Worksheet: Palaeozoic invertebrates

This practical session will help you to:

- Become familiar with key features of common Palaeozoic invertebrates
- Develop your observational skills
- Appreciate the process of classifying fossils

Structure

This practical will introduce you to trilobites and brachiopods. You should also have time to meet the bryozoans and corals. Together these four groups are perhaps the most abundant and important that lived during the Palaeozoic.

We're going to consider the process of classification, and along the way try to learn how best to study fossil material. There is often more to a fossil than meets the eye, and the art of identifying fossils and extracting data from them is largely a process of training the eye to make careful observations.

Choose now whether you will study the brachiopods or the trilobites first (the order doesn't matter).

First taxon (45 minutes)

Collect two different fossils from your chosen taxon (any two trilobites, or a brachiopod from each of the two different trays). As a brainstorming exercise, quickly write down how the two fossils differ from one another morphologically. Aim to spot at least five differences.

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How easy did you find it to find differences? Was it easy to describe them verbally?

Two key skills in the palaeontologist's toolkit are valuable aids in this process.

Sketching fossils is important not just because it allows you to remember what the fossil looked like later – a photograph could do that – but also because it forces you to observe and interpret features in the specimen. When you were just looking at the fossil, you might not have paid much attention to the number of ridges (say) or the angle between them – sketching a fossil compels you to observe such details.

Using appropriate **terminology** is also enormously helpful. Unfamiliar terms can be a pain to memorize, but it's much easier and more precise to say "facial suture" than "the wiggly line that runs along the head bit", and someone else who knows the lingo will know straight away what you mean.
What is more, the vocabulary of technical terms is carefully chosen to refer to features that are homologous (i.e. equivalent, or inherited from a last common ancestor) within a group. This means that the same word can be used for different fossils within that group, and often means that the *absence* of such and such a feature is in itself notable.
Finally, each term is something that can be described; once you know what a delthyrium is, you might notice differences in the delthyrium shape that you would otherwise have overlooked.

Try now producing labelled sketches of the two fossils you have chosen. Refer to the handouts to see the terms as they apply to idealized fossils, then identify the features on your own fossils. A good sketch need not be an artistic masterwork: focus on keeping your drawing as simple as possible, whilst depicting (and annotating) the key features of the fossil. Remember to include a scale. Use all the available space, drawing the fossil from different angles if necessary.

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Having produced a labelled anatomical sketch of your two specimens, can you add any other differences to the list you prepared earlier? Express the differences using appropriate terminology.

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Systematic description (10 minutes)

Now we'll attempt a systematic description of a new fossil. Collect a third trilobite or brachiopod from either drawer. Imagine for a moment that you have just pulled it out of a cliff face, and your expert friend tells you that it is new to science! Naturally you'll want to describe it as a new species. Let's work through the process of a formal description here.

Classification

The first step is to identify which larger group the new taxon belongs to. With the help of the handouts, can you identify the phylum, class, and order of your new species?

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Name

Next, you need to name your species. A **binomial** is the full name of a species: the name of the genus it belongs to, followed by its **specific epithet** (species-level name), written in italics with the name of the genus capitalized (i.e. *Genus species*). For example, *Lingula rostrum* is a species (*rostrum*) of brachiopod in the genus *Lingula*. Species names can be anything at all, so long as their binomial name is unique and pronounceable. (There other species called '*rostrum*', for example the gastropod snail *Calliotropis rostrum*; this is why the genus name is always given.) Names are commonly descriptive and Latinised. Species are often named after their discoverer, or an eminent figure in the discipline – but it is considered poor form to name a species after yourself.

Give your species a name – be creative!

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Diagnosis

A diagnosis describes what makes your species unique. Ideally you would establish what makes it different from every other species in its genus (or if describing a new genus, what makes it distinct from every other genus in its family). For now, why not emphasise ways that it is different from the two fossils that you have just sketched.

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Type material

Next, a single specimen must be designated the holotype. In the case of uncertainty, future fossil finds will be compared to the holotype to determine whether or not they belong to the same species. As you only have one specimen, your choice of holotype is made for you, but if you had the choice, would the specimen make a good holotype? What are some properties of a *bad* holotype specimen?

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Figure

No description is complete without a figure of the new taxon: people will need to see what it looks like! Provide an annotated sketch, highlighting its diagnostic characteristics.

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A test of your description

Congratulations! Now all you need to do is publish your observations in a scientific journal and you will have described your first species. Now let's see how effective your descriptive skills have been. A good sketch will contain all the information you need to classify a fossil. With the help of the additional handouts, but *looking only at the notes and sketches* that you've made – perhaps you want to return your specimens to their drawers? – can you assign your other two specimens to a phylum, class and order?

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Second taxon (25 minutes)

Now is your opportunity to put what you have learned about fossil description into practice. If you've been looking at trilobites, it's time to switch to brachiopods, and vice versa. Collect two different specimens from this second taxon.

This time, let's start by sketching the two fossils. Use the glossary sheet to annotate key features. Remember to include a scale bar!

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Once you've completed your sketches and consulted the glossary, list the differences between the two taxa in as much detail as you can manage (keeping an eye on the time available). Can you classify your specimens to a phylum, class and order?

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Phylum Cnidaria (30 minutes)

Identification

Use the sheet of morphological characters and the reference set to familiarise yourself with the principal features of corals. Solitary corals are difficult to identify from external features unless the growth form is very distinctive and/or details of septal arrangement can be clearly seen. Among colonial corals, tabulate corals can usually be readily distinguished from rugose corals through the much smaller corallites of the former; corallite arrangements allow most tabulate corals to be separated into suborders. Unless calical surfaces are particularly clear, detailed identification requires thin sections.

On the accompanying diagrams of a generalised solitary coral, label the following:

proximal, distal, calice, septum, tabula, dissepiment, epitheca.

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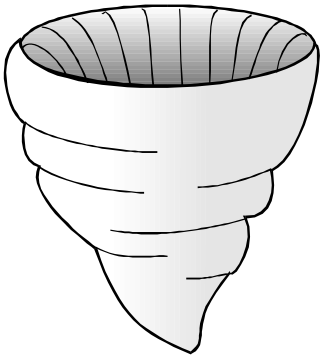

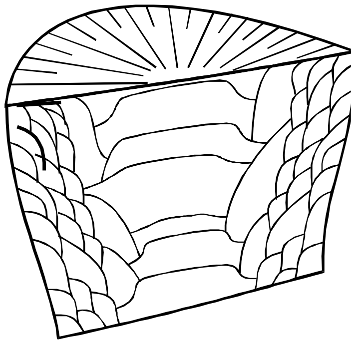

List the three important classes of fossil corals, noting their stratigraphic ranges. Quickly sketch a representative specimen from the drawers, labelling what you consider to be the three most important morphological characteristics of each.

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Which growth forms or structural organizations did the corals you chose exhibit? Find and sketch further specimens so that you have examples of three different structures of both solitary and colonial corals.

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Phylum **Cnidaria**

Class **Hydrozoa** (Prec-R) - enteron unpartitioned; mainly soft bodied polyps, polyp colonies or medusae; few with calcareous skeletons.

Class **Scyphozoa** (Prec-R) - enteron with four simple partitions; mainly soft bodied medusae.

Class **Anthozoa** (Prec-R) - enteron partitioned in series or cycles of 2, 4, 6 and 8, some with paired mesenteries; polypoid only; many with skeletons. Only subclass with important fossil orders listed.

Subclass **Zoantharia** (Camb-R) - enteron partitioned by paired mesenteries inserted serially or cyclically in 2, 4 or 6 positions; anemones and corals (only latter listed below).

Order **Rugosa** (m.Ord-P) - solitary and colonial corals, usually with epitheca; major septa inserted serially in quadrants; minor septa often present; calcitic skeleton.

Suborder **Cystiphyllina** (m.Ord-m.Dev) - septa weak or absent; horizontal tissue either absent, simple tabulae or poorly differentiated vesicular tissue.

Suborder **Stauriina** (m.Ord-P) - septa generally well developed; tabulae and dissepiments usually clearly distinguished.

Order **Tabulata** (l.Ord-P) - colonial corals, usually with epitheca; septa often spinose or lacking; many with intercorallite communication; calcitic skeleton.

Suborder **Lichenariina** (Ord) - cerioid, fasciculate, incommunicate.

Suborder **Sarcinulida** (m.Ord-m.Dev) - cerioid, coenenchymal, thick trabecular walls, communicate.

Suborder **Auloporina** (m.Ord-P) - chains and bushes of small, conical to cylindrical corallites.

Suborder **Syringoporina** (m.Ord-P) - fasciculate, communicate.

Suborder **Favositina** (m.Ord-P) - cerioid, massive or branching, communicate.

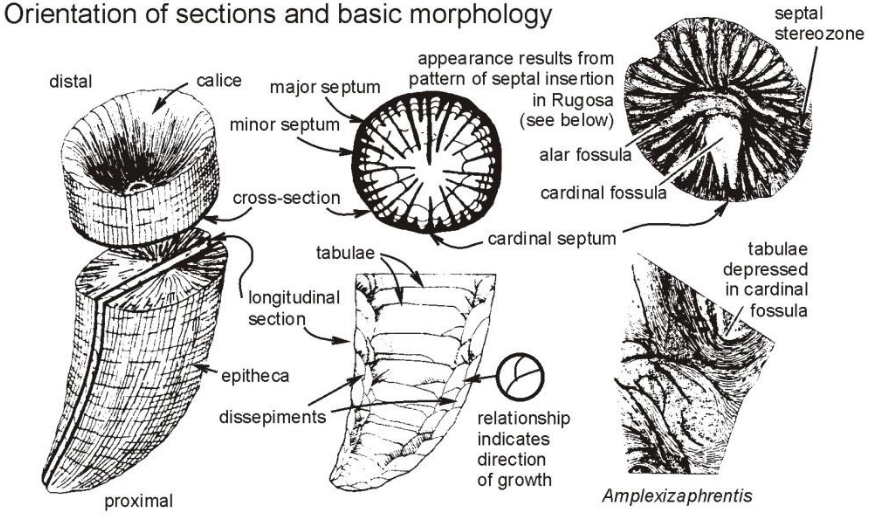
Suborder **Halysitina** (m.Ord-u.Sil) - cateniform, incommunicate.

Suborder **Heliolitina** (m.Ord-m.Dev) - coenenchymal incommunicate.

Order **Heterocorallia** (Dev-Carb) - solitary corals; septa inserted by repeated division of peripheral ends of single protoseptum; calcitic skeleton; rare.

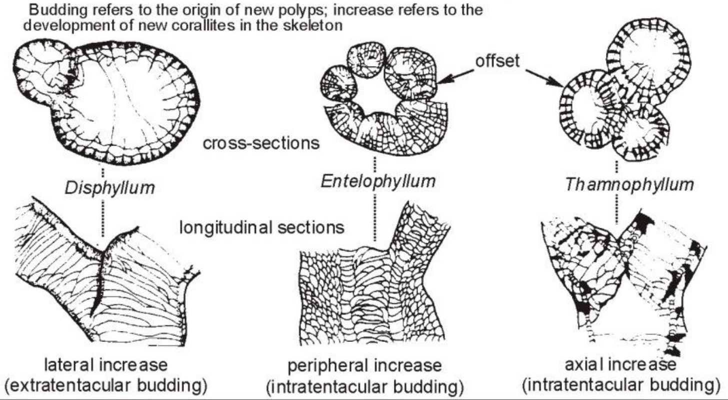
Order **Scleractinia** (m.Trias-R) - solitary and colonial corals; usually lacking an epitheca; septa inserted cyclically in sextants; aragonitic skeleton. Subdivisions currently under review.

Orientation of sections and basic morphology



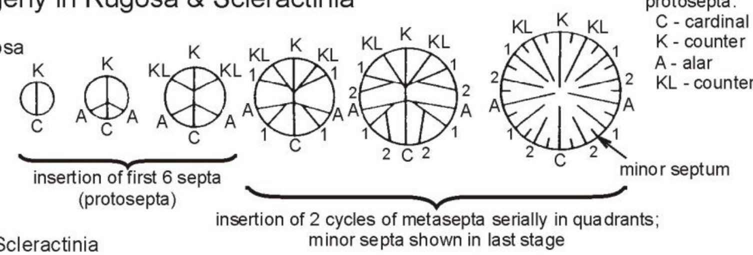
Increase (and probable budding type in polyp)

Budding refers to the origin of new polyps; increase refers to the development of new corallites in the skeleton



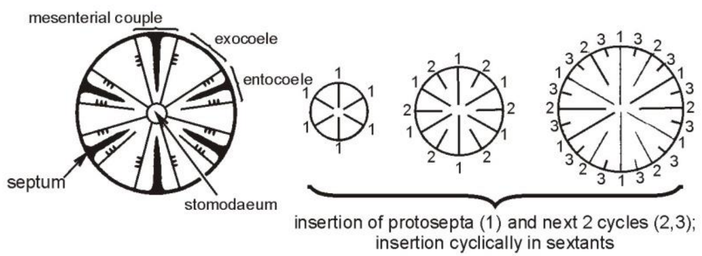
Ontogeny in Rugosa & Scleractinia

A. Rugosa

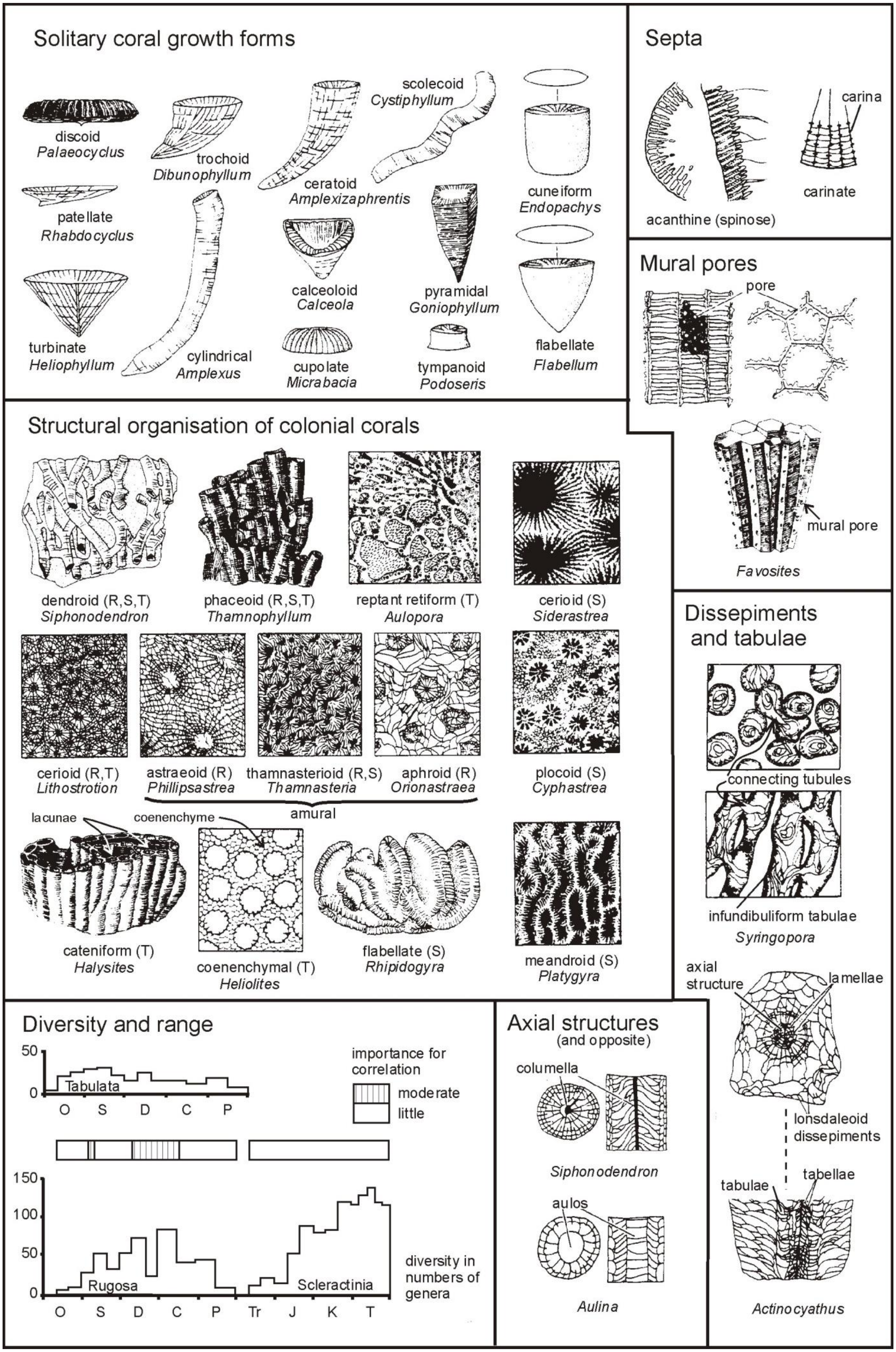


protosepta:
C - cardinal
K - counter
A - alar
KL - counter-lateral

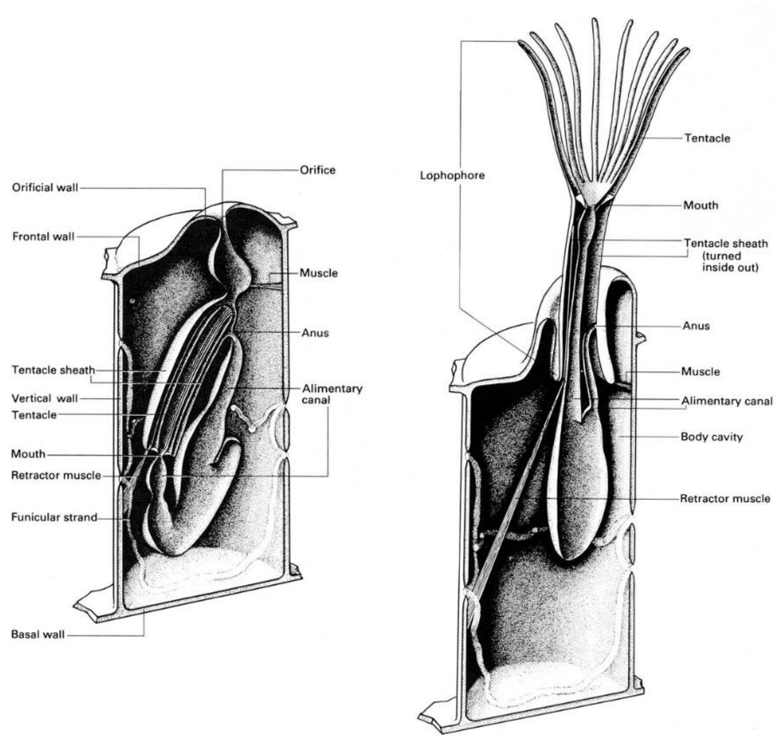
B. Scleractinia



At left:
Relationship of protosepta to mesenterial couples; ticks show position of muscular pleats on mesenteries


Solitary coral growth forms
discoid
Palaeocyclus
trochoid
Dibunophyllum
ceratoid
Amplexizaphrentis
scolecoid
Cystiphyllum
cuneiform
Endopachys
patellate
Rhabdocyclus
calceoloid
Calceola
pyramidal
Goniophyllum
flabellate
Flabellum
turbinate
Heliophyllum
cylindrical
Amplexus
cupolate
Micrabacia
tympanoid
Podoseris
Septa
carina
carinate
acanthine (spinose)
Mural pores
pore
mural pore
Favosites
Structural organisation of colonial corals
dendroid (R,S,T)
Siphonodendron
phaceoid (R,S,T)
Thamnophyllum
reptant retiform (T)
Aulopora
cerioid (S)
Siderastrea
cerioid (R,T)
Lithostrotion
astraeoid (R)
Phillipsastrea
thamnasterioid (R,S)
Thamnasteria
aphroid (R)
Orionastraea
plocoid (S)
Cyphastrea
amural
lacunae
coenenchyme
cateniform (T)
Halysites
coenenchymal (T)
Heliolites
flabellate (S)
Rhipidogyra
meandroid (S)
Platygyra
Dissepiments and tabulae
connecting tubules
infundibuliform tabulae
Syringopora
axial structure
lamellae
lonsdaleoid dissepiments
tabulae
tabellae
Actinocyathus
Diversity and range
50
0
Tabulata
O S D C P
importance for correlation
moderate
little
150
100
50
0
Rugosa
Scleractinia
O S D C P Tr J K T
diversity in numbers of genera
Axial structures
(and opposite)
columella
Siphonodendron
aulos
Aulina

Phylum Bryozoa
(10 minutes)



Bryozoans are a phylum of colonial marine invertebrates, loosely related to the brachiopods. Each individual bryozoan (a ‘zooid’) is around 0.5 millimetres long, but together they form colonies that can reach several centimetres in length. They are filter feeders, sieving food particles from the water using their retractable lophophore (a basket of hair-lined tentacles). In many of the 4000 species alive today, zooids within a single colony are differentiated to perform different functions: some take care of the eating and excreting, for example; others do all the reproducing.

Almost all bryozoan species secrete mineralized skeletons, affording them an excellent fossil record that can be tracked back to the Ordovician period.

Bryozoan colonies have a range of morphologies. With reference to the reference material, make sketches that summarise the variety of colony morphology. If you have time, use a hand lens or binocular microscope to identify and sketch the arrangement of individual zooids within a colony. Can you see evidence of zooid specialization?

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Homework: Essay writing practice

Your final examination will include essay questions. Practicing writing essays now will help you to produce better work when the time comes.

Before next week, please write an essay on the topic **How I define an individual for palaeoecological purposes**

A good essay will not just answer the question, but will answer it interestingly.

In this example, you would be expected to demonstrate that you understand why this question is worth asking. When might the answer not be straightforwards? (In particular, think about how the corals and bryozoans that you met in the practical might complicate the issue.) What are the implications of different definitions? (Think back to previous lectures: remember, for instance, that we might count the number of individuals to calculate the relative abundance of particular species.)

Make sure that you conclude your essay with a clear and justified statement of how you will define individuals, phrased such that your peers could use this statement to count individuals in their own material. We'll use the consensus decision to define our class data handling protocol.

Make an essay plan, then spend no more than 45 minutes writing an essay.

To help prepare for exam conditions, I'd suggest hand-writing your essay.

Get your essay to me by noon, the day before our next session – drop it in my pigeon hole, or e-mail me a (legible) copy.