Almost all the major groups of invertebrates including those living today appeared in the fossil record near the end of early Cambrian period around 514 million years (Myr) ago. The Cambrian or early Palaeozoic life was largely confined to the marine realm in which brachiopods and corals were the two major components in addition to some others. Hence, it is true to say that life the history of these groups of invertebrates is considerably long, about 514 Myr old. Brachiopods and corals are marine animals. Today both these groups have decreased in numbers compared to Palaeozoic times. You can see the living brachiopods at a few beaches and corals in shallow tropical waters. In this unit, we will discuss the systematics, morphology and geological history of brachiopods and corals.
Expected Learning Outcomes

After reading this unit, you should be able to:

- define brachiopods and corals;
- describe the morphology of brachiopod shell or valves and coral skeleton;
- discuss the geological history of brachiopods and corals;
- list the major groups of brachiopods and corals; and
- analyse the significance of coral growth rings.

13.2   BRACHIOPODS

The Brachiopoda (Brack-i-oh-poda) is a major fossil group of animals. Though present day brachiopods are an insignificant group, they have a long fossil history and at one time they were a dominant and diverse phylum of invertebrate animals. They are entirely marine animals with bilateral symmetry and having a soft coiled ciliated feeding and respiratory organ known as lophophore, which is present within a two-valved shell. Brachiopods occur in all oceans at depths ranging from the intertidal to 5000 m. Most brachiopods live on the bottom of the ocean floor, though some burrow. Till date no brachiopod has been found in the fresh water environment.

13.2.1   What Is Brachiopoda?

Brachiopoda is an independent phylum of invertebrates. The name Brachiopoda is derived from Latin words brachium meaning arm and poda meaning foot, which gave its name to the phylum (literally arm-foot). Brachiopods are commonly known as lamp shells, because these shells have some resemblance to Roman oil lamps. All brachiopods are sessile (non-mobile), benthic, solitary marine animals having shells made of two unequal valves and live on the sea floor usually in clusters. Many of them remain fixed to the sea floor while others just lie on the sea-bed. They are filter-feeders and collect their food particles from ocean currents by using the lophophore. They have been found living in a wide range of marine environments from shallow marine to deep marine and warm tropical waters to cold Antarctic seas. The presence of brachiopod fossils in sedimentary rocks indicates ancient marine conditions.

The brachiopod shells are made up of mineral calcite (CaCO$_3$ - Calcium Carbonate). They consist of two unequal valves that enclose its soft body’s tissues such as mantle, lophophore, pedicle and muscles. The two valves vary in size and morphology and are joined together in two different ways either by hinge (teeth and sockets) or by muscles (Fig. 13.1). Based on the nature of joining two valves, the brachiopods were previously grouped into two classes, namely, Articulata and Inarticulata. In articulate brachiopods, the two valves are joined by means of teeth and sockets and in inarticulate brachiopods, they are held together by muscles only. Presently, brachiopods are divided into three classes: Linguliformea, Craniiformea and Rhynchonelliformea based on cladistic analyses. However, linguliformeans and craniiformeans represent inarticulate brachiopods and rhynchonelliformeans refer to articulate brachiopods (Benton and Harper, 2009; Milsom and Rigby, 2010).
Brachiopods have some superficial similarity to bivalves in that the shell of both animals is made of two valves. The fundamental difference between these two groups of animals is in the size and position of the valves. In brachiopods, the two valves are of unequal size while size of valves is equal in case of bivalves. Moreover, the valves of brachiopods are ventral and dorsal in position (Fig. 13.2) while those of bivalves are right and left. We will discuss bivalves in Unit 14.

**Fig. 13.2: Schematic of a living brachiopod showing the position of pedicle and brachial valves with respect to the soft body parts. The valve that bears the pedicle opening is always known as ventral and the valve that contains the support for the lophophore is dorsal.**

### 13.2.2 Systematic Palaeontology

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subkingdom</td>
<td>Metazoa</td>
</tr>
<tr>
<td>Phylum</td>
<td>Brachiopoda</td>
</tr>
<tr>
<td>Subphyla</td>
<td>Linguliformea</td>
</tr>
<tr>
<td></td>
<td>Craniiformea</td>
</tr>
<tr>
<td></td>
<td>Rhynchonelliforma</td>
</tr>
</tbody>
</table>

The basic differences between the above mentioned subphyla of brachiopods are listed in Table 13.1.

**Did you know:** In palaeontology, the term calcareous is used to represent the chemical composition of the shells of organisms e.g., molluscs, which are made up of mainly calcium carbonate. However in geology, the term
calcareous is applied to a sediment, sedimentary rock, or soil type which contains a high proportion of calcium carbonate.

**Table 13.1: Simplified characteristics of three subphyla of brachiopods.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Phylum Brachiopoda</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subphylum Linguliformea</td>
</tr>
<tr>
<td>Shell chemistry</td>
<td>Organo-phosphatic</td>
</tr>
<tr>
<td>Valves joining system</td>
<td>Valves are not joined by teeth and socket joining mechanism</td>
</tr>
<tr>
<td>Pedicle</td>
<td>Present</td>
</tr>
</tbody>
</table>

### 13.2.3 Morphology

The shell of a brachiopod consists of two-valves which are held together either by teeth and socket (e.g., rhynchonelliformeans or articulates) or by muscles (e.g., linguliformeans and craniiformeans or inarticulates). It is important to note that there are certain basic morphological features, which are common in all types of brachiopods. Since articulate brachiopods are well-represented in the fossil records, they are more important from a paleontological point of view than inarticulates. Also they bear all the hard parts that are seen in inarticulates, hence, here we will describe the morphology of articulate brachiopods only.

The two valves of brachiopods are morphologically quite different, especially in terms of size, shape and orientation. However, in typical brachiopods, each valve is bilaterally symmetrical and one valve is always larger than the other. The larger valve is commonly known as **pedicle** or **ventral valve**. It contains an opening known as **pedicle opening** or **foramen** at the beak where a fleshy or muscular stalk called the **pedicle** emerges and attaches the animal to the ocean floor or to another animal. The smaller valve is known as **brachial** or **dorsal valve** (Fig. 13.3). It contains the lophophore (a food gathering organ) along with its supports. Lophophore has two arms called **brachia**, which give the name to the valve.

Each valve has a pointed end which is known as **beak** and it marks the beginning of shell growth. In brachiopod shells, the shell growth mostly occurs in the forms of concentric lines, radial ribs or corrugations on the exterior surface of the valves. The arched part of the valve near the beak is called **umbo** and it is more pronounced on the pedicle valve. The beak is considered the **posterior** end of the valve whereas the rounded margin located opposite to the beak is the **anterior** end as shown in Fig. 13.4.
Commissure is the line where the two valves meet (Fig. 13.4b). It may be straight or zig-zag. Brachiopods have muscles that are used to open and close their valves. They are attached inside the valves and their places of attachment are marked by smooth, depressed or elevated areas which are described as muscle scars or markings. In articulate brachiopods, the opening and closing of the valves are controlled by two sets of muscles, namely, the diductor and adductor muscle scars. The diductor muscle scars open the valves while adductor muscle scars close the valves (Fig. 13.5). There is another set of muscle scars that are present on the pedicle valve known as adjustor muscle scars. In living conditions, a set of adjustor muscles are attached here and on the other side they are attached to pedicle to facilitate the movement of pedicle.

In some brachiopods, the pedicle valve has a deep medial depressed area described as the sulcus that receives a medial elevated portion termed as fold of the brachial valve. Teeth are knob-like projections that are present on
the posterior end of the pedicle valve and fit into the small depressions known as sockets of the brachial valve. The contact point where teeth and sockets of the two valves rotate to open and close forms the hinge and the portion of the posterior end where both valves meet is known as hinge line (Fig. 13.5). A straight hinge line is described as strophic, while a curved one is named as astrophic.

The flat or curved surface between the beak and hinge line is called the interarea, which may be present on both the valves. Interarea of pedicle and brachial valves are commonly known as the pedical interarea and brachial interarea, respectively. An interarea is more conspicuous on the pedicle valve. Directly beneath the beak, the interarea of the pedicle valve may be interrupted by a triangular cavity called delthyrium from which emerges the pedicle. The corresponding cavity in the brachial valve is known as notothyrium as shown in Fig. 13.6. The delthyrium may be partly or fully closed by the two calcareous deltidial plates forming the deltidium and the corresponding covering of notothyrium is known as chilidium (Moore et al., 1997).

Fig. 13.6: Posterior view of a brachiopod shell showing external morphology.

In the delthyrium area, the single calcareous plate covering is termed as deltidial plate and if the same area has more than one plate then it is termed as deltidium. Single calcareous plate covering of notothyrium is known as chilidial plate and two or more plates covering is described as chilidium.

The shell of most articulate brachiopods consists of two layers; an outer layer made of organic compounds periostracum, and mineralised (inorganic) inner layers referred to as primary and secondary. Brachiopod valves come in a variety of shapes like convex, concave or flat and some forms show interesting external ornamentation of costae and plicae. Costae are very fine radial ridges on the external surface of the valve originating from the beak and plicae are radial ridges present on external as well as internal surfaces of the valve. In a few forms, the valves are covered with spines.

**Key morphological features of brachiopods:** pedicle (ventral) valve, brachial (dorsal) valve, beak, umbo, commissure, teeth, sockets, hinge line and interarea.
Unit 13  
Brachiopods and Corals

SAQ 1

a) What is the function of a lophophore in brachiopods?
b) Name the three subphyla of Brachiopoda.
c) Match the following:
   (i) Inarticulate brachiopods   (a) Brachiopods with teeth and sockets
   (ii) Pedicle valve bears       (b) Posterior end where valves meet
   (iii) Hinge line               (c) Brachiopods without teeth
   (iv) Articulate brachiopods   (d) Brachiopod valves
   (v) Unequal valves with a     (e) Pedicle opening
      bilateral symmetry

13.2.4 Geological History
Brachiopods have a very long geological history because they first appeared near the beginning of the Cambrian period and some of the forms are still alive today on the floor of the modern oceans (Fig. 13.7). Most of the Cambrian brachiopods were considered to be inarticulates, but few forms of primitive articulate brachiopods are also known from Cambrian. They diversified in the Ordovician and reached the peak of their diversity during the Ordovician, Silurian and Devonian. Cambrian faunas were dominated by the inarticulate and Ordovician by articulate brachiopods. They remained a dominant community in the marine ecosystem throughout the Palaeozoic era. At the end of Palaeozoic, many brachiopod families became extinct, and only a very few of them made the transition to the post-Palaeozoic (i.e. Mesozoic and Cenozoic) time. Only a few orders of brachiopods such as Lingulida, Discinida, Craniida, Rhynchonellida, Thecideida and Terebratulida have living representatives today. Because of their great diversity, they have been used as index fossils for dating the Palaeozoic rocks. The geological range of some of the orders of brachiopods is given in Table 13.2.

Table 13.2: Geological range of some orders of brachiopods.

<table>
<thead>
<tr>
<th>Subphylum</th>
<th>Order</th>
<th>Geological range</th>
<th>Important genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguliformea</td>
<td>Lingulida</td>
<td>Cambrian to Recent</td>
<td>Lingula, Obolus, Pseudolingula</td>
</tr>
<tr>
<td>Craniiformea</td>
<td>Craniida</td>
<td>Ordovician to Recent</td>
<td>Crania, Neocrania</td>
</tr>
<tr>
<td>Rhynchonelliformea</td>
<td>Oboelligida</td>
<td>Cambrian</td>
<td>Oboella, Trematobolus</td>
</tr>
<tr>
<td></td>
<td>Strophomenida</td>
<td>Ordovician to Triassic</td>
<td>Billingsella, Eopectodonta</td>
</tr>
<tr>
<td></td>
<td>Productida</td>
<td>Ordovician to Triassic</td>
<td>Productus, Gigantoproductus</td>
</tr>
<tr>
<td></td>
<td>Orthida</td>
<td>Cambrian to Permian</td>
<td>Orthis, Dalmanella</td>
</tr>
<tr>
<td></td>
<td>Pentamerida</td>
<td>Cambrian</td>
<td>Pentamerus,</td>
</tr>
</tbody>
</table>
The brachiopods faced five major events of extinction which were followed by events of recoveries and diversifications. These events are end-Ordovician, late Devonian, end-Permian, end-Triassic and end-Cretaceous mass extinctions. Out of these, three events, namely, end-Ordovician, end-Permian and end-Cretaceous were very severe events which caused about 80%, more than 90% and around 70%, extinction among brachiopods at family and species levels, respectively. As a result of such extinction events, out of 4500 fossil genera of brachiopods, only 120 are living today while all others are extinct.

**Story of Lingula – As a Living Fossil**

*Lingula* is the best known representative of linguliformean (inarticulate) brachiopods and belongs to the class Lingulata. It first appeared in the
Cambrian and is still persisting today. Thus Lingula has a long geological history, ranging from Cambrian to Recent (i.e., more than 550 million years) and its body shows morphological stability, meaning no significant changes took place in the biology of Lingula during its entire span of life history. Since Lingula has survived today without any significant morphological changes from the early Palaeozoic, it is often considered as one of the classic examples of living fossils. It is important to note that Lingula has escaped every major extinction event throughout history.

**SAQ 2**

a) What is the geological range of brachiopods?

b) Which of the following brachiopods appeared first in the fossil record?
   i) Inarticulate brachiopods
   ii) Articulate brachiopods

c) Which of the following era is also known as age of brachiopods?
   i) Mesozoic  (ii) Palaeozoic  (iii) Cenozoic

d) Lingula belongs to the order:
   i) Lingulida  (ii) Rhynchonellida  (iii) Spiriferida

### 13.3 CORALS

Corals are cnidarians (Ni-da’-ri-ans). Apart from corals, phylum Cnidaria also includes anemones, jellyfish, sea fans, sea pens and their close relatives. Most cnidarians live in the seas, but a few thrive in the fresh water environment. Cnidarians are characterised by their cylindrical body, radial symmetry and carnivorous nature. They have two basic life forms, namely, polyp and medusa (Fig. 13.8). Polyps are usually sessile animals, which have a tube-shaped body with an opening at the top that functions both as a mouth and anus. This opening is surrounded by a number of tentacles. Typical examples of polyps are corals and sea anemones. While medusae (singular medusa) are free-swimming sea inhabitants and their body has an inverted orientation relative to that of polyps. The mouth of a medusa is located downward. The jellyfish is a common example of medusa. Since the tentacles of cnidarians have poisonous stinging cells, they are also known as “nettle-bearers” (Benton and Harper, 2009).

![Fig. 13.8: Life cycle of cnidarians showing polyp and medusa forms. Note that polyp is attached to the bottom/substratum and has its mouth upward. Medusa is a floating form of cnidarians having its mouth downward.](Source: simplified after Clarkson, 1979; Benton and Harper, 2009)
13.3.1 What are Corals?

Corals are flower-like simple sea animals (Fig. 13.9a). They are composed of tiny, fragile animals known as **coral polyps**. They have no medusa forms. Corals occur mostly in the form of colonies (groups of thousands of coral polyps) (Fig. 13.9b), and very few corals are solitary (Fig. 13.9c). The size of an individual coral ranges from tiny up to 30 cm in diameter. Coral polyps are nocturnal; as a consequence, they remain inside their skeletons during the day. At night, polyps extend their tentacles to feed by capturing and eating planktons. Some coral polyps, for example, polyps of scleractinian corals have established a symbiotic relationship with an important group of photosynthetic algae known as **zooxanthellae**. Zooxanthellae give brilliant colour to the corals and keep them healthy by providing them nutrition and removing their waste.

![Fig. 13.9: Corals: a) Living; b) Colonial; and c) Solitary corals. (Courtesy: Prof. G.V.R. Prasad for b and c)](image)

Corals are classified into two types: hard corals and soft corals.

i) **Hard Corals**: They have a hard exo-skeleton made of calcium carbonate (limestone). Hard coral polyps extract calcium from the sea water and use it to create a hardened structure for protection and growth. They are also known as the **stony** and **reef building corals**.

ii) **Soft Corals**: They have no exo-skeleton; hence they are more tree-like and flexible. The skeleton of soft coral is located within their bodies and is less rigid than the skeleton of hard corals.

To survive and grow, corals require shallow, clean, mud/sediment free water where sunlight can reach. They thrive in water having 5 to 10 m depth, however, some corals can grow poorly at depths of 90 m. Hard corals grow best in warm water (tropical oceans) having temperature in the range of 21 - 29°C whereas soft corals thrive mainly in cold, high-latitude waters (Garrison, 2009). Corals prefer salt water to survive, so this is the reason that they do not thrive in areas where rivers drain fresh water into the ocean.

13.3.2 Systematic Palaeontology

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subkingdom</td>
<td>Metazoa</td>
</tr>
<tr>
<td>Phylum</td>
<td>Cnidaria</td>
</tr>
<tr>
<td>Class</td>
<td>Anthozoa (corals and sea anemones)</td>
</tr>
</tbody>
</table>
Corals belong to the class Anthozoa. Anthozoans include two groups of corals as discussed above, namely, soft corals and hard corals. Soft corals (subclass Octocorallia), have a poor fossil record because of their soft skeleton, but they are well known in modern oceans and are represented by the sea pens and sea fans. Hard corals (subclass Zoantharia) have left a good fossil record due to the easy preservation of their skeletons. Hence, palaeontologists are more concerned with the hard corals. Zoantharians comprise three orders: Rugosa, Tabulata and Scleractinia. Of these, rugose and tabulate corals are extinct and all modern corals are scleractinian corals.

### 13.3.3 Morphology

Coral skeletons are calcareous, which can be made either by calcite or aragonite (both are mineral forms of calcium carbonate – \( \text{CaCO}_3 \)). As you know polyp is an individual coral animal and it has a soft body that secretes a cup-shaped skeleton in which the animal sits. The whole skeleton of a simple coral is known as the corallum (Fig. 13.10). In case of the colonial corals, the skeleton of each individual coral of the colony is described as a corallite. The skeleton of a simple coral is more or less conical or horn-like in shape. The shape of the colonial corals tends to be dome-like. The bowl-shaped depression at the distal end of the corallum which contains soft parts of the animal is termed as calyx (plural calices). The outermost calcareous wall of the skeleton which forms the boundary of corallum and sometimes shows growth rings is called epitheca (Fig. 13.10).

![Fig. 13.10: Line drawings of corals showing morphological features. (source: redrawn after Nield and Tucker, 1985; Milsom and Rigby, 2010)](image-url)

A number of vertical and horizontal structures are developed within the corallum to support the growth of the polyp. The vertical structures/plates radiating from the centre of the cavity within the corallum are termed as septa (singular septum). Thin plates joining the adjacent septa are the dissepiments. The septa may vary in size. As the polyp grows more septa are required to adjust the growth of the skeleton. The first formed septa known as prosepta (primary septa), which are longer and thicker than the secondary septa, metasepta intercalated between them (Fig. 13.11). Sometimes, the
Invertebrate Palaeontology

Block 4

Septa appear outside the corallum as ridge-like structures called costae. The horizontal structures/plates are known as tabulae (singular tabula).

Fig. 13.11: Line drawing showing coral morphology: a) coral skeleton; b) enlarged view of calyx (a) showing prosepta and metasepta.

Fossula is a pit/depression at the surface of the calyx which forms due to the stoppage of growth of septa. Columella is a vertical rod which occupies the central region of the coral and extends from the base of the coral’s chamber at the bottom of the calyx (Fig. 13.10). A solid structure of columella with knob or pointed end at the calyx is said to be styliform.

Key morphological features of corals: corallum, corallite, calyx, epitheca, septa, dissepiments, prosepta, metasepta, costae, tabula, fossula, columella, and styliform.

Some corals do not form colonies and remain simple or single throughout life. While other corals which are simple in their young stage form communities during the later stage by giving off buds. Such corals are called reef building corals. The budding process involves a loss of individuality and transforms a simple coral polyp into a compound individual, which gives rise to a mass of polyps known as a colony. Therefore, it is not necessarily true that all corals possess all above described morphological characters. Now let us familiarise ourselves with the three groups (orders) of the hard corals in brief.

i) Tabulate Corals (Order Tabulata): They are colonial corals and their skeletons are made of calcite. They have very well developed tabulae and weakly developed septa (Fig. 13.12a).

ii) Rugose Corals (Order Rugosa): They are solitary and colonial corals and their skeletons are made of calcite. They have well-developed septa and possess coarse ridges on the outer wall of corallum known as rugae. The rugae are the rough ridges or wrinkles (rugae) present on the outer surface of the rugose coral Tabulae and dissepiments are common elements of rugose corals (Fig. 13.12b).

iii) Scleractinian Corals (Order Scleractinia): They are solitary and colonial corals. They have light and porous skeletons made of aragonite. They differ from the rugose corals by their patterns of septal insertion. The septal insertion in the scleractinian corals are arranged in sets or multiples of six and in sets of four in case of rugose corals (Fig. 13.12c).
13.3.4 Geological History

In the preceding sections of the unit, you have learnt about the general morphology of a coral and about the three orders of hard corals. In this section, we will discuss the geological history of hard corals (Fig. 13.13).

**Fig. 13.13**: Stratigraphic distribution of three orders of corals. Inferred evolutionary relationships are shown by thin dotted lines. Each group of corals evolved separately possibly from a soft-bodied ancestor. Thickness of the columns shows the abundance of the particular order of corals in a specific period (source: redrawn and modified after Milsom and Rigby, 2010; Jones, 2011). Width of column represents the abundance of corals in a particular period/era.

---

**Fig. 13.12**: Groups of corals: a) Tabulate; b) Rugose; and c) Scleractinian corals.
As you know, corals belong to phylum Cnidaria. Cnidarians first appeared in the Precambrian and there are some doubtful tabulate corals which are known from the Cambrian period. We mentioned earlier that rugose, tabulate and scleractinian are the important fossil coral groups because they have long and well-preserved fossil record. Rugose and tabulate corals evolved in the Ordovician period from soft-bodied anemone ancestors. They are also known as corals of Palaeozoic era. They appeared in the Late Ordovician period, diversified in the Silurian, Devonian and declined in the Late Devonian and Carboniferous, and finally became extinct at the end of the Permian period (Fig. 13.13). Scleractinian corals evolved in the middle Triassic from soft-bodied ancestors. They first appeared in the Triassic period and diversified throughout the Mesozoic. However, some representatives or genera of scleractinians became extinct at the Cretaceous/Tertiary boundary, but others radiated rapidly after the Cretaceous/Tertiary boundary mass extinction at around 66 Ma ago (Fig. 13.13). They are also known as modern reef building corals and corals of Meso-Cenozoic era.

SAQ 3

a) Corals belong to class ......................
b) Is medusa present in the corals? Yes or No.
c) Corals are .................... (Sea animals or Sea plants ).
d) Which group of corals form coral reefs? (a) Octocorallia, (b) Zoantharia.
e) Match the following:
   (i) Calyx    (a) Rugose and tabulate corals
   (ii) Corallum (b) Outer wall of coral’s skeleton
   (iii) Epitheca  (c) Skeleton of a simple coral
   (iv) Septa     (d) Horizontal plates present in the body of corals.
   (v) Tabulae   (e) Scleractinian corals
   (vi) Columella (f) Bowl-shaped depression at the top of corallum
   (vii) Palaeozoic (g) Vertical plates radiating from the centre of the
corals        cavity within the corallum
   (viii) Meso-Cenozoic (h) Vertical rod occupies the central portion coral
                      of corals

13.4 CORAL AND EARTH’S ROTATION

You have already learnt about epitheca is the outer wall of the corallite or corallum. In some corals, epitheca shows the development of growth rings or incremental lines. These rings or lines are similar to the tree rings. Let us discuss how corals develop the growth rings in their skeleton. The corals grow by extracting calcium carbonate (CaCO$_3$) from the sea waters and using it to make their skeletons. The density of the coral skeleton varies according to their diurnal, monthly or yearly response to the lunar orbit and environmental conditions, for example, light, weather and temperature. Coral skeletons
formed in different conditions have different densities. This creates growth rings on the coral which may reflect daily, monthly or yearly growth increments.

The growth rings are clearly visible in the well-preserved specimens of corals. Commonly, a fossil coral displays three types of growth bandings: fine, thick and widely spaced that reflect daily, monthly and yearly growth cycles, respectively.

Scientists have been studying these rings present in fossil corals to know whether there was any relationship between the development of growth rings in corals and change in the rotation of the Earth. An interesting study to understand this relationship was carried out by John Wells of Cornell University, USA in 1963. Wells worked on Devonian (416 – 359 Myr ago) corals, which had been dated as 370 Myr old using radiometric methods. He calculated the yearly growth bands on a variety of Devonian corals and found that Devonian corals had an average 400 daily growth bands per year. On the basis of these observations, he further suggests that the Devonian year had about 400 days, which means that each day was 21.9 hours long. Another study of corals indicates 390 days per year in the Carboniferous (359 – 229 Myr ago) as compared with approximately 360 days per year in present times. Therefore, based on the coral’s growth band study (also known as a coral clock), it has been concluded that the Earth’s rate of rotation is decreasing slowly from ancient times due to the gravitation pull of the moon as suggested by astronomical estimates. Hence, coral-clock provides a consistent support to the idea of a decrease in the Earth’s rate of rotation which is forwarded based on astronomical and radiometric methods.

13.4 ACTIVITY

Below is a posterior view of a brachiopod shell (Fig. 9.14). Label the following morphological features: pedicle (ventral) valve, brachial (dorsal) valve, beak, umbo, hinge line and ribs.

![Fig. 9.14: Posterior view of a brachiopod shell.](image)

13.5 SUMMARY

In this unit, you have learnt that:

- Brachiopods and corals are marine invertebrates.
Pedicle or ventral valve, brachial or dorsal valve, beak, umbo, commissure, teeth, sockets, hinge line and interarea are the morphological features of brachiopod shell.

Brachiopods are also classified into three groups: Linguliformea, Craniiformea and Rhynchozontiformea. They first appeared in Cambrian and a very few groups are living today. They were more dominant during the Palaeozoic and had experienced five major extinction events.

Corallum, corallite, calyx, epitheca, septa, dissepiments, prosepta, metasepta, costae, tabula, fossula, columella and styliform are major morphological features of coral skeleton.

Corals are divided into three groups, namely, Rugosa, Tabulata and Scleractinia. Rugose and tabulate corals were dominant during the Palaeozoic whereas scleractinian corals were dominant in Mesozoic and are still living.

13.6 TERMINAL QUESTIONS

1. Discuss the morphology and geological history of brachiopods.
2. Define corals and describe the morphology of coral skeleton.
3. What is stratigraphic range of corals?

13.7 REFERENCES

- Clarkson, E.N.K. (1979) Invertebrate Palaeontology and Evolution, Blackwell Science Ltd., USA.

13.8 FURTHER/SUGGESTED READINGS

1. a) Lophophore is the soft-bodied internal food gathering organ of brachiopods located inside the smaller (brachial) valve of brachiopods. They use it to pump sea water and sieve small food particles from the water.

b) Linguliformea, Craniiformea and Rhynchonelliformea.

c) (i) – (c), (ii) – (e), (iii) – (b), (iv) – (a) and (v) – (d).

2. a) Cambrian to Recent (Present or Holocene)

b) (i) Inarticulate brachiopods

c) (ii) Palaeozoic

d) (i) Lingulida

3. a) Anthozoa

b) No

c) Sea animal

d) (b) Zoantharia

e) (i) – (f), (ii) – (c), (iii) – (b), (iv) – (g), (v) – (d), (vi) – (h), (vii) – (a) and (viii) – (e).

**Terminal Questions**

1. Refer to section 13.2.

2. Refer to subsection 13.3.1 and 13.3.3.

3. Refer to subsection 13.3.4.