

Ctenophora

Urochordata

Nemertea

Echinodermata

Platyhelminthes

**How are phyla related?**

Kamptozoa

Nematomorpha

Sipuncula

**When did they appear?**

Brachiopoda

Porifera

Cnidaria

**How has diversity changed?**

Annelida

Arthropoda

Bryozoa

**What mechanisms underlie  
diversification?**

Cnidaria

Acanthocephala

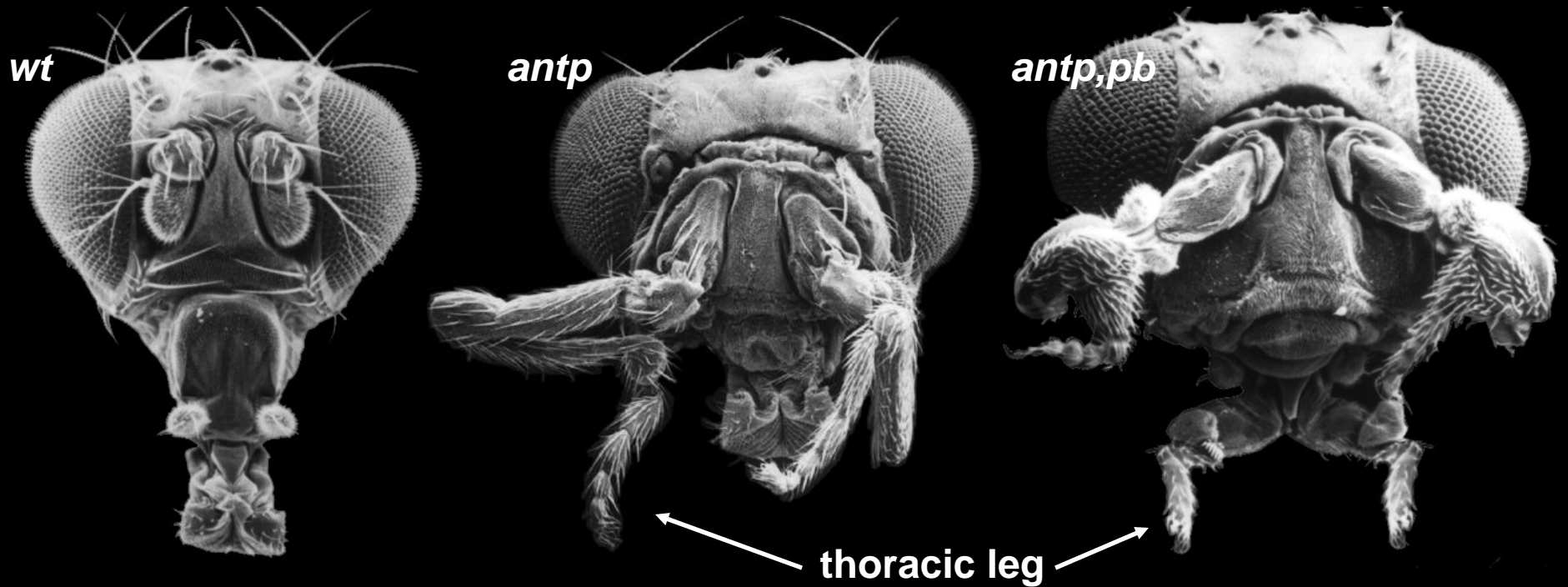
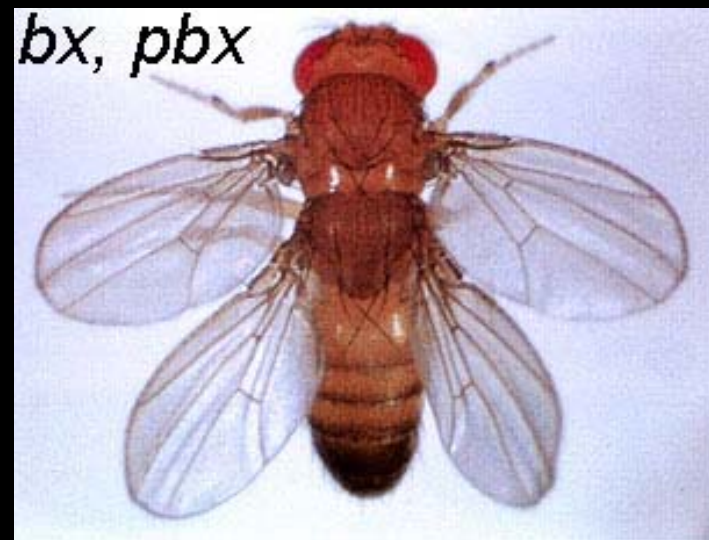
Nematoda

Hemichordata

Rotifera

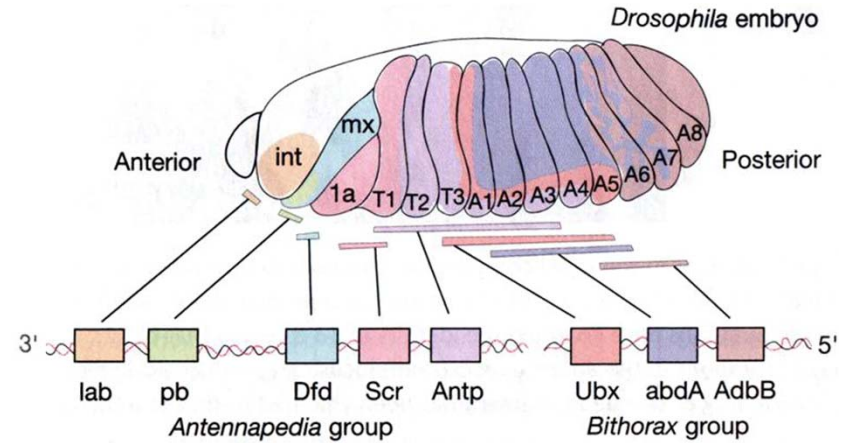
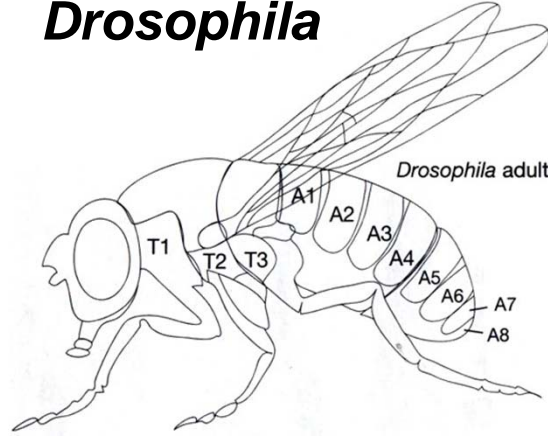
# 1. Major regulatory genes

Ex. Homeotic mutations in *Drosophila*

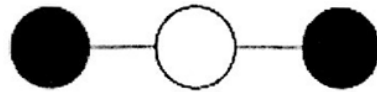


DNA  
 ↓ transcribe  
 RNA  
 ↓ translate  
 Protein

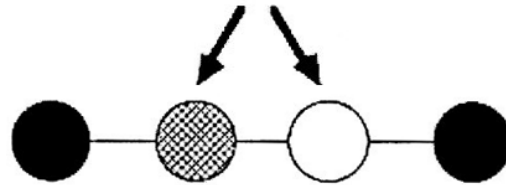
# HOM gene expression in *Drosophila*



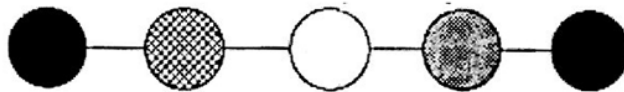
Ancestral arthropod



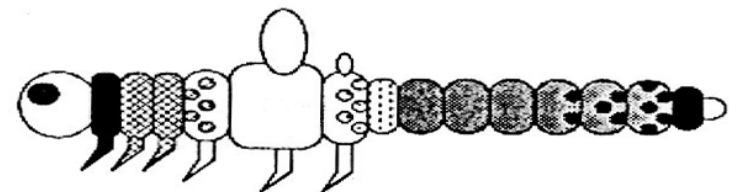
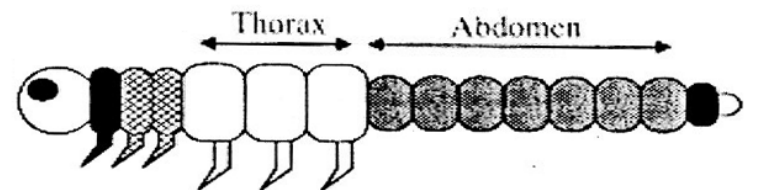
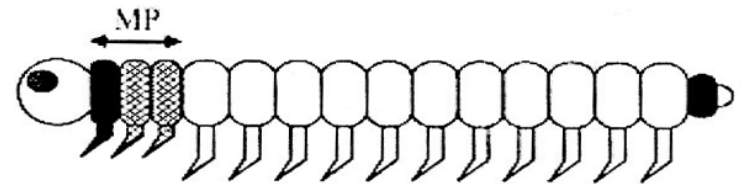
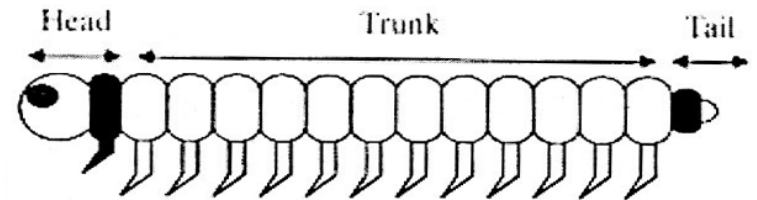
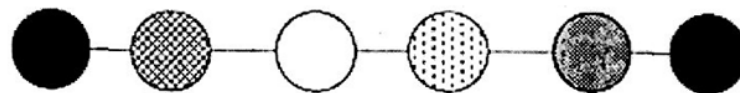
Myriapod

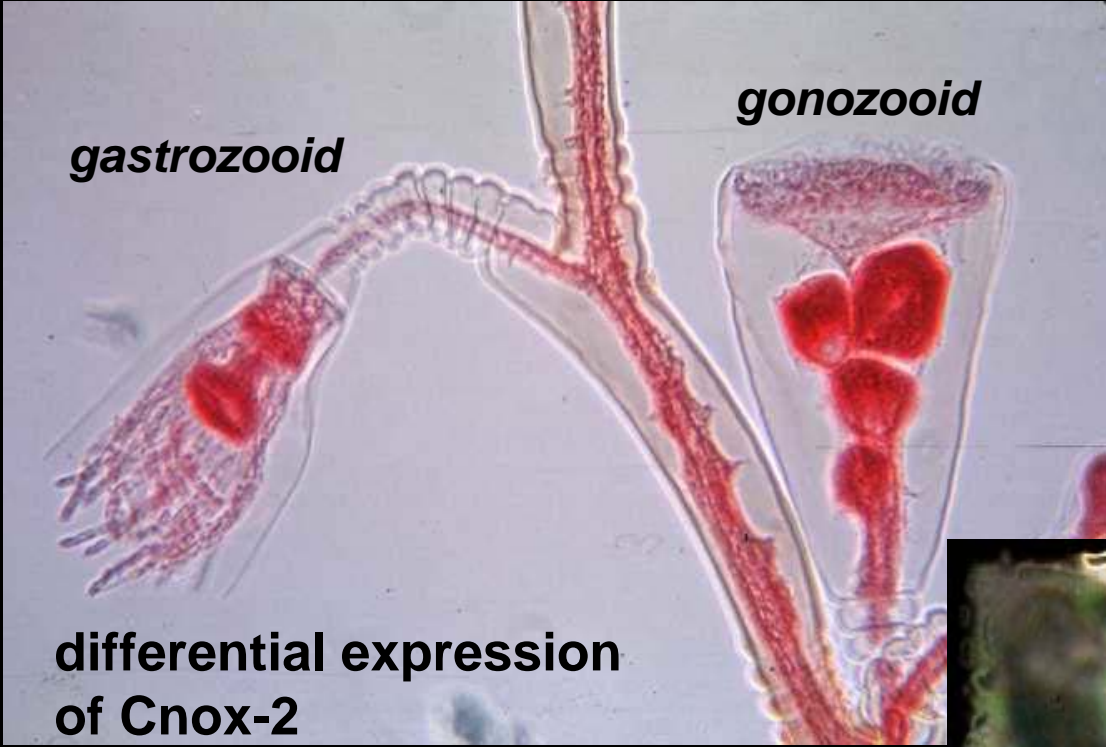


Ancestral hexapod

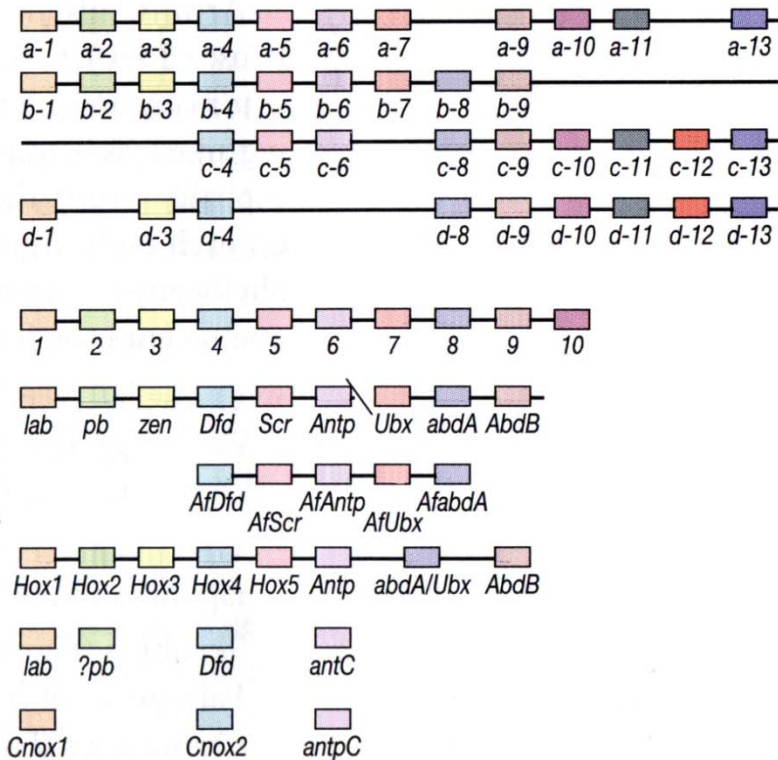
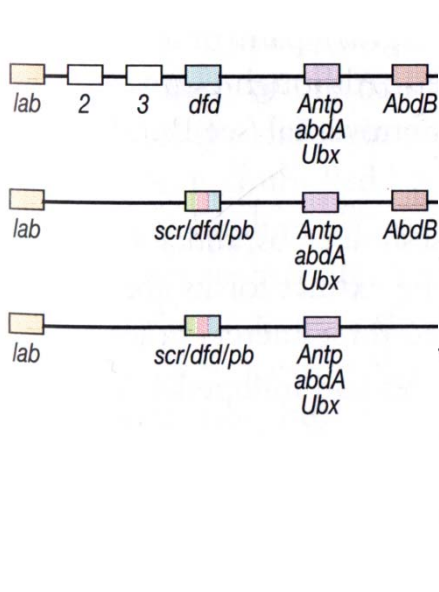
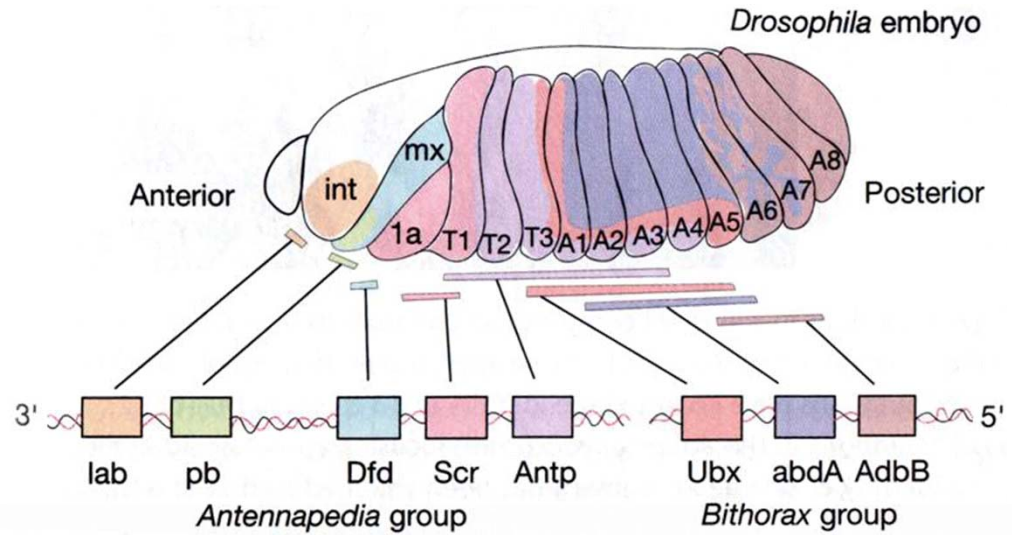


*Drosophila*





# Reconstructing the phylogenetic pattern of HOM/HOX duplication events

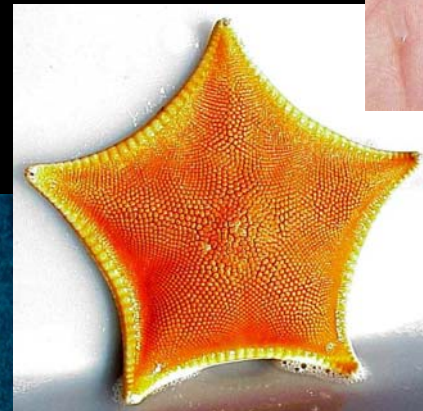
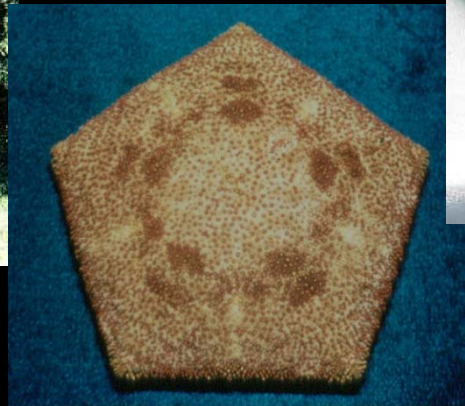
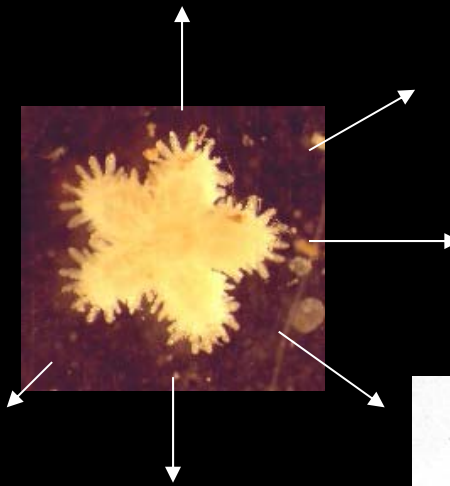


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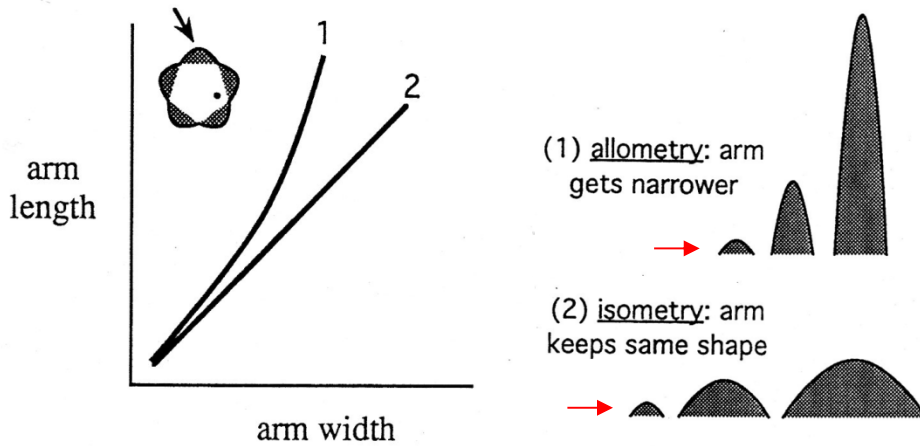
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## 2. Differential growth

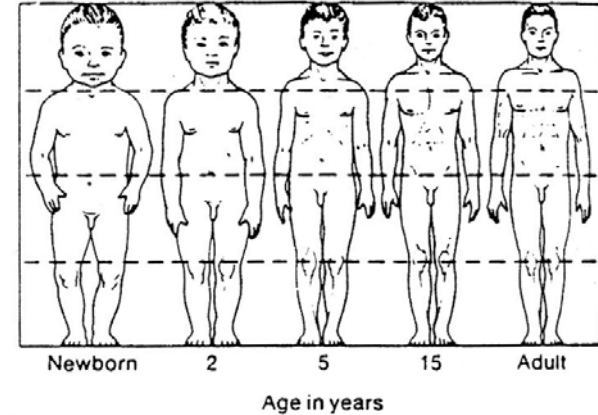
Ex. Allometry of arm vs. disk growth in asteroids



# Growth: isometry vs. allometry



## Allometry in human growth



## D'arcy Thompson's (1917) "Method of transformations" as applied to...

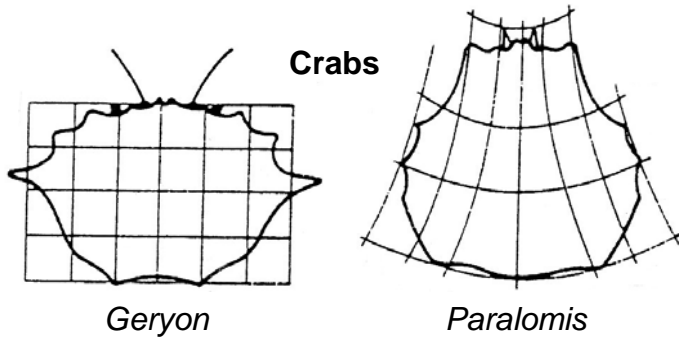
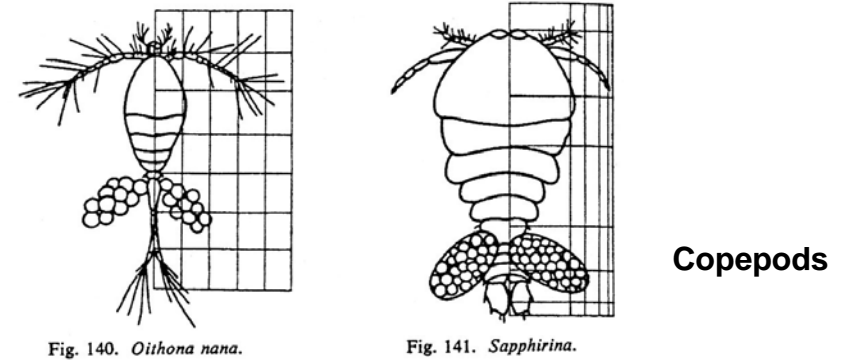
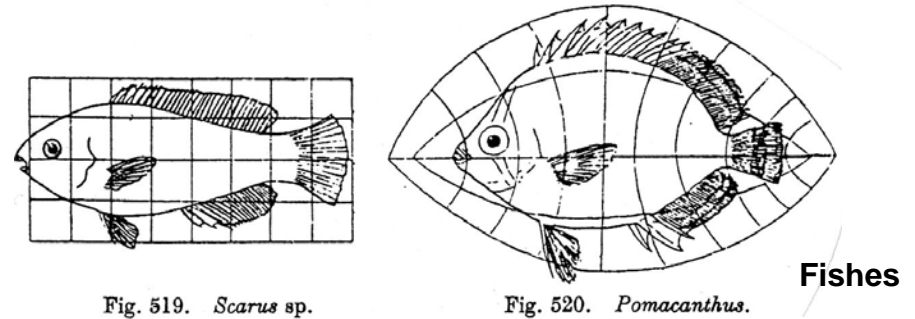
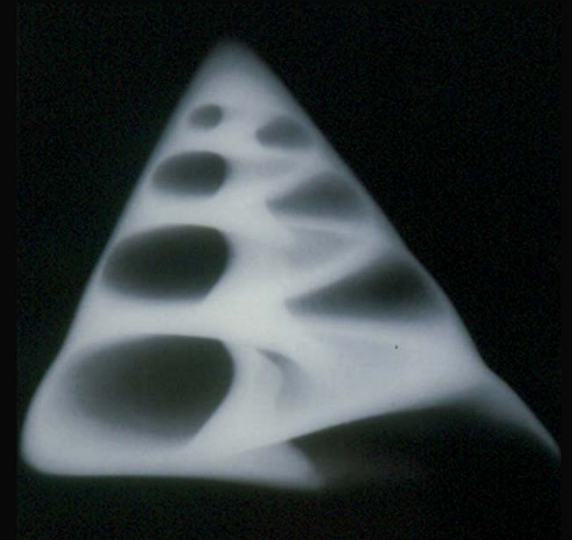
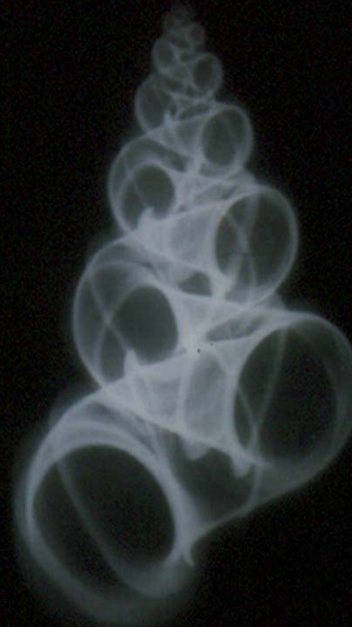


Figure 4-1 Two-dimensional outlines of the carapaces of several crabs. Appropriate transformations of the grid on which the outline of one genus is plotted give good approximations to the carapaces of the other genera. Numerous, apparently unrelated, minor differences in shape are thus seen as part of the same overall transformation. From Thompson (1917).



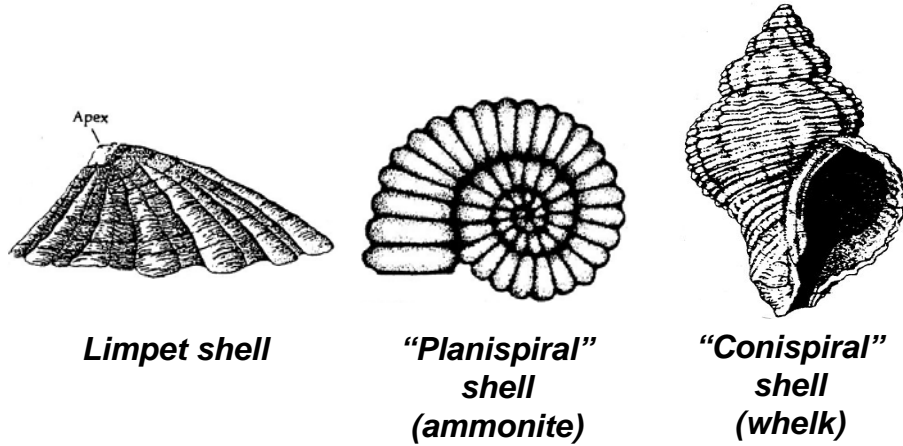
## 2. Differential growth

Ex. Isometric growth of gastropod shells:  
are there simple rules?

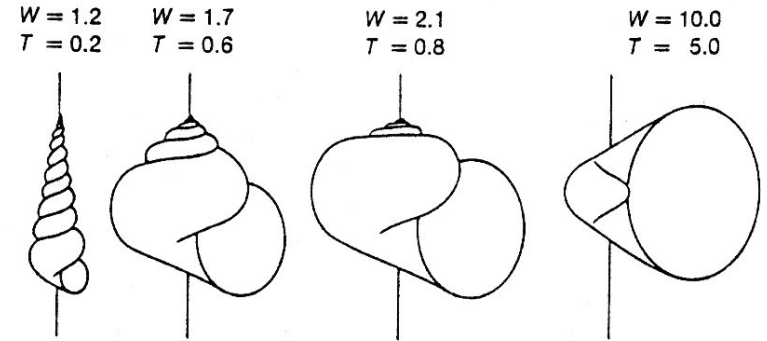




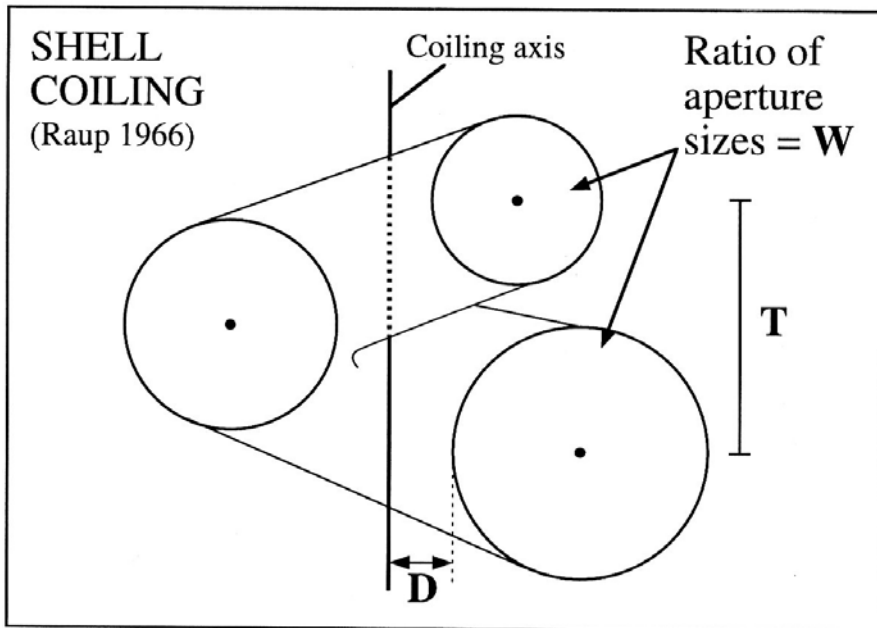
# Modelling mollusc shell growth and diversity



## Computer-generated "diversity"



## Simple rules for shell growth?



## A shell "morphospace"

