ADAPTATIONS OF BRACHIOPODS

ADAPTIVE RADIATION

Brachiopods have evolved in a variety of different shapes and sizes as a response to the environment they lived in and the selection pressures in that environment.

Specific adaptations are linked to three main environments: turbulent waters, quiet water and a soft, muddy substrate.

A Commisure is the margin at the posterior between the valves. It may be curved, folded or zigzagged.

ADAPTATION TO TURBULENT WATERS

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Possible reason for adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A large pedicle opening/foramen</td>
<td>To support the protrusion of a large muscular pedicle for secure attachment to a substrate in high energy waters. More muscle and strength is need for stability and to align the brachiopod to the current</td>
</tr>
<tr>
<td>Strongly ribbed valves</td>
<td>Add strength to the shell to protect against wave action.</td>
</tr>
<tr>
<td>A folded or zigzagged margin/Commisure</td>
<td>To reduce the amount and particle size of sediment entering the shells when the valves are open.</td>
</tr>
<tr>
<td>A thick heavy shell (if pedicle is absent)</td>
<td>To provide extra stability on the substrate and prevent rolling in the current.</td>
</tr>
</tbody>
</table>

![Diagram showing adaptation through time with width of bars proportional to the number of genera known from each geologic time period.](image)
### Adaptation to Quiet Waters

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Possible reason for adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>May have a median fold and sulcus</td>
<td>To separate currents entering and leaving the animal and prevent the mixing of fresh water and waste. This is both for efficiency, hygiene and prevents the entering of sediment.</td>
</tr>
<tr>
<td>May have an extension of the valves to form <code>wings</code></td>
<td>This provides a large surface area to prevent the shell sinking into the sediment (quiet waters are often muddy environments).</td>
</tr>
<tr>
<td>Smooth to weekly ribbed surface texture</td>
<td>No need to be robust in quiet conditions with no wave action.</td>
</tr>
<tr>
<td>No pedicle opening</td>
<td>The pedicle is not needed for attachment, they are free lying.</td>
</tr>
</tbody>
</table>

### Adaptation to Soft, Muddy Environments (also Quiet Water)

<table>
<thead>
<tr>
<th>Adaptation</th>
<th>Possible reason for adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves are flat with a large resting area</td>
<td>This provides a large surface area to prevent sinking into the sediment.</td>
</tr>
<tr>
<td>One part of the margin maybe turned upwards away from the sediment (a large fold).</td>
<td>This ensures that some part of the shell remains out of the sediment for feeding.</td>
</tr>
</tbody>
</table>

- On part of the valve is folded up out of sediment.
- Weakly ribbed
- Valves are relatively flat to rest on sediment
- No pedicle
- Fold and sulcus
- Extension to the valve forms wings
Brachiopods are classed on their external morphology since their internal structures are often so difficult to see and are not always preserved.

**RHYNCHONELLIDS ~ HIGH ENERGY TURBULENT WATER BRACHIPODS**

- Extant: Ordovician to recent
- Most abundant / acme: Mesozoic
- Usually, a pedicle, showing their attachment to the sea floor.
- Strong radiating ribs are common in this group. They were able to cope with high-energy water.
- The Commisural is zigzagged so that the edge of the shell stops larger particles getting in.
- Maybe a thick heavy shell, depend on the species in question?
- They have a strong fold and a sulcus. Clearly developed in species of Rhynchonella, common in the Jurassic.
- Hinge line is short and curved (astrophic), for streamlining. Also, no soft sediment so no need for a large surface area.
- The Rhynchonellids are biconvex with a bulbous shell.

**TEREBRATULIDS ~ HIGH ENERGY TURBULENT WATER BRACHIPODS**

- Extant: Devonian to recent
- Most abundant / acme: Common today (Cenozoic) but also common in the Jurassic and Cetaceous (Mesozoic)
- A circular pedicle foramen for a pedicle showing it attached to the seafloor.
- Maybe a thick heavy shell, depend on the species in question?
- Hinge line is short and curved (astrophic), for streamlining. Also, no soft sediment so no need for a large surface area.
- The valves are smooth and ovoid, giving them streamlining in high energy water.
- Many are found on oolites and sandstones showing they did live in high energy water.
- They can have a fold and a sulcus.
- The Commisural can be zigzagged so that the edge of the shell stops larger particles getting in.

**DEPENDS on ONS SPECIES HERE**
SPIRIFERIDS ~ LOW ENERGY QUIET WATER BRACHIOPODS

- Extinct: Ordovician to Jurassic
- Most abundant / acme: Carboniferous (Paleozoic)
- They have a long straight (strophic hinge line) that results in an extension of the valves to form ‘wings’.
- They often have a fold and sulcus in the middle of each valve.
- They have no pedicle foramen as they were free lying on the sediment.
- They may have only weak ribbing as they do not need to be robust.
- The folded edge of the shell remains clear of sediment, above the sediment for filter feeding and respiration.

The characterizing feature of a Spiriferid is that the Lophophore support system is a spiral shape, called spirella. This gives Spiriferid their name, ‘spiral-bearers’. The spiralled lophophore is often preserved as a thin ribbon of calcite tightly coiled within the shell.

PRODUCTIDS ~ LOW ENERGY QUIET WATER BRACHIOPODS LIVING ON SOFT SUBSTRATE

- Extinct: Devonian to Permian
- Most abundant / acme: Carboniferous (Paleozoic)
- The shell is semicircular and thick with a straight hinge line (strophic).
- They have no pedicle.
- They are either anchored by hollow tabular spines into a soft ooze or mud on the sea floor. Or, they rest on the substrate with their strophic hinge line.
- They typically have one flat brachial valve (upper/dorsal) and one lower highly convex pedicle valve (ventral). This helps the organism stay in place on the sea floor.
- Depending on the species, there may be a margin folded up away from the sediment for feeding and respiration. DEPENDS ON SPECIES

The genus, Productus, was very abundant with a wide geographical range. Some species are large - over 60mm across. They had both valves radiated. The spines are fragile.