Palaeontology

Practical 8

Phylum Arthropoda – Class Trilobata

Arthropods

- Chitinous exoskeleton
- Bilaterally symmetrical
- Articulated segmented bodies that are partitioned in three
- Paired jointed appendages for movement and feeding
- Periodic moulting (ecdysis)
- Antennae and/or multiple eyes

- 75% of all living animal species
- Includes insects, crustaceans, spiders, extinct trilobites and eurypterids
- Coelomates, possibly related to annelids
- Developed nervous and circulatory systems
- Advanced feeding, many have jaw structures
- The most successful invertebrate group
- Advanced in terms of feeding and locomotion
- Able to invade different environments and modes of life
- Thus, marine and terrestrial
- Good geological record (hard exoskeleton) from the Lower Cambrian

Trilobites

- Trilobites are the oldest group of arthropods.
- They first appear in rocks of **Lower Cambrian** and died out in the **Late Permian**.
- They were marine, mainly benthic and had
- extremely variable morphologies and lifestyles.
- They have a distinctive **tri lobed**
- morphology (hence their name)
- Over 1500 genera are known and several thousand species
- Usually small, between 5-8 cm but some forms could get up to 70 cm

General morphology

- Segmented bodies with chitinous exoskeletons and joined, paired limbs
- The body is divided longitudinally into three regions:

1. The cephalon
2. The thorax
3. The pygidium

- The exoskeleton covers both the dorsal and ventral side of the body
- Consists of a two-layered cuticle of chitin
- Usually it is hardened by the impregnation of calcium carbonate

The cephalon

- the head which consists of a single plate, made up of several fused segments.
- sense organs are found on the head
- there are also certain lines of weakness, known as **cephalic sutures,** which look like cracks on the surface but apparently facilitated ecdysis
- They are important for taxonomic determinations

- shape pentagonal to semicircular with transverse posterior edges.
- In the centre of the cephalon a raised central hump (the **glabella),** bounded at the sides by diverging **axial furrows** and reaching to the **anterior border**
- The glabella is indented by three short **glabellar furrows** and is closed off at the back of the ccphalon by an arched **occipital ring.**
- Stretching out sideways from the occipital ring are the **posterior border** furrows, which delimit a thin strip of the cephalon at the posterior edge, the **posterior border**
- **The lateral border furrow** runs parallel with the semicircular lateral border,
- Placed laterally to the glabella arc the eyes
- Above the eye lies the flat **palpebral lobe,** separated by a **palpebral furrow** from the small raised **palpebral area.**
- The thin **facial suture** runs between the palpebral lobe and the visual surface; this suture extends forwards to entour the front of the glabella, being continuous with the facial suture on the other side of the head.

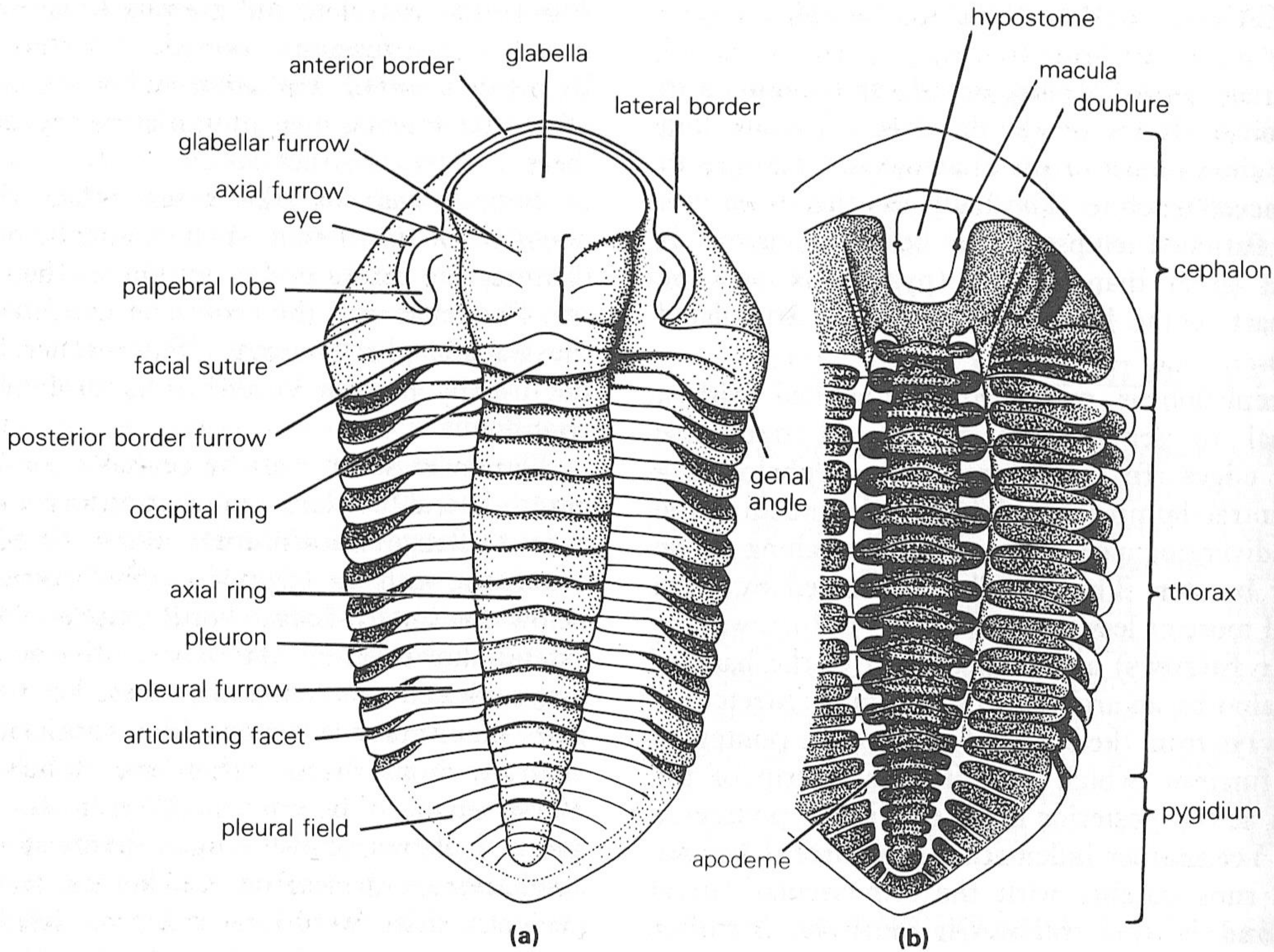
- the **genal angle** is the most postero-lateral point of the cephalon, it may project backwards and form a **genal spine**
- The region lateral to the glabella though within the suture is the **fixigena;** outside it is the **librigena.**
- In many trilobites the cephalon may distintegrate before burial into three components: the two librigenae and the central **cranidium,** which is the glabella plus fixigenae.

Ventral features

- The antero-lateral lower surface of the cephalon continues ventrally as a narrow flange **(doublure)**
- Two pairs of pronounced knobs (the **apodemes)** project ventrally from the posterior two glabellar furrows
- These are associated with the attachment and articulation of the ventral appendages. Identical apodemes are present on the thoracic segments, and evidently there were legs under the head as well as under the thorax

Ventral features

- the **hypostome** is a large plate with a central 'blister' attached to the rear edge of the anterior cephalic doublure, found below the glabella.
- The mouth lays behind the hypostome
- The shape and position of the hypostome is very variable and characteristic amongst trilobites
- A couple of small swellings (the **maculae)** lie towards the rear of the hypostome.

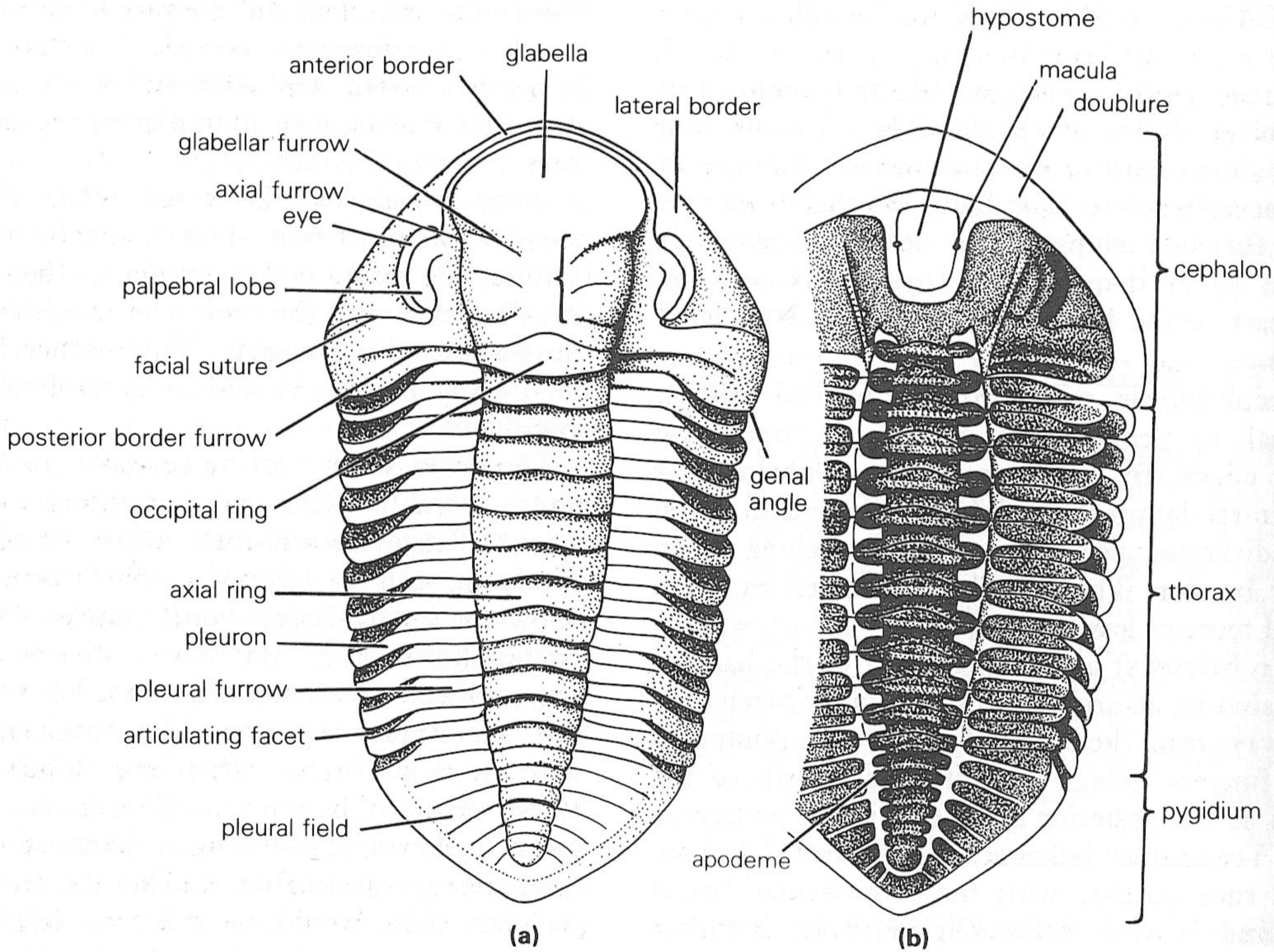

anterior border
glabella
glabellar furrow
axial furrow
eye
palpebral lobe
facial suture
posterior border furrow
occipital ring
axial ring
pleuron
pleural furrow
articulating facet
pleural field
lateral border
genal angle
hypostome
macula
doublure
cephalon
thorax
pygidium
apodeme
(a)
(b)

The thorax

- Consists of thoracic segments (2 or more)
- They are all identical in form, though the posterior ones arc slightly smaller.
- In each there is an arched **axial ring** identical in form to the occipital ring of the cephalon and defined laterally by paired **axial furrows.**
- The axial ring is bounded anteriorly by a groove (**the articulating furrow**), in front of which projects a semicircular articulating half-ring which in life fits neatly under the axial ring in front.
- The paired **pleura** (sing. pleuron) project horizontally from the axial ring, though their outer extremities are sharply turned down. Each pleuron is indented by an oblique pleural furrow.
- There is a short doublure on the outer edge of each pleuron.
- The anterior edge of the downturned distal part of each pleuron is a flat and truncated articulating facet (helped it to roll up in a ball)
- The pleura are separated by **interpleural furrows.**

The pygidium

- The pygidium is a flat plate of fused segments resembling those of the thorax (1 in Cambrian olonelids to 30 segments)
- It has a similar half-ring at the front and is articulated with the last thoracic segment in the same way as the thoracic segments
- The pygidial axis has a series of furrows equivalent to articulating furrows, becoming more closely spaced and fainter towards the rear.
- The lateral parts of the pygidium (**pleural fields**) are sculpted by two kinds of indentation: one series equivalent to the edges of the thoracic segments (interpleural furrows), the other to the thoracic pleural furrows.
- Often the latter are more strongly pronounced in the trilobite pygidium. The pygidial doublure has about the same width as the cephalon.



anterior border
glabella
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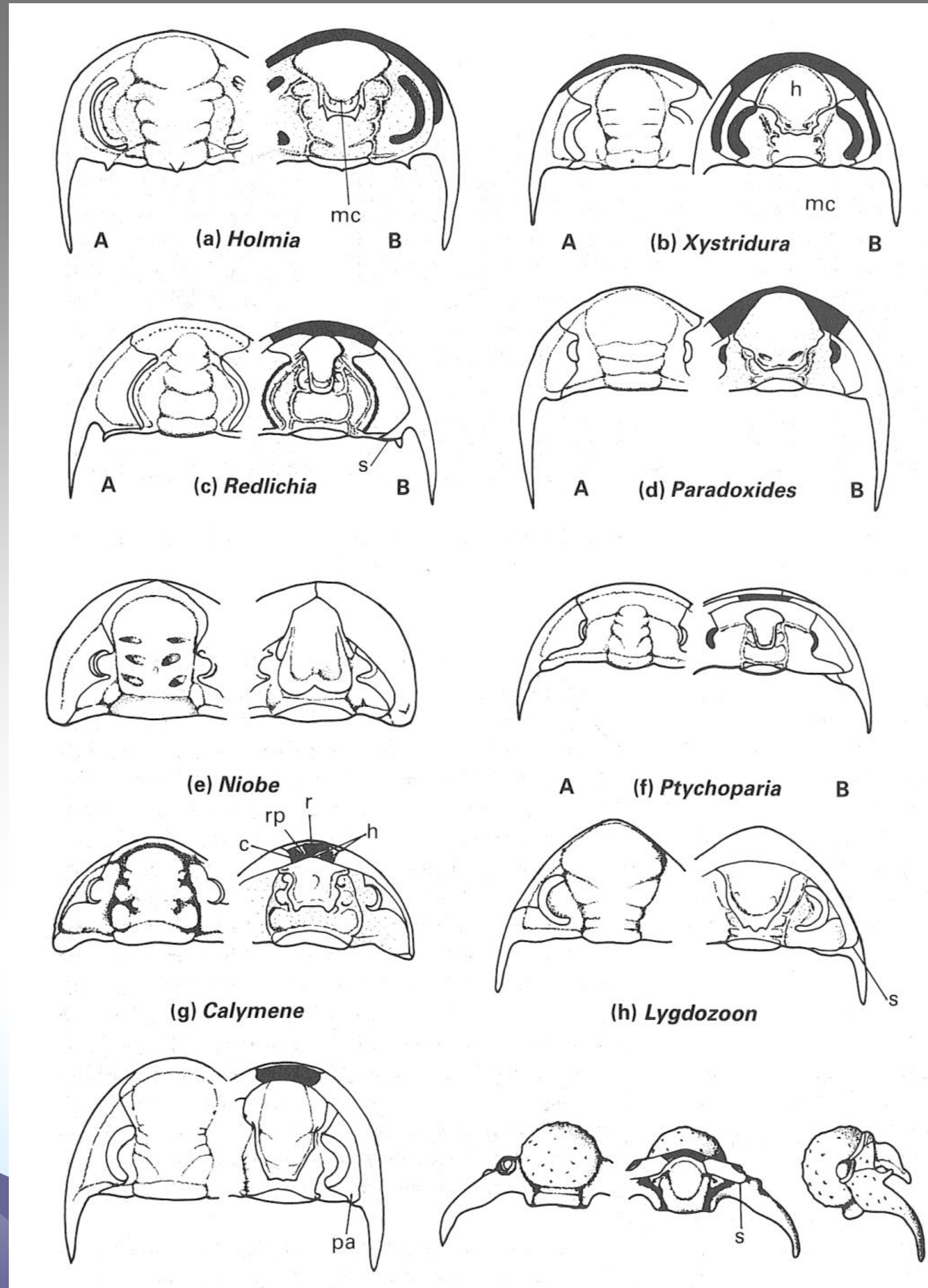
cephalon
thorax
pygidium
apodeme
(a)
(b)

The cephalic sutures

- The cephalic sutures, which are unique amongst arthropods, include the facial sutures and **ventral cephalic sutures** which are sometimes present.
- The facial sutures are of four main kinds:

1. **Proparian:** the posterior branch passes in front of the genal angle or spine
2. **Opisthoparian:** it cuts the posterior border anterior to the genal angle
3. **Marginal:** it runs along the edge and is not visible on the dorsal surface.
4. In one family, the Calymenidae, it is **gonatoparian** and runs directly through the genal angle

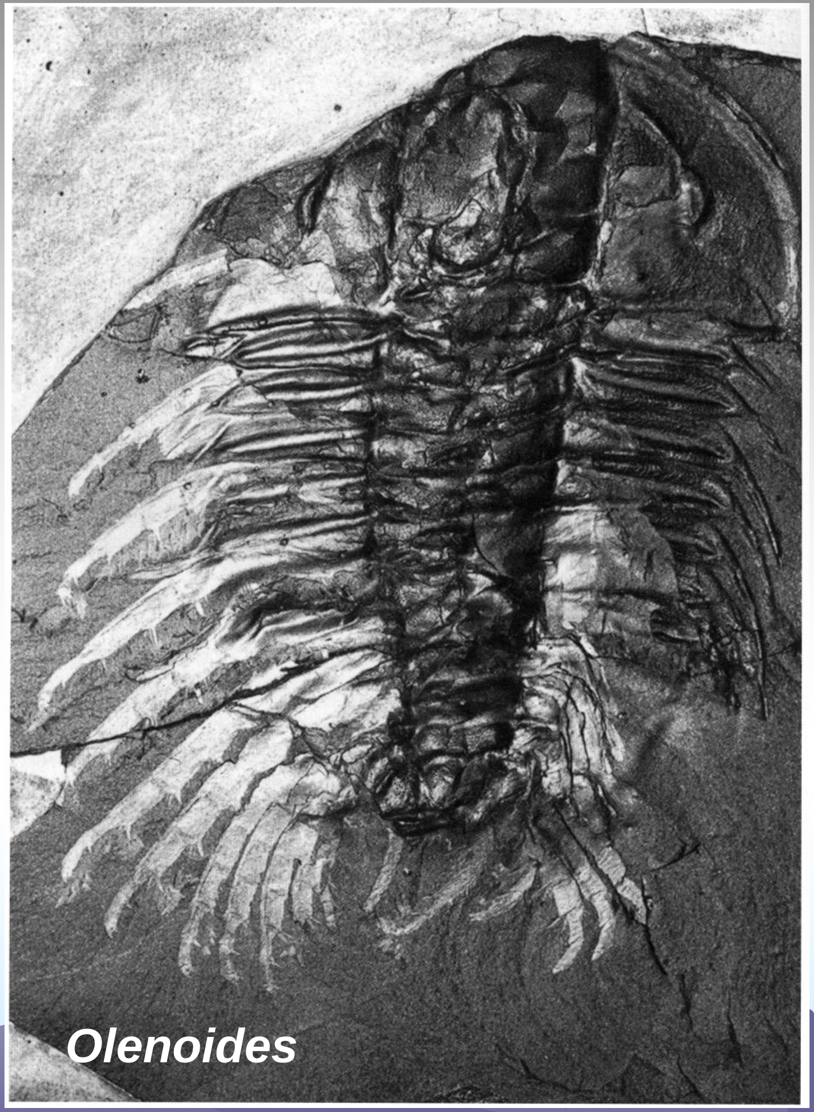

mc
A
(a) Holmia
B
h
mc
A
(b) Xystridura
B
s
A
(c) Redlichia
B
A
(d) Paradoxides
B
(e) Niobe
A
(f) Ptychoparia
B
rp
r
c
h
s
(g) Calymene
(h) Lygdozoon
pa
s

Size of the pigidium

- Size relative to the cephalon:

1. **Micropygous:** with fairly small pygidia, most Cambrian trilobites
2. **Heteropygous:** tend to have smaller than the cephalon pygidia, post-Cambrian genera
3. **Isopygous:** pygidia of equal-size with the cephalon
4. **Macropygous:** pygidia larger than the cephalon (rare)

apendages



eyes

- The eyes of trilobites are the most ancient visual system known
- the earliest of all well developed sensory systems.
- Trilobite eyes are compound, and like the lateral eyes of modern crustaceans and insects they were composed of radially arranged visual units pointing in different directions and often encompassing a wide-angled visual field.
- the eyes of trilobites are analogous to those of modern arthropods, but not necessarily homologous.

- In most modern arthropods the visual units are the **ommatidia** a cylinder of cells with the photosensitive elements (**rhabdom**) located deep within it.
- Each ommatidium is capped by a **corneal lens**, underlying which is a subsidiary dioptric apparatus (the crystalline cone).
- The lens and cone together focus light on the rhabdom. The rhabdom consists of a cylinder of stacked plates, each made of parallel **microvilli** (alternate plates have their blocks of tubules arranged at right angles to one another)
- These tubules are the site of the photoreceptive pigments whose chemical alteration by light triggers and electrical discharge in the ommatidial nerves.

Types of eyes

- **Holochroal**: having many round or polygonal lenses (30 to 200 μm) whose edges are all in contact and which are covered by a single corneal membrane. Lenses made of calcite. The most ancient kind of eye. Found in most trilobites
- **Schizochroal**: confined to Suborder Phacopina (Ord.-Dev.), are a unique visual system. In schizochroal eyes, the lenses are large (20—750 μm) and separated from each other by an interstitial material (**sclera**) of the same structure as the rest of the cuticle. Each lens has its own corneal covering. Lenses also made of calcite. Provided stereoscopic vision through 360º
- A third type **abathochroal**, similar to schizochroal but with fewer lences

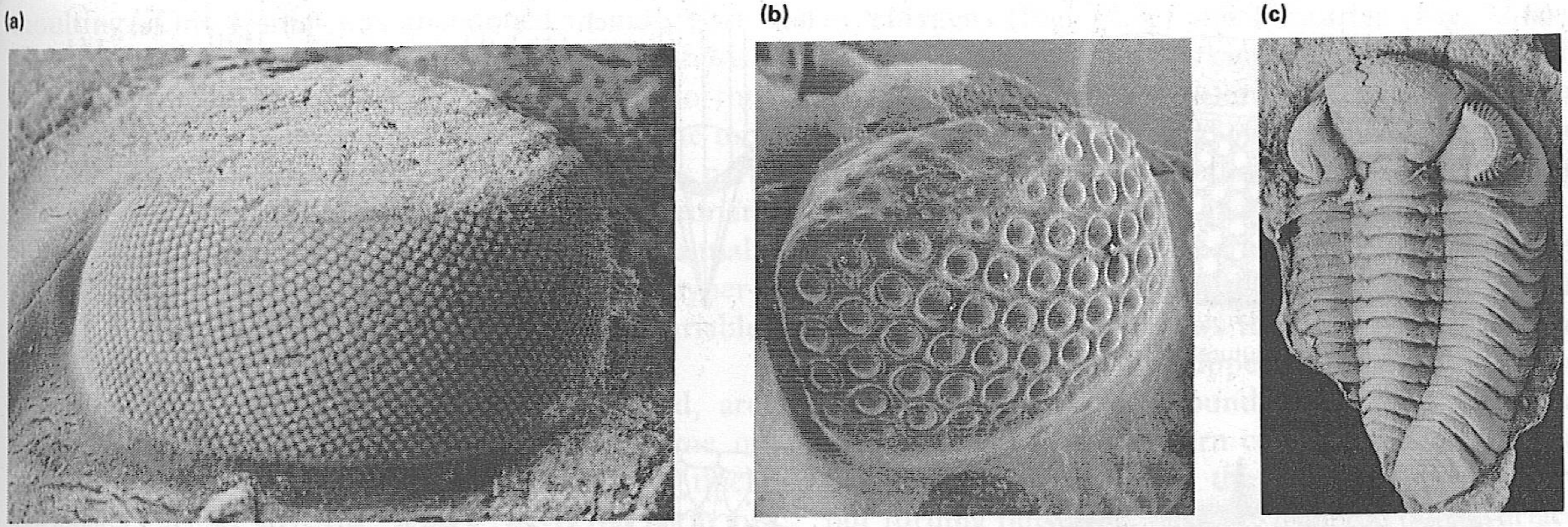
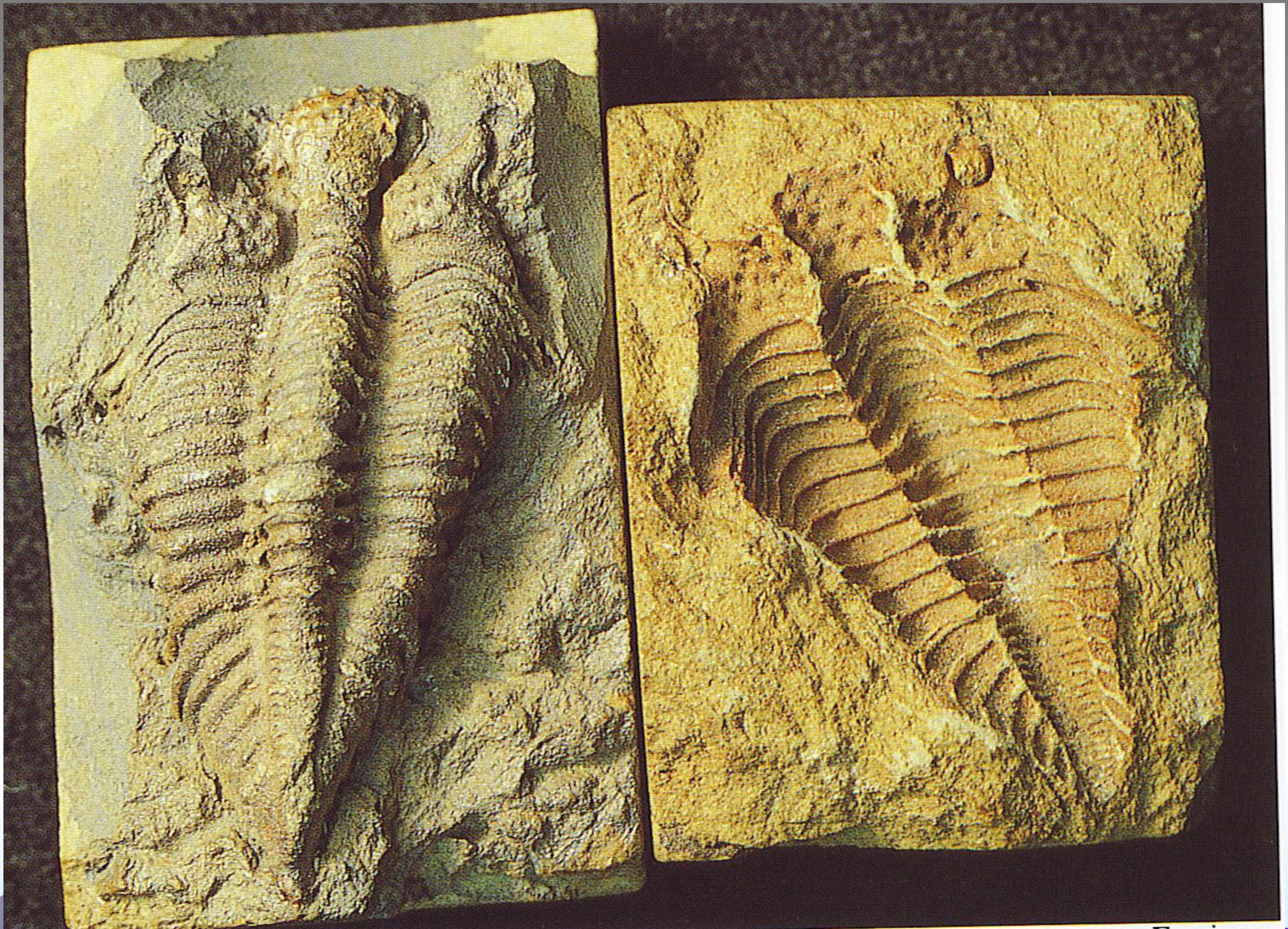


Figure 11.7 (a) Holochroal eye of *Paralejurus brongniarti* (Dev.), Bohemia, Dvorce-Prokop Limestone (×8); (b) schizochroal eye of *Phacops rana* (Dev.), Silica Shale, Ohio (×18); (c) *Acernaspis (Eskaspis) sufferta* (Sil.), Pentland Hills, near Edinburgh, Scotland (×2.5)

- The morphology of trilobite eyes can tell us something about their lifestyles. The following are evident:
- **Blind trilobites:** No eyes = burrower? or deep marine.
- **Eyes on stalks:** a shallow burrower cf. flat fishes today.
- Some trilobites had huge eyes relative to their head size, it is thought that this is an adaptation to a planktonic mode of life.

Calymene



Encrinurus

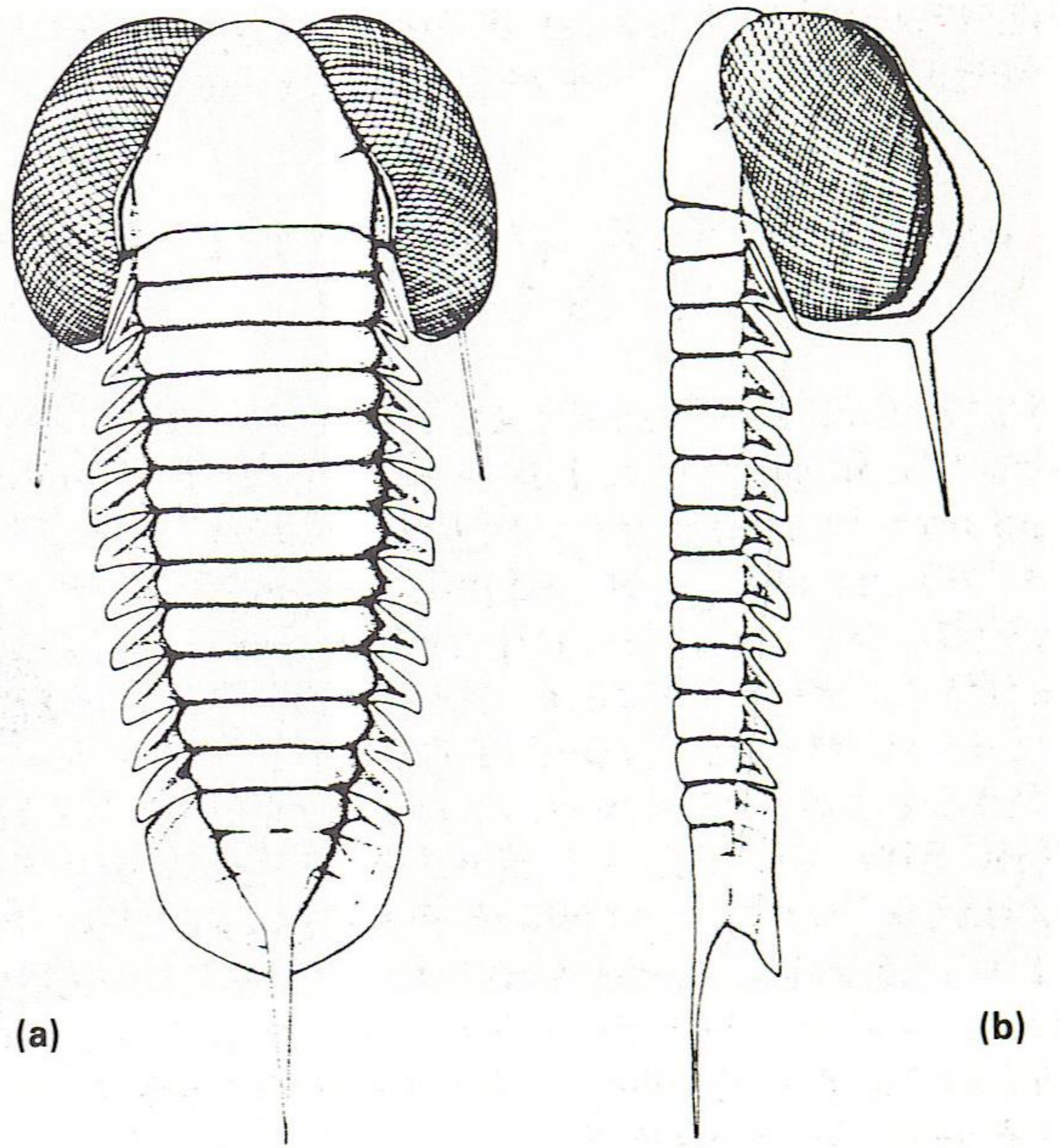
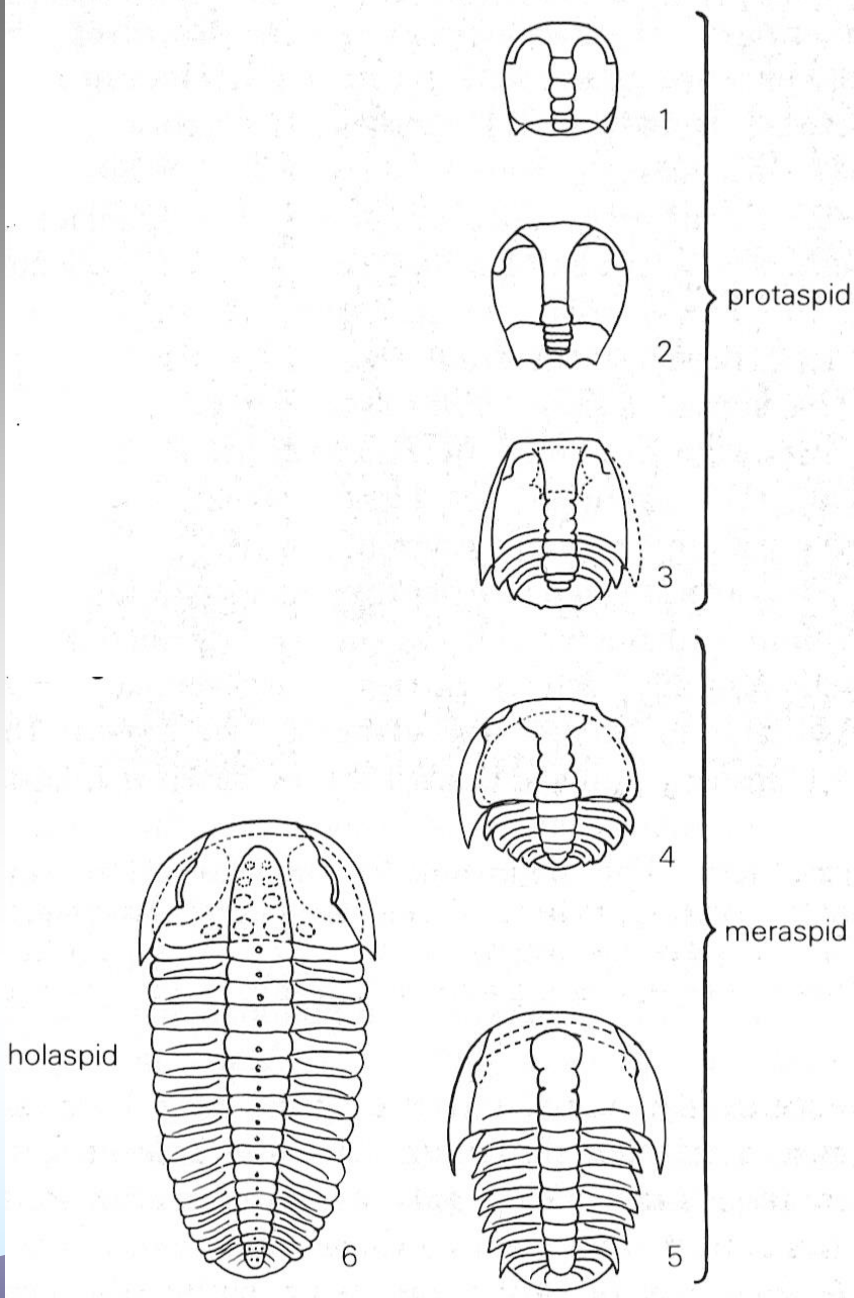


Figure 11.17 *Opipeuter*, an Ordovician pelagic trilobite (redrawn from Fortey 1977)

Acidaspis

Ontogeny

- Change stages through ecdysis (moulting)
- The earliest stage is **protaspis**
- The **meraspid** stage begins when the pygidium becomes free. The thoracic segments then form in a zone of growth along the front of the pygidium. They are actually part of the pygidium for a while, and then they are released in turn and liberated from its anterior part. Meraspides are numbered in degrees — 0, 1, 2, 3, ... — according to how many thoracic segments have been freed from the anterior edge of the transitory pygidium
- When the adult number of thoracic segments has been reached the trilobite is now a **holapsis,** though it may have to pass through many more moults before it is of fully adult proportions



(c) ***Sao hirsuta***

Classification

- Order 1 Agnostida (L.Camb.-U.Ord.)
- Small, subequal cephalon & pygidium, mostly blind.
- Order 2 Redlichiida (L.-M.Camb.)
- Large semicircular cephalon & strong genal spines, numerous thorassic segments & small pygidium.
- Order 3 Corynexochida (L.-U.Camb.)
- Parallel sided, thorax with 7 to 8 segments.
- Order 4 Ptychopariida (L.Camb.-U.Dev.)
- S.O. 1 Simple tapering glabella, small pygidium, large thorax.
- S.O. 2 Large smooth isopygous.
- S.O. 3 Large isopygous, smooth or tuberculate with rostral plates.
- S.O. 4 Large cephalon & genal spine + fringe & small eyes.
- S.O. 5 Large cephalon, no eyes, marginal suture.

- Order 5 Proetida (Ord.-Perm.)
- Large glabella + genal spines.
- Order 6 Phacopida (L.Ord.-U.Dev.) Proparian suture.
- S.O. 1 Variable.
- S.O. 2 Back tapering glabella, 4-5 lobes.
- S.O. 3 forward tapering glabella.
- Order 7 Lichida (L.Ord.-U.Dev.)
- Large cephalon and pygidium, broad glabella
- Order 8 Odontopleura (U.Camb.? or L.Ord.-U.Dev.)
- Very spiny trilobites.

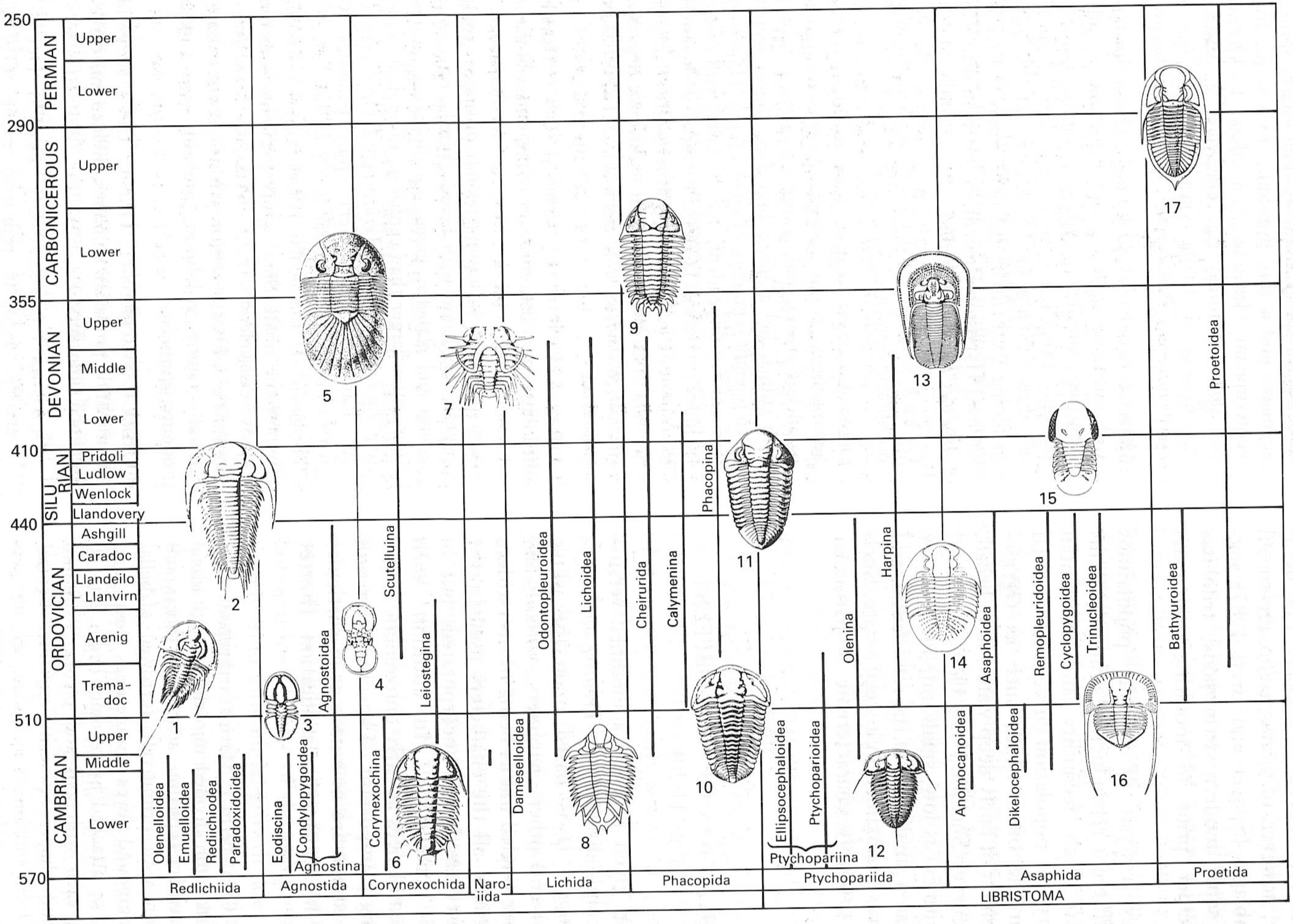


Figure 11.20 Time ranges of orders (e.g. Phacopida) and suborders (e.g. Calymenina) of trilobites. Genera illustrated are as follows: 1, *Paedumias* (L. Cam.); 2, *Paradoxides* (M. Cam.); 3, *Eodiscus* (L. Cam.); 4, *Agnostus* (U. Cam.); 5, *Scutellum* (L. Dev.); 6, *Kootenia* (M. Cam.); 7, *Dicranurus* (Dev.); 8, *Trochurus* (U. Ord.-M. Sil); 9, *Cheirurus* (U. Ord.-M. Sil.); 10, *Calymene* (Sil.-Dev.); 11, *Acaste* (Sil.); 12, *Leptoplastus* (U. Cam.); 13, *Harpes* (M. Dev.); 14, *Ogygiocaris* (M. Ord.); 15, *Cyclopyge* (Ord.); 16, *Trinucleus* (Ord.); 17, *Paladin* (L. Carb)

- (1) **Palaeogeography/biogeography**
- Trilobites show distinctive geographical variability in distribution at different times in geological history (such variability is known as **faunal provinciality**). Their distribution can therefore be used to determine past Palaeozoic palaeogeographies.

- (2) **Biostratigraphy**
- The **Cambrian** is zoned using trilobites, since this is where they are at their peak and most widespread.
- Nearshore **Ordovician** marine sequences can be zoned using trilobites, whereas offshore Ordovician section can be zoned using graptolites.
- Trilobites are only good for local correlation of Silurian, Devonian and Carboniferous successions.