Fossil Shell Morphology

Or

The Terminology used in the Description of Externally Shelled Cephalopods (Nautiloids and Ammonoids)

By Kevin Bylund

The structure secreted by the mantle of cephalopods for protection or neutral buoyancy is called the **Shell** or **Conch**. The complete shell is basically a hollow cone with two major parts, the **Body Chamber**, or **Living Chamber**, and the **Phragmocone**. The opening on the large end is called the **Aperture**, and the **Apex** is at the tip of the small end. The shell or **Test** that forms the cone is called the **Shell Wall**.

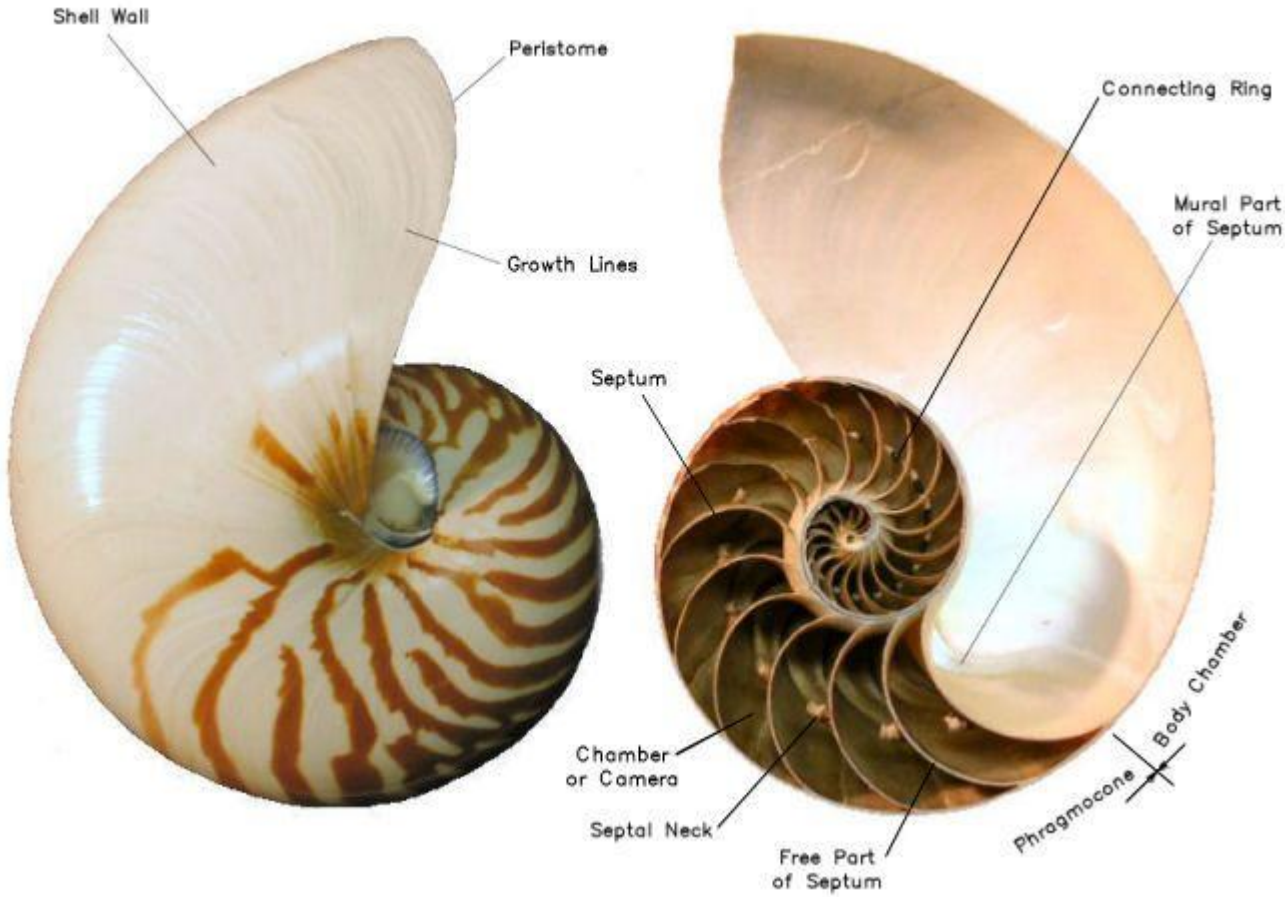

Figure 1. Two lateral views of the shell of *Nautilus*, external on the left and internal on the right.

Orientation

Ventral is the side the hyponome or siphon was on, usually identified by the **Hyponomic Sinus**, an indentation in the shell to let the hyponome protrude. **Dorsal** is the opposite side. **Adoral**, **Adapertural**, and **Forward**, are towards the aperture, **Adapical** and **Backward** are towards the apex. **Anterior** is adapertural and **Posterior** is adapical. **Lateral** is between ventral and dorsal. **Longitudinal** is in an anterior to posterior direction, and **Transverse** is in a dorsal to ventral direction.

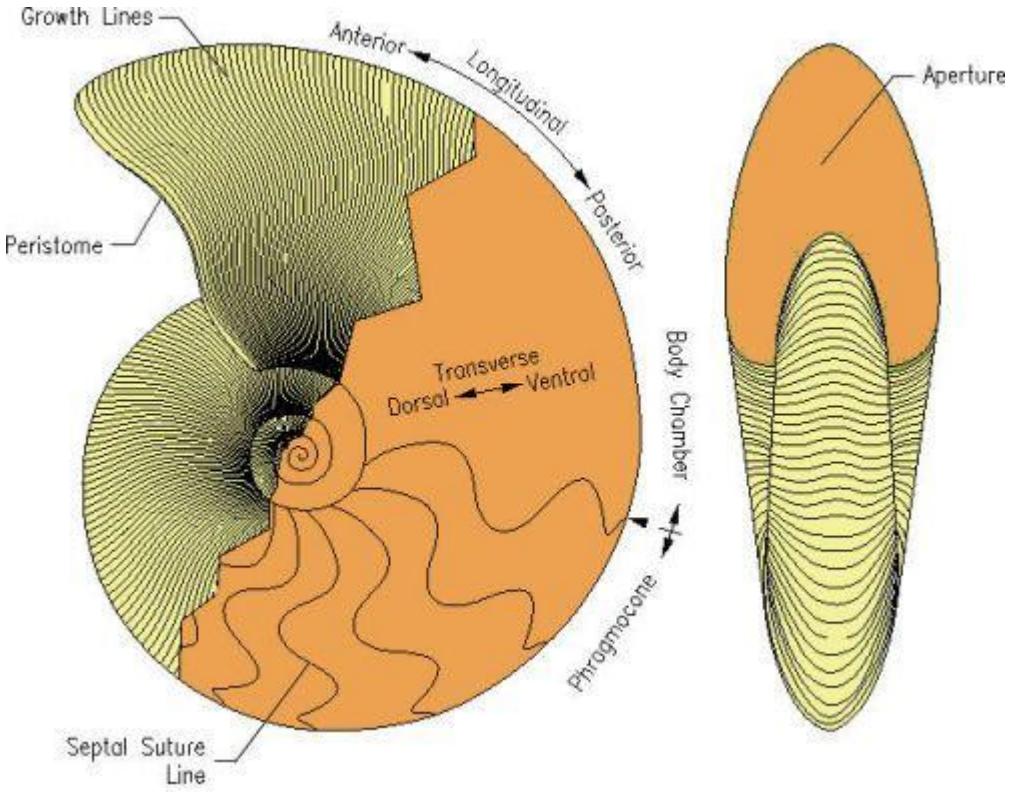

Figure 2. Drawings of an imaginary coiled cephalopod shell.
lateral view on left (Part of the shell is broken away to reveal the suture lines on the internal mold) and apertural view on right.

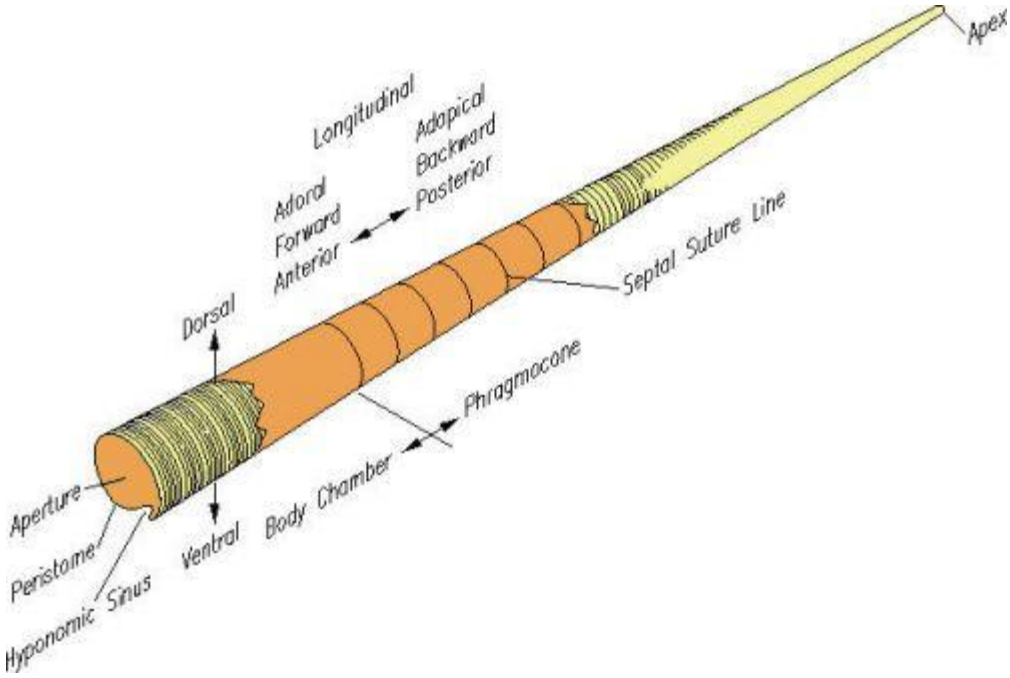

Figure 3. Drawing of an orthoconic cephalopod shell and internal mold.

Body Chamber

The body chamber was the part of the shell occupied by the living animal. The edge of the aperture is the **Peristome**. Body chambers in coiled shells are termed **Brevidomic** if they are less than ½ whorl in length, **Mesodomic** if between ½ and ¾ whorls, and **Longidomic**, if more than ¾ whorls.

At maturity several kinds of modifications can occur on the aperture. **Lateral Lappets** are projections from the lateral part of the peristome. A **Ventral Lappet** or **Rostrum** projects from the venter. A **Constriction** is a necking down; a **Contraction** is a closing off. Sometimes the whole body chamber is **Expanded**.

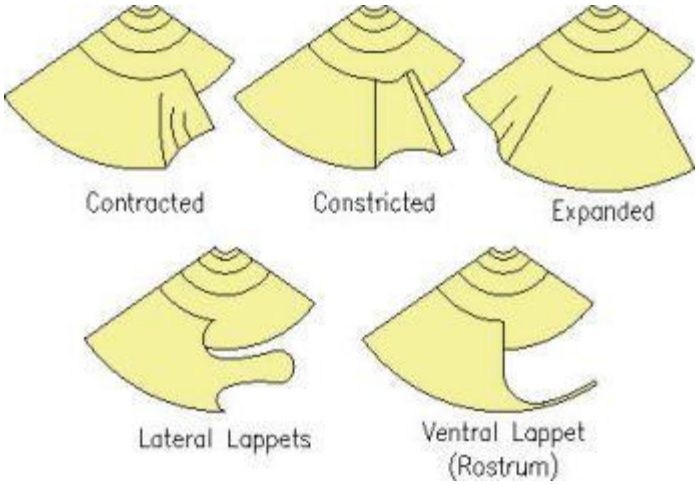

Figure 4. Drawings showing some of the modifications that can occur on mature shells.

Phragmocone

As the animal grew, it occasionally moved forward in the body chamber and secreted a **Septum** at the back of the mantle. This created a series of **Chambers**, or **Camerae**, called the Phragmocone. Some septa are deposited a short distance along the shell wall, this part is called the **Mural Part**. The **Free Part** of the septum is between the mural part and the septal neck.

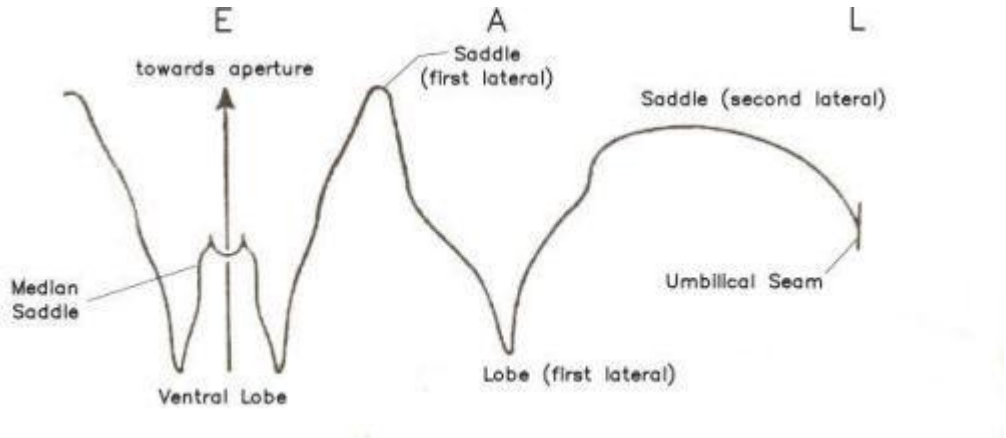

Figure 5. Parts of a Septal Suture line.

The septum is attached to the shell wall along a **Suture**, seen as a series of simple to complex lines on internal molds. Parts of the suture line directed adorally are termed **Saddles**, and those directed adapically are termed **Lobes**. **Orthoceratitic Sutures** are relatively simple having shallow lobes and saddles. **Agoniatitic Sutures** have broad lobes and saddles with a narrow mid ventral lobe. **Goniatitic Sutures** have strong, mostly angular lobes and angular to rounded saddles. **Ceratitic Sutures** have strong rounded saddles and serrated lobes. **Ammonitic Sutures** have complex lobes and saddles.

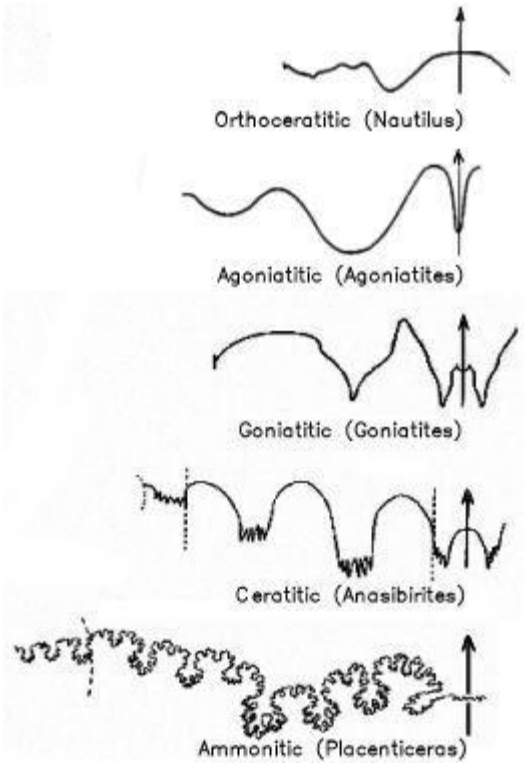

Figure 6. Types of suture lines.

Sutural formulas are sometimes used to describe suture patterns (mostly Paleozoic ammonoids, and only briefly described here). The primary lobes are given a letter designation, **E** for the External (ventral) Lobe, **L** for the Lateral Lobe and **I** for the Internal (Dorsal) Lobe. Adventitious Lobes, lobes forming later, between **E** and **L**, are lettered **A** and numbered consecutively in accordance with their ontogenetic appearance. New lobes appearing between **L** and **I** are Umbilical Lobes, lettered **U**, and numbered the same way.

Siphuncle

In fossil cephalopod shells, anything that was in contact with the siphuncular chord is considered part of the **Siphuncle**. The non-living part of the siphuncle that covers the living siphuncular chord is termed the **Ectosiphuncle** it is composed of the septal neck and the connecting ring. The area, and any structures, inside the ectosiphuncle are termed the **Endosiphuncle**.

The **Septal Neck** is where the siphuncle passes through the septum. Septal necks directed adorally are termed **Prochoanitic**, those directed adapically are termed **Retrochoanitic**. Several other terms are used for retrochoanitic necks. **Acoanitic** necks are barely developed or extremely short. **Loxochoanitic** necks point inward at moderate lengths. **Orthochoanitic** necks are directed adapically and are less than ½ the length of the chamber. **Hemichoanitic** necks extend ½ to ¾ the length of the chamber. **Subholochoanitic** necks curve inward just before reaching the next septum. **Holochoanitic** necks reach to the next septum or slightly beyond. **Macrochoanitic** necks extend longer than the distance to the next septum. **Suborthochoanitic** necks are barely recurved. **Cyrtochoanitic** necks are recurved, some almost touching the free part of the septum.

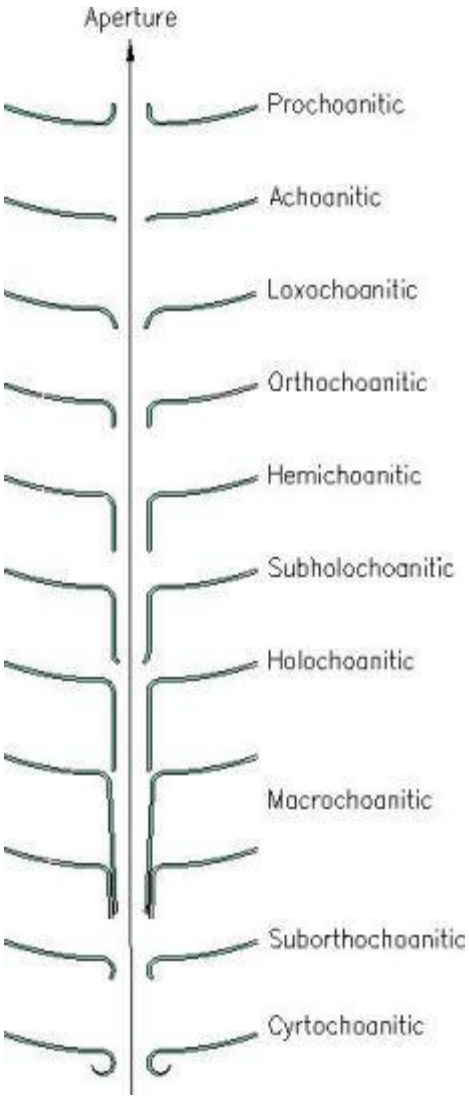

Figure 7. Types of Septal Necks.

Connecting Rings are tubular structures connecting the septa or septal necks. Some rings are thin and simple, others are thick and composed of two or three layers of deposits. Connecting rings can be straight, concave, convex or bulbous.

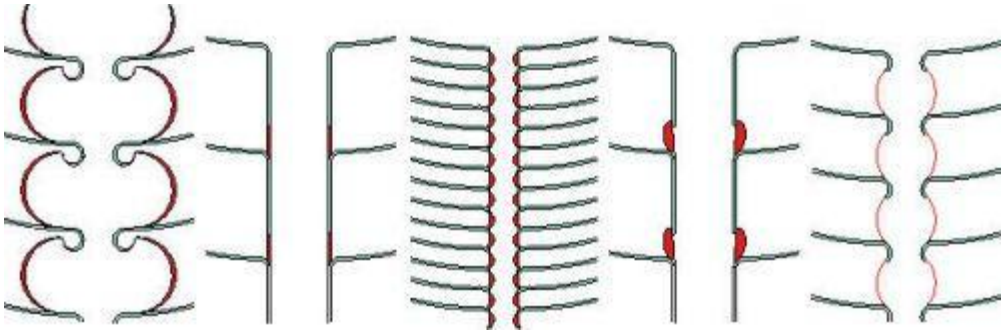

Figure 8. Several types of connecting rings (in red).

Deposits

Some Cephalopods, mostly Nautiloids, deposited calcareous structures inside the shell, probably for buoyancy and attitude control. **Cameral Deposits** were deposited inside the chambers, **Mural Deposits** are on the shell wall, **Episeptal Deposits** on the adapertural side of the septum and **Hyposeptal Deposits** on the adapical side of the septum. **Endosiphuncular deposits** include cone shaped **Endocones**, longitudinal **Lamellae**, transverse partions called **Diaphrams**, **Rods** are round structures laying on the ventral wall of the siphuncle, **Annulosiphonate** deposits are donut shaped deposits inside the siphuncle, and **Parietal** are deposits looking like and attached to the inside of the septal neck.

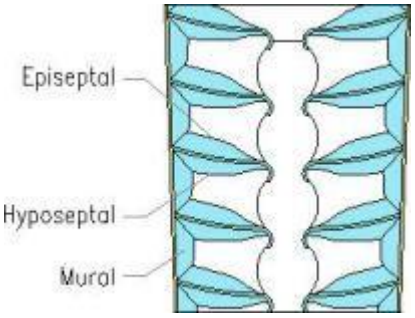

Figure 9. Cameral deposits (in blue).

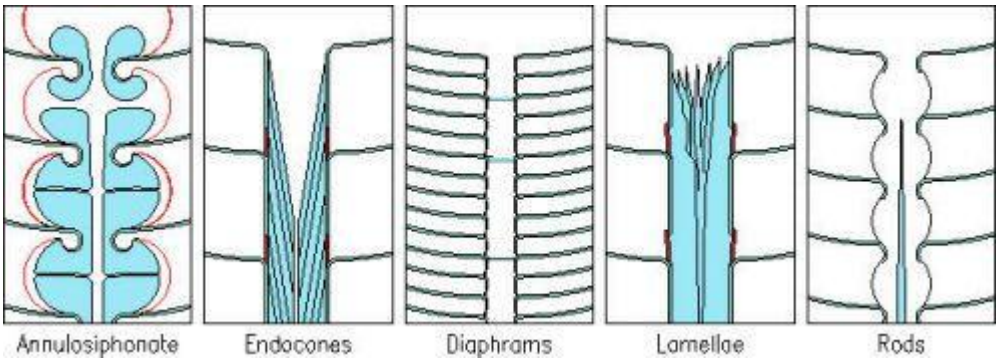

Figure 10. Endosiphuncular deposits (in blue).

Shell Shape

Nautiloid shells can be **Planispirally Coiled** (coiled in one plane) or straight, curved, open spiral etc., ammonoids not Planispirally coiled or have an open spiral are termed **Heteromorphs**. Curved or coiled shells are **Exogastric** if the ventral side, or **Venter**, is convex and on the outer side, and **Endogastric** if the dorsal side, or **Dorsum**, is convex and on the outer side.

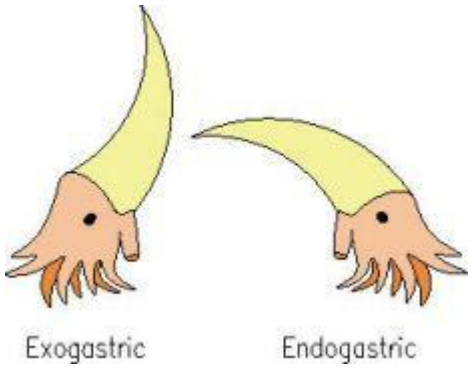

Figure 11. Cartoon showing Exogastric and Endogastic coiling.

The cross sectional shape, or **Whorl Section**, can be **Round**, **Oval**, **Square**, **Rectangular**, **Triangular**, **Lanceolate** (shaped like a lance point), **Fastigate** (tapering towards the venter), **Tabulate** (with a flattened venter) or some variation of each. **Compressed** shells are shorter laterally, and **Depressed** shells are shorter ventro-dorsally.

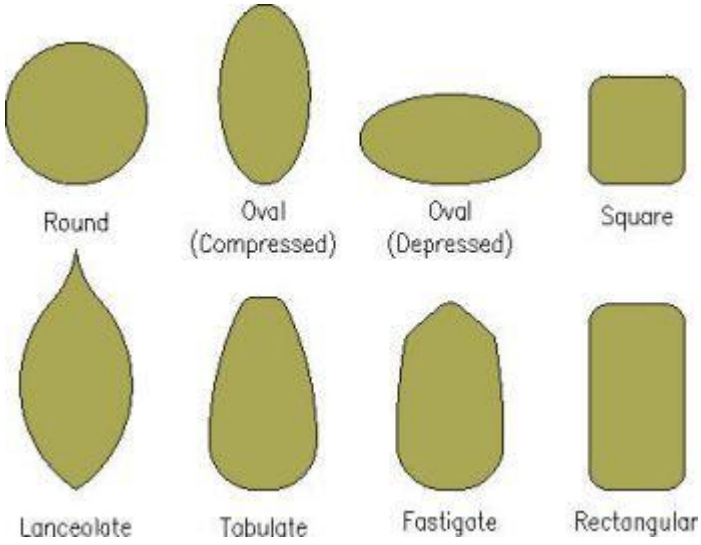

Figure 12. Common whorl section shapes.

A **Whorl** is one complete volution of a coiled shell. The space enclosed on both sides by the last whorl is termed the **Umbilicus**. Shells with a wide umbilicus are termed **Evolute** and shells with a narrow umbilicus are termed **Involute**. The **umbilical Seam** is where the shell wall attaches to the preceding whorl. The **Umbilical Wall** is between the umbilical shoulder and the umbilical seam. The **Umbilical Shoulder** is where the shell wall bends toward the preceding whorl. The **Ventrolateral Shoulder** is where the shell bends toward the venter, and the **Side** or **Flank**, is between the ventrolateral shoulder and the

umbilical shoulder.

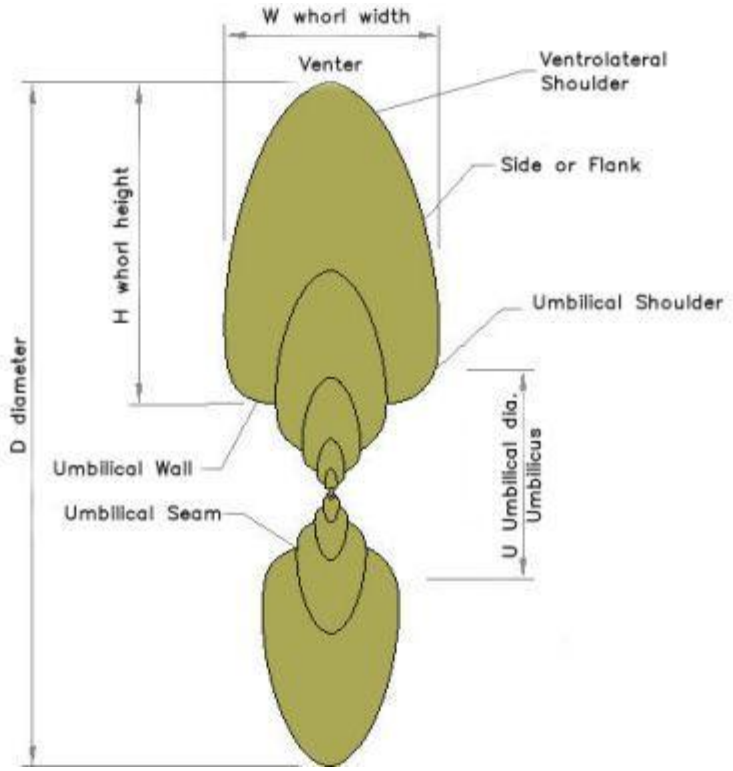

Figure 13. Cross section of a coiled shell showing parts and common dimensions.

Dimensions most commonly used for the description of coiled shells are the diameter, **D**, whorl width, **W**, whorl height, **H**, the umbilical diameter, **U**, the umbilical ratio, **U/D**. Lately it has become appropriate to have an arrow pointing at the last septum, if visible.

Straight shells are **Orthocones**, curved shells are **Cyrtocones**, either of these could be long, **Longiconic**, or short, **Breviconic**. Curved shells that make at least one volution are termed **Gyrocones**. Coiled shells that touch or are just barely impressed by the preceding whorl are **Tarphycones**. **Serpenticones** are very evolute with many subcircular or depressed whorls. Involute to moderately involute shells with subrectangular, compressed whorls are termed **Platycones**. Shells that are involute with subtriangular, compressed whorls are **Oxycones**. **Discocones** have involute shells with an oval whorl section. **Spherocones** are subglobular with a small umbilicus and subcircular whorls. **Cadicones** are subglobular with an open, angular, umbilicus. **Planorbicones** are evolute with relatively few subcircular depressed whorls. **Ancylocones** have open or closed, planispiral or helical early whorls followed by a hook. **Torticones** have helical whorls. Shells that form two or more straight shafts are called **Hamiticones**. Irregular, worm like shells are termed **Vermicones**.

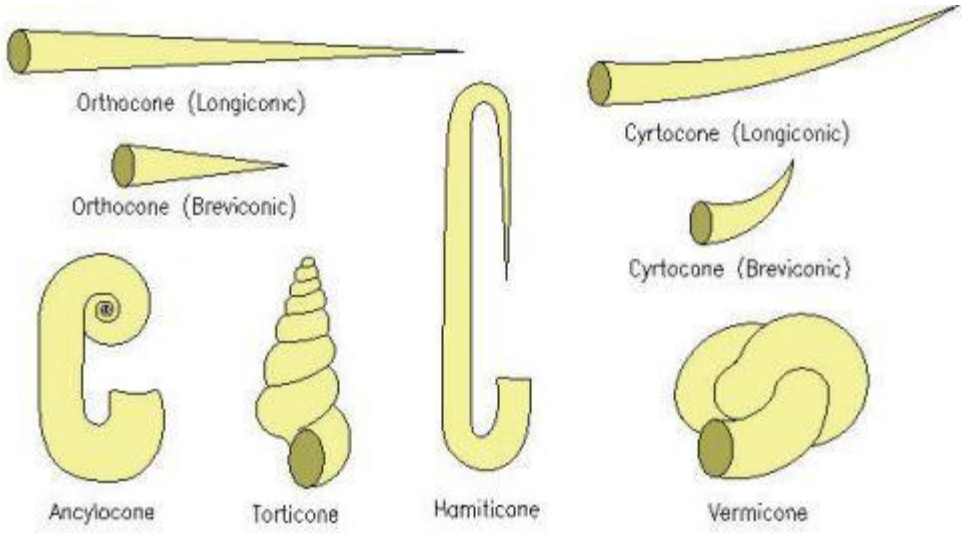

Figure 14. Irregular or Heteromorphic shell shapes.

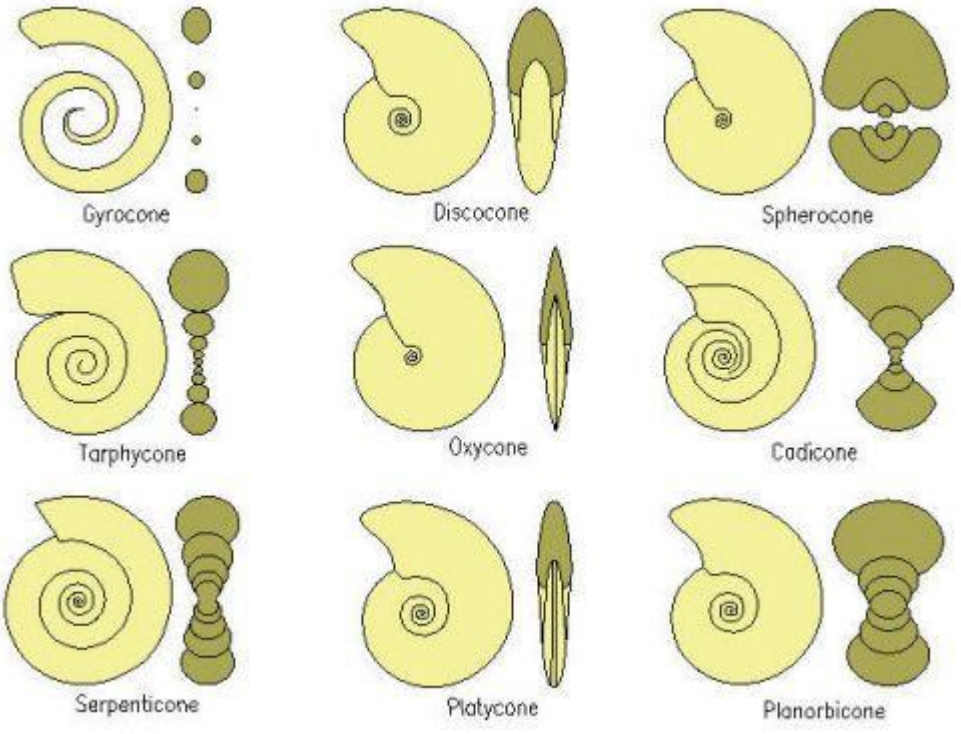

Figure 15. Planispiral shell shapes.

Ornamentation

All cephalopod shells are ornamented with at least **Growth Lines**, each one representing a former position of the peristome.

Ribs are usually radial folds of the shell so they are equally apparent on internal molds, sometimes they are thickenings of the outer part of the shell and don't show on internal molds. Ribs directed radially are **Rectiradiate**, those inclined forward are **Prorsiradiate**, and those inclined backward are **Rursiradiate**. Ribs can be **Dense**, closely spaced, or **Distant**, widely spaced. **Sinuous** ribs snake across the flanks, **Falcate** ribs are sickle-shaped, **Falcoid** ribs are generally falcate, **Projected** ribs are inclined forward on the outer portion. **Branching** ribs have **Secondary Ribs** that branch from **Primary Ribs**. **Virgatotone** ribs have other ribs branching from a single inclined rib. **Intercalated Ribs** are ribs not connected to other ribs. **Bundled** ribs are connected at one dorsal point. **Zigzag** ribs are alternately connected at the dorsal and ventral ends. **Looped** ribs are connected at both ends.

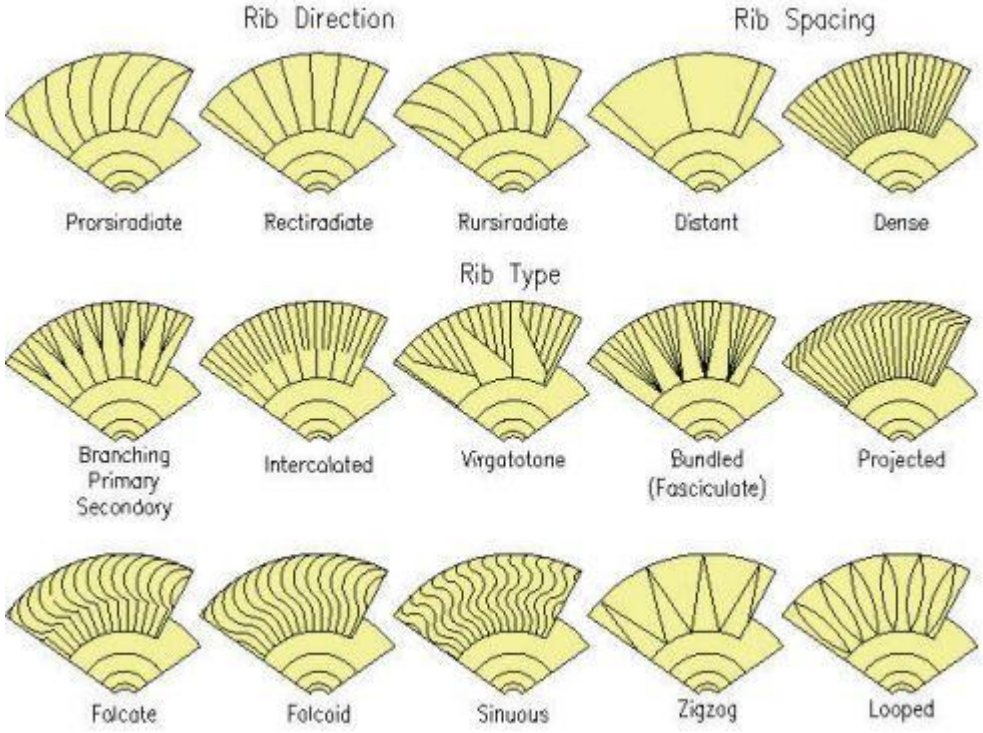

Figure 16. Type, direction and spacing of ribs.

Constrictions are internal shell thickenings and usually only show on the internal mold as sinuous transverse grooves. **Lirae** are small, usually longitudinal, raised portions of the shell separated by **striae**, small grooves. If they are strong enough they will show on internal molds.

Tubercles and other **Nodes** are present on some shells. Nodes on internal molds are commonly the bases of **Spines**. Spines were usually formed hollow on the peristome and sealed later as the shell grew. Tubercles elongated radially are termed **Bullae**, and those elongated longitudinally are termed **Clavi**.

A raised longitudinal ridge on the venter is called a **Keel**. Keels can be **Entire** (smooth), **Serrated** or **Clavate**. Sometimes a **Furrow** or groove can be found on each side of the keel.

A large, deep, longitudinal groove is called a **Sulcus**, and can be found on the venter or in a lateral position.

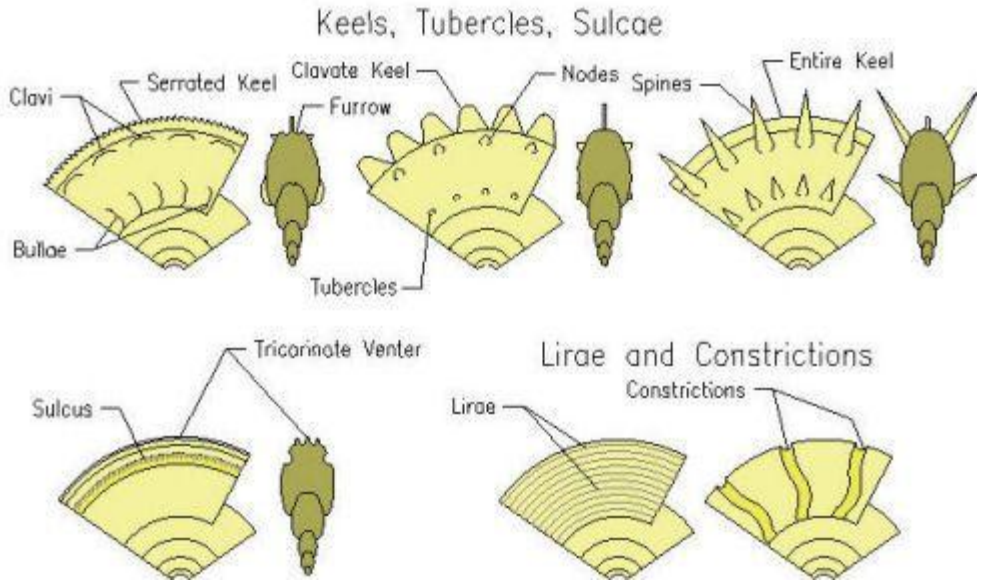

Figure 17. Ornamentation other than ribs.

Sources

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