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This A GENERAL DESCRIPTIVE KEY TO THE  
TETRABRANCHIATE CEPHALOPODA, WITH SPECIAL REFERENCE TO  
THOSE SPECIES OF ACANTHOSCAPHITES, DESMOSCAPHITES  
~~not~~ DISCOSCAPHITES, SCAPHITES, AND BACULITES,  
REPRESENTED IN THE UNIVERSITY  
OF COLORADO COLLECTION

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By

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B.A., UNIVERSITY OF COLORADO, 1927.

A Thesis Submitted to the Faculty of the  
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Department of Geology

June 6, 1928  
June 1928.

1. Simple sutures; prominent hyponomic sinuses; umbilical perforation usually in coiled form; septa concave toward apex; funnels usually short and usually prosiphonate; initial chamber marked by a cicatrix.

SARTILOIDEA

A. Forms referable to a single plane.

This Thesis for the M. A. Degree, by

Penel L. Boss

not proof read, has been approved for the

Department of

Geology

By

W. C. Joepelman

Junius Henderson

June 6, 1928

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I. Simple sutures; prominent hyponomic sinuses; umbilical perforation usually in coiled forms; septa concave toward apex; funnels usually. Short and usually prosiphonate; initial chamber marked by a cicatrix.

-----NAUTILOIDEA

A. Forms referable to a single plane.

1. Straight forms.

a. Elongate, tapering.

1'. Siphuncle large; not nummuloidal.

a'. Funnels reaching to preceding septum.

Endoceras

Camerocheras

b'. Funnels reaching beyond preceding septum.

Vaginoceras

c'. Funnels short, not reaching preceding septum

1". Organic deposits generally present.

Nanno

Nartheoceras

2". No deposits.

Balthoceras.

2'. Siphuncle large, nummuloidal; organic deposits

a'. Funnels short, recurving.

Actinoceras

b'. Funnels short, inflated above into a rim.

Huronis.

c'. Funnels long.

Tretoceras

d'. Extreme compressed shells, with projecting lateral flanges.

Gonioceras

e'. Surface with annulations and longitudinal

ridges.

Protocycloceras

3'. Siphuncle small, not nummuloidal.

a'. Narrow, pencil shaped form.

Protobactrites

b'. Gradually tapering.

Orthoceras.

c'. Rather rapidly expanding.

Geisonoceras

4'. Siphuncle small, nummuloidal.

a'. Annulated.

1". With continuous longitudinal ridges.

Spyroceras

2". With discontinuous longitudinal ridges.

Cycloceras

3". Longitudinal striae only in early stages.

Kionoceras

4". Frilled bands of growth between annuli.

Dawsonoceras

5". Longitudinal ridges between annuli and

with three internal folds in living chamber

Gtenoceras

6". Subtrigonal section; undulating sutures

forming broad sinus on ventral side, and an

obscure saddle on dorsal side.

Jovellania

b'. Not annulated.

1". Smooth surface.

Loxoceras

2". Fine longitudinal ridges.

Protokinonoceras

b. Short or breviconic forms.

1'. Aperture restricted.

a'. Strongly contracted laterally.

1". Aperture with two brachial sinuses.

Mandaloceras

2". Aperture with two brachial and a median

- 3". Aperture with four brachial sinuses.  
Teteramoceras
- a. El. 4". Aperture with four brachial and a median  
1'. More sinus. regularly tapering.  
Pentameroceras
- a". Siphuncle large, tubular; shell annulated.  
5". Aperture with six brachial sinuses.  
Hexamerous
- b". Siphuncle large, nummuloidal; shell smooth;  
aperture sub-trigonal.  
6". Aperture with six brachial and a medial  
sinus.  
Septemeroceras
- c". Siphuncle small, annular; shell annulated.  
7". Aperture with eight brachial sinuses.  
Octameroceras
- d". Siphuncle small, nummuloidal.  
b'. Aperture moderately contracted.  
1". Aperture subtrigonal; irregularly expand-  
ing shell.  
Poterioceras
- 2". Shell annulated and with longitudinal ridges  
throughout.  
2". Aperture laterally contracted shell regul-  
arly expanding.  
Gomphoceras
- 3". Shell annulated, and with longitudinal  
ridges which bear spines.  
2". Aperture not restricted.  
a'. Living chamber long in comparison to camerat-  
ed portion. tapering shells.  
a' 1". Endosiphuncle, and organic deposits. restricted  
Rizoceras  
by the formation of three large sigmoidal  
2". No endosiphuncle or deposits.  
Cyctolomiceras complete ventrally.
- b'. Normal living chamber.  
b'. Similar to Rizoceras but have complete septa.  
1". Funnels short and crumpled.  
Campyloceras
- c'. Genera like similar to preceding but having  
no sigmoidal saddles.  
2". Funnels present on internal side but split  
or absent on outer side.  
Conoceras.

b. 3". Minute forms, with conic septa.  
Volborthella

2. Curved forms.

a. Elongate types.

1'. More or less regularly tapering.

a'. Siphuncle large, tubular; shell annulated.  
Protocycloceras

b'. Siphuncle large, nummuloidal; shell smooth;  
aperture sub-trigonal.  
Ooceras

c'. Siphuncle small, tubular; shell annulated.  
Cycloceras

d'. Siphuncle small, nummuloidal.

1". Shell annulated and with longitudinal  
striae only in younger stages.  
Kionoceras

2". Shell annulated and with longitudinal ridges  
throughout.  
Spyroceras

3". Shell annulated, and with longitudinal  
ridges which bear spines.  
Therococeras

2'. Irregularly tapering shells.

a'. Gerontic living chamber internally contracted  
by the formation of three large sigmoidal  
saddles; septa incomplete ventrally.  
Ascoceras

b'. Similar to Ascoceras but have complete septa.  
Billingsites

c'. General form similar to preceding but having  
no sigmoidal saddles.  
Choanoceras

aperture sub-trigonal; contracted living

## b. Short or breviconic types.

## 1'. Endogastric.

## a'. Siphuncle large

1". Aperture open, smooth surface.

Codoceras

2". Aperture contracted laterally, shell compressed.

Phragmoceras3". Similar to Phragmoceras but has open aperture.Protophragmoceras

## b'. Siphuncle small

1". Living chamber very long in comparison to camerate part.

Rizoceras

## 2'. Exogastric chamber flattened laterally.

## a'. Aperture restricted

1". Large siphuncle, contracted T-shaped aperture. Shells very large.

Cyrtoceras

2". Large siphuncle, moderately contracted aperture. Short hyponomic sinus.

Gomphoceras

3". Siphuncle small; irregularly expanding shell; sub-trigonal aperture; hyponomic sinus not distinct.

Potrioceras4". Similar to Potrioceras but more arcuate and with distinct hyponomic sinus.Streptoceras

5". Nummuloidal siphuncle; shell compressed; aperture sub-trigonal; contracted living

chamber.

Onococeras

- 6". Venter narrow and channeled; bordered by crenulated ridges; siphuncle small and tubular; shell costate.

Homaloceras

b'. Aperture open.

1". Living chamber contracted.

- a". Siphuncle nummuloidal; aperture flaring and open.

Eremoceras

- b". Slender, compressed; living chamber long and less contracted than in others.

Cyclostomiceras

- c". Siphuncle nummuloidal; aperture elongate; living chamber flattened laterally.

Onococeras

2". Living chamber not contracted.

- a". Living chamber long in comparison to camerate part.

Rizoceras

3. Loosely coiled.

- a. Section circular b". Similar to Rizoceras but more compressed;

1'. Gerontic aperture living chamber not so long; sutures more widely large sinuous.

Cyrtorizoceras

2'. Large shells c". Siphuncle large; funnels present on internal side but absent or split on outer longitudinal side.

Cyrtocerina

3'. Shells varied d". Large shells, crenulated bands of growth siphuncle large often expanded into spout-like spinous ventral processes which form coarse longitudinal

ridges.  
Ryticeras

3'. Forms not belonging to foregoing divisions  
(1' or 2')

a'. Globular living chamber with contracted  
aperture.  
Mesoceras

b'. Siphuncle very large; sutures sinuous;  
concave septa; endocones developed.  
Piloceras

c'. Siphuncle large, nummuloidal; suture with  
broad ventral saddles and lateral and dor-  
sal lobe.  
Uranoceras

d'. Closely set frilled bands of growth be-  
tween prominent annulations.  
Zittleoceras

e'. Smooth or finely ridged; siphuncle num-  
muloidal; funnels short and crumpled.  
Campyloceras

3. Loosely coiled.

a. Section circular, elliptical, or oval.

1'. Gerontic aperture, much contracted laterally; siph-  
uncle large and ventrad.  
Comphoceras

2'. Large shells, having crenulated bands of growth  
often expanded into spout-like processes which form  
longitudinal ridges.  
Ryticeras

3'. Shells very large; compressed, long living chamber;  
siphuncle large and nummuloidal; sutures with broad  
ventral saddles dorsal and lateral lobes.

Gigantoceras

4' Smooth shells; compressed; last whorl somewhat reflected.

Aphetoceras

5'. Siphuncle very large and dorsally situated; frilled and filled with organic deposits.

Cyrtendoceras

b. Section trigonal or sub-trigonal.

1'. Venter concave; shell fluted; siphuncle small, tubular.

Trigonoceras

2'. Row of nodes at ventro-lateral angles; siphuncle small and tubular.

Halloceras

3'. Siphuncle ventrad, nummuloidal; suture with pronounced ventral lobe.

Naedyoceras

4. Closely coiled forms.

a. Initially coiled, but latter portion straight.

Lituities

b. Completely coiled--all volutions in contact.

1'. Evolute; globose

a'. Venter smooth.

1". Section circular, oval, or elliptical.

EurytomitesNephriticerasGermanonautilusEdaphoceras

2". Section trapezoidal.

Hercoceras

3". Section quadrangular.

Mojsvaroceras

b'. Venter not smooth.

1". Section circular, oval, or elliptical.

2". Section trapezoidal.

Ternochellus

3". Section quadrangular.

Tainoceras

Centroceras

2'. Evolute; discoidal.

a'. Compressed.

1". Venter smooth.

a". Section circular, oval or elliptical.

Barrandoceras

Tarphyceras

Discoceras

Remeloceras

Trocholites

b". Section quadrangular.

Plectoceras

Pleuronautilus

Metacoceras

Domatoceras

Diodoceras

2". Venter not smooth.

a". Section circular, oval, or elliptical.

Ophidioceras

b". Section trapezoidal.

Stroboceras

Apheloceras

b'. Robust.

1". Venter smooth.

a". Section circular, oval, or elliptical.

Eurystomites

b". Section trapezoidal,

Hercoceras

c". Section quadrangular.

Moisvaroceras

Domatoceras

Thrinoceras

Metacoceras

2". Venter not smooth.

b'a". Section trapezoidal.

- Temnocheilus
- Stroboceras

b". Section quadrangular.

- Tainoceras
- Centroceras

3'. Involute; globose.

a'. Venter smooth.

1". Section helmet or kidney shaped.

- Ephippioceras
- Stearoceras

B. Forms not restricted to a single plane.

1. Low spiral

- Leuroceras
- Asymptoceras
- Solenoccheilus
- Eutrophoceras
- Nautilus

2. High spiral

- Paranautilus
- Styrionautilus
- Proclydonautilus
- Eutrophoceras

II. Complex suture, shells usually highly ornamented; aperture with ventral sinuses.

2". Section sub quadrangular.

- Clydonautilus

subb'. Venter not smooth, ventrally situated; no cicatrix

1". Section sub-trapezoidal.

A. Forms restricted to a single plane.

- Triboloceras

4'. Involute; discoidal.

a'. Compressed, of ammonitic sutures consisting of few

1". Venter smooth, and saddles but mostly straight

a". Section lanceolate or helmet shaped.

- Nautilus
- Clymonautilus
- Syringoceras
- Hercoglossa

b. Complex suture; oval or elliptical

- Pseudonautilus
- Aturia
- Cosmonautilus

b". Section subquadrangular.

- Phacoceras

2". Venter not smooth.

2. a". Section lanceolate or helmet shaped.

- Clydonautilus

b'. Robust.

1". Venter smooth.

a". Section helmet shaped.  
Cymatoceras

b". Section sub trapezoidal.  
Grypoceras

2". Venter not smooth.

a". Section sub-trapezoidal.  
Cymatoceras

B. Forms not referable to a single plane.

1. Low spired forms.

Terpoceras  
Sphyradoceras

2. High spired forms.

Mitroceras

II. Complex suture; shells usually highly ornamented; aperture with ventral rostra instead of hyponomic sinuses; small siphuncle usually ventrally situated; no cicatrix  
-----AMMONOIDEA.

A. Forms referable to a single plane.

1. Straight forms.

a. Simplest of ammonitic sutures consisting of few simple lobes and saddles but mostly straight or undulating; elliptical or sub-elliptical in section.

Bactrites.

b. Complex dendritic suture; oval or elliptical section.

Baculites, Ptychoceras, etc.  
See section 11 A. 4.c.

c. Goniatitic suture; circular section.  
Rhabdoceras.

2. Curved forms.

- a. Curving through one hundred eighty degrees two or three times but not actually coiled. Surface ornamented by annular, somewhat oblique costae which are continuous all around shell. Oval or sub-circular in section  
Hamites
- b. Fragmentary curved specimens possibly  
Ancyloceras; see section II.A.3.
- 3. Loosely coiled forms.
  - a. First whorls regularly involute but not in contact, succeeding portion deflected more or less straight away from coil, and is usually reflected back in a hook-like manner. Shell oval in section, and ornamented with annular, more or less oblique costae which are nodose or spinose.  
Ancyloceras.
  - b. Symmetrically coiled; surface ornamented by ribs and two or three rows of spines on either side of median line of venter.  
Crioceras
- 4. Closely coiled forms.
  - a. Entirely coiled--all volutions in contact.
    - 1'. Suture simple; evolute; globose.
      - a'. Venter not keeled.
        - 1". Section circular to sub-elliptical.  
Shumardites  
Prionoceras
      - 2'. Suture simple; evolute; discoidal.
        - a'. Compressed.
          - 1". Venter not keeled.

a". Section circular to sub-elliptical

Nomismoceras

Prolecanites

Pericyclus

Tornquistites

3'. Suture simple; involute; globose.

a'. Venter not keeled.

1". Section kidney or helmet shaped.

Goniatites

Schistoceras

Schumardites

Tardoceras

Nannites

2". Section sub-trapezoidal.

Goniatites

4'. Suture simple; involute; discoidal.

a'. Compressed.

1". Venter keeled.

a". Section lanceolate or helmet shaped.

Schucertites.

2". Venter not keeled. sub-elliptical.

a'. Section lanceolate or helmet shaped.

Agoniatites

Pronorites

Medlicottia

Gastricoceras

Paralegoceras

Aganides

Muensteroceras

Gonioloboceras

Dimorphoceras

Milleroceras

Agathiceras

Popanoceras

Manticoceras

Paraganices

Dieneria

Xenaspis

Celtites

Ecanites

Polycyclus

b'. Section sub-trapezoidal.

Glyphioceras

a". Section circular to sub-elliptical.

Gastrioceras

c'. Section sub-quadrangular

ParalecanitesChoristocerasNeolobites

b'. Robust.

1". Venter keeled.

a". Section lanceolate or helmet shaped.

Tropiceltites

2". Venter not keeled.

a". Section helmet shaped.

Paraganides

1". Venter keeled.

GastriocerasMuenstrocerasPopanoceras to sub-elliptical.

b". Section sub-trapezoidal.

Gastrioceras

5'. Suture moderately complex; evolute; globose.

a'. Venter keeled.

1". Section circular to sub-elliptical.

1". Section lanceolate or helmet shaped.

MargaritesMetosibirites

2". Section subtrapezoidal.

MargaritesMetosibirites

6'. Suture moderately complex; evolute; discoidal.

a'. Compressed.

1". Venter keeled.

a". Section circular to sub-elliptical.

InvoitesThisbitesRodiotites

b". Section subquadrangular.

AnatropitesThisbites

2". Venter not keeled.

a". Section circular to sub-elliptical.

- Tropogastrites
- Dinarites
- Danubites
- Columbites
- Xenaspis
- Ophiceras
- Flemingites
- Xenodiscus

b". Section subtrapezoidal.  
Columbites

c". Section subquadrangular. *met shaped.*  
Dinarites  
Clionites

b'. Robust.

1". Venter not keeled.

a". Section circular to sub-elliptical.  
Acrochordiceras

b". Section subtrapezoidal.  
Californites

7'. Suture moderately complex; involute; globose.

a'. Venter keeled.

1". Section lanceolate or helmet shaped.

- Halorites
- Microtropites
- Homerites
- Jovites
- Metosibirites

b'. Venter not keeled.

1". Section lanceolate or helmet shaped.

- Leconteiceras
- Leconteia
- Tardeceras
- Popanoceras
- Prosphingites

8'. Suture moderately complex; involute; discoidal.

a'. Compressed. *lanceolate or helmet shaped.*

1". Venter keeled.

a". Section lanceolate or helmet shaped.  
Sphenodiscus

b". Sect Metengonoceras dal.  
Eutomoceras  
Longobardites  
Owenites  
Aspenites  
Hendenstroemia  
c". Sect Pseudosageceras lar.  
Hungarites  
Prodromites

9". 2". Venter not keeled. ; globose.

a". Section lanceolate or helmet shaped.

Mojsigovicsia

1". Sectio Protengonoceras

Engonoceras

Meekoceras

b". Venter Aspidites

Nevadites

1". Sectio Proptychites sub-elliptical.

Sageceras

Hendenstroemia

2". Sectio Clypites dal.

Cordillerites

Lanceolites

10". Suture complex, evolute; discoidal.

b". Section subquadrangular.

c". Compres Sandlingites

b". Robust. keeled.

1". Venter keeled. angular.

a". Section helmet shaped

Ceratites

Nathoratites

b". Section subtrapezoidal.

Ceratites

2". Venter Nathorstites

Buchiceras

a". Sect Roemeroceras to sub-elliptical.

c". Section subquadrangular.

Pulchella

2". Venter not keeled.

a". Section lanceolate or helmet shaped.

Parannites

b". Sect Beyrichites lar

Ceratites

Nicksclia

- b". Section subtrapezoidal.  
Metioceras  
Heinzia  
Knemiceras  
Ceratites
- c". Section subquadrangular.  
Knemiceras  
Triolites
- 9'. Suture complex; evolute; globose.
- a'. Venter keeled.
- 1". Section trapezoidal.  
Tropites
- b'. Venter not keeled.
- 1". Section circular to sub-elliptical.  
Stephanoceras
- 2". Section trapezoidal.  
Tropites
- 10'. Suture complex; evolute; discoidal.
- a'. Compressed.
- 1". Venter keeled.
- a". Section quadrangular.  
Prionotropis  
Scholenbachia  
Prionocyclas  
Hildoceras  
Coroniceras  
Arnioceras
- 2". Venter not keeled.
- a". Section subcircular to sub-elliptical.  
Rhacophyllites  
Coeloceras  
Dactyloceras  
Perisphinctus  
Sibyllites  
Monophyllites  
Aegoceras
- b". Section quadrangular  
Aspidoceras

b'. Robust.

1". Venter keeled.

a". Section quadrangular.

Acanthoceras  
Scholenbachia  
Mortoniceras

2". Venter not keeled.

a". Section circular, etc.

Gabbioceras  
Lytoceras  
Douvilleiceras

b". Section quadrangular.

Acanthoceras  
Dactyloceras

11'. Suture complex; involute; globose.

a'. Venter keeled.

1". Section lanceolate or helmet shaped.  
Paratropites.

b'. Venter not keeled.

1". Section lanceolate or helmet shaped.

Cladiscites  
Sagenties  
Ptychites  
Juvavites  
Arcestes  
Joannites  
Waagenoceras

12'. Suture complex; involute; discoidal.

a'. Compressed.

1". Venter keeled.

a". Section lanceolate or helmet shaped.

Ussuria  
Amaltheus  
Harpoceras  
Ludwiges  
Discotropites  
Pinacoceras  
Eulophoceras  
Coelophoceras

b". Section subtrapezoidal.

Barroisiceras

c". Section quadrangular.

Peroniceras

2". Venter not keeled.

a". Section lanceolate or helmet shaped.

Desmoceras

Hoplites

Lioceras

Phylloceras

Rhaeophyllites

Parkensonia

Sonneratia

Haurites

Placites

Kamathites

Fremontites

Reinckia

Placenticeras

Trachyceras

b". Section subquadrangular.

Haresiceras

Binneyites

b'. Robust.

1". Venter not keeled.

a". Section lanceolate or helmet shaped.

Sirenites

Trachyceras

Fuzozia

Pachydiscus

Marcocephalites

Olcostephanus

Gaudryceras

b". Section subtrapezoidal.

Placenticeras

c". Section subquadrangular

Tetragonites

b. Last volution becoming somewhat elongate, but

reflected back to or toward spiral.

1'. Large size shell; whorls higher than wide; ribs more or less straight, and having a nodose thickening at the umbilicus; intercalated secondary ribs; lateral and ventral

nodes; suture with long external lobe, long bifid first lateral lobe, and much shorter secondary lateral and auxiliary lobes; three internal saddles; suture much incised.

-----Acanthoscaphites Nowak.

a'. Ovate in general form much longer than high, quite ventricose; inner volutions form one-half length but much less than one-half bulk; small umbilical opening; aperture sinuous and forming an angle of one hundred degrees with the straight part of the shell. Distinct, subangular costae which intercalate so as to form three, four, or five on the broadly rounded dorsum which they cross with a slight forward curvature. Two rows of nodes on each side--one row situated about one-third width of volution from umbilicus, the other row near the border of the rounded dorsum.

-----A.nodosus Owen

b'. Similar to above but is less ovate, has shorter deflected portion, finer costae, smaller nodes, and especially a more compressed shell and more narrowly rounded dorsum.

-----A.nodosus var.brevis. Meek

c'. Differs still more widely along the same lines as brevis-- chiefly in that it is more laterally compressed, back of body whorl is distinctly flattened, costae are finer, dorsal nodes nearer margin of venter.

-----A.nodosus var.quadrangularis Meek

d'. Same general description, but is much larger than others, very ventricose, and the nodes are more rounded or tumid.

-----A.nodosus var.plenus Meek

2'. Moderately large shells with constrictions on the early whorls and with a symmetrically trifid first lateral lobe in the adult suture.

-----Desmoscaphites Reeside

a'. D. bassleri.

b'. D. novomexicanus

(Only described species, but not represented in the collection).

3'. Strongly compressed shells, moderately large

size; strongly involute; surface ornamented by sinuous ribs which increase by intercalation and forking; nodes few or numerous; shell sub-circular or sub-oval.

-----Discoscaphites Meek

a'. Shell oval or subcircular, much compressed, volutions so deeply embracing so as to leave only a very small umbilicus, all strongly compressed laterally; aperture narrow, oval; surface ornamented by numerous, small, somewhat undulating costae which increase by division and intercalation. No nodes except a single row along each side of flattened periphery; costae cross periphery with a moderate forward curvature.

-----D. nicolleti Morton

b'. Shell short oval-subdiscoidal or subcircular in outline, and rather strongly compressed, often attaining a very large size; section of volution oval, being higher than wide; inner turns closely involute, and deeply embracing, generally nearly rounded on the periphery; umbilicus small; deflected part of outer volution very short and scarcely or not at all free at aperture which is oval. Surface ornamented with moderate sized, straight or slightly arched costae some of which bifurcate once or twice while the shorter ones intercalate between others; costae pass straight over periphery but often become nearly obsolete toward aperture on nonseptate portion; six or eight concentric rows of nodes on lateral surfaces; nodes of outer row around each margin of flattened periphery larger than others.

-----D. conradi Morton

c'. More gibbous than D. conradi and having two or three rows of tubercles less on each side. The deflected and widening of the nonseptate portion of the outer whorl are also less distinctly marked, and the costae on that part of shell instead of becoming finer and more crowded become obsolete toward aperture.

-----D. conradi var. gulosus

d'. Shell oval-subcircular, much compressed, volutions so deeply embracing so as to leave a very narrow umbilicus, all rather distinctly compressed laterally; last or deflected half of outer turn so short so as not to become free at aperture which is oval being longer

- than wide, and more or less sinuous on the inner side. Surface ornamented by numerous, somewhat flexuous costae which increase by division and the intercalation of the shorter ones between the others so as to number five times as many on the periphery as at the umbilicus; those of each side of the inner volution as well as the inner half of the outer, being provided with five rows of small tubercles, exclusive of the row of rather prominent ones around each side of the narrow periphery; costae of the last half of the outer volution becoming very fine, crowded, and nearly destitute of tubercles excepting the two rows near the periphery which are largest and most widely separated on the lower side of this part.

----- D. conradi var. intermedius

embracing and composing rather large (Meek) of entire shell, deflected part short so as to be only slightly disconnected from inner turns at aperture--- surface ornamented by numerous straight costae which are small and regular on inner volution but become larger and on the inner one-half of body portion support a row at the outer end; costae pass straight across periphery.

----- S. veriformis M & H.

- c'. Shell medium to large, oval, ventricose, broadly rounded on periphery; inner turns closely involute, deeply embracing and composing a large portion of entire bulk; deflected portion very short, umbilicus very small and deep; surface costate; costae pass straight over periphery and on the sides every fifth one is larger and more prominent.

----- S. ventricosus M & H

- d'. Larger whorls ventricose, with eight prominent tubercles (lateral) and two others more elevated at the inner margin on each side; back delicately ribbed between lateral tubercles; an obscure ridge from each of the later to the umbilical margin; no visible septa; small whorl compressed, half concealed, costated all around. Septa numerous serrated like those of an ammonite. (from Norton)

----- S. hippocrepis DeKay

- e'. ----- S. hilli Adkins and Winton

## 4'. Forms not included in 1', 2', or 3'.

-----Scaphites Parkinson

a'. Shell small, transversely sub-ovate, moderately compressed; inner volution nearly circular, closely involute and composing rather large part of entire bulk; deflected part short; surface costate and without proper nodes, costae small on inner volutions, on body portion every fourth or fifth becomes enlarged and extends entirely across side and over periphery where they bifurcate or give off lateral branches.

-----S. warreni Meek and Hayden

b'. Shell under medium size, ovate subdiscoidal in form; umbilicus very small; inner regularly coiled volutions closely involute, deeply embracing and composing rather large portion of entire shell; deflected part short so as to be only slightly disconnected from inner turns at aperture--- surface ornamented by numerous straight costae which are small and regular on inner volutions but become larger and on the inner one-half of body portion support a node at the outer end; costae pass straight across periphery.

-----S. veriformis M & H.

c'. Shell medium to large, oval, ventricose, broadly rounded on periphery; inner turns closely involute, deeply embracing and composing a large portion of entire bulk; deflected portion very short, umbilicus very small and deep; surface costate; costae pass straight over periphery and on the sides every fifth one is larger and more prominent.

-----S. ventricosus M & H

d'. Larger whorls ventricose, with eight prominent tubercles (lateral) and two others more elevated at the inner margin on each side; back delicately ribbed between lateral tubercles; an obscure ridge from each of the later to the umbilical margin; no visible septa; small whorl compressed, half concealed, costated all around. Septa numerous serrated like those of an ammonite. (from Morton)

-----S. hippocrepis DeKay

e'. -----S. hilli Adkins and Winton

c. Small initial coil but greater part of shell straight and staff-like. (Small coil rarely preserved).

1'. Entirely straight.

a'. Goniatic suture; shell circular in section.

-----Rhabdoceras

b'. Ammonitic suture; shell oval or elliptical in section.

-----Baculites

1". Large sized shells.

a". Elongate and rather gradually tapering; section ovate, the antisiphonal side being more broadly rounded than the opposite; surface of young and medium sized specimens generally nearly smooth while the monseptate part of the adult shell is provided with broad, undefined obliquely transverse ridges, or undulations, that arch parallel to the obscure lines of growth and become nearly or quite obsolete as they approach the siphonal side. Septa moderately closely arranged---(From Meek).

-----B.ovatus Say

b". Rather rapidly tapering, particularly in the young, or near the smaller extremity of adult specimens, strongly compressed laterally in medium sized examples, but more convex in the young and toward the larger extremity of large adults; nonseptate portion of fully developed specimens provided with large, broad lateral undulations; lines of growth generally obscure. Septa usually crowded and with lobes and sinuse deeply divided into slender branches (Meek).

-----B.compressus Say

2". Small to medium sized shells.

a". Small, very gradually tapering shell,

with an ovate section and ornamented along each side, near the antisiphonal margin, both on the septate and nonseptate portions by a row of rather distinctly separated node-like prominences that show the faintest tendency to extend obliquely forward and toward the siphonal side, as undulations parallel to the lines of growth. Septa similar to B. ovatus.

-----B. asper Morton

b". Small, very slender and very gradually tapering; section ovate, being rounded or slightly flattened on the antisiphonal side, and more narrowly rounded, or sometimes obtusely subangular, and often crossed by scarcely perceptible little ridges on the siphonal margin; lateral surfaces ornamented by strong regular, arcuate costae or undulations that sometimes become obsolete toward the smaller extremity.

-----B. anceps Meek

c". Shell small and very slender; transverse section varying from broad ovate to sub-elliptical; surface sometimes nearly smooth but usually with numerous distinct, rounded costae or undulations that are straight on siphonal side from which they curve backward parallel with lines of growth-gradually becoming fainter and disappearing before reaching opposite side. In addition to the costae there are broad, rather obscure constrictions at intervals of about one-half inch that completely circle the shell. These are more distinct on siphonal side and are parallel with lines of growth, passing nearly straight across the siphonal and antisiphonal sides and curve sharply backward on the flank. bears nodes on the v-----B. gracilis Shumard

d". Small shells-largest reaching twenty mm.; rapidly tapering; section well rounded, ovate as in B. asper. Surface shows numerous, fairly prominent, arcuate nodes on the antisiphonal half of the shell, each of which correspond to one or more ill-defined inclined ribs on the siphonal margin. Nodes are distinct on the very smallest specimens. Suture shows relatively simple elements, rounded and little incised, with the anomalous feature that

the saddle dividing the siphonal lobe is itself divided by a single, pointed marginal lobe on the siphonal line.

-----B. Codyensis Reeside

2'. Last portion of shell reflected back.

a'. Very sharp reflection causing impressed zone.

-----Ptychoceras

b'. No impressed zone.

-----Marcoscaphites

B. Forms not referable to a single plane.

1. Symmetrically coiled.

a. Closely coiled high spired cone in which the last volution or the body chamber is not reflected from the spire. Umbilical space small as compared to Helioceras or Heteroceras. Surface ornamented with nodes and costae.

-----Turrillites

2. Unsymmetrically coiled.

a. Initial somewhat regular spire but last volution becoming deflected but usually recurving back toward spire. Volutions more or less in contact. Surface ornamented by annular which frequently bears nodes on the ventral side of coil.

-----Heteroceras

b. Shell slender, coiled in a rather loose depressed spire having a broad umbilical space. Last volution deflected from spire. Surface ornamented by costae.

-----Helioceras



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