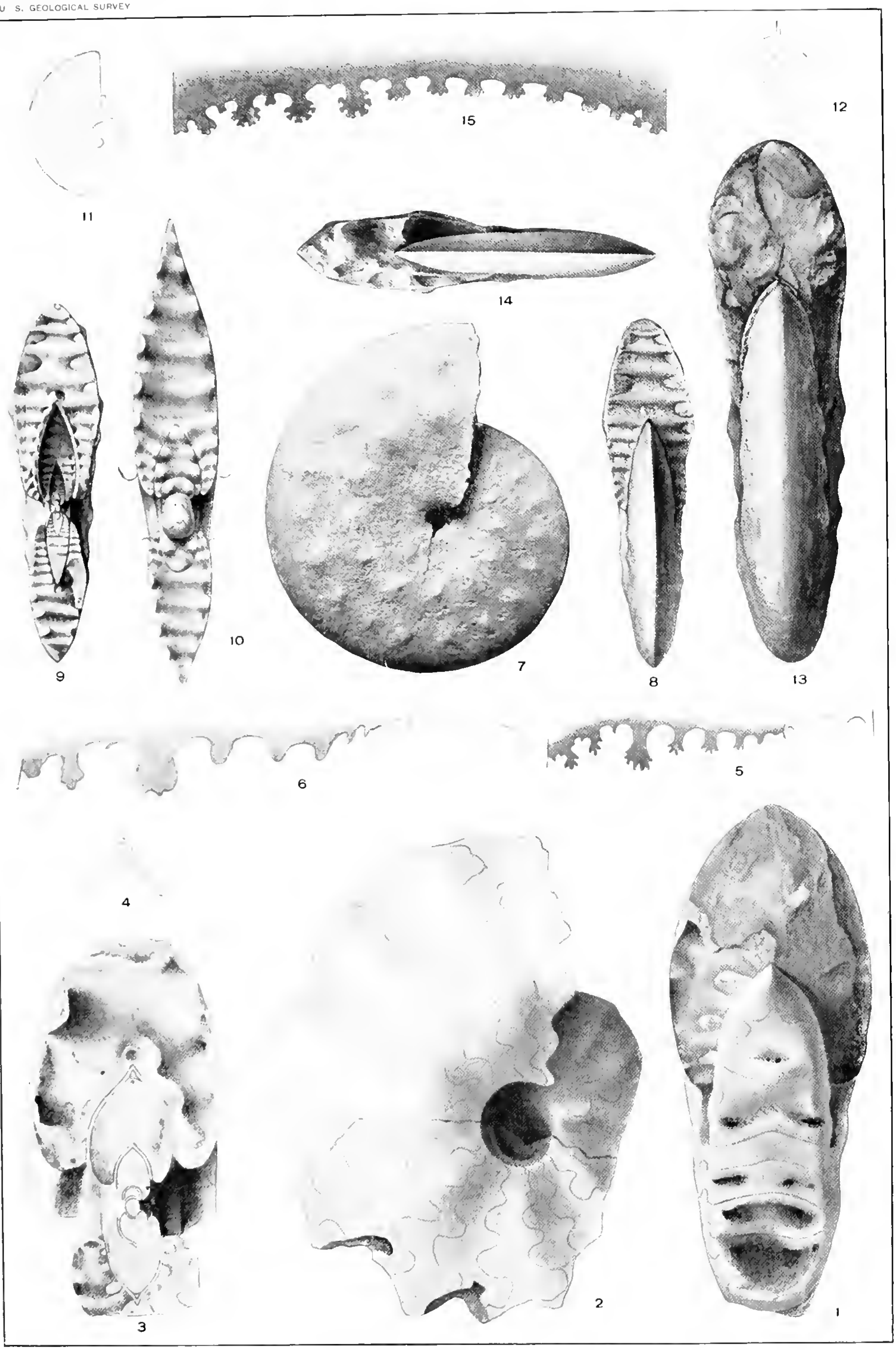
11, 12. Enlarged outlines of young of fig. 9.

13. Older specimen than figs. 7–12, showing the rounding of the venter. Near Eagle Pass, Tex.; U. S. Nat. Mus. Coll. No. 19145a.

14. Loc. same, coll. same, No. 19145b. Same age as figs. 7 and 8, but showing more acute venter and more prominent tubercles; this variation has been slightly increased by compression.

15. Suture $\times 2\frac{1}{2}$ of specimen represented by Pl. V, fig. 3. Rio Pecos, (?) Tex.; Coll. Columbia University, No. 10881c.

All on this plate are casts.



PARATISSOTIA. SPHENODISCUS

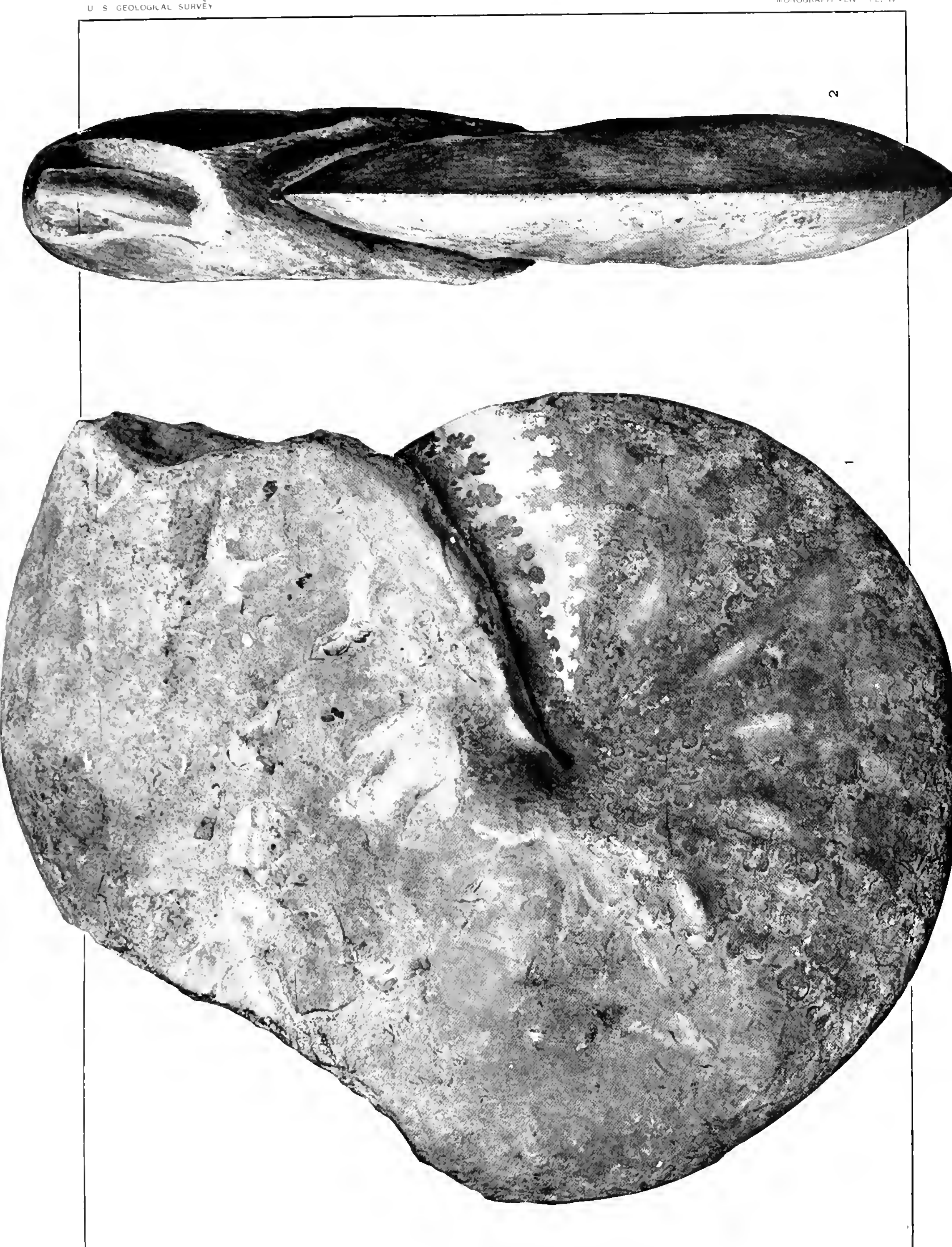
PLATE IV.

PLATE IV.

SPHENODISCUS PLEURISEPTA (Conrad).

(Page 59.)

FIGS. 1, 2. Loc. No. 1473, near Eagle Pass, Tex.; Upper Cretaceous; Coll. U. S. Geol. Survey.

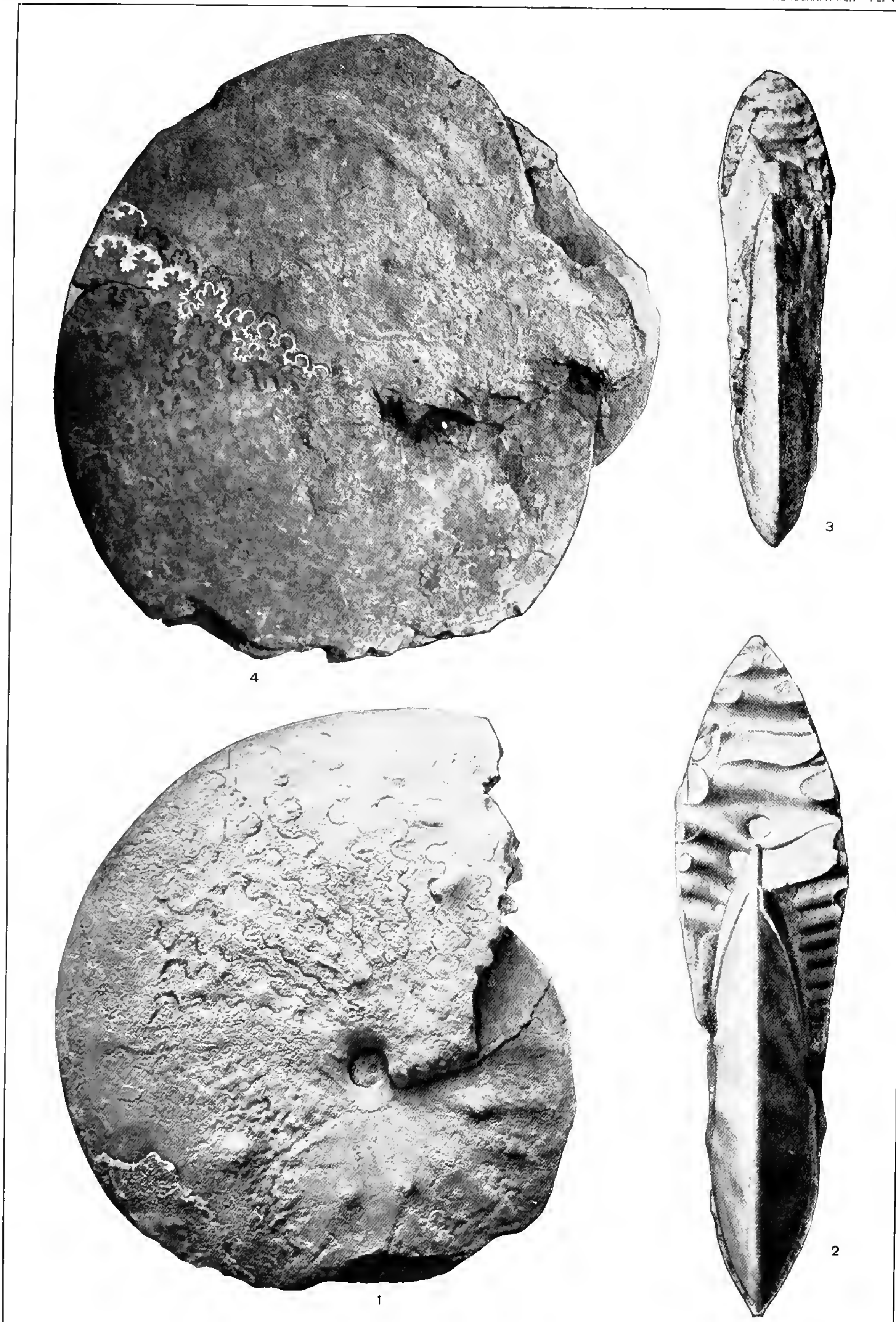


SPHENODISCUS

PLATE V.

PLATE V.

SPHENODISCUS.



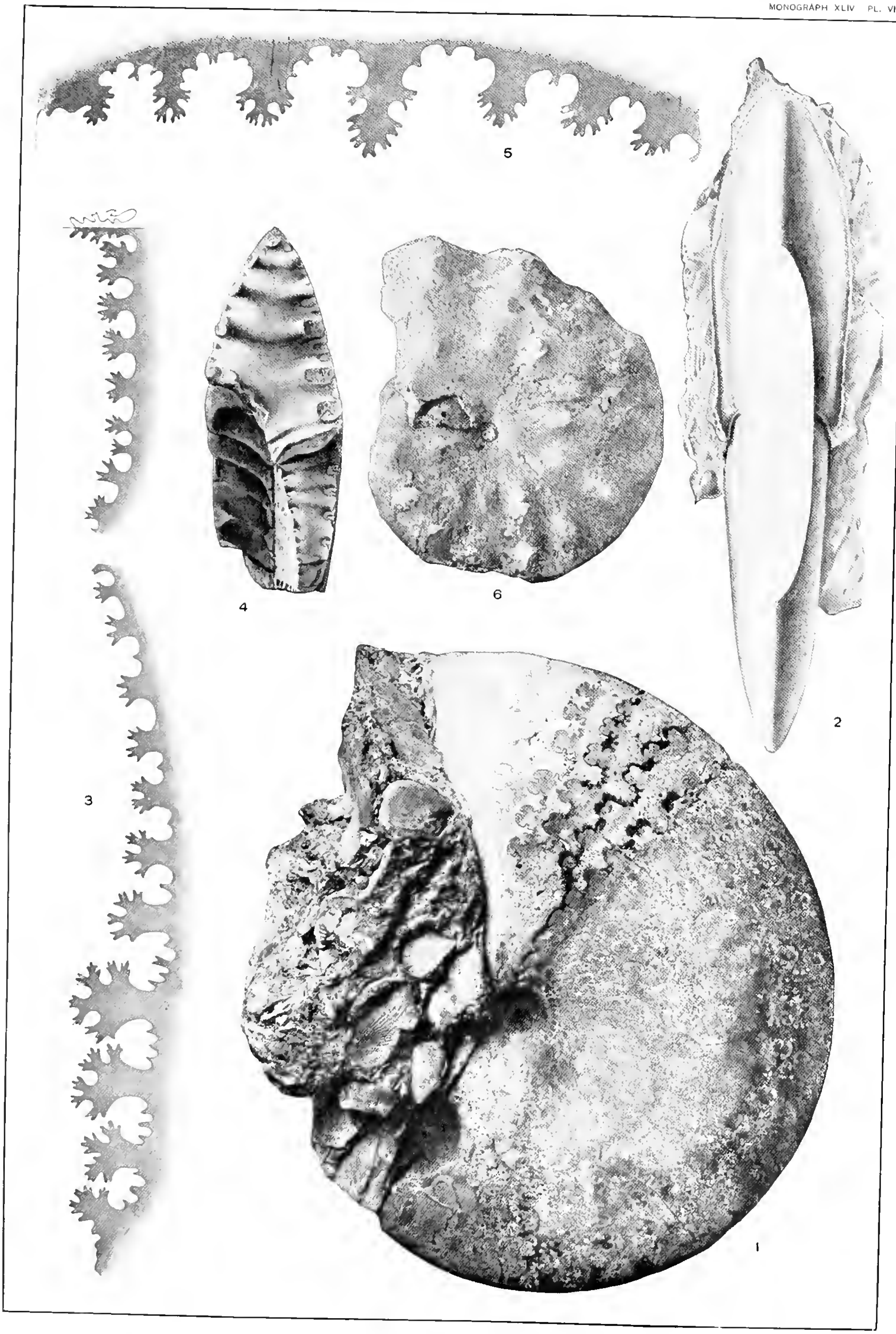
SPHENODISCUS.

PLATE VI.

PLATE VI.

SPHENODISCUS.

		Page.
FIGS. 1, 2.	*Sphenodiscus lobatus* (Tuomey)	66
	Shows the abnormally shortened living chamber and flaring abnormal aperture and partly absorbed sutures. Lander's mill, Tippah County, Miss.; Ripley group; Coll. U. S. Nat. Mus., No. 20577.	
FIGS. 3, 4.	*Sphenodiscus beecheri* Hyatt	78
	Birmingham, N. J.; Lower or Middle Greensand marls, Upper Cretaceous; Coll. Yale Univ. Mus., No. 200.	
FIG. 5.	*Sphenodiscus stantoni* Hyatt	70
	Suture from specimen figured on Pl. V, fig. 4, showing the principal saddles and lobes, ×3.	
FIG. 6.	*Sphenodiscus pleurisepta* (Conrad)	59
	Buncombe Hills, Pontotoc County, Miss.; Ripley group, Upper Cretaceous; Coll. Frederick Braun.	



SPHENODISCUS.

PLATE VII.

PLATE VII.

SPHENODISCUS LOBATUS (Tuomey).

(Page 66.)

FIGS. 1, 2. Pontotoc County, Miss.; Ripley group, Upper Cretaceous; Coll. U. S. Nat. Mus., No. 2403, ¾ natural size.


2


1

SPHENODISCUS

PLATE VIII.

PLATE VIII.

SPHENODISCUS.

Page.

FIGS. 1, 2. *Sphenodiscus lenticularis* (Owen) 71

Fig. 1. Young of supposed typical form, natural size. See also Pl. IX.

2. Suture of same $\times 6\frac{1}{2}$.

Moreau River,? Dakota; Fox Hills group; Coll. U. S. Nat. Mus., No. 7754.

FIGS. 3-7. *Sphenodiscus lenticularis* var. *splendens* Hyatt 75

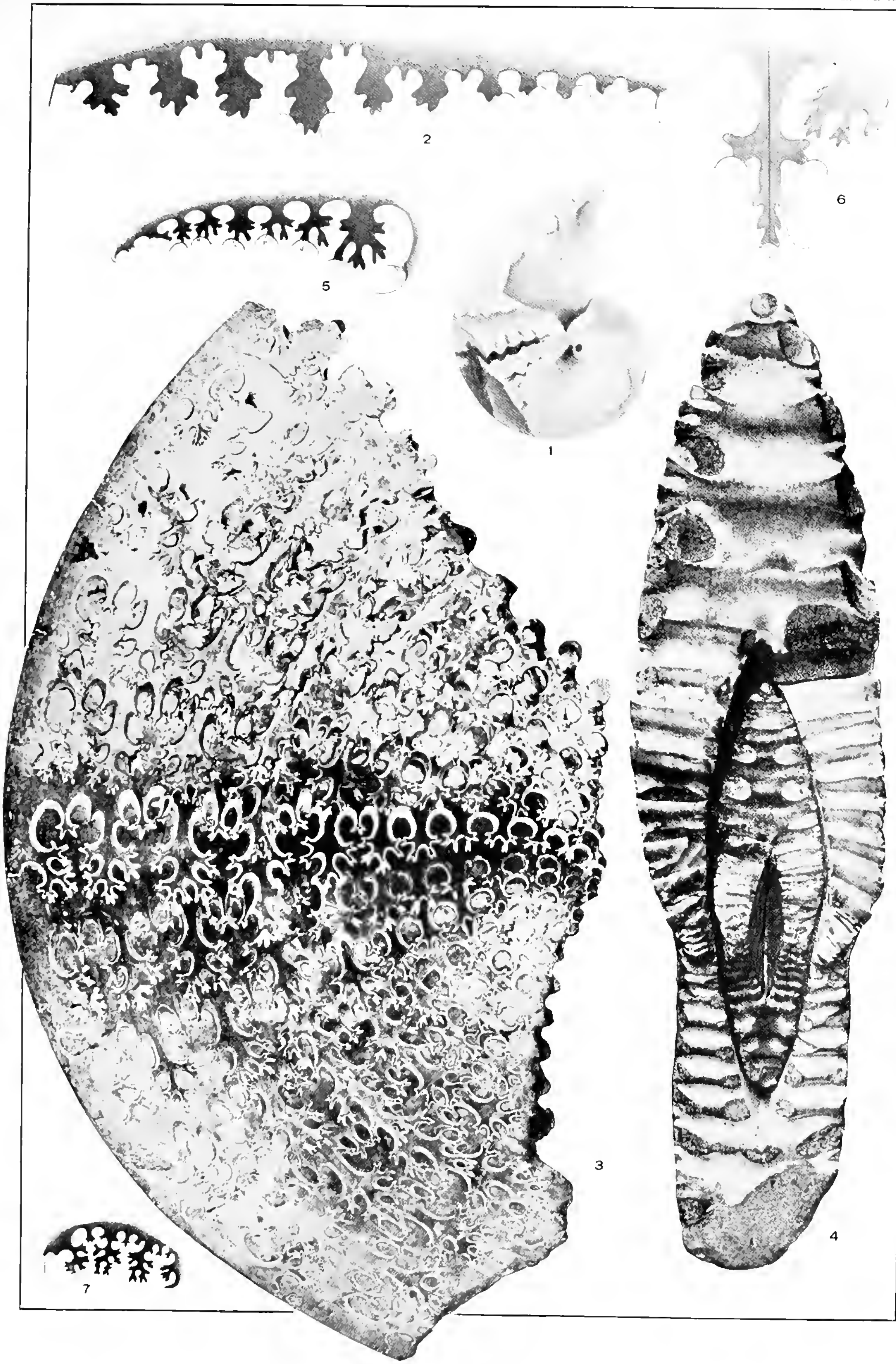
Figs. 3, 4. Views of fragments showing lateral sutures and internal, loose younger volution, natural size.

5. Dorsal suture of one side of about same age as the one painted in on fig. 3, natural size.

6. Antisiphonal lobe of fig. 5, much enlarged.

7. First three saddles and siphonal saddle to show outlines on the next inner volution to that of fig. 3, natural size.

South Dakota; Fox Hills group; my collection.



SPHENODISCUS.

PLATE IX.

PLATE IX.

Sphenodiscus.

Page.

Figs. 1–6. *Sphenodiscus lenticularis* (Owen) 71

Fig. 1. Suture of paranepionic substage, × 25.

2. Details of siphuncle, showing what seemed to be a collar above and a prolonged funnel reaching from the septum to the opening of the collar.

3. Sutures of the neanic stage, showing the division of the first primitive lateral into three saddles, first, second, and third of the later stages, and the mode of increase of the so-called auxiliary saddles and lobes on the line of involution, × 5.

4. Section of the two youngest volutions observed, × + 4.

5. Lateral suture of later but not fully adult stage, × 6.

6. Dorsal suture of same age, × 8.

Rock Creek, Wyoming; Fox Hills group; Coll. Yale University, No. 1697.

Figs. 7–9. *Sphenodiscus lenticularis* var. *mississippiensis* Hyatt 77

Fig. 7. Lateral suture, natural size.

8. Dorsal suture of same age, but one-fifth over the natural size; actual measurement is 48 mm. instead of 60 mm., the length of the figure.

9. Lateral suture, natural size, from specimen in Coll. Acad. Nat. Sci. Philadelphia.

Three miles northeast of Ripley, Miss.; Ripley group; Coll. U. S. Nat. Mus., No. 20863c.

Fig. 10. *Sphenodiscus beecheri* Hyatt 78

Suture, natural size. Fox Hills group; Coll. Mus. Comp. Zool., Cambridge.

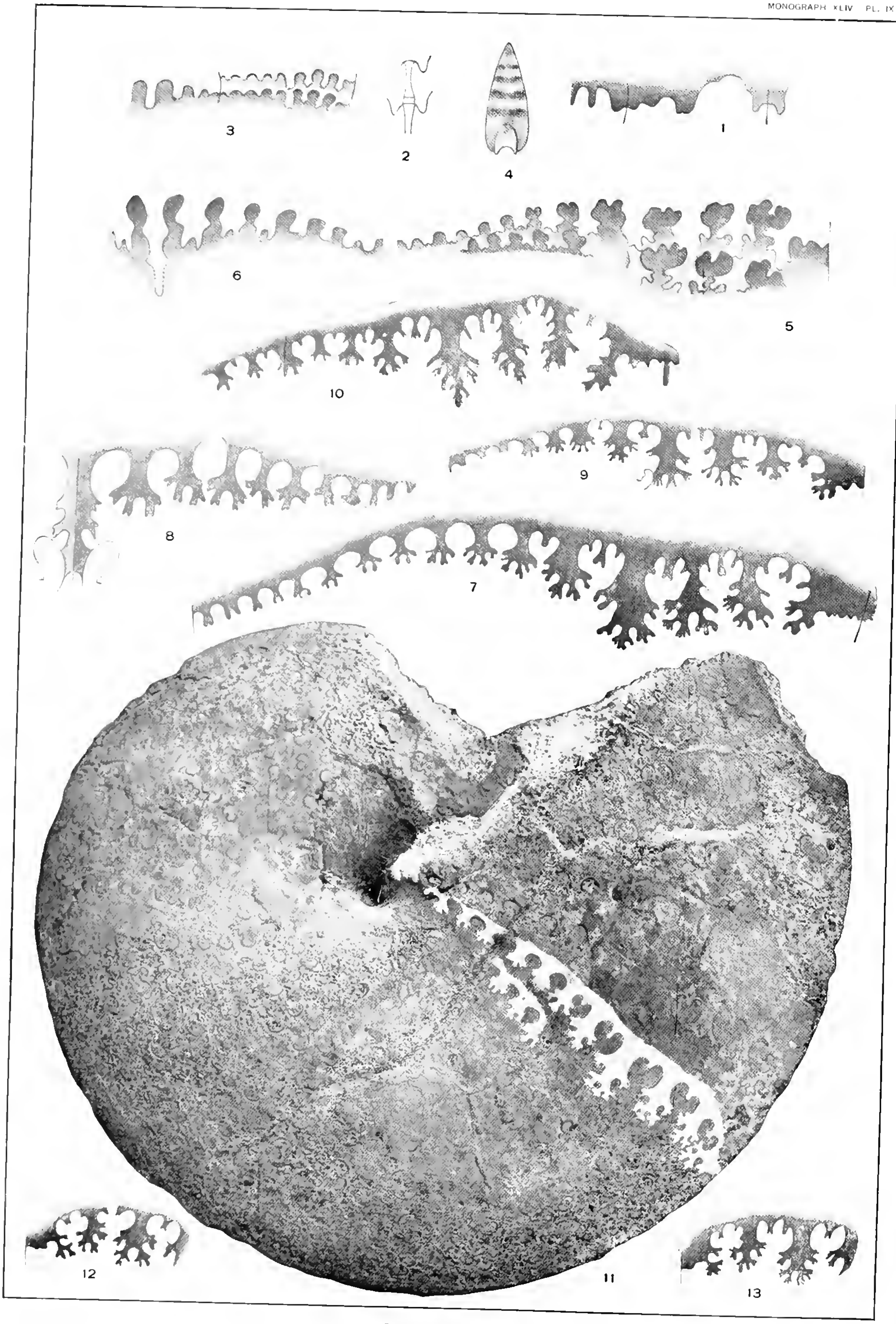
Figs. 11–13. *Sphenodiscus lobatus* (Tuomey) 66

Fig. 11. Right side.

12. First three saddles of left side at same age, natural size.

13. First three saddles of left side of the youngest suture shown on Pl. VII, fig. 1, natural size, for comparison with fig. 12.

Buncombe Hills, Pontotoc County, Miss.; Ripley group; Coll. Frederick Braun, Brooklyn, N. Y.



SPHENODISCUS

PLATE X.

PLATE X.

Coilopoceras, Sphenodiscus.

Page.

Figs. 1–4. *Coilopoceras novimexicanum* Hyatt 94

Figs. 1–3. Natural size, showing hollow keel, etc.

4. One entire lateral suture and parts of two others, × 2. The terminations of the saddles were more or less pointed depressions in the cast and were not at first observed.

Near Carthage, N. Mex.; my collection.

Figs. 5–21. *Coilopoceras colleti* Hyatt 91

Figs. 5, 6. Natural size, section partly restored; see also Pl. XI, fig. 1.

7. Lateral suture same as in side view, × 2.

8. The dorsal suture of same age, but a suture or two later.

9. Youngest suture shown in fig. 5, × 2, showing the marked changes that occur on this volution.

10. First to third suture of nepionic stage, × 20.

11a. An entire suture of latter part of first volution, × 20.

11. Two entire sutures of first quarter of second volution, × 20.

12. Entire suture of fourth quarter of fourth volution, × 8, when the sutures are beginning to show subdivision.

13. The protoconch and part of the first volution, × 22, same age as fig. 14.

14. More enlarged side view of the same.

15, 16. An older stage of the same shows less of the protoconch and more sutures.

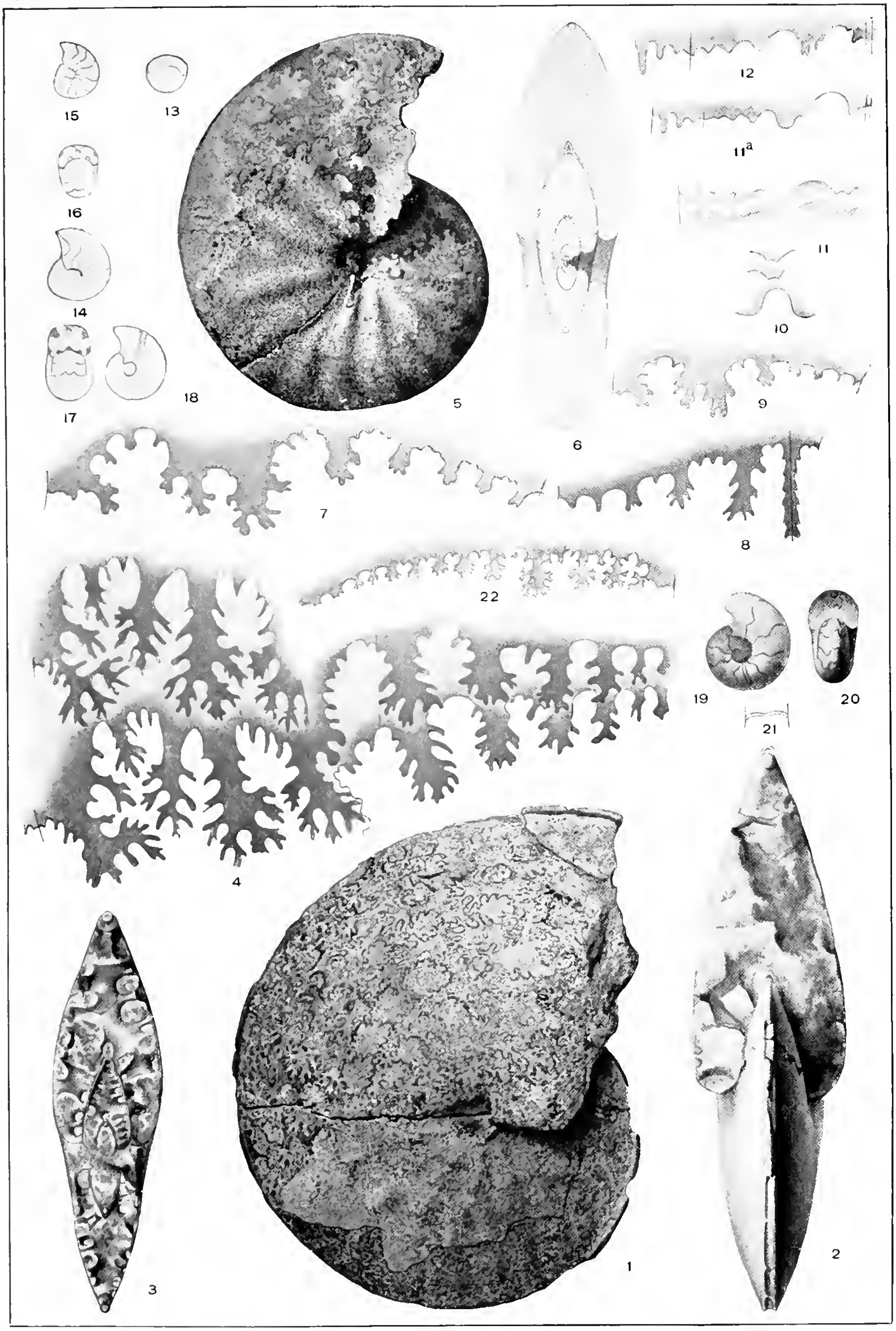
17, 18. A still older stage, showing the decreasing transverse diameter of the volution in the goniatitic stage, and the first constriction or mark of a nepionic aperture.

19, 20. An older stage of same, center of fig. 6, and also of fig. 1, Pl. XI.

21. Shows the hyponomic sinus of constriction or permanent aperture given in figs. 18 and 19. The normal rate of growth and increase in diameters of volution has begun in this nepionic substage.

Near Carthage, N. Mex.; my collection.

Fig. 22. [Suture of Sphenodiscus introduced for comparison.—T. W. S.]



COILOPOCERAS, SHPENODISCUS.

PLATE XI.

PLATE XI.

Coiloceras, Eulophoceras, Metoicoceras.

Page.

Fig. 1. *Coilopoceras colleti* Hyatt 91

Section same as Pl. X, fig. 6, enlarged.

Figs. 2–6a. *Eulophoceras natalense* Hyatt 86

Fig. 2. Side taken before specimen was ground to show section.

3. Section somewhat more than natural size, and somewhat restored, shows the umbilicus on the right completely filled by the shell layers. This filling occurs in the adolescent stage, inclosing the dark spots on both sides of the center, which indicate that the shell did not fill the umbilici at an earlier stage.

4. Enlarged view of center restored.

5, 6. Shows keel to have been solid at this age.

6a. Enlarged drawing of hollow keel of venter connected by a dotted line.

Natal, South Africa; Cretaceous; Yale Museum.

Figs. 7–24. *Metoicoceras swallovi* (Shumard) 118

Fig. 7. Protoconch and part of nepionic volution, $\times$ 56+, actual transverse diameter 3/10 mm.

8. Side view of same, showing the abrupt bend in the protoconch before the nepionic tube began to be formed, and the first two sutures.

9. Optical section of same along dotted line in fig. 8 and from front of view shown by the arrow.

10. Front view of the specimen before removal of the outer volution, $\times$ 36.

11. Enlarged view of the cæcum and first section of siphuncle, showing also the ventral lobe divided by a siphonal saddle.

12, 13. Neanic stage, showing the aspidoceran-like form and tubercles, $\times$ 6.

14, 15. A little older stage with living chamber complete at the umbilical shoulder, over 1/2 volution in length, $\times$ 6. Back of this shows rounded venter of the neanic stage just becoming divided by the incoming of two rows of tubercles.

16, 17. Early ephebic substage.

18. Sutures of fig. 12 about first quarter of fourth volution, $\times$ 12.

19. Suture of second quarter of same volution.

20. Suture of probably fourth quarter of same volution.

21. Dorsal suture of the second volution, $\times$ 12.

22. Dorsal suture of what was considered to be the last of fifth or part of sixth volution, $\times$ 12.

23. Dorsal suture later in age than fig. 22, $\times$ 12, of same age as suture Pl. XIII, fig. 1.

24. Lateral suture of fig. 16 enlarged 3 diameters. The ventral lobe has been distorted by setting the siphonal saddle at an eccentric angle.

Texas; Colorado epoch; my collection.

See Pl. XIII for other figures of this species.

COILOPOCERAS, EULOPHOCERAS, METOICOCERAS

PLATE XII.

PLATE XII.

Coilopoceras, Aconeceras, Sphenodiscus.

Page.

Figs 1–3 *Coilopoceras springeri* Hyatt 96

Fig. 1. Suture of right side of shell.

2. Suture of left side.

3. Antisiphonal lobe and first dorsal saddle. Lower part of lobe below dotted line and right side is restored; the point, however, was seen to be bifid.

All natural size.

Rit du Plain, Colfax County, N. Mex.; Colorado epoch, Upper Cretaceous; Coll. Mus. Comp. Zool.

Figs 4–6 *Aconeceras nisum* (d'Orbigny) 100

Figs. 4, 5. Natural size (after d'Orbigny's figures).

6. Sutures enlarged, showing similarity to phylloceran outlines.

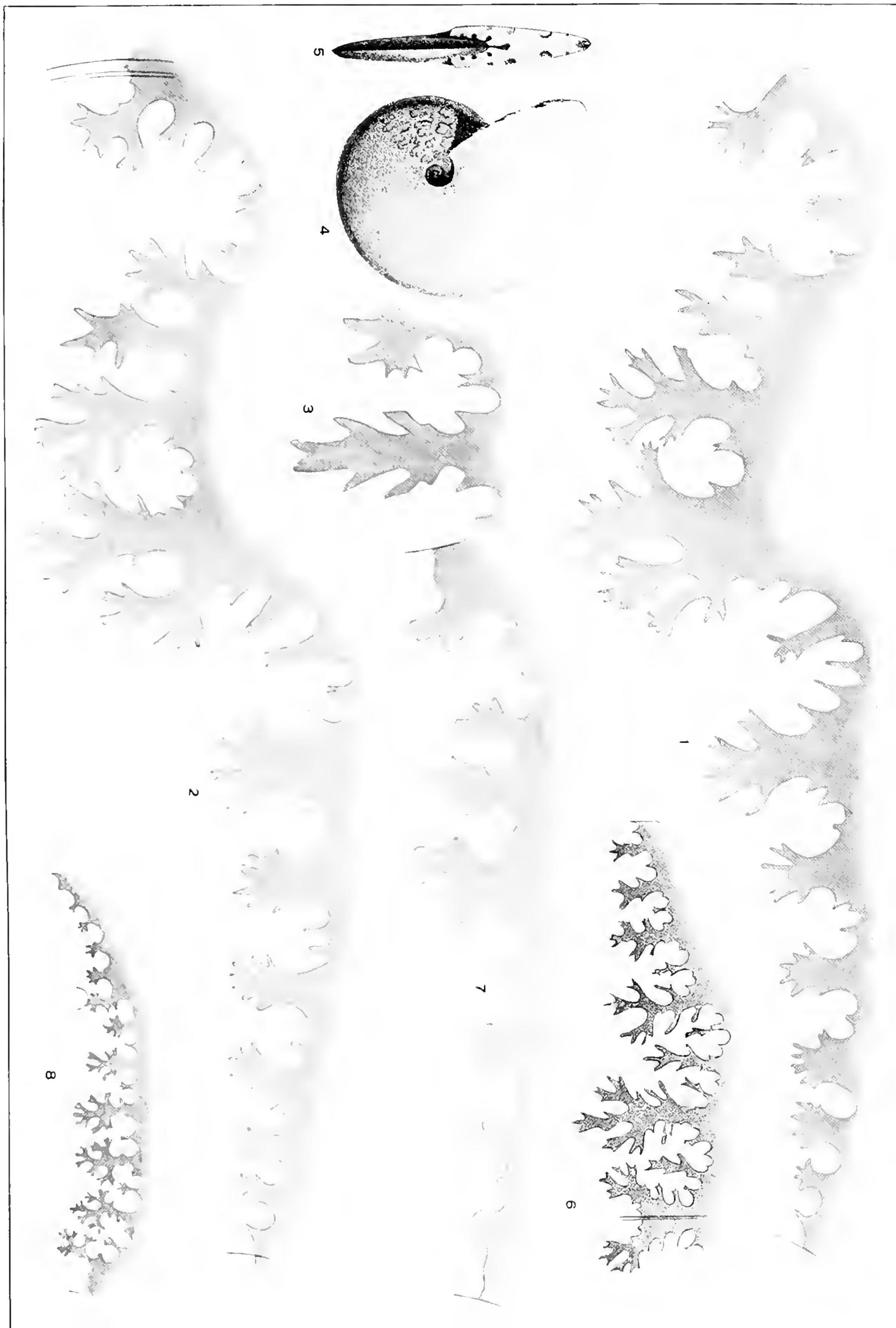
Fig. 7 *Coilopoceras grossouvrei* Hyatt 100

Figure of supposed *Sphenodiscus requienianus* d'Orb., showing coilopoceran suture. (After Grossouvre.)

Fig 8. *Sphenodiscus konincki* Hyatt 82

Fig. 8. Suture natural size. Part of one suture is shown and this is continued by the auxiliaries of the next suture below.

Near Maestricht; Senonian; DeKoninck Coll. Mus. Comp. Zool., Cambridge.



COILOPOCERAS, ACONECERAS, SPHENODISCUS.

PLATE XIII.

PLATE XIII.

Metoicoceras.

Page.

Figs. 1–2. *Metoicoceras swallovi* (Shumard) 118

Fig. 1. Same as Pl. XI, figs. 20–23. First three saddles and two lobes of lateral suture, × 12, to show mode of division of saddles and their distinct marginals at this late neanic substage.

2. Grayson County, Tex; Coll. D. S. Martin.

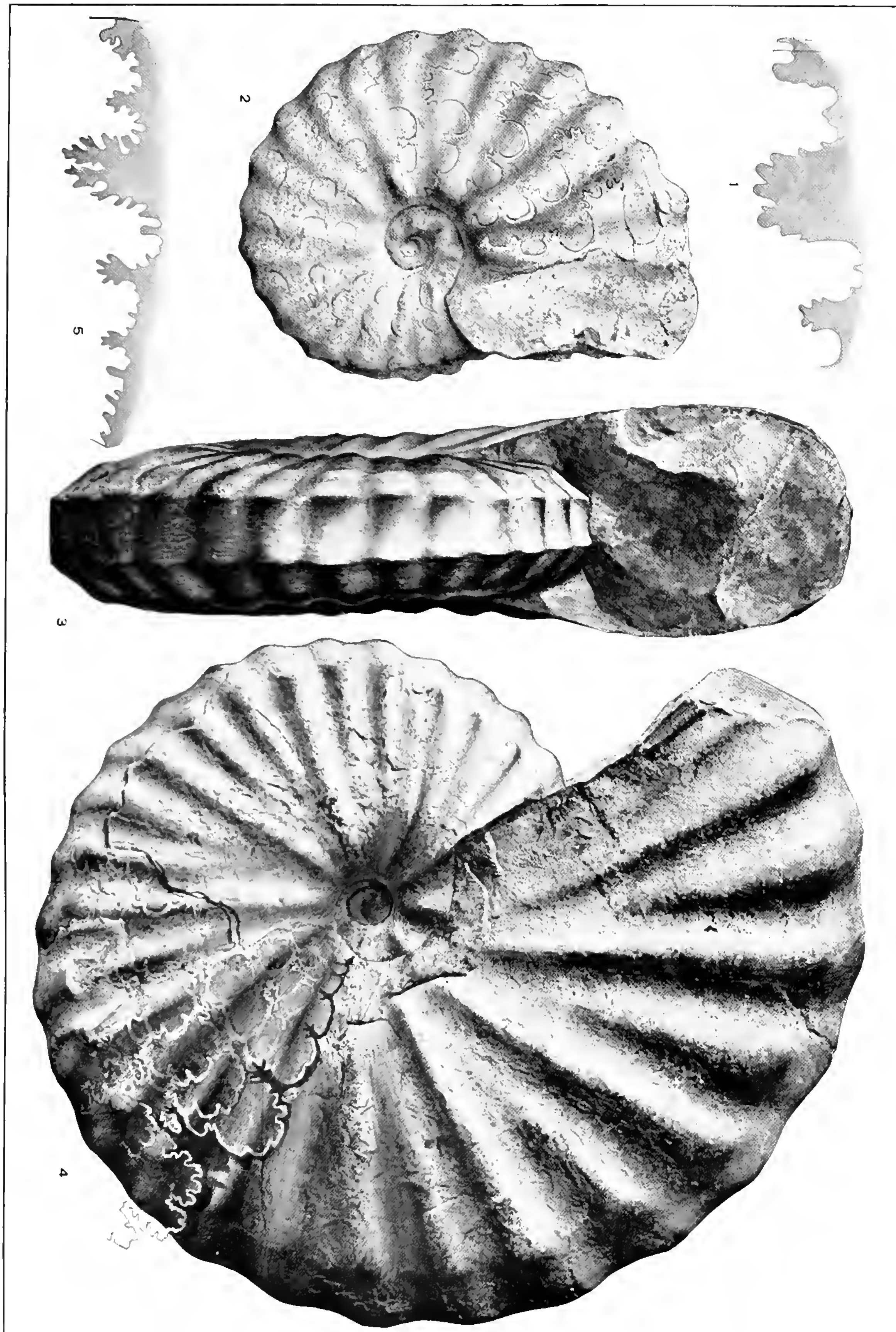
Figs. 3–5. *Metoicoceras whitei* Hyatt 122

Fig. 3. Shows shell on part of outer volution and how little this differs from the cast.

4. Shows this also as well as the rounding of the living chamber on the venter in old age. See also younger suture from opposite or left side; Pl. XIV, fig. 10.

5. Last suture of another specimen of about the same size as fig. 4.

Upper Kanab Valley, Utah; Coll. U. S. Nat. Mus.



METOICOCERAS.

PLATE XIV.

PLATE XIV.

METOICOCERAS, VASCOCERAS.

Page

FIGS. 1–10. *Metoicoceras whitei* Hyatt 122

Figs. 1, 2. Exterior, natural size, showing living chamber nearly three-fourths of a volution in length, complete to its inner border.

3. Lateral suture of the last septum, × 3.

Elm Fork, Horton's mill, Dallas County, Tex.; Colorado epoch.

4, 5. Specimen somewhat older than fig. 1, natural size.

Probably from Texas; my collection.

6. Lateral suture, × 3. Living chamber, probably nearly complete, is one-half of a volution in length.

7, 8. Type of species, natural size.

9. Suture, natural size, somewhat older than fig. 4, whole diameter about 56 mm.

Elm Fork, Horton's mill, Dallas County, Tex.

10. Lateral suture, left side of fig. 4, Pl. XIII, taken from halfway between the base of the living chamber and the opening of the same.

FIGS. 11–14. *Metoicoceras acceleratum* Hyatt 127

Figs. 11–13. Specimen in which the living chamber is complete and over three-fourths of a volution in length, natural size.

14. Part of suture visible at base of living chamber on the opposite side to that figured, × 4.

Elm Fork, Horton's mill, Dallas County, Tex.

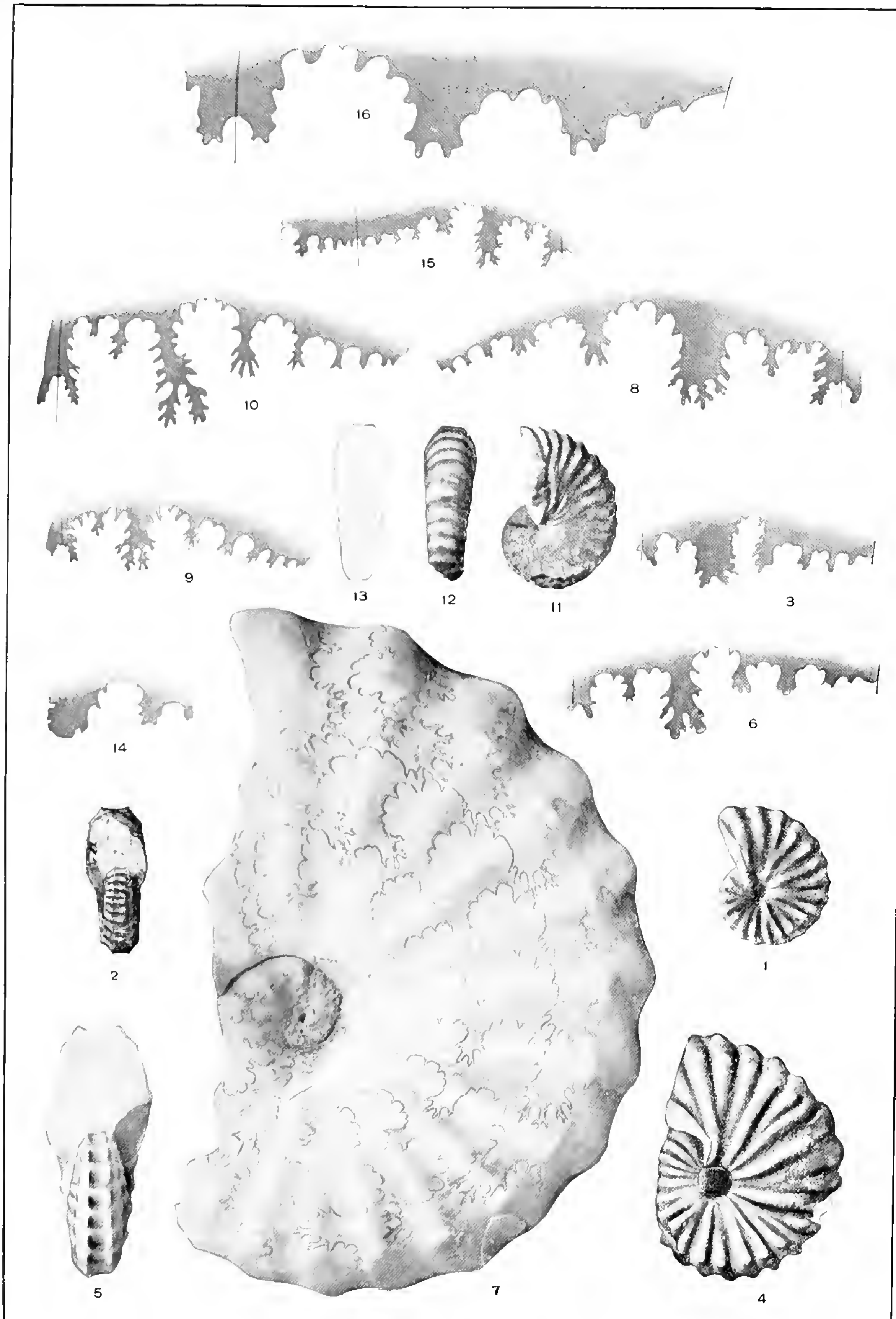
FIG. 15. *Metoicoceras whitei* Hyatt 122

Dorsal suture, natural size.

Elm Fork, Horton's mill, Dallas County, Tex.

FIG. 16. *Vascoceras hartti* (Hyatt) 103

Suture, natural size.



METOICOCERAS, VASCOCERAS.

PLATE XV.

PLATE XV.

METOICOCERAS, HEINZIA.

Page.

FIGS. 1-4. *Metoicoceras swallovi* (Shumard) 118

Figs. 1, 2. The imperfect and crushed base of living chamber restored in fig. 2.

3, 4. Right and left sutures of fig. 1, of same age, showing differences in number and outlines of auxiliaries. All natural size.

Texas; Colorado epoch; Coll. Amer. Mus. Nat. Hist., New York.

FIGS. 5-8. *Metoicoceras gibbosum* Hyatt 121

Figs. 5, 6. Natural size.

7, 8. Suture of right and left sides, respectively, as seen when looking at the specimen fig. 5, natural size.

Texas; Coll. Amer. Mus. Nat. Hist., New York.

FIGS. 9-11. *Metoicoceras kanabense* Hyatt [a].

Figs. 9, 10. Natural size.

11. Suture of left side of the second quarter of outer volution, $\times 2\frac{1}{2}$. The living chamber extended from the crack in the specimen, fig. 10, for the remaining one-half volution, and was most probably nearly complete.

Upper Kanab Valley, Utah; Colorado epoch; Coll. U. S. Nat. Mus.

FIGS. 12-18. *Heinzia matura* Hyatt 132

Fig. 12. Entire specimen, right side.

13. Same separated and center excavated, left side.

14. Front view of same, center one-half restored.

15. Ventral view of fig. 12.

16. Suture at place marked by arrow in fig. 13, $\times 7$, actual length 3 mm.

17. Dorsal suture, $\times 8$, of second quarter of outer volution of fig. 12, one-half actual diameter 2 mm.

18. Suture of right side fourth quarter of outer volution of fig. 12, $\times 3$.

All natural size except figs. 16, 17, and 18.

Escragnolles, France; Barrémian; Coll. Mus. Comp. Zool., Cambridge.

FIGS. 19, 20. *Heinzia provincialis* (d'Orbigny) 131

Fig. 19. Dorsal suture next to outer volution across the umbilicus and opposite termination of outer volution, $\times 9$, one-half actual diameter 1.5 mm. Of same type, but more immature at the same age than in *Heinzia matura*.

20. Natural size.

Locality and collection same.

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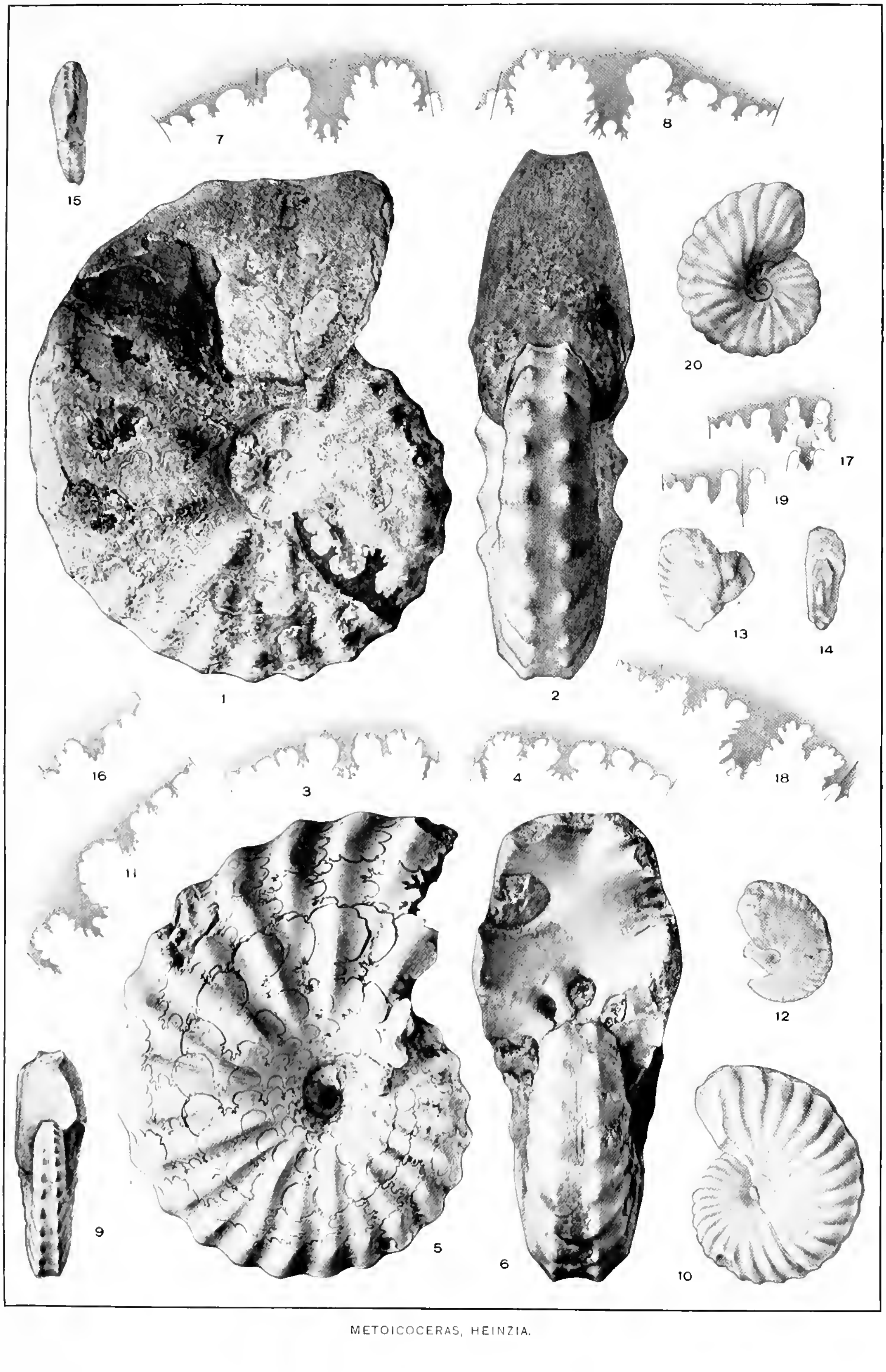
[a] No description of this species was found in the manuscript.—T. W. S.

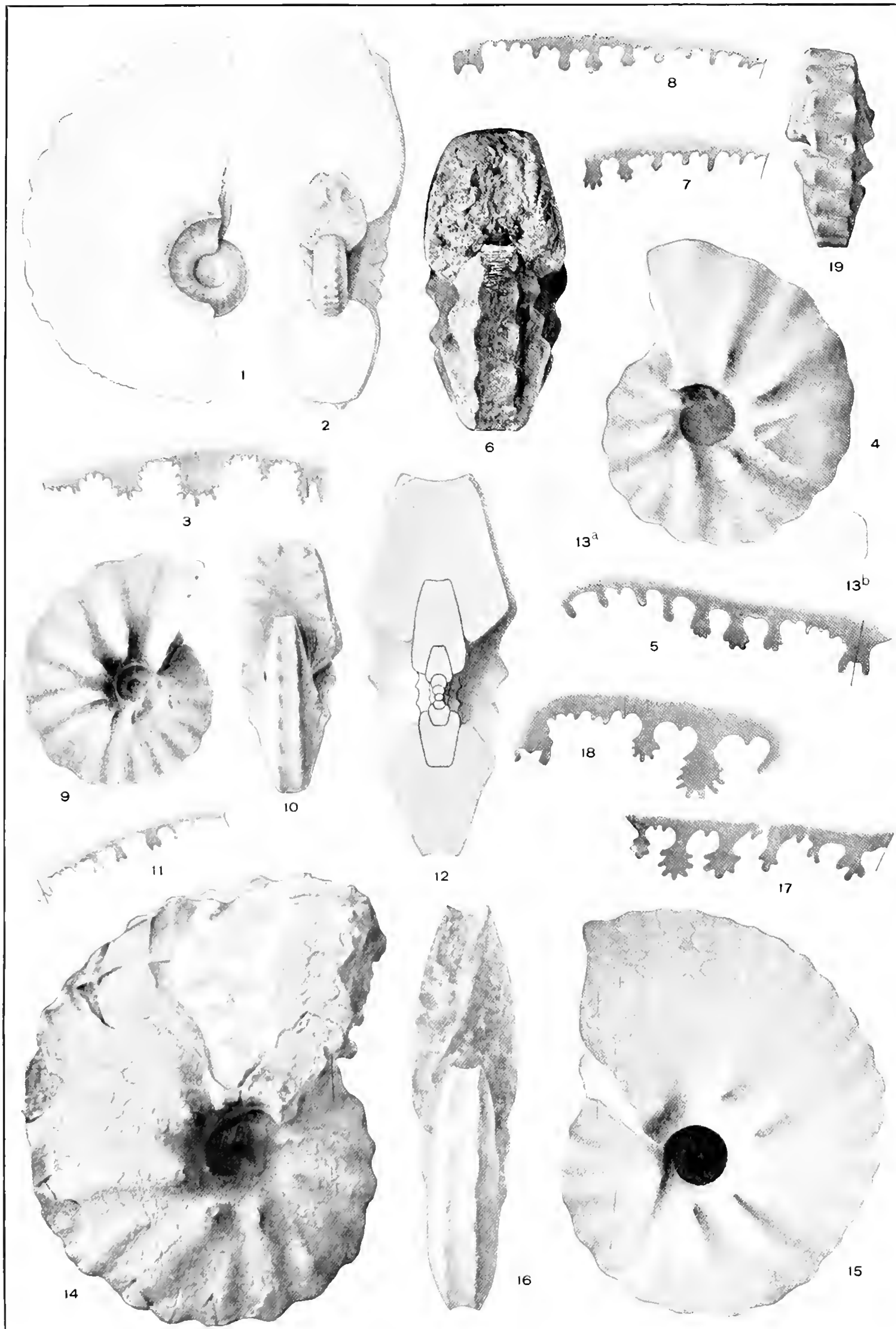


METOICOCERAS, HEINZIA.

PLATE XVI.

PLATE XVI.

Heinzia, Knemiceras.



HEINZIA, KNEMICERAS

PLATE XVII.

PLATE XVII.

Subpulchellia, Nicklesia, Pulchellia, Knemiceras. Protengonoceras.

Page.

Figs. 1–5. *Subpulchellia castellanensis* Hyatt 140

Figs. 1, 2. With shell complete on side of fig. 1.

3, 4. Same fossil, shell partly taken off. Right side of fig. 3 shows length of living chamber about one-half of last volution.

5. Lateral suture of fig. 3, × 3.

All natural size except fig. 5.

Castellanes, France; Neocomian; Coll. Mus. Comp. Zool., Cambridge.

Figs. 6–8. *Nicklesia dumasiana* (d'Orbigny) 139

Figs. 6, 7. Natural size.

8. Lateral suture, × 3.

Locality and collection same as last.

Figs. 9–12. *Pulchellia compressissima* (d'Orbigny) 142

Figs. 9–11. Natural size.

12. Suture after Nicklès, Pal. sud-est de l'Espagne, pl. 3, fig. 1b, × 5.

Locality and collection the same.

Figs. 13–15. *Knemiceras attenuatum* (Hyatt) 151

Figs. 13, 14. Natural size; shows living chamber nearly three-fourths of a volution.

15. Suture, × 2.

Celendin, Peru; Cenomanian?

Figs. 16–20. *Protengonoceras gabbi* (Böhm) 153

Fig. 16. Shows living chamber to have one-half a volution in length. Shell is preserved on the living chamber.

17. Section shows the concave venter with lateral ridges at an early stage.

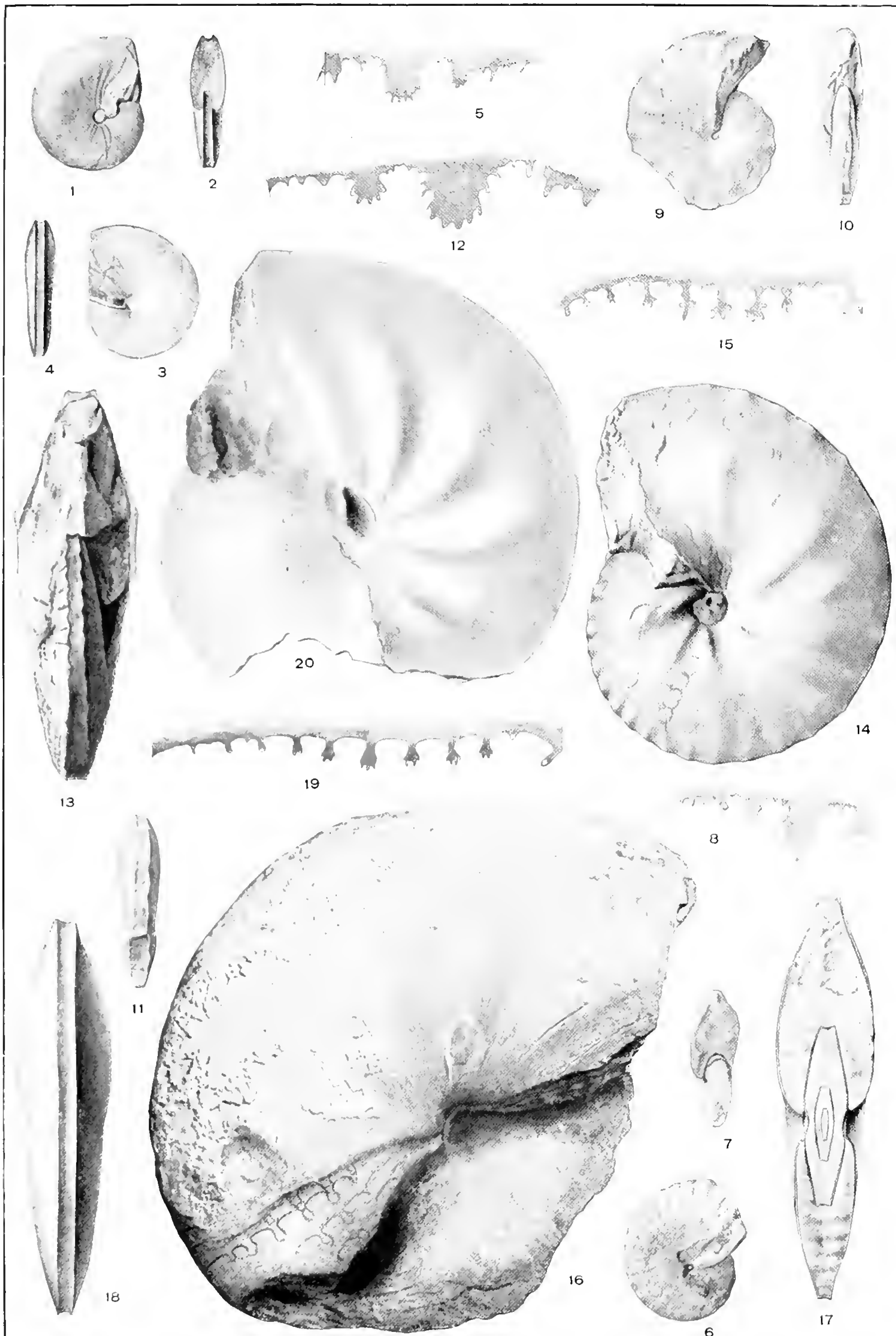
18. Ventral view of same.

19. Septum of same, × 2.

All natural size except the last, and all in Coll. Mus. Comp. Zool., Cambridge.

20. Specimen in Coll. Acad. Nat. Sci. Phila. Showing living chamber one-half of a volution, part of aperture on right side, and old-age folds.

Arivechi, Sonora, Mexico.



SUBPULCHELLIA NICKLESIA PULCHELLIA, KNEMICERAS, PROTENGONOCERAS.

PLATE XVIII.

PLATE XVIII.

KNEMICERAS, ENGONOCERAS, PROTENGONOCERAS.

Page

FIGS. 1–3. *Knemiceras gabbi* Hyatt 152

Figs. 1, 2. Natural size. (After Gabb.)

3. Lateral suture enlarged. (After Gabb.)

Quebrada de Huari, Peru; Cenomanian?

FIGS. 4, 5. *Engonoceras belviderense* (Cragin) 158

Figs. 4, 5. Lateral and ventral views.

Belvidere, Kans.; Washita epoch; Coll. Cragin, Colorado College.

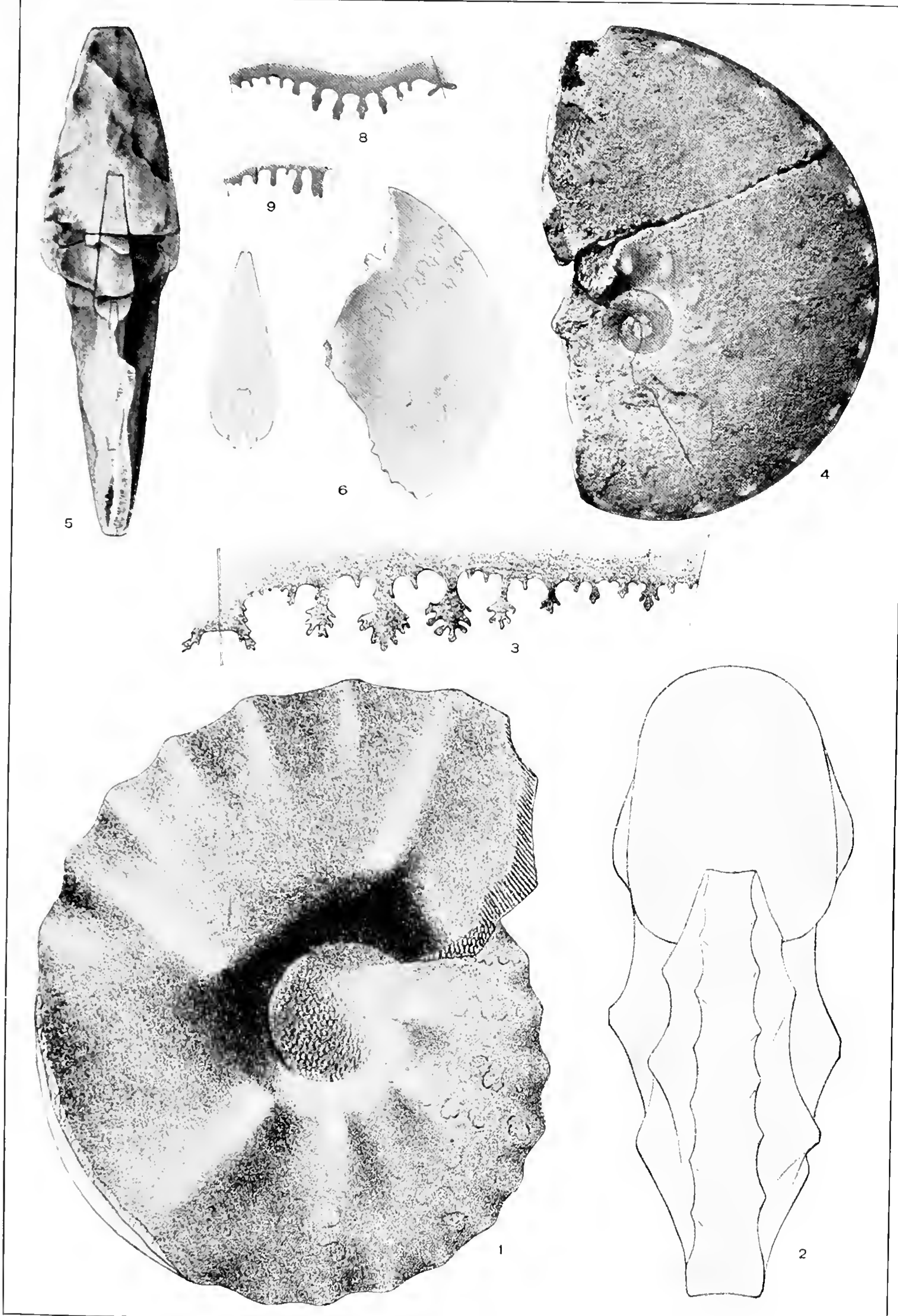
FIGS. 6–9. *Protengonoceras planum* Hyatt 156

Figs. 6, 7. Lateral and ventral views, × 2.

8. Lateral suture, × 2; the auxiliary saddles Nos. 8 to 10 should be a trifle broader.

9. Dorsal suture of the same age, × 2.

Texas, my collection.



KNEMICERAS, ENGONOCERAS, PROTENGONOCERAS.

PLATE XIX.

PLATE XIX.

Engonoceras.

Page.

Figs. 1–6. *Engonoceras uddeni* (Cragin) 159

Figs. 1, 2. Type specimen from near Lindsborg, Kans., natural size.

3. Lateral suture of same, slightly enlarged.

4, 5. Specimen from McPherson County, Kans. Natural size, showing living chamber probably almost complete along the umbilical shoulder and about one-half of a volution in length. The crease on the side of the venter of fig. 5 is an accident due to compression. Coll. U. S. Nat. Mus.

6. Lateral suture of opposite or left side, $\times 2\frac{1}{2}$. The curvature is somewhat less than it is on the specimen.

Kiowa shales, Comanche series, Lower Cretaceous; my collection.

Figs. 7–14. *Engonoceras serpentinum* (Cragin) 162

Figs. 7, 8. Natural size, living chamber one-half of a volution probably nearly complete on umbilical shoulder. The venter of inner volution of fig. 8 is decidedly concave.

9. Lateral suture, $\times 2$.

10. Part of sutures of young fragment, $\times 2$. This specimen is from near Denison, Tex.

11. Variety with broad ends to the costæ and crowded peculiar sutures.

12. Lateral sutures, $\times 2$.

13. Ventral view of cast, with similar costæ.

14. Suture of same more like those of fig. 9. This is not due to difference of age. The last 5 and half of sixth saddle are dorsal.

Four and one-half miles northeast of Gainesville, Tex., Denison; Washita epoch; Coll. U. S. Geol. Survey.

Figs. 15–17. *Engonoceras retardum* Hyatt [a] 160

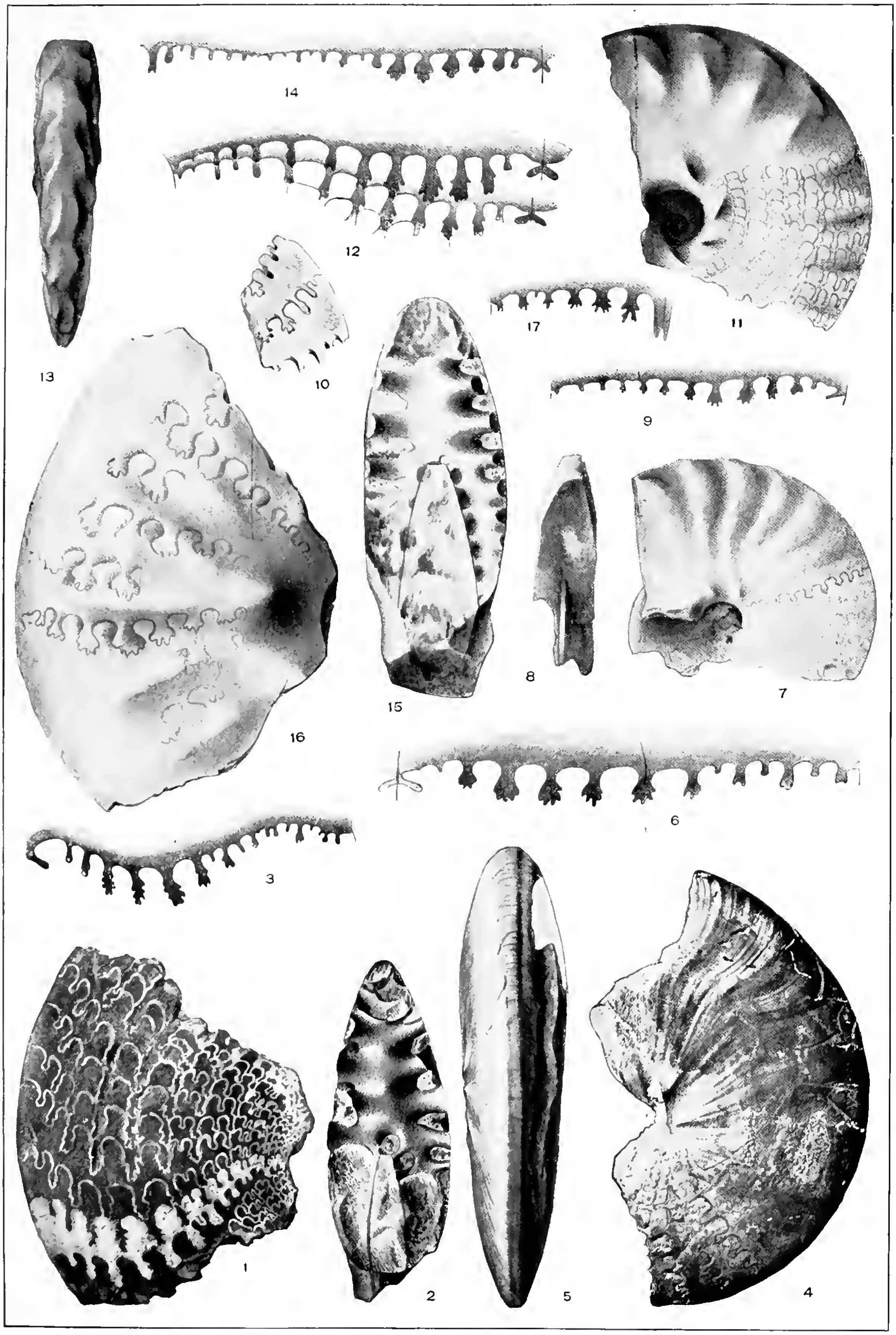
Fig. 15. Natural size, showing the late age at which the venter remains angulated, flat, and without tubercles. The rounded venter of the older stage is in part due to abrasion.

16. Shows what was seen of the lateral sutures.

17. Dorsal suture of same age as oldest suture on fig. 16.

Near Pottsboro, Tex.; Upper Comanche (Grayson). Washita epoch; Coll. U. S. Geol. Survey.

[a] The specimen here figured as *E. retardum* is described as *E. uddeni* on page 160.—T. W. S.



ENGONOCERAS

PLATE XX.

PLATE XX.

Engonoceras.

Page.

Figs. 1–5. *Engonoceras serpentinum* (Cragin) 162

Fig. 1. Suture showing all of one side, part of the other and dorsal suture, × 2.

2, 3, 4. Three views of one of Cragin's figured types.

5. Suture of same, × 2.

Near Denison; Washita epoch; Coll. Cragin, Colorado College.

Figs. 6–13. *Engonoceras pierdenale* (von Buch) 165

Figs. 6, 7. Specimen from Towash, Tex.; Coll. Mus. Comp. Zool., Cambridge.

8. Suture of same, × 2.

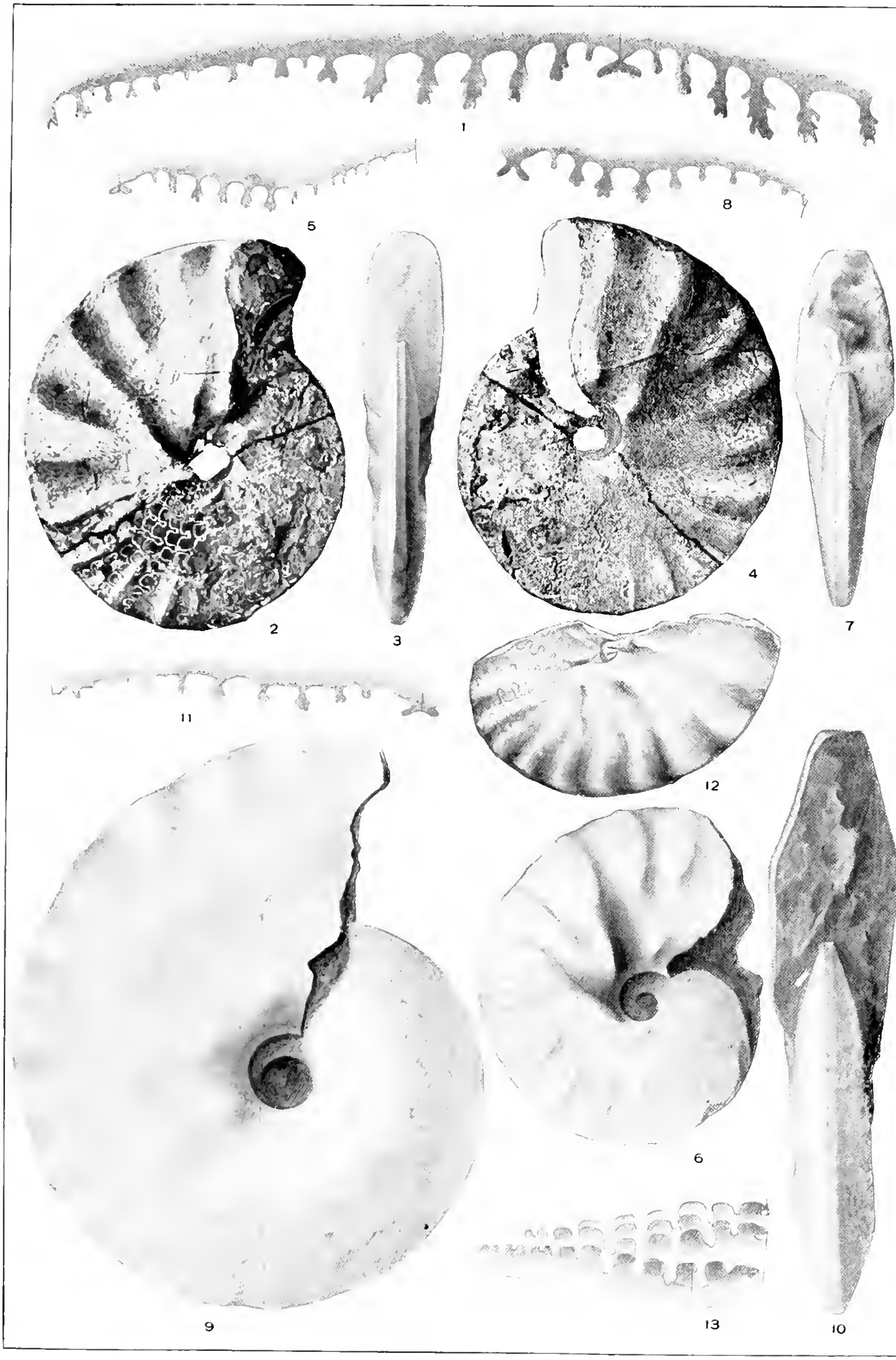
9, 10. Specimen from near Cerrogordo, Ark.; Coll. U. S. Nat. Mus., No. 22643.

11. Suture of same, natural size.

12. Specimen from Seven Knobs, 5 miles southeast of Glenrose, Tex.

13. Suture of same, × 2.

Fredericksburg group, Comanche series.

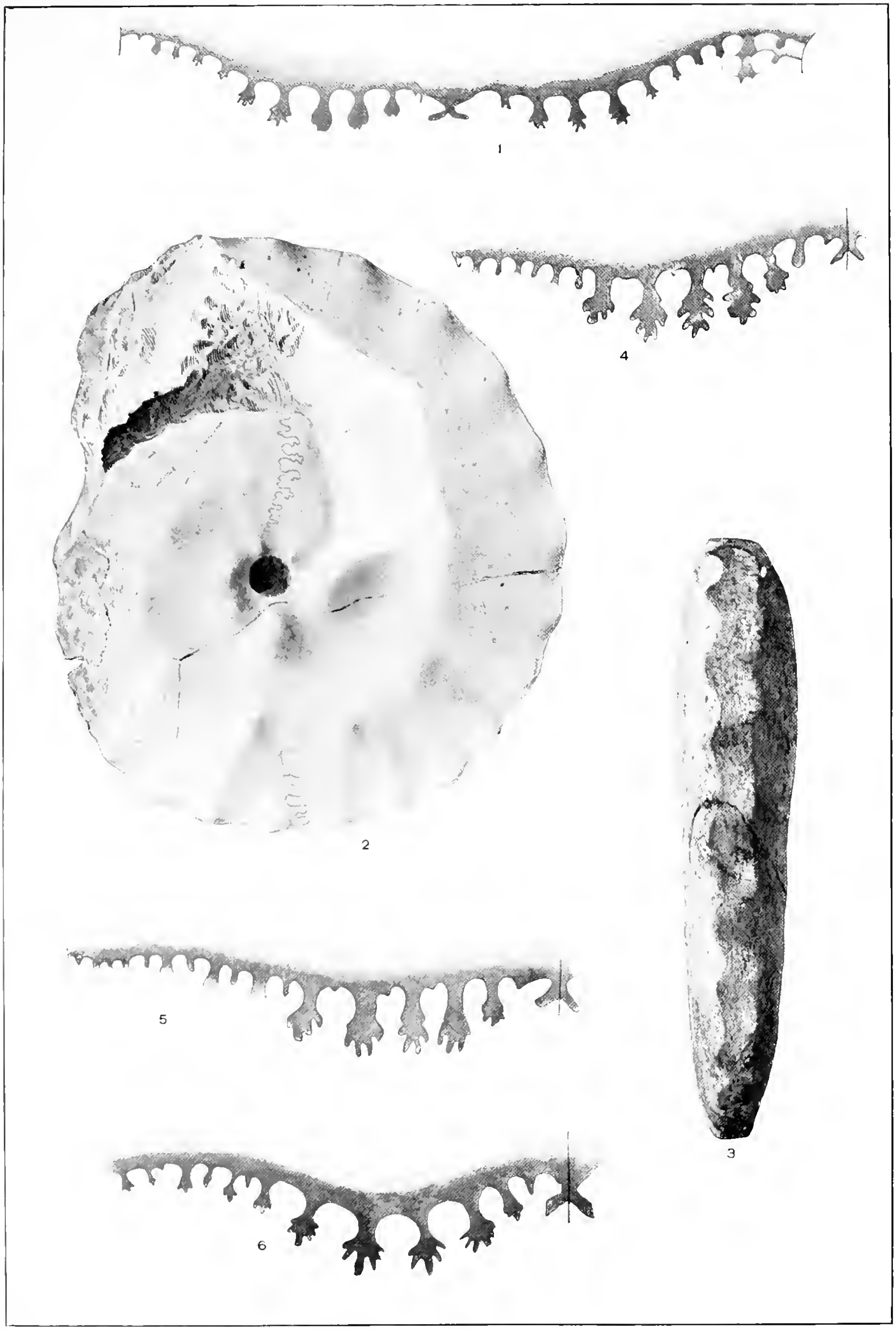


ENGONOCERAS.

PLATE XXI.

PLATE XXI.

Engonoceras.



ENGONOCERAS.

PLATE XXII.

PLATE XXII.

Engonoceras.

Page.

Figs. 1–5. *Engonoceras subjectum* Hyatt 168

Fig. 1. Specimen from Duck Creek beds, near Denison, Tex.; Coll. U. S. Geol. Surv.

2. Suture of same, very slightly abraded, × 2.
3. Specimen from Grayson, Tex.; Coll. D. S. Martin.
4. Suture of same, × 2.
5. Suture of specimen from Tarrant County, Tex.; Coll. Cragin, Colorado College.

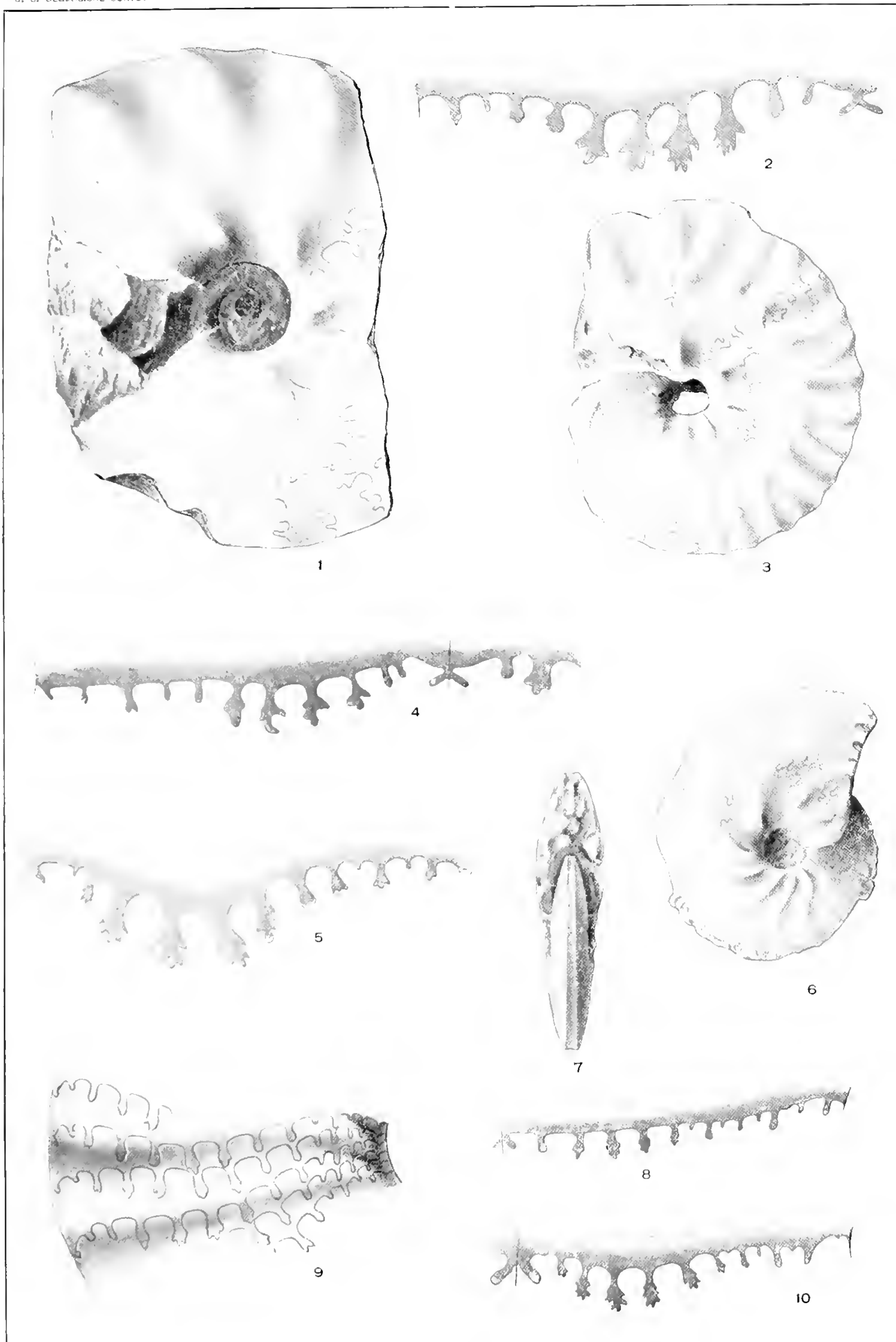
Washita (?) group, Comanche series.

Figs. 6–10. *Engonoceras gibbosum* Hyatt 171

Fig. 6. Lateral view of a small specimen from Goodland limestone, 15 miles west of Denison; Coll. U. S. Geol. Surv.

7. Ventral view of same, partly restored.
8. Septum of same, × 2.
9. Fragment doubtfully referred to the species, from Bell County, Tex.; Coll. U. S. Nat. Mus., No. 8301a, × 2.
10. Septum of same, partly restored, × 2.

Fredericksburg group, Comanche series.



ENGONOCERAS.

PLATE XXIII.

PLATE XXIII.

Engonoceras.

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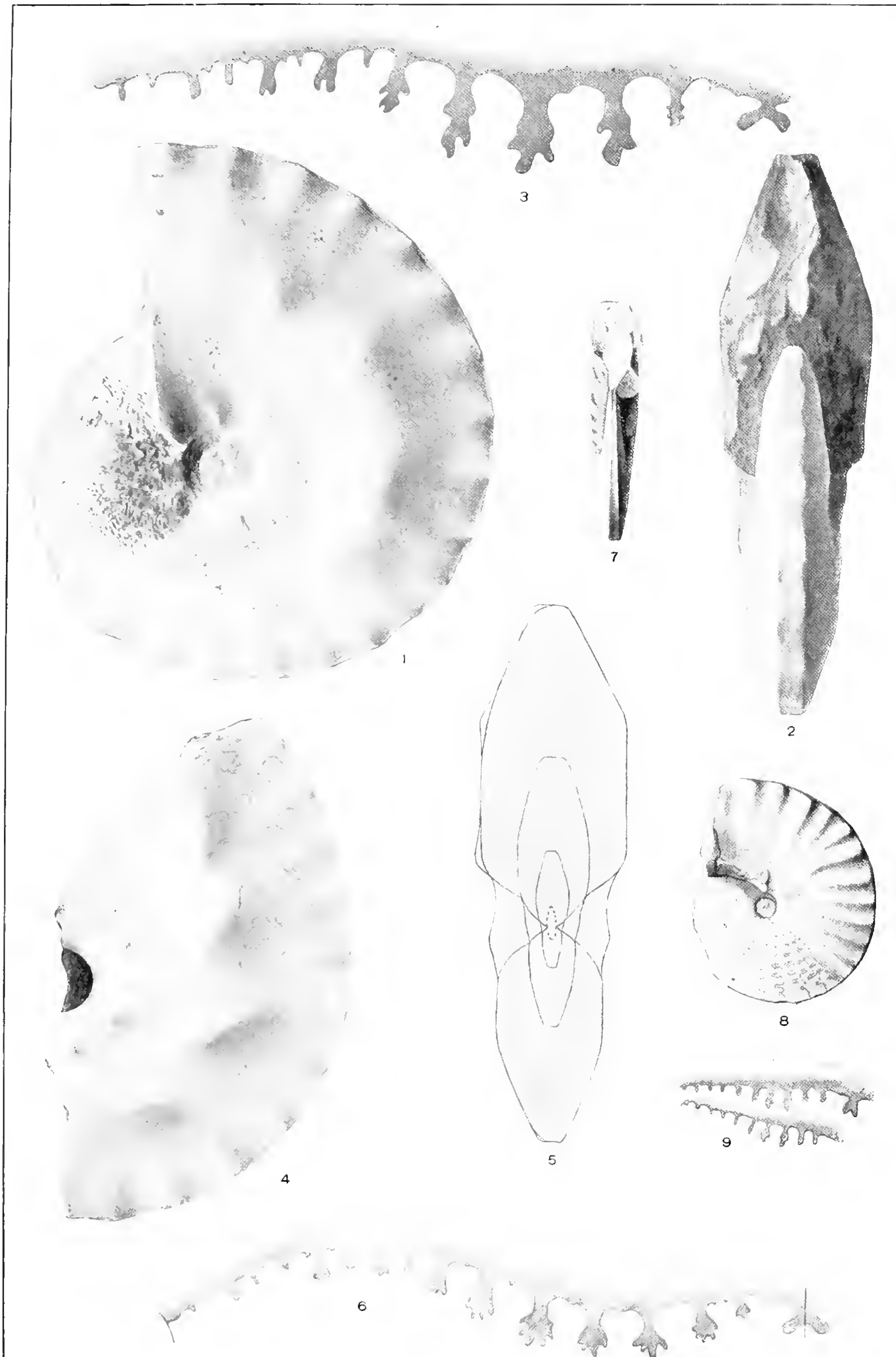
Figs. 1–6. *Engonoceras gibbosum* Hyatt		171
	Figs. 1, 2. Specimen from Cook County, Tex.; my collection.	
	3. Suture of same, × 2.	
	4, 5. A fragment from the Goodland limestone, 15 miles southwest of Gainesville, Tex.	
	6. Suture of same, × 2.	
	Fredericksburg group, Comanche series.	
Figs. 7–9. *Engonoceras stolleyi* Böhm		175
	Figs. 7, 8. Young specimen in Cragin Collection, Colorado College.	
	9. Suture of same, × 2.	
	Fredericksburg group [?], Comanche series.	



ENGONOCERAS.

PLATE XXIV.

PLATE XXIV.

ENGONOCERAS.

Figs. 1, 2. Specimen in my collection, partly restored.

3, 4. Specimen in Coll. Hill, U. S. Geol. Surv. ["Hill 4a."] (?)

5. Suture of same, × 2. This is somewhat worn down.

Fredericksburg group [?], Comanche series.

Figs. 6, 7. Type specimen from near Austin, Tex. Coll. Hill, U. S. Geol. Surv.

8. Suture of same, × 2.

Comanche Peak limestone of Fredericksburg group, Comanche series.

ENGONOCERAS.

PLATE XXV.

PLATE XXV.

NEOLOBITES, METENGONOCERAS.

		Page.
FIGS. 1–4.	*Neolobites choffati* Hyatt	178

FIGS. 1, 2. Copies of Choffat's figures 3a, 3b, published as *N. vibrayeanus*.

3, 4. Suture of probably the same species (after Choffat).

Cenomanian; Portugal.

FIGS. 5–9.	*Metengonoceras inscriptum* Hyatt	180

FIG. 5. Section of fragmentary specimen from west of Walnut Springs, Texas· Coll. Cragin, Colorado College.

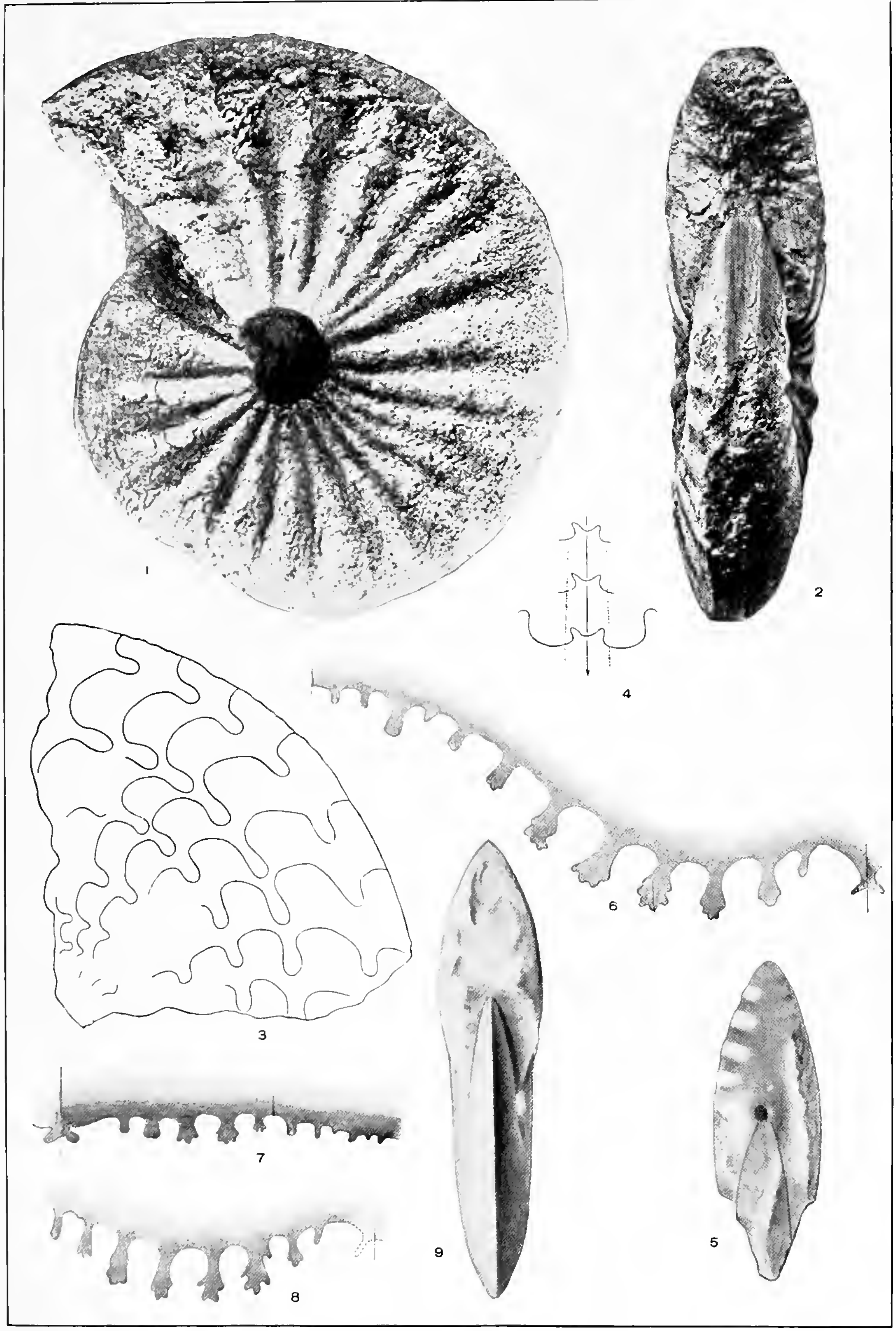
6. Suture of same, enlarged.

7. Suture of a small fragmentary specimen from 12 miles northwest of Decatur, Tex.; Coll. U. S. Geol. Surv.

8. Suture of fragment from 15 miles west of Denison, Tex.; Coll. U. S. Geol. Surv.

9. Ventral view, partly restored, of specimen from 12 miles northeast of Decatur, Tex. For other figures see Pl. XXVI.

Fredericksburg group, Comanche series.



NEOLOBITES, METENGONOCERAS.

PLATE XXVI.

PLATE XXVI.

METENGONOCERAS.

Page.

FIGS. 1–4. *Metengonoceras inscriptum* Hyatt.. 180

Fig. 1. Enlarged suture of specimen represented by figs. 2 and 3, and by Pl. XXV, fig. 9.

2, 3. Specimen from 12 miles northeast of Decatur, Tex.

4. Suture of large fragment from 9 miles from Austin, on Beecaves road. Coll. U. S. Geol. Surv. [This drawing was labeled *M. ambiguum*, but the specimen is described under *M. inscriptum*.—T. W. S.]

Fredericksburg group, Comanche series.

FIGS. 5–7. *Metengonoceras ambiguum* Hyatt.. 183

Fig. 5. Side view of type.

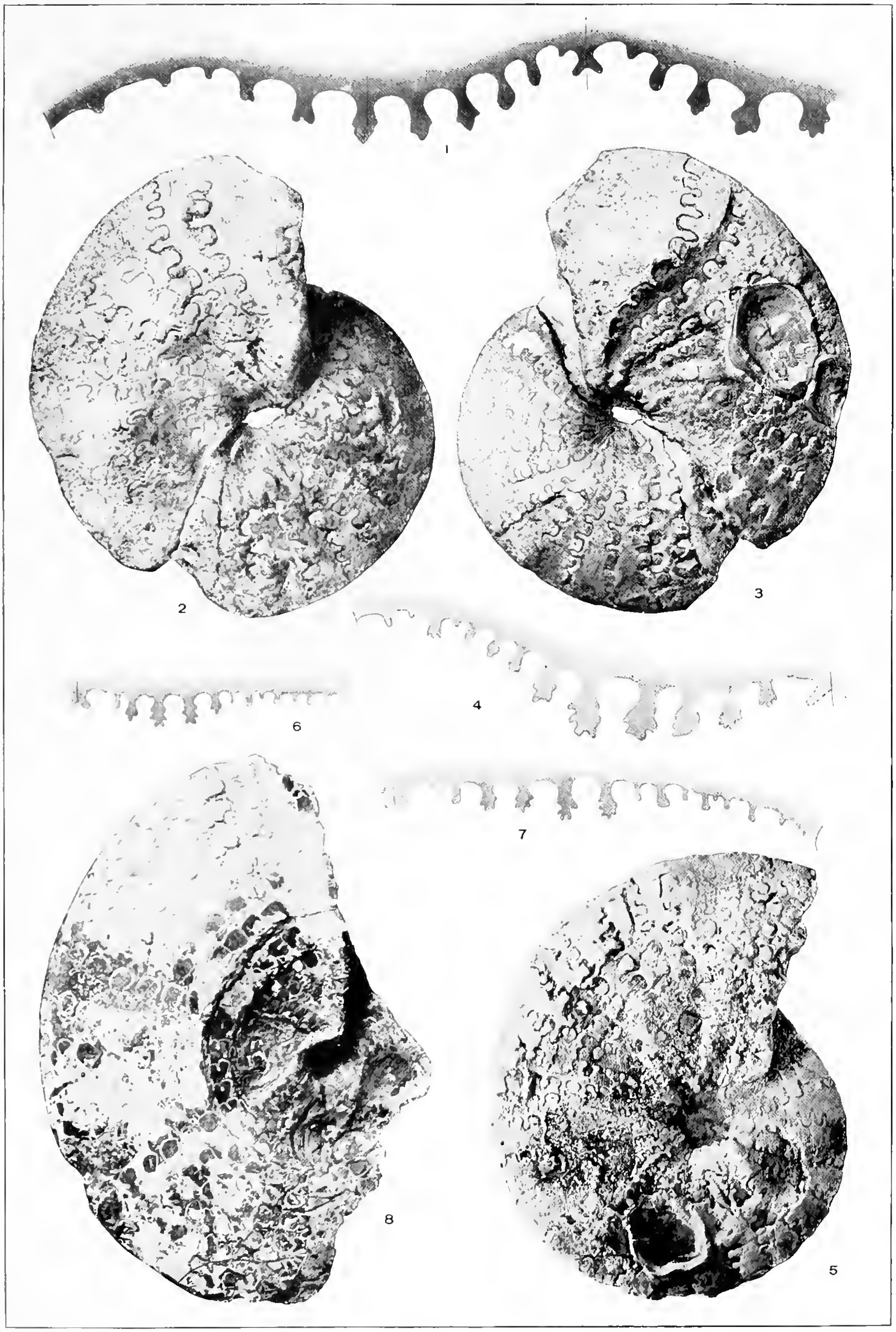
6, 7. Suture of same specimen, × 2.

Nine miles from Austin, on Beecaves road; Fredericksburg group, Comanche Peak limestone, Comanche series. Coll. U. S. Geol. Surv.

FIG. 8. *Metengonoceras acutum* Hyatt.. 184

Side view of fragmentary type specimen.

Elm Fork, Dallas County, Tex.; probably Eagle Ford shales, Upper Cretaceous. Coll. Mus. Comp. Zool., Cambridge.

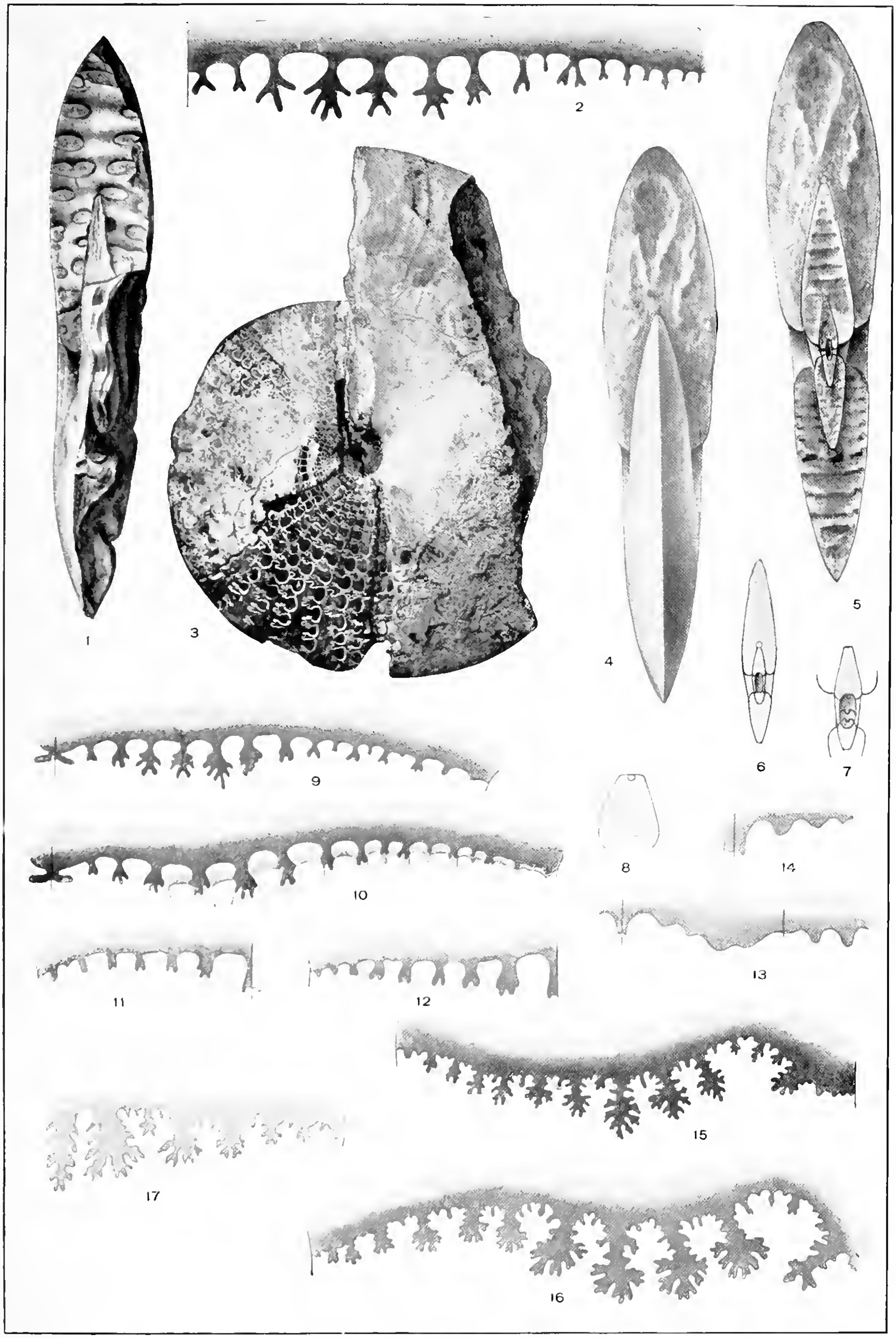


METENGONOCERAS

PLATE XXVII.

PLATE XXVII.

METENGONOCERAS, PLACENTICERAS.



METENGONOCERAS PLACENTICERAS

PLATE XXVIII.

PLATE XXVIII.

Placenticeras syrtale (Morton).

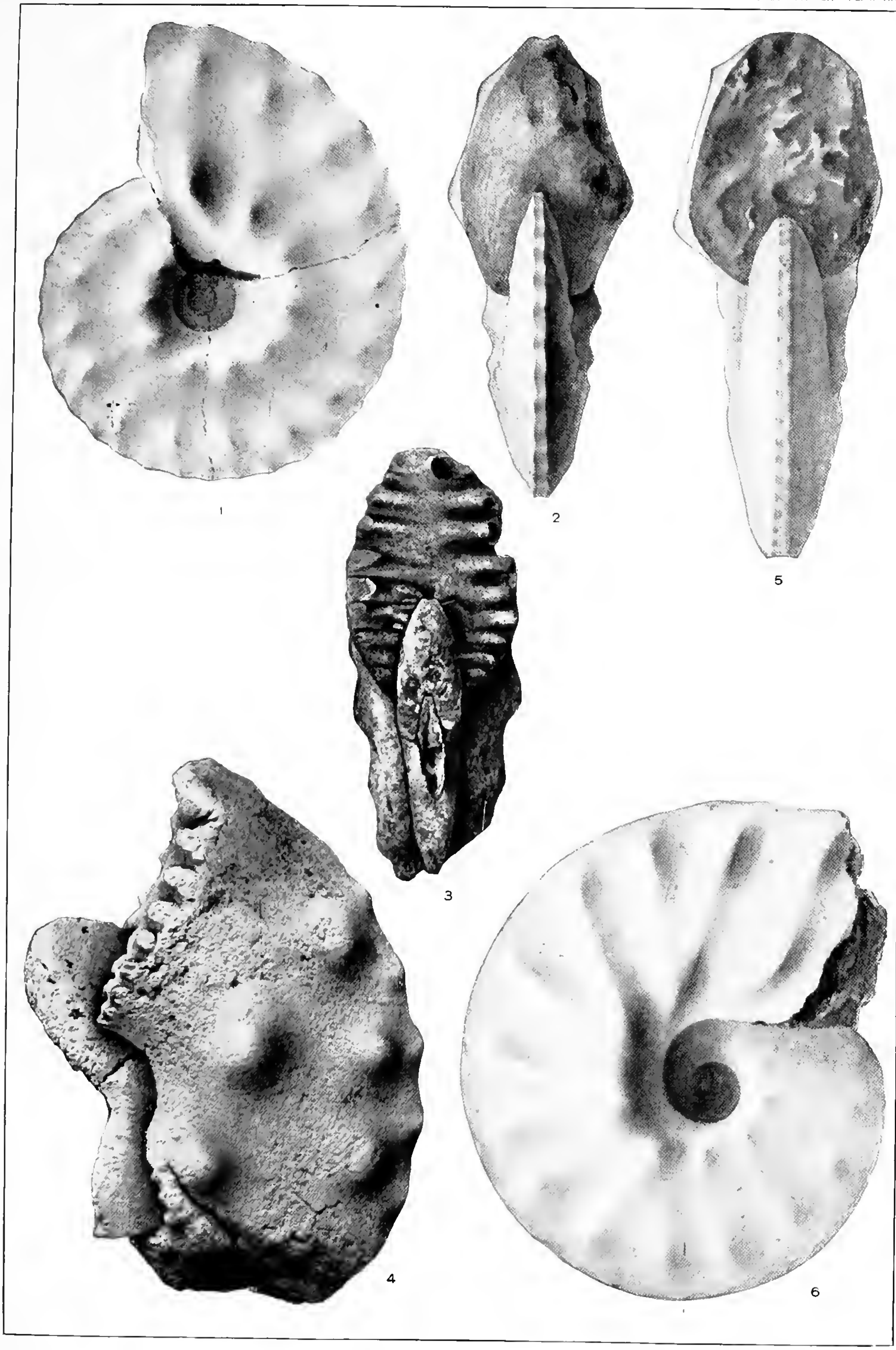
(Page 205.)

Figs. 1, 2. Two views of the type, Coll. Acad. Nat. Sci. Phila. (For suture, see Pl. XXVII, fig. 15.)

3, 4. Type of var. *halei*, Bost. Soc. Nat. Hist., No. 8577. (For suture, see Pl. XXVII, figs. 16 and 17.)

5, 6. Another specimen of var. *halei*, same collection.

Eutaw beds (?), Upper Cretaceous, Greene County, Ala.



PLACENTICERAS.

PLATE XXIX.

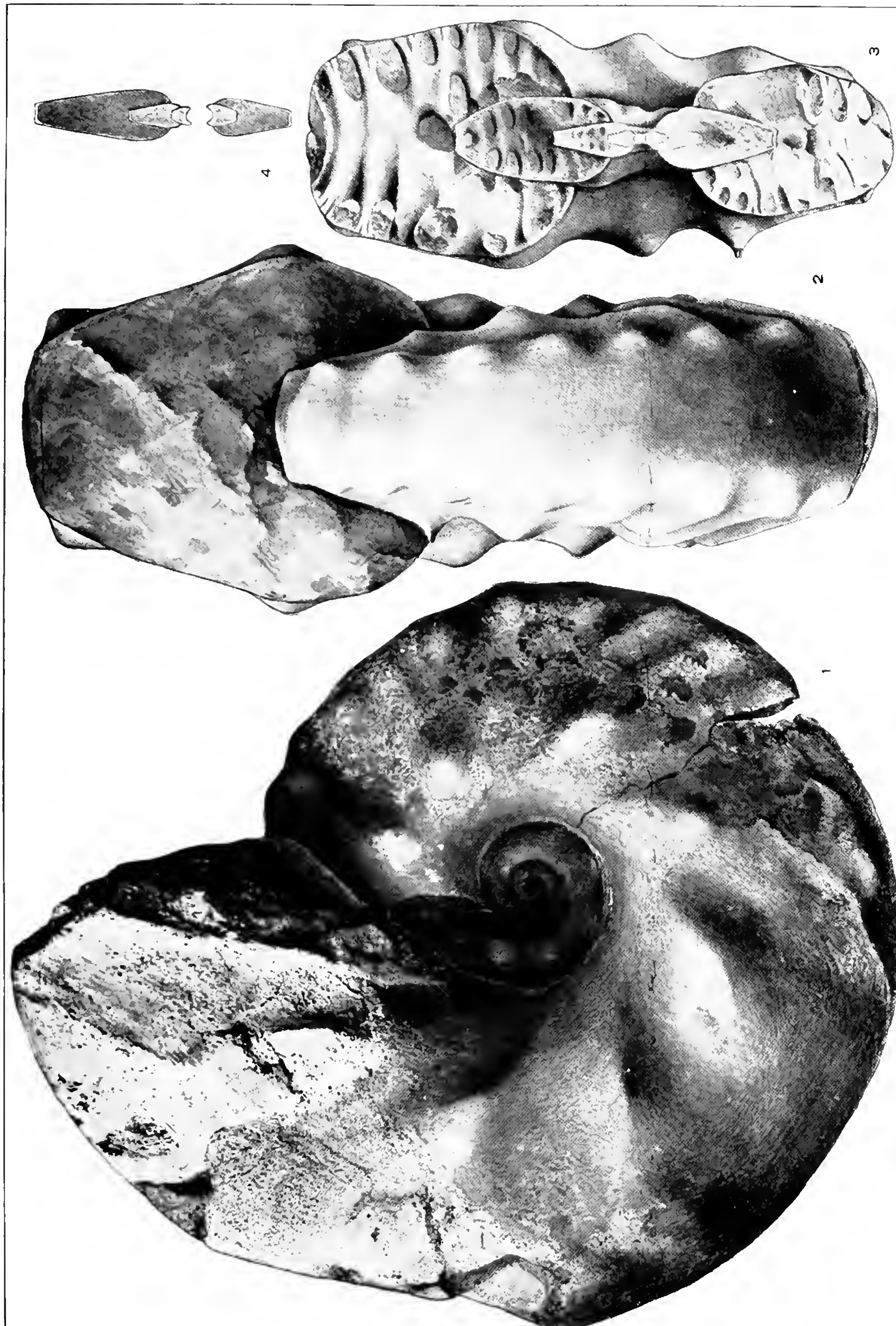
PLATE XXIX.

Placenticeras guadalupæ (Roemer).

(Page 197.)

Fig. 1. Lateral view of a large specimen.
2. Aperture view of same considerably restored.
3. Section of same.
4. Enlarged section of inner whorls of same.

Near Fort Worth, Tex.; Taylor beds (?); Upper Cretaceous; my collection.



PLACENTICERAS.

PLATE XXX.

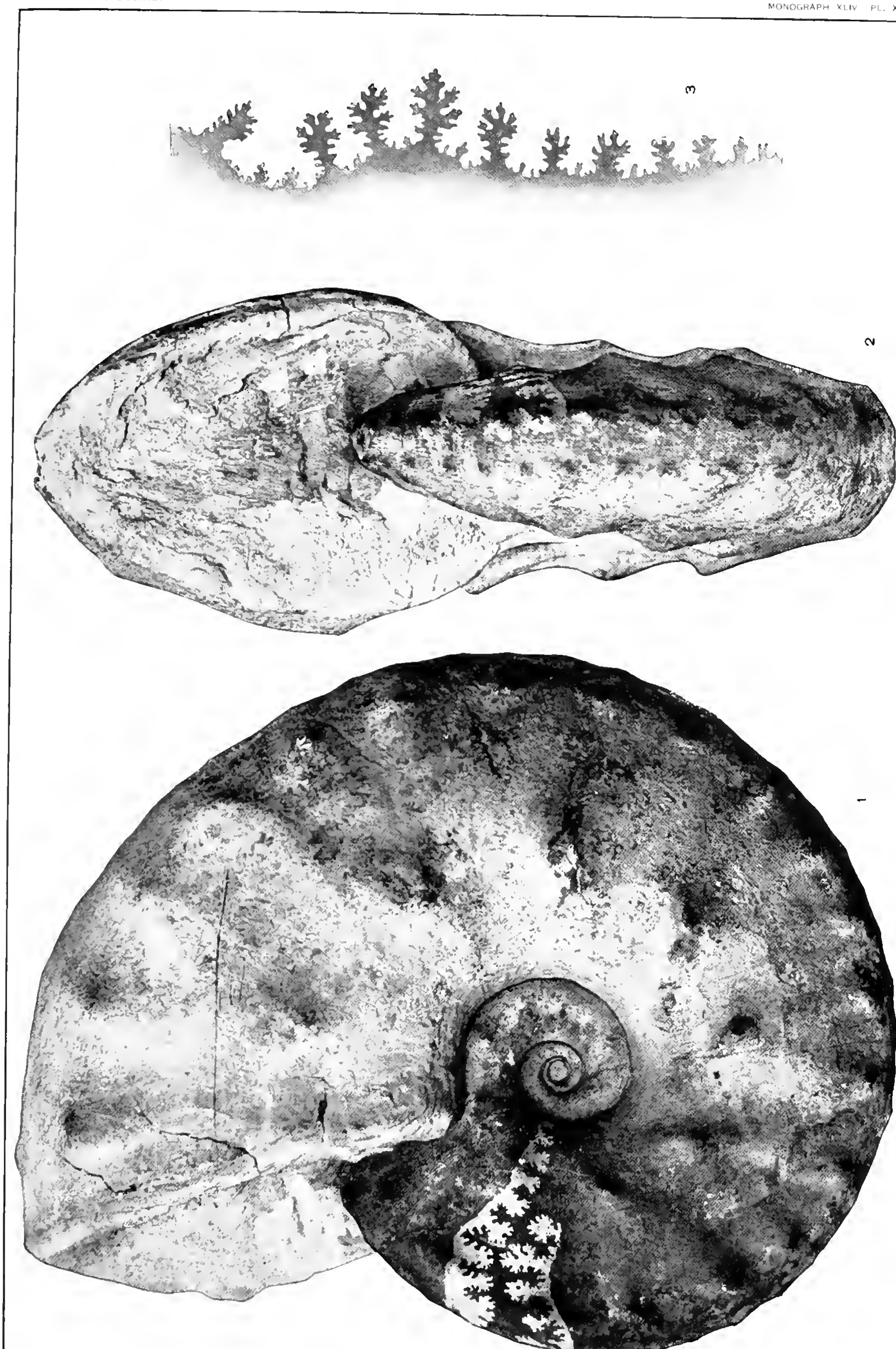
PLATE XXX.

PLACENTICERAS SANCARLOSENSE Hyatt.

(Page 200.)

Fig. 1. Side view of an average-sized specimen
2. Aperture view of same.
3. Suture of same, × 2.

San Carlos, Presidio County, Tex.; San Carlos beds; Upper Cretaceous; Coll. U. S. Geol. Surv.



PLACENTICERAS

PLATE XXXI.

PLATE XXXI.

Placenticeras.

Page.

Figs. 1, 2. *Placenticeras sancarlosense* Hyatt 200

Fig. 1. Section of a small specimen—"passage form between this species and guadalupæ."

2. Side view of same.

San Carlos, Presidio County, Tex.; San Carlos beds, Upper Cretaceous; Coll. U. S. Geol. Surv.

Figs. 3–5. *Placenticeras newberryi* Hyatt 203

Fig. 3. Side view of the type specimen.

4. Section of same.

5. Aperture view of same.

Near Presidio Del Norte, Chihuahua, Mexico; San Carlos beds, Upper Cretaceous; Coll. Columbia University, No. 10073G.

PLACENTICERAS

PLATE XXXII.

PLATE XXXII.

PLACENTICERAS SANCARLOSENSE var. PSEUDOSYRTALE Hyatt.

(Page 200.)

Side view of type of variety (see Pl. XXXIII, fig. 1).
Near Fort Worth, Tex.; Taylor beds (?), Upper Cretaceous; my collection.

PLACENTICERAS

PLATE XXXIII.

PLATE XXXIII.

PLACENTICERAS.

Page.

FIG. 1. *Placenticeras sancarlosense* var. *pseudosyrtale* Hyatt 200

Fig. 1. Aperture view of specimen figured on Pl. XXXII.

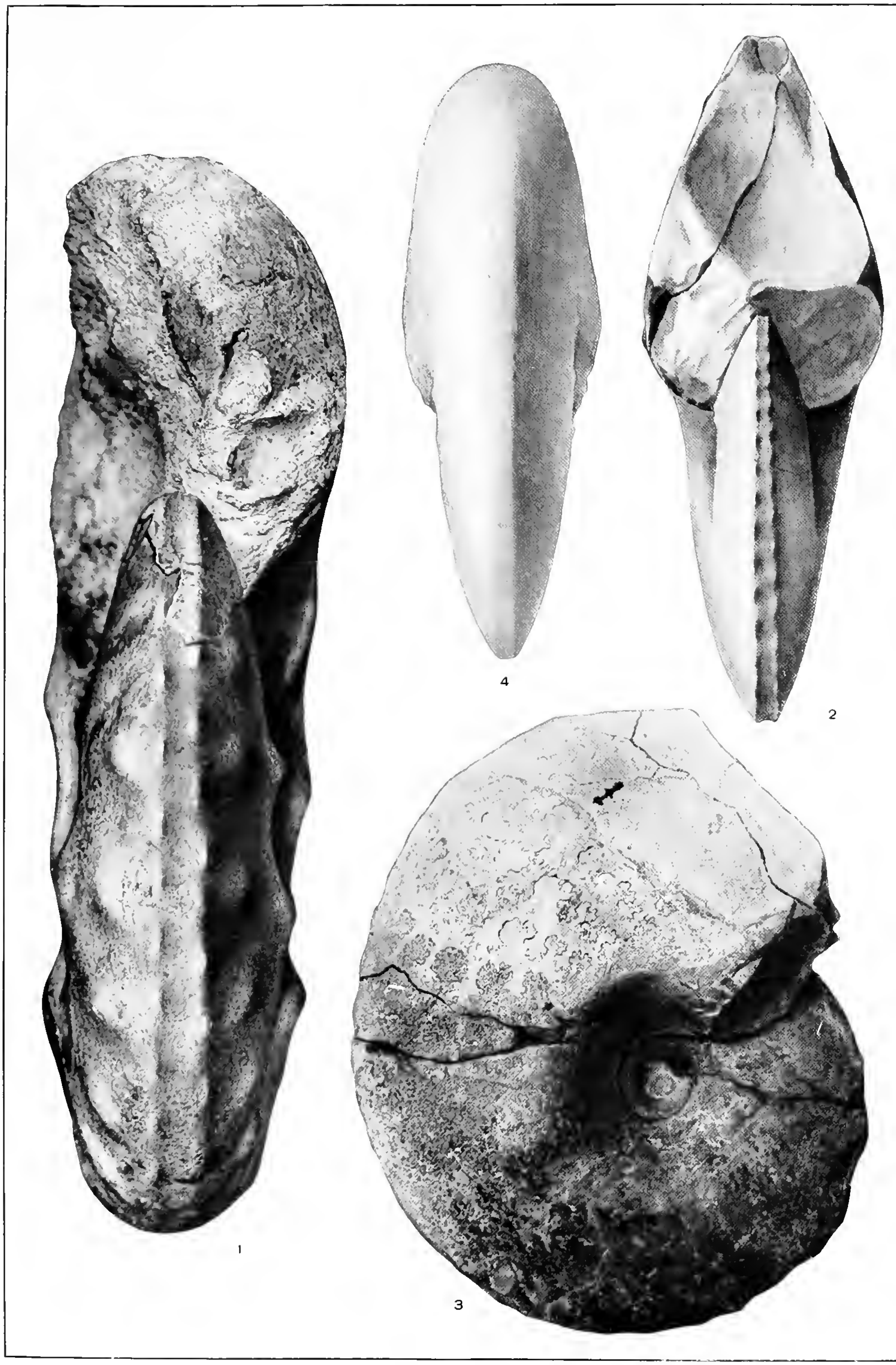
FIGS. 2–4. *Placenticeras planum* Hyatt 202

Fig. 2. Aperture view of medium-sized specimen partly restored.

3. Side view of same.

4. Peripheral view of another specimen showing less development of nodes. (See Pl. XXXIV, fig. 1.)

San Carlos, Presidio County, Tex.; San Carlos beds, Upper Cretaceous; Coll. U. S. Geol. Survey.



PLACENTICERAS.

PLATE XXXIV.

PLATE XXXIV.

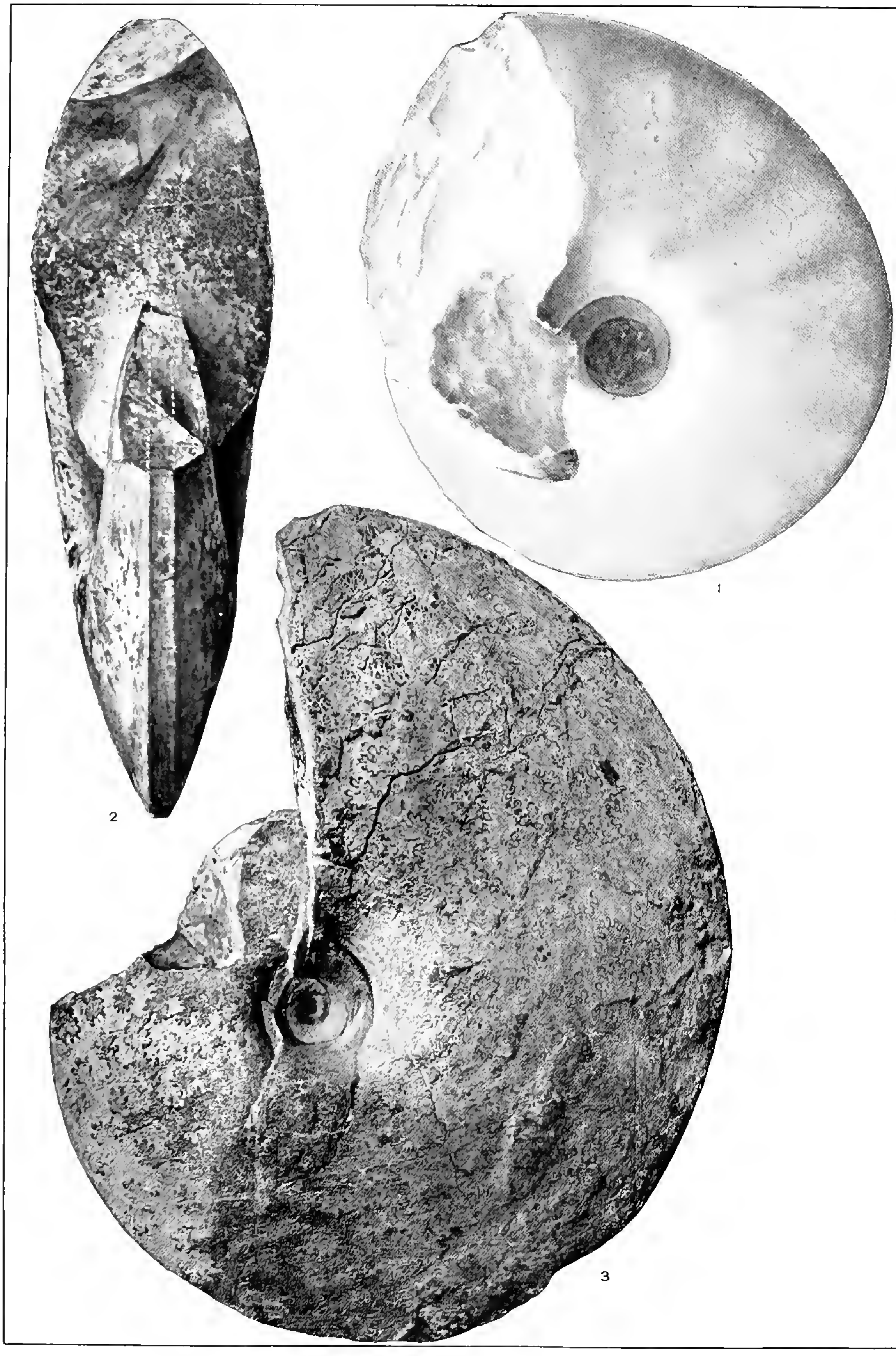
Placenticeras planum Hyatt.

(Page 202.)

Fig. 1. Side view of the small specimen represented by Pl. XXXIII, fig. 4.

2, 3. Aperture and side views of a larger specimen.

San Carlos, Presidio County, Tex.; San Carlos beds, Upper Cretaceous; Coll. U. S. Geol. Survey.



PLACENTICERAS.

PLATE XXXV.

PLATE XXXV.

Placenticeras intercalare Meek.

(Page 207.)

Figs. 1, 2. Side and aperture views of medium specimen (see Pl. XXXVI, fig. 1). [Black Hills?], Fort Pierre, Upper Cretaceous; Coll. Yale University No. 1863.

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1

PLACENTICERAS

PLATE XXXVI.

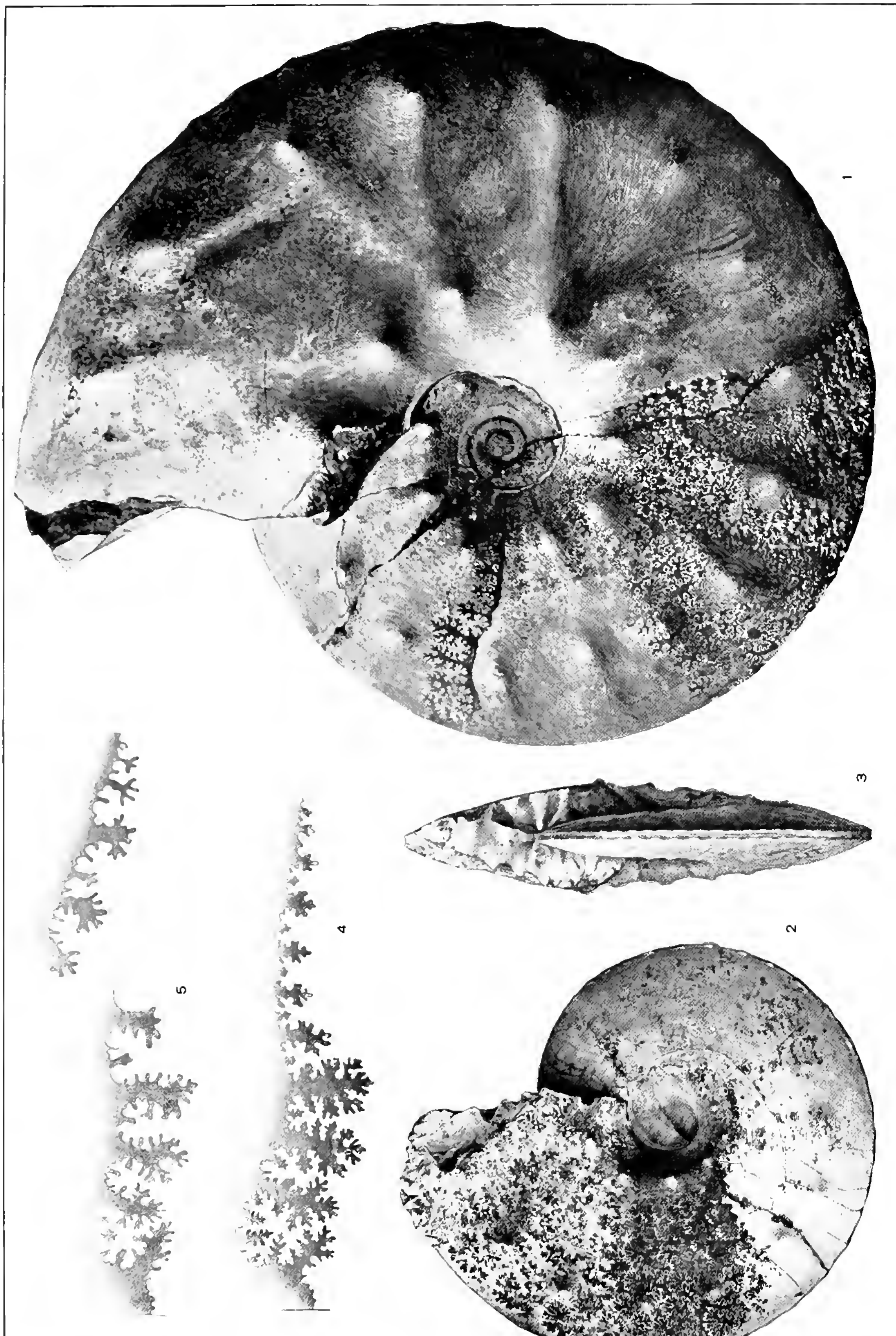
PLATE XXXVI.

Placenticeras intercalare Meek.

(Page 207.)

Fig. 1. Opposite side of specimen figured on Pl. XXXV.
2, 3. Side and aperture views of small specimen, No. 2104b.
4. Suture of same, × 2.
5. Parts of two septa of Geological Survey specimen from Harper, Wyo., represented by Pl. XXXVII, figs. 1, 2.

Fort Pierre, Upper Cretaceous, Coll. Yale University (except fig. 5).



PLACENTICERAS.

PLATE XXXVII.

PLATE XXXVII.

Placenticeras intercalare Meek.

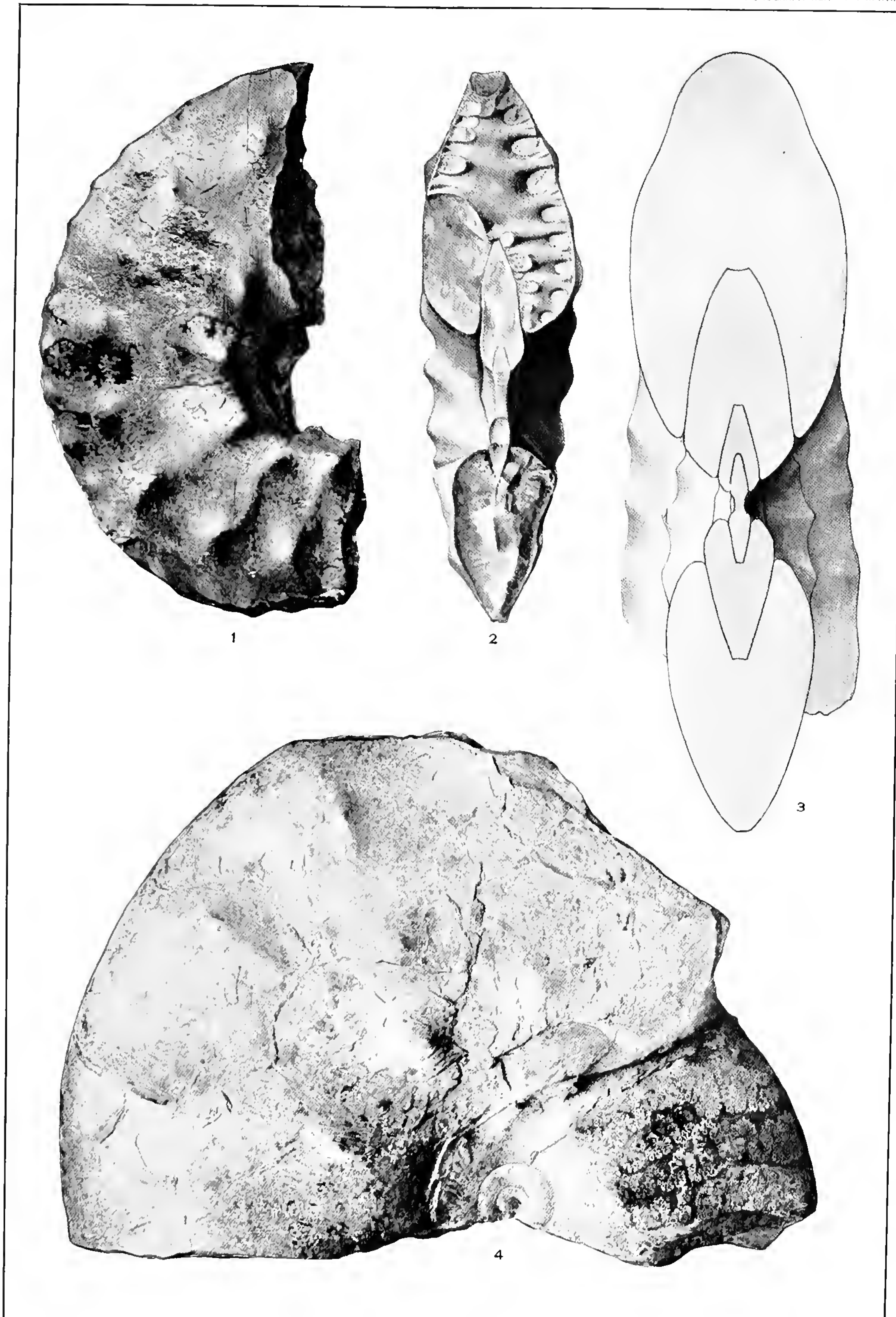
(Page 207.)

Figs. 1, 2. Fragmentary small specimen from near Harper, Laramie Plains, Wyo.; Coll. U. S. Geol. Survey. (See Pl. XXXVI, fig. 5.)

3. Section of specimen "approximating to some varieties of *P. stantoni*," from Ponil Canyon, New Mex.; Coll. U. S. Nat. Mus., No. 9735.

4. Side view of same specimen. (For suture, see Pl. XXXVIII, fig. 1.)

Montana group, Upper Cretaceous.



PLACENTICERAS.

PLATE XXXVIII.

PLATE XXXVIII.

PLACENTICERAS.

Page.

FIG. 1. *Placenticeras intercalare* Meek 207

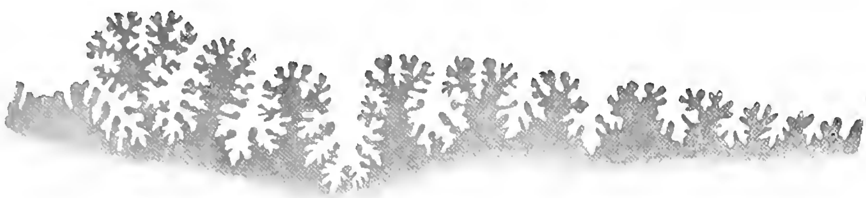
Suture of specimen from near Harper, Wyo. (See Pl. XXXVII.)

Montana group, Upper Cretaceous.

FIG. 2. *Placenticeras intercalare* var. *costatum* Hyatt 207

Side view of type of variety, my collection, purchased from Ward. Probably from Black Hills, S. Dak.

Montana group, Upper Cretaceous.



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PLACENTICERAS.

PLATE XXXIX.

PLATE XXXIX.

PLACENTICERAS.

Page.

FIGS. 1, 2. *Placenticeras intercalare* var. *costatum* Hyatt 207

Figs. 1, 2. Aperture view and suture of specimen represented by Pl. XXXVIII, fig. 2.

FIGS. 3–6. *Placenticeras placenta* (Dekay) 211

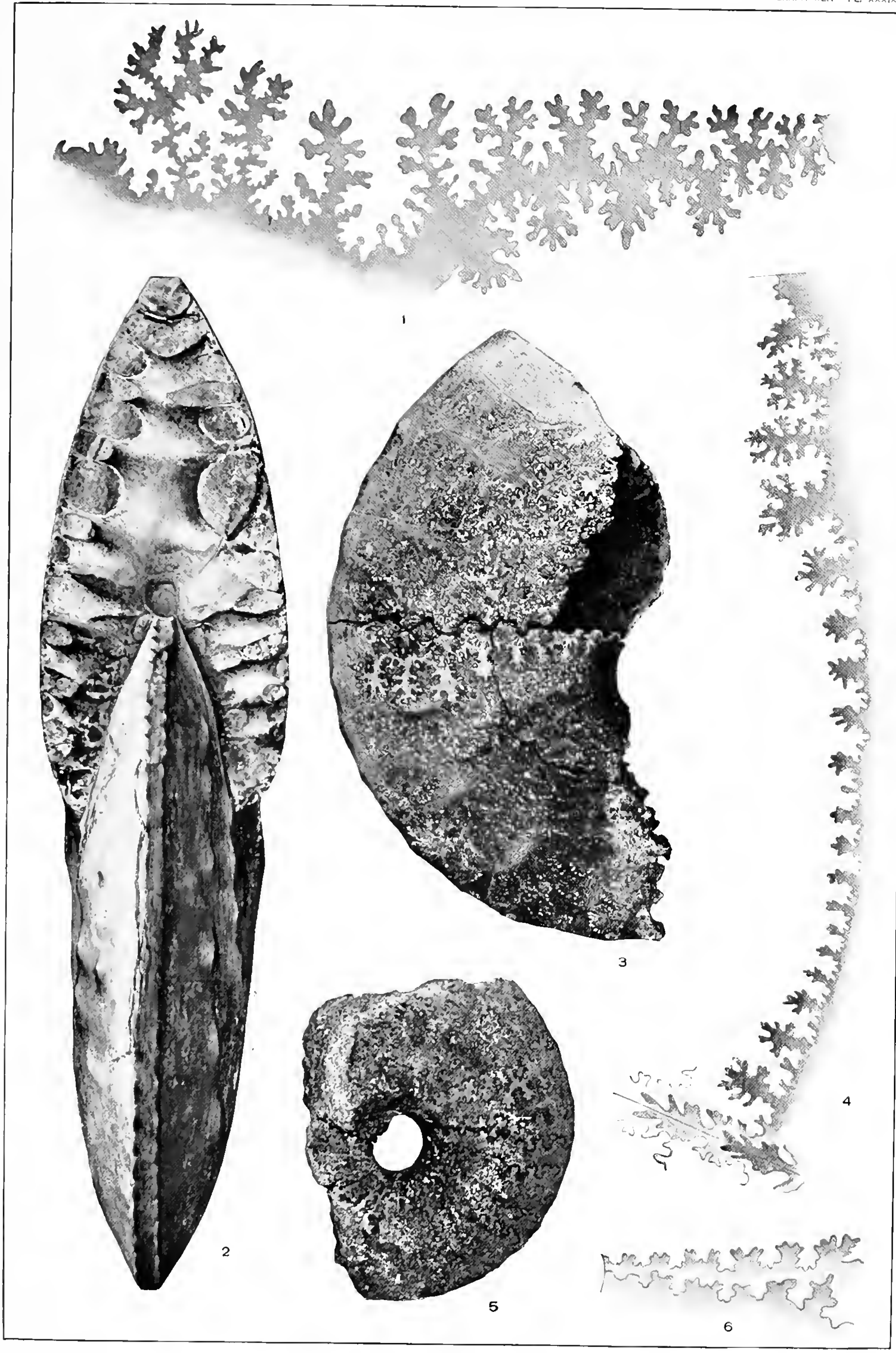
Fig. 3. Fragment of a small specimen from Chesapeake and Delaware Canal, Coll. Acad. Nat. Sci. Phila.

4. Suture of same, × 2.

5. Side view of small specimen from Lenola, N. J.

6. Sutures from smaller end of volution represented by fig. 5 enlarged four diameters (see Pl. XL, figs. 1, 2).

Matawan (?) formation, Upper Cretaceons..

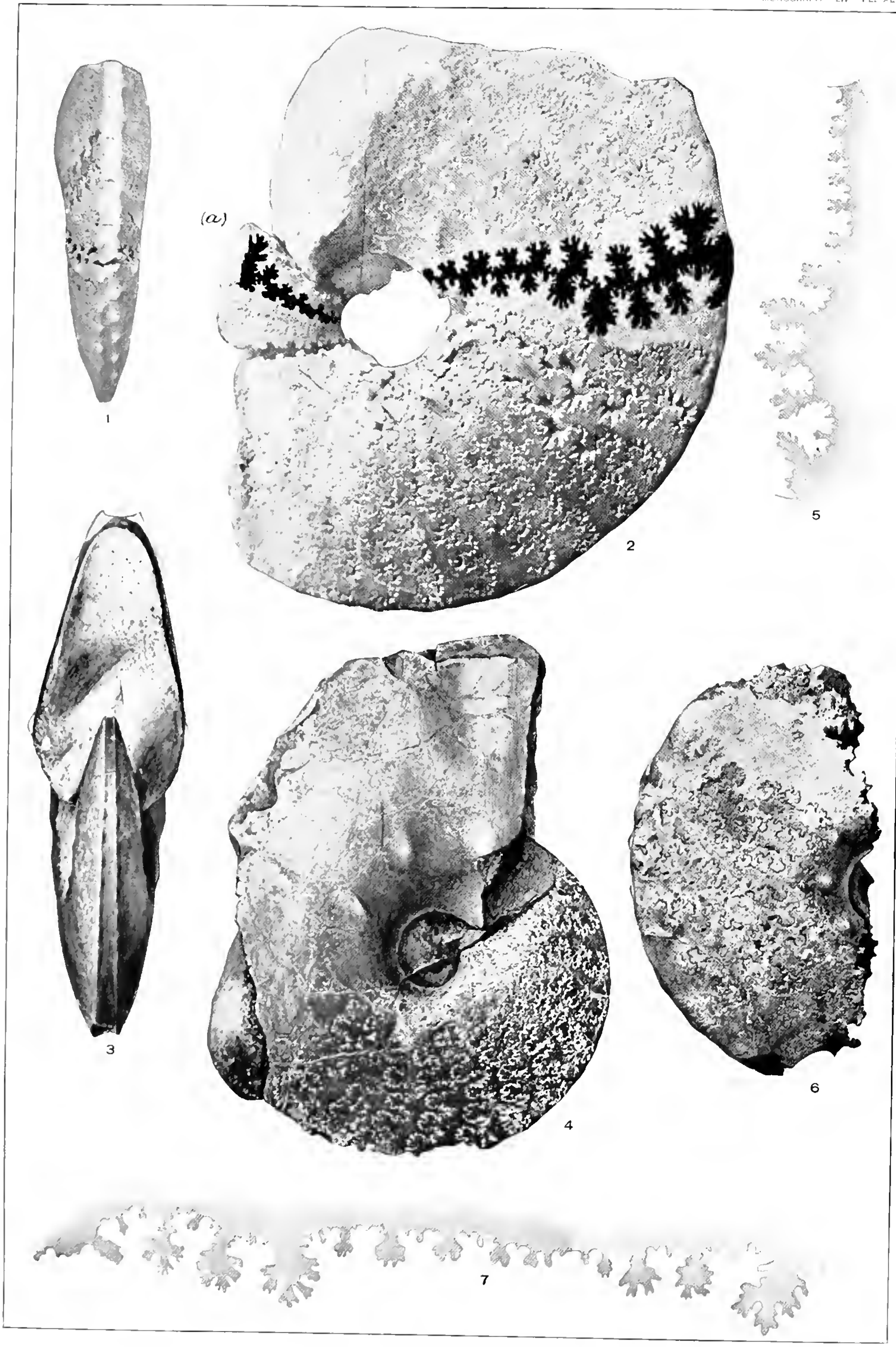


PLACENTICERAS.

PLATE XL.

PLATE XL.

Placenticeras.



PLACENTICERAS.

PLATE XLI.

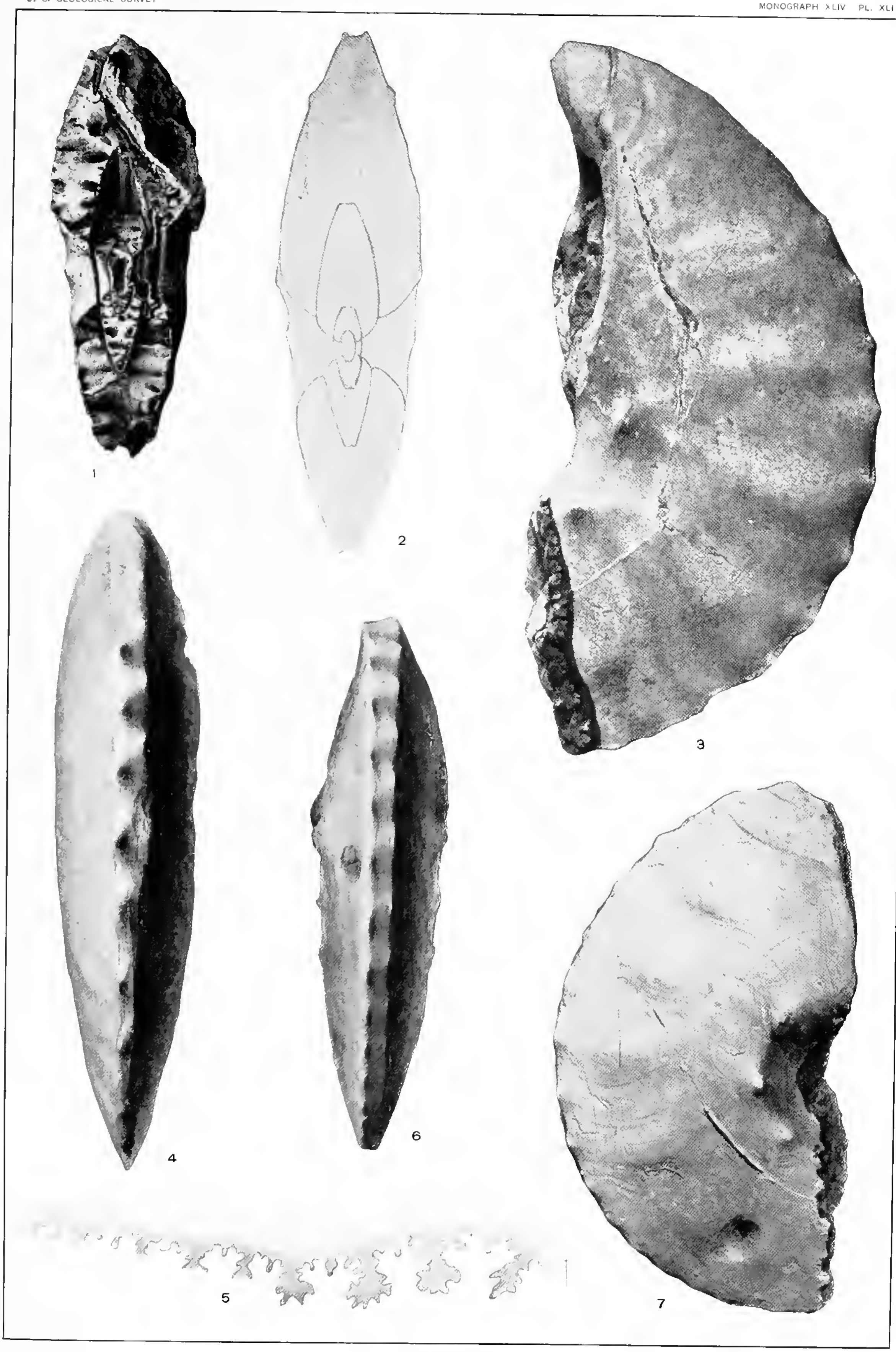
PLATE XLI.

PLACENTICERAS STANTONI var. BOLLI Hyatt.

(Page 214.)

FIG. 1. Sectional view of specimen represented by Pl. XL, figs. 6 and 7.
2. Restored section of same.
3, 4. Living chamber of a larger specimen.
5. Last suture of same specimen.
6, 7. Living chamber of another specimen.

Horton's mill, Dallas County, Tex.; Taylor beds (?), Upper Cretaceous; Coll. Mus. Comp. Zool., Cambridge.



PLACENTICERAS.

PLATE XLII.

PLATE XLII.

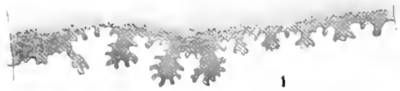
Placenticeras stantoni var. bolli Hyatt.

(Page 214.)

Fig. 1. Suture of young specimen enlarged about $2\frac{1}{2}$ diameters.

2. Part of living chamber and last septa of a large specimen.

Horton's mill, Dallas County, Tex.; Taylor beds (?), Upper Cretaceous; Coll. Mus. Comp. Zool., Cambridge.



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PLACENTICERAS.

PLATE XLIII.

PLATE XLIII.

PLACENTICERAS.

Page.

FIGS. 1, 2. *Placenticeras stantoni* var. *bolli* Hyatt 214

Fig. 1. Side view of small costate specimen.

2. Suture of same, × 2.

Horton's mill, Dallas County, Tex.; Taylor beds (?), Upper Cretaceous; Coll. Mus. Comp. Zool., Cambridge.

FIGS. 3-11. *Placenticeras pseudoplacenta* Hyatt 216

Fig. 3. Side view of small fragmentary specimen.

4. Sectional view of same.

5. Center of same enlarged.

6. Ventral view of first whorls of same specimen much enlarged.

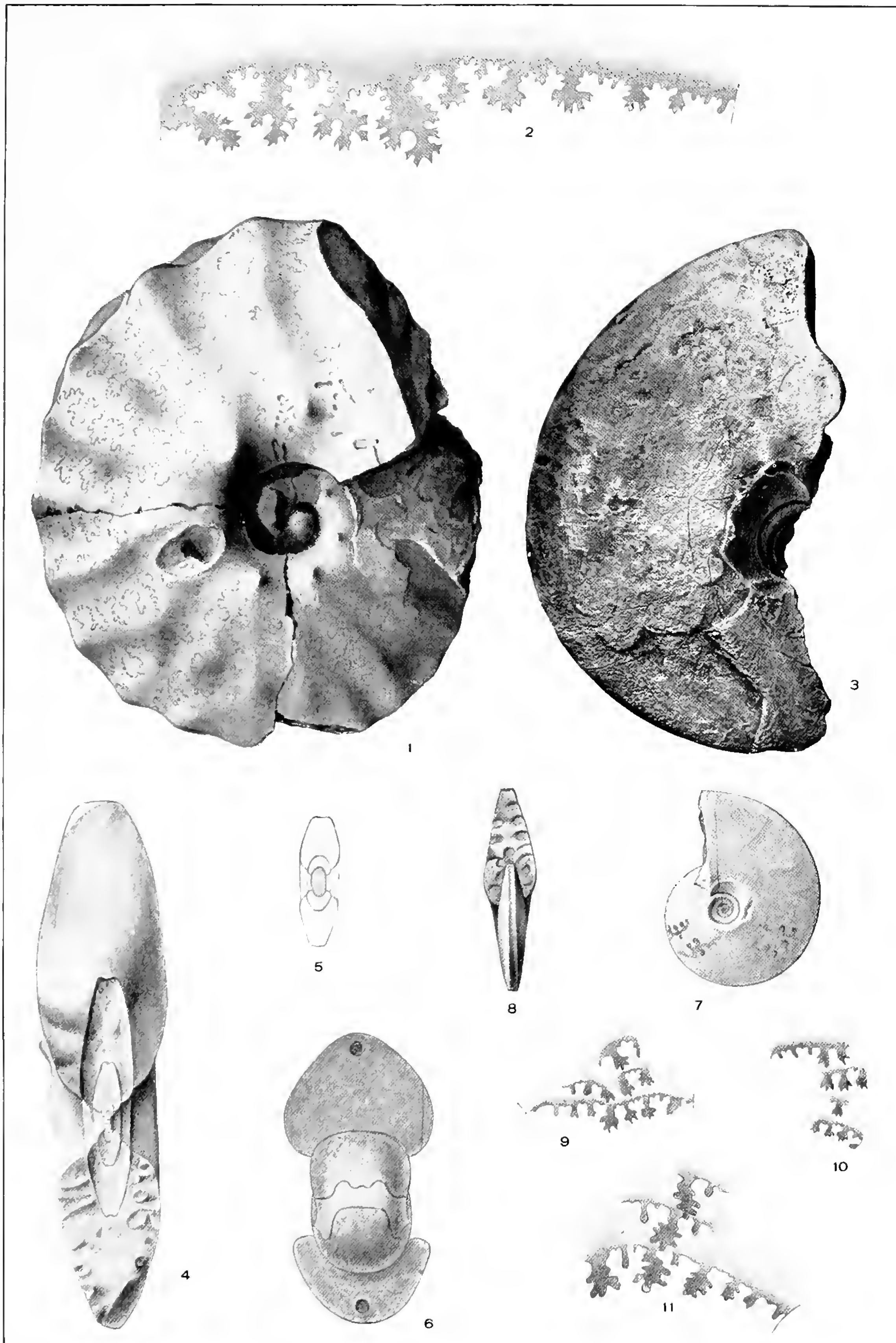
7, 8. Inner whorls of another specimen, natural size.

9, 10. Lateral sutures of last whorl of same as indicated on fig. 7.

Upper Kanab Valley, Utah; Colorado group; Upper Cretaceous; Coll. U. S. Nat. Mus., No. 22344.

11. Parts of internal sutures of ephebic stage when dorsoventral diameter of volution measures 49 mm.

Muddy Creek, Huerfano County, Colo.; Fort Benton formation; Upper Cretaceous; Coll. U. S. Nat. Mus., No. 22199.



PLACENTICERAS

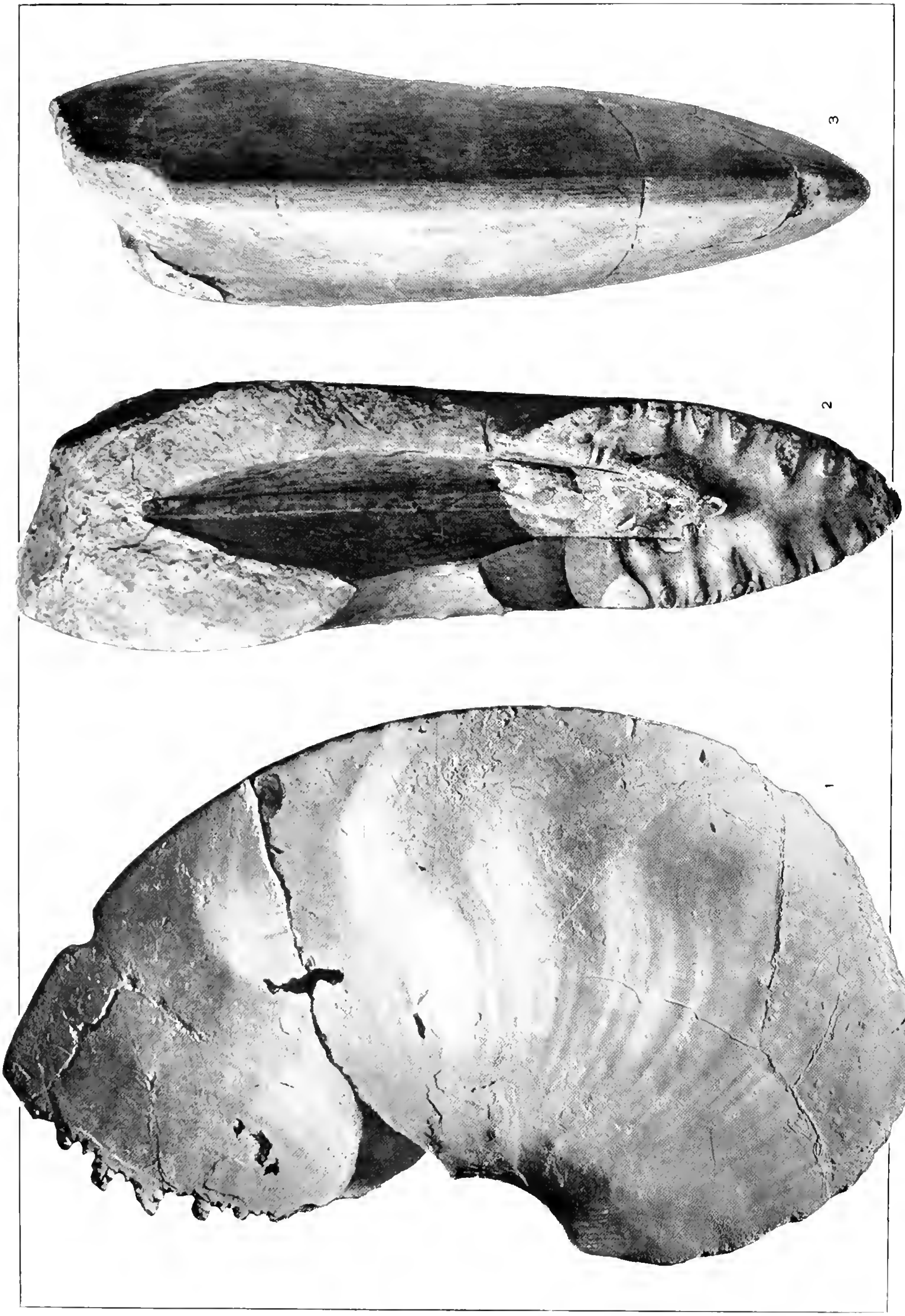
PLATE XLIV.

PLATE XLIV.

PLACENTICERAS PSEUDOPLACENTA Hyatt.

(Page 216.)

FIGS. 1, 2, 3. Three views of living chamber of fragmentary specimen.
Bad Lands, near Black Hills; Upper Cretaceous, S. Dak.; my collection.



PLACENTICERAS.

PLATE XLV.

PLATE XLV.

PLACENTICERAS.

		Page.
FIGS. 1, 2.	*Placenticeras pseudoplacenta* var. *occidentale* Hyatt	217

Fig. 1. A specimen from the Upper Missouri River; Coll. Columbia University, No. 10622G.

2. Suture of a young specimen from Horton's mill, Dallas County, Tex.; Coll. Mus. Comp. Zool., Cambridge.

FIGS. 3–16.	*Placenticeras whitfieldi* Hyatt	221

Fig 3. Side view of small fragmentary specimen from Clifford, Nebr., in Coll. Mus. Comp. Zool., Cambridge, enlarged.

4. Section of same showing venter of earliest whorls, × 3.

5. Center of same, × about $6\frac{1}{2}$ diameters.

6. First two sutures and beginning of siphuncle of same specimen, much enlarged.

7. Beginning of siphuncle of same after etching with acid, still further enlarged.

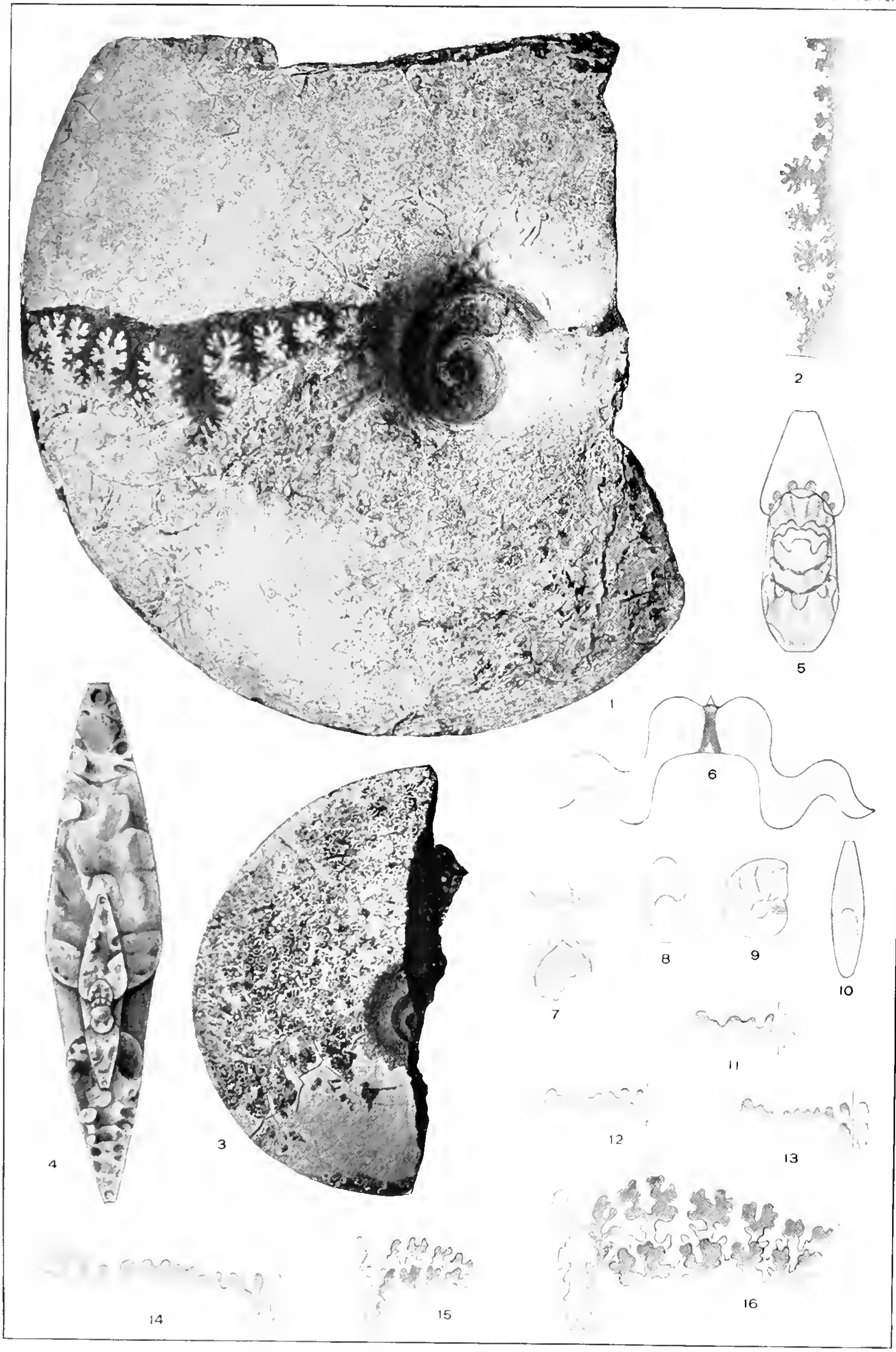
8–10. Early stages obtained by breaking down a larger specimen from the Black Hills, South Dakota, in my collection; enlarged about 5 diameters.

11–14. Complete sutures from dorsum to venter of same stages as figs. 8, 9, 10. Fig. 11 is earliest suture visible on fig 9; fig. 12 is on last quarter of same whorl; fig. 13 is last suture on fig. 10, and fig. 14 is nearly a volution earlier.

15. Dorsal (internal) sutures at diameter of 15 mm.

16. Same at diameter of 40 mm. The last two figures may not be from same specimen as figs. 8–14.

Montana group, Upper Cretaceous.



PLACENTICERAS

PLATE XLVI.

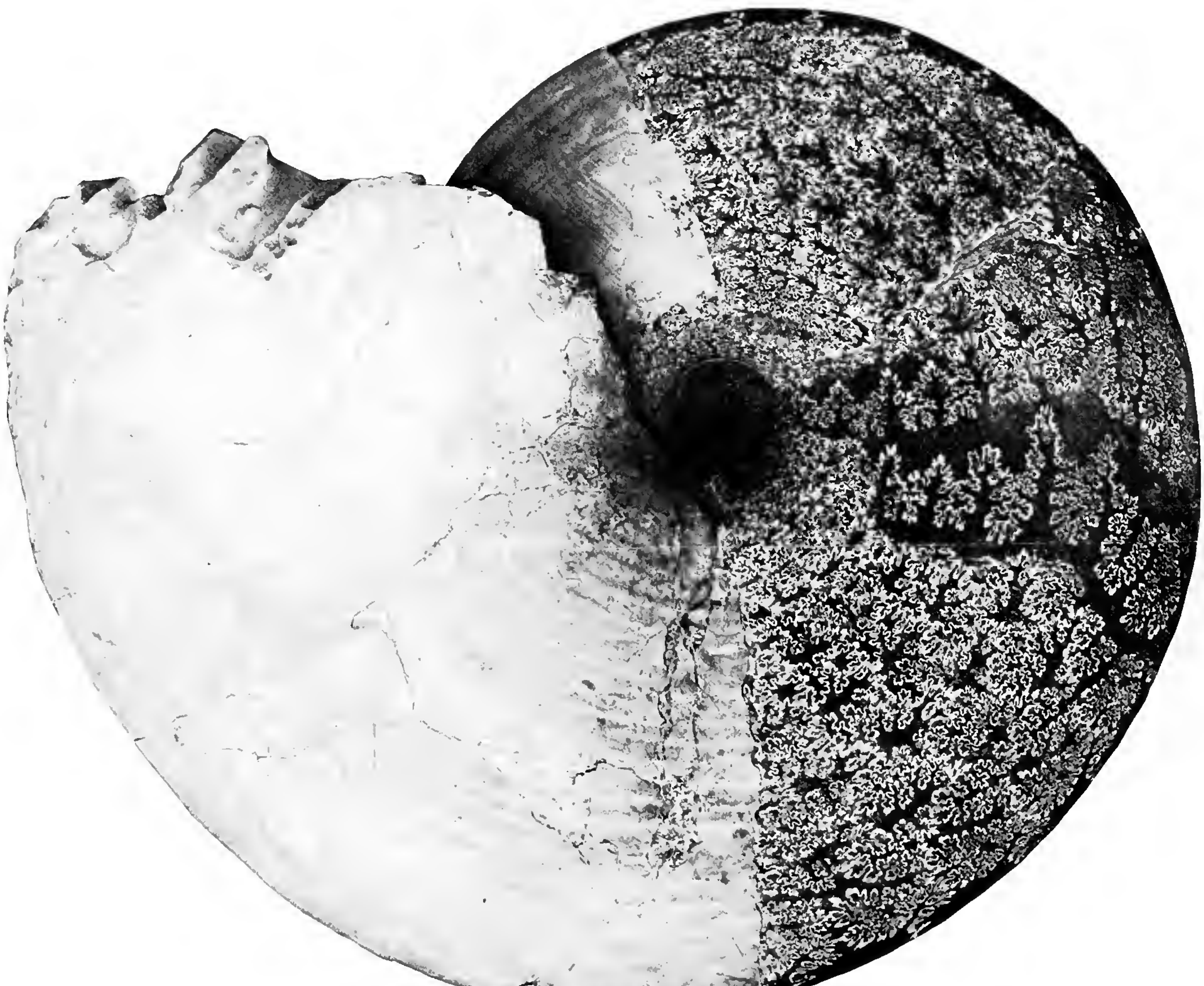
PLATE XLVI.

PLACENTICERAS WHITFIELDI Hyatt.

(Page 221.)

FIGS. 1, 2. Two views of a large specimen, $\frac{9}{13}$ actual diameter.
Black Hills, South Dakota; Montana formation, Upper Cretaceous; Coll. Bost. Soc. Nat Hist., No. 11124.

2



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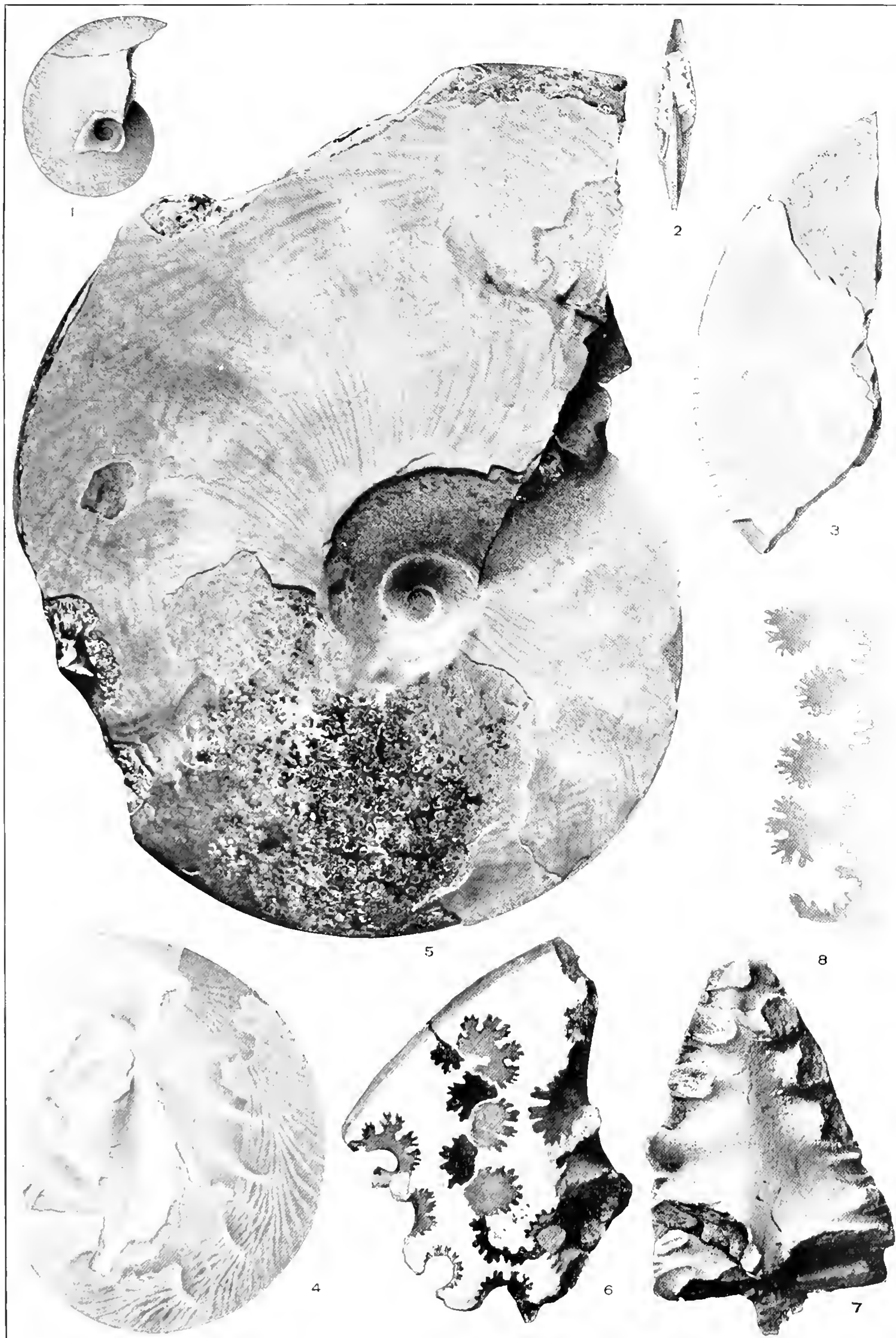
PLACENTICERAS.

PLATE XLVII.

PLATE XLVII.

PLACENTICERAS.

[NOTE.—Professor Hyatt indicated that the drawings for figs. 6 and 7 were unsatisfactory to him, but the specimen is too imperfect to serve as the basis for a restoration].



PLACENTICERAS

INDEX.

[Names in italic are synonyms; figures in black-face type are numbers of pages on which descriptions appear; figures in italic denote illustrations.]

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Monograph XLIV.]

The serial publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of the United States—folios and separate sheets thereof, (8) Geologic Atlas of the United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

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