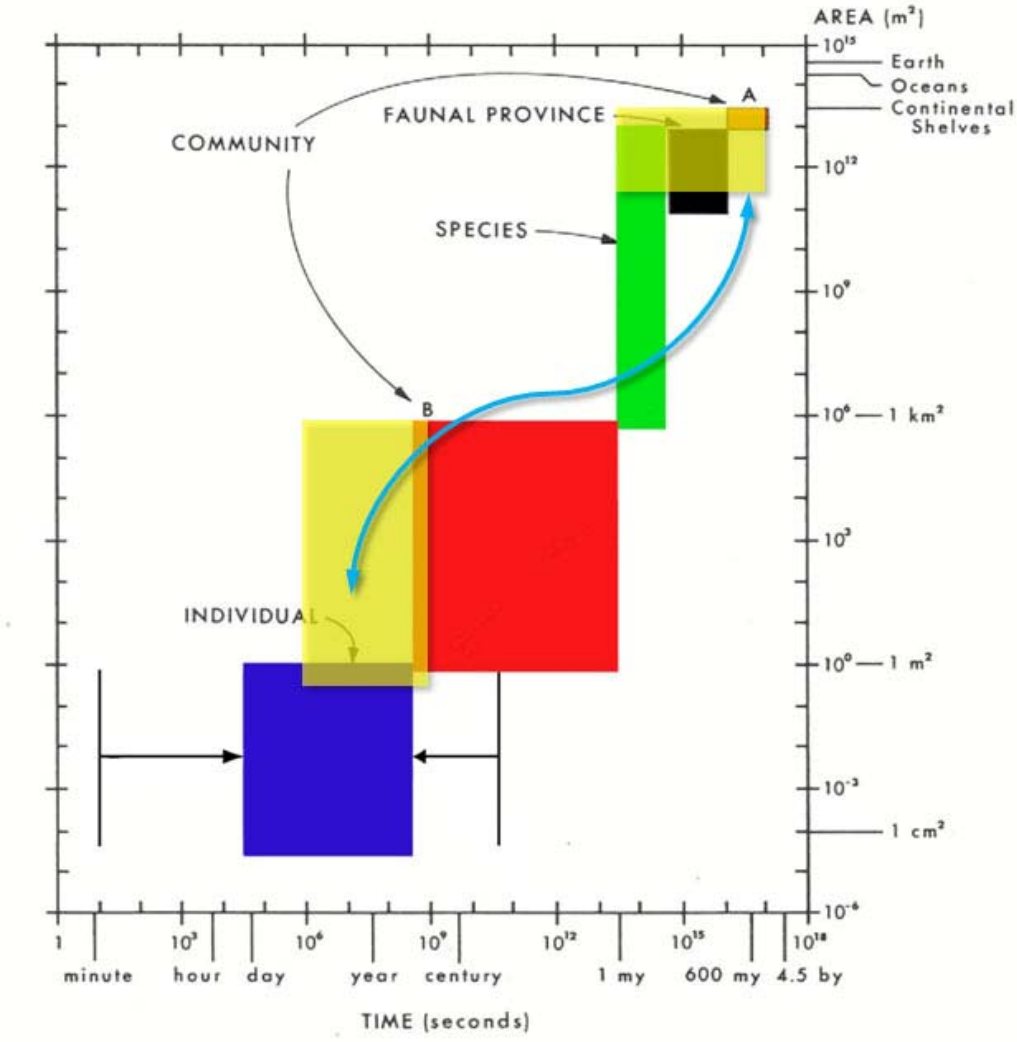
Macroevolution and Phylogenetics

Macroevolution is evolution above the species level, and includes the origins and fates of major novelties, changes in diversity of lineages through time, and the impact of geological and other physical factors on the evolutionary process. Paleontology plays a central role in macroevolution. The fossil record provides insights onto large-scale evolutionary patterns, and thus documents macroevolutionary phenomena, and provides a natural laboratory for the framing and testing of macroevolutionary hypotheses.



Schopf 1972

Species-level selection and macro-evolution – the entire species lineage is the unit that differentially survives and/or reproduces. Requires emergent properties such as…

David Jablonski and geographic range

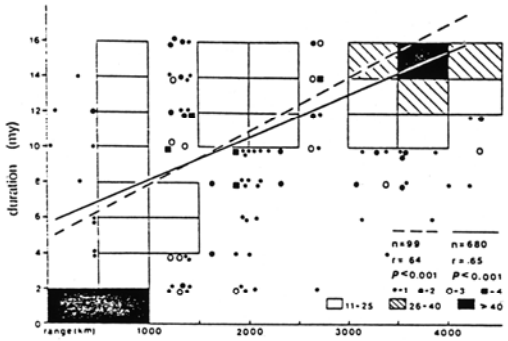


FIGURE 6. Scatterplot and regression of the results of our simulation using systematic sampling and a 1% resolution level (solid line). Dashed line is the regression obtained from plotting duration on range for a published set of prosobranch gastropod data from the Cretaceous of North America (Jablonski 1986: table 1. Duration = 0.0015 × Range − 2.44, $N = 99$, $r = 0.64$, $P < 0.001$). The two slopes are not significantly different ($P < 0.05$, t-test: Sokal and Rohlf 1981).

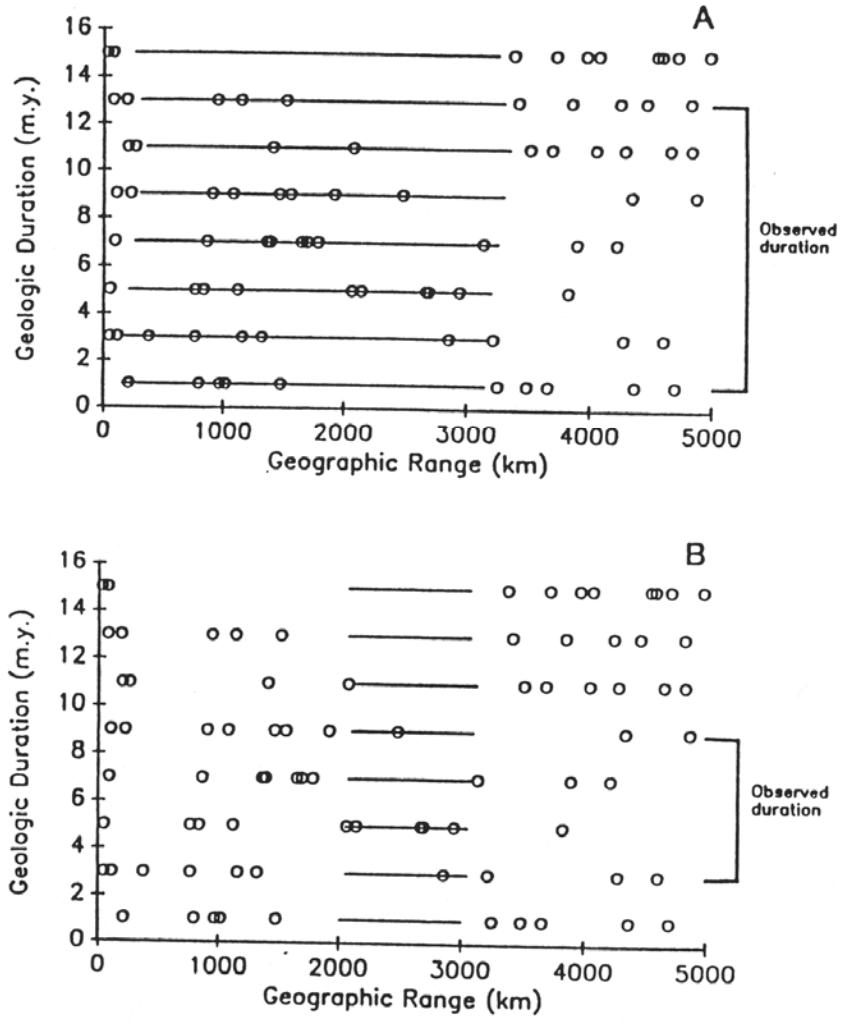
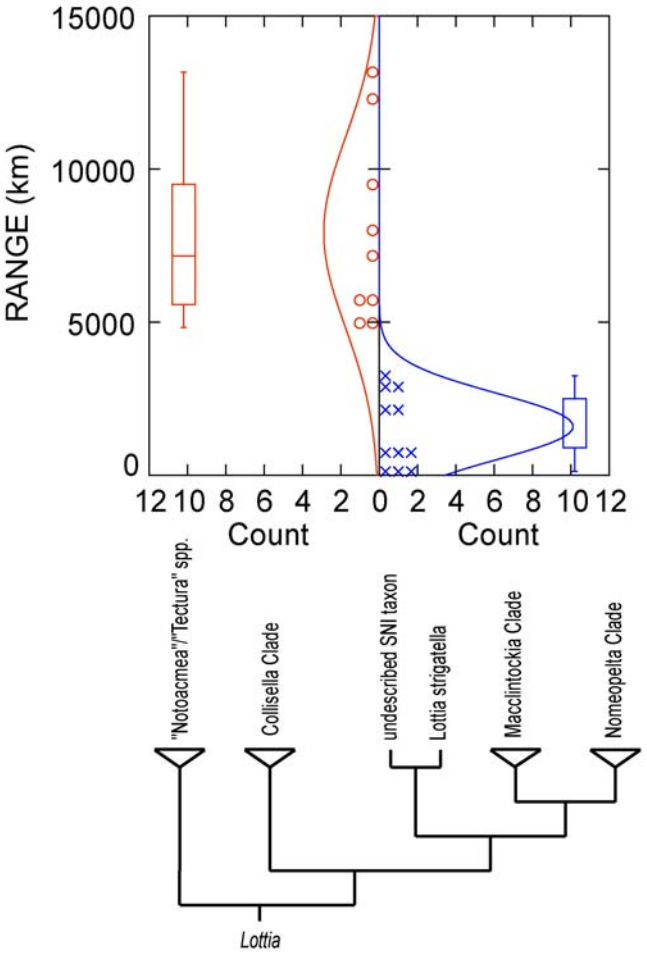
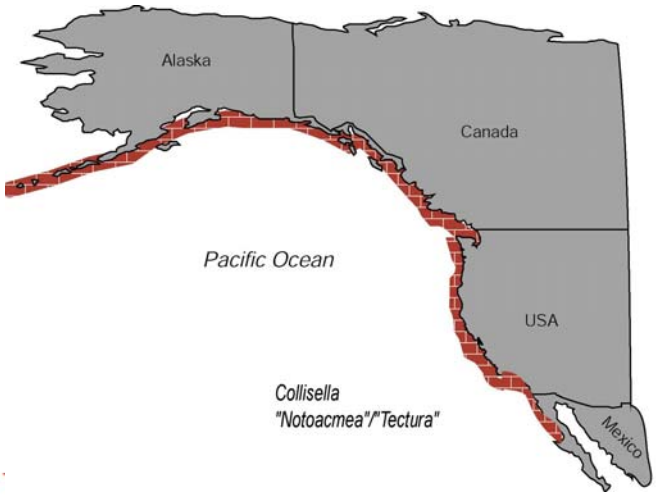
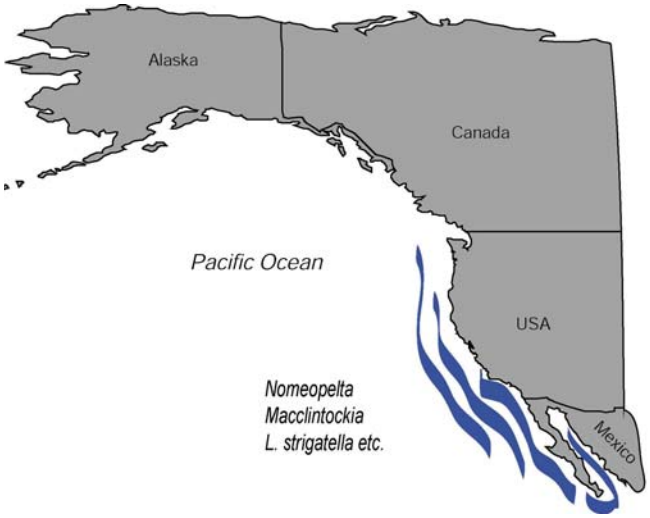


FIGURE 1. The geographic range of a species (X-axis) is represented as a horizontal line in the eight stratigraphic horizons (Y-axis). The circles represent fossil localities. Although there is no difference in the actual durations of the long-ranging (A) and short-ranging species (B), there is a difference in the observed durations. For the geographic range and geologic duration simulations, each plot represents a point along the species or Z-axis of the matrix.

Ranges


15000
10000
5000
0
RANGE (km)
12 10 8 6 4 2 0 2 4 6 8 10 12
Count
Count
"Notoacmea"/"Tectura" spp.
Collisella Clade
undescribed SNI taxon
Lottia strigatella
Macclintockia Clade
Nomeopelta Clade
Lottia


Alaska
Canada
Pacific Ocean
USA
Collisella
"Notoacmea"/"Tectura"
Mexico


Alaska
Canada
Pacific Ocean
USA
Nomeopelta
Macclintockia
L. strigatella etc.
Mexico

Size

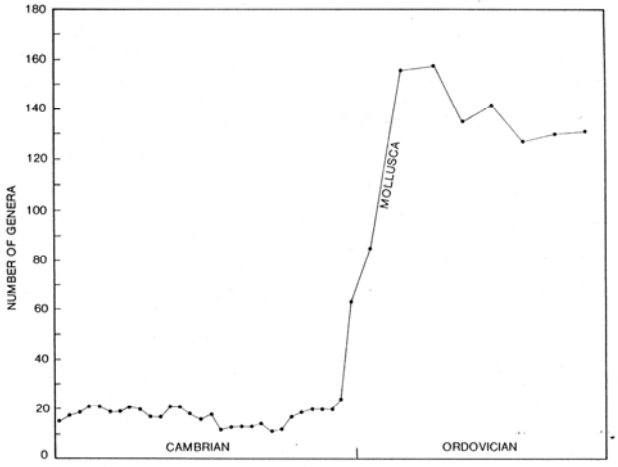


Fig. 2. Diversity of Cambrian and Ordovician molluscs (except cephalopods). All measurements shown are likely to be underestimates but the relative differences are probably correct. Modified from Runnegar (1982a), copyright Geological Society of Australia Incorporated, republished with permission.

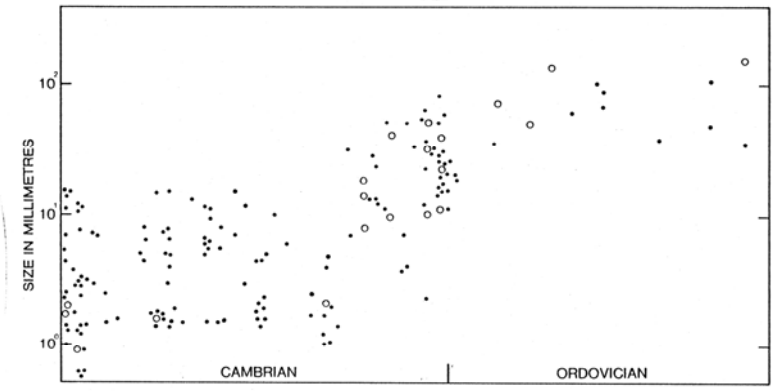
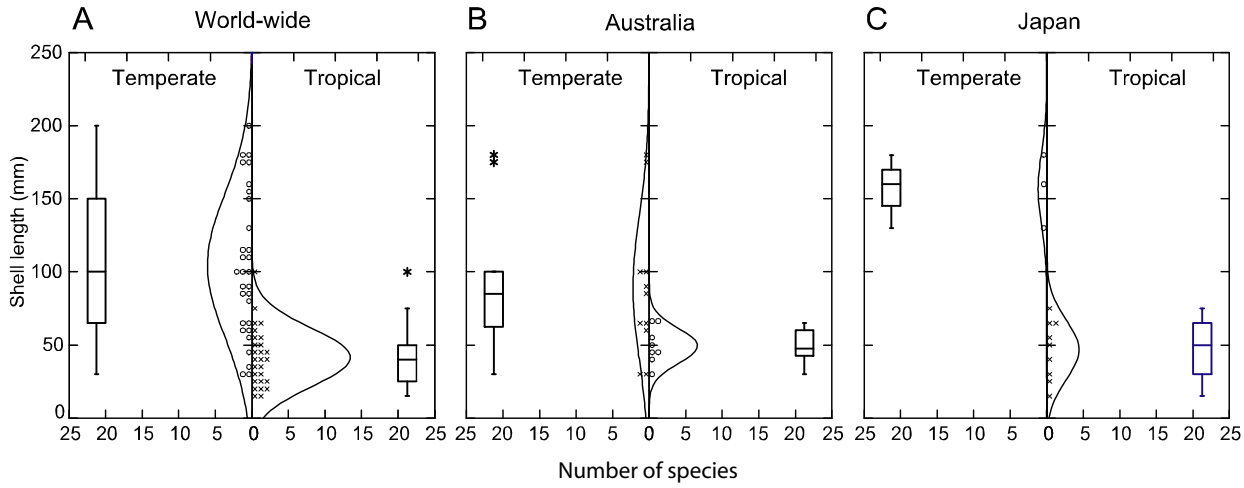
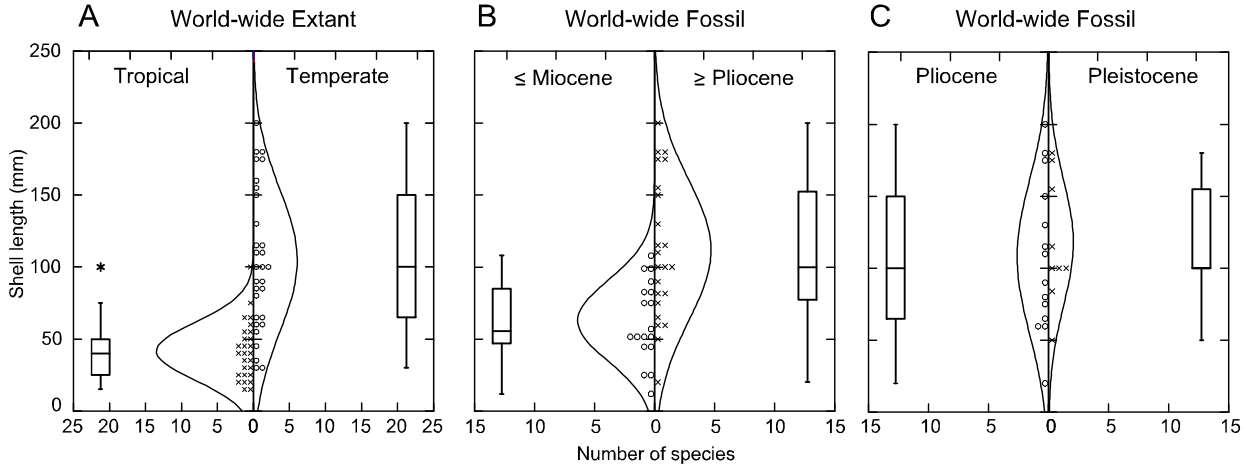
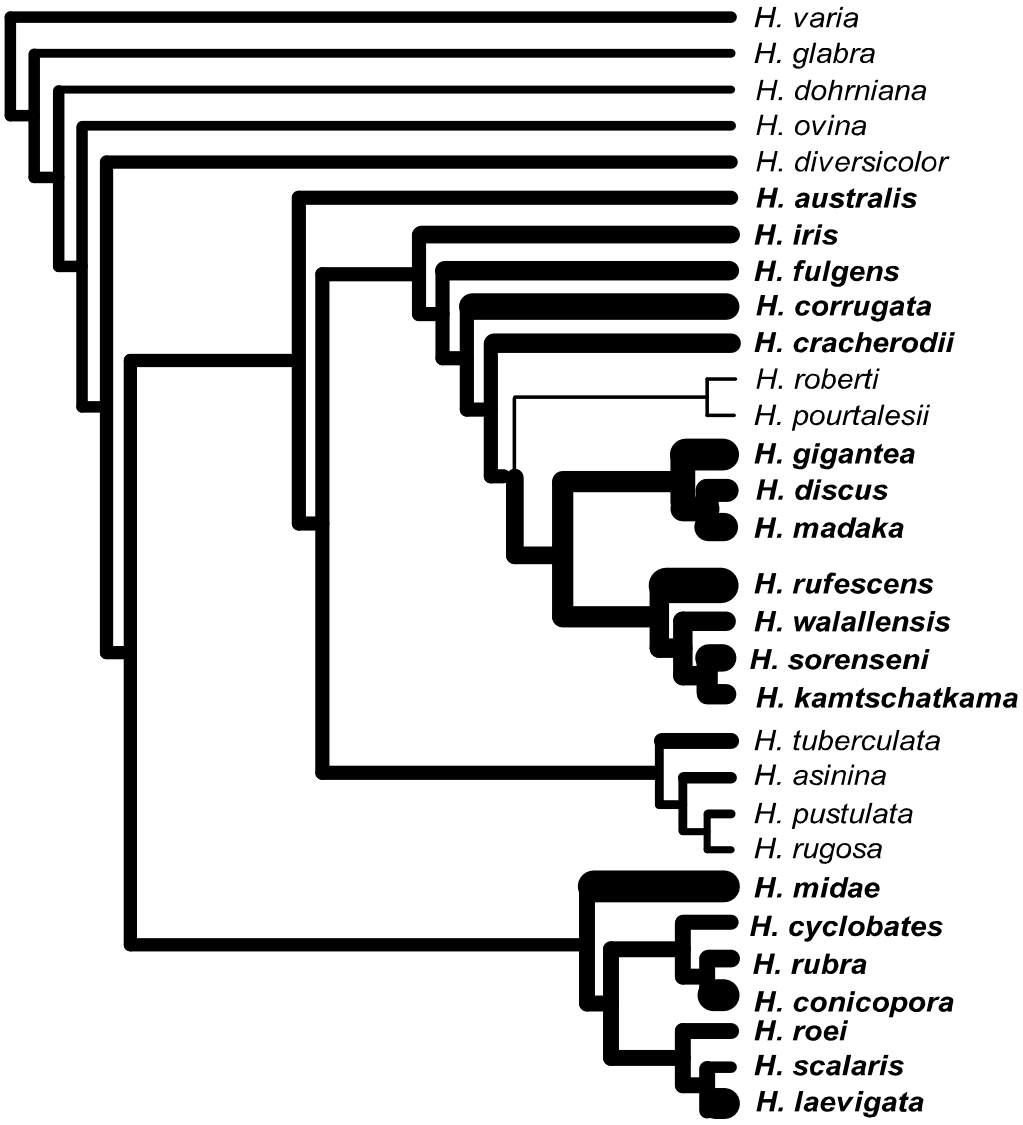


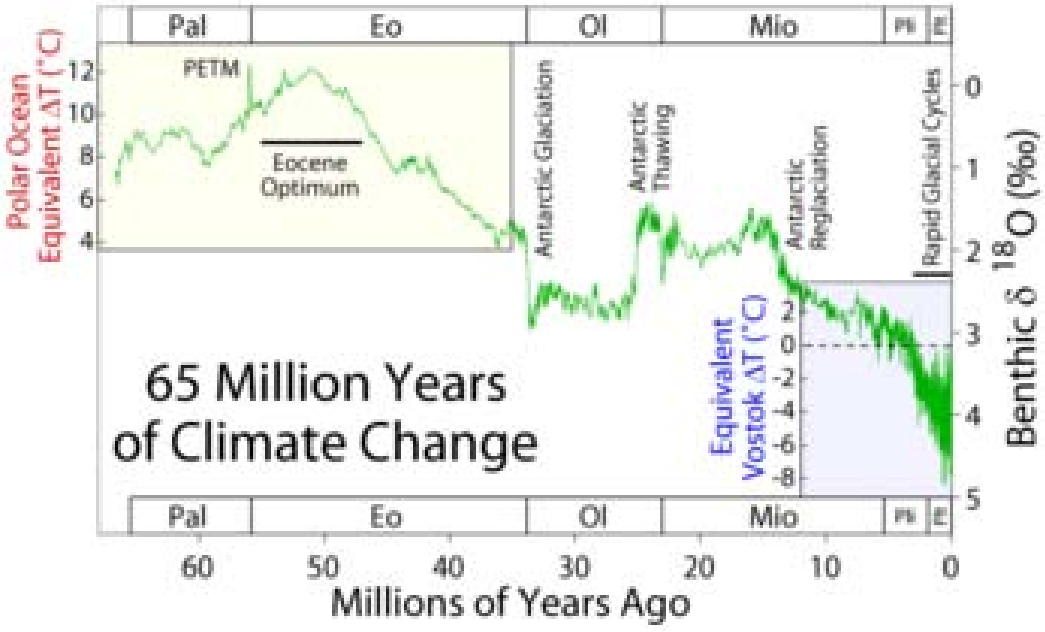
Fig. 3. Maximum size (longest dimension) of the largest measured individual of 173 species of Cambrian and Ordovician molluscs. Only a few large Ordovician molluscs were measured and plotted; the Cambrian points were selected from 375 measurements of published photographs and suitable available specimens.

Most kinds of molluscs became larger in the Late Cambrian and Ordovician. The open circles represent measurements made from a single lineage, the macluritacean snails *Nomgoliella* Missarzhevsky, *Cambrospira* Yü, *Barskovia* Golubev, *Yuwenia* Runnegar, *'Platyceras chronus'* Walcott, *Protoscaevogyra* Kobayashi, *Kobayashiella* Endo, *Scaevogyra* Whitfield, *Matherella* Walcott, *Matherellina* Kobayashi, *Palliseria* Wilson, *Teiichispira* Yochelson & Jones, *Maclurites* Lesueur (left to right). See Runnegar (1982a, fig. 4) for post-Ordovician data.

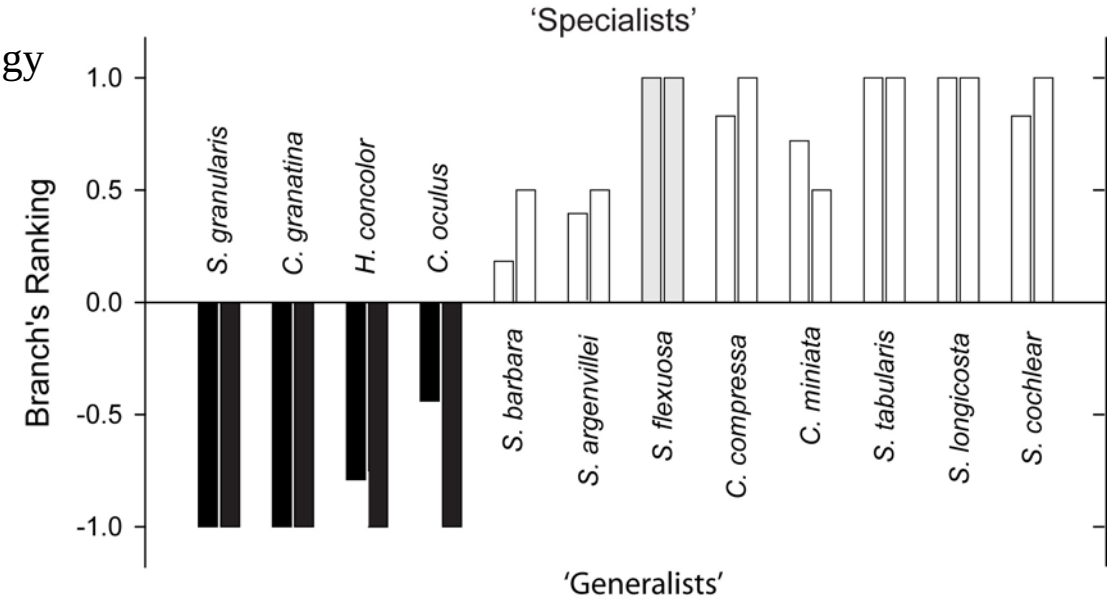


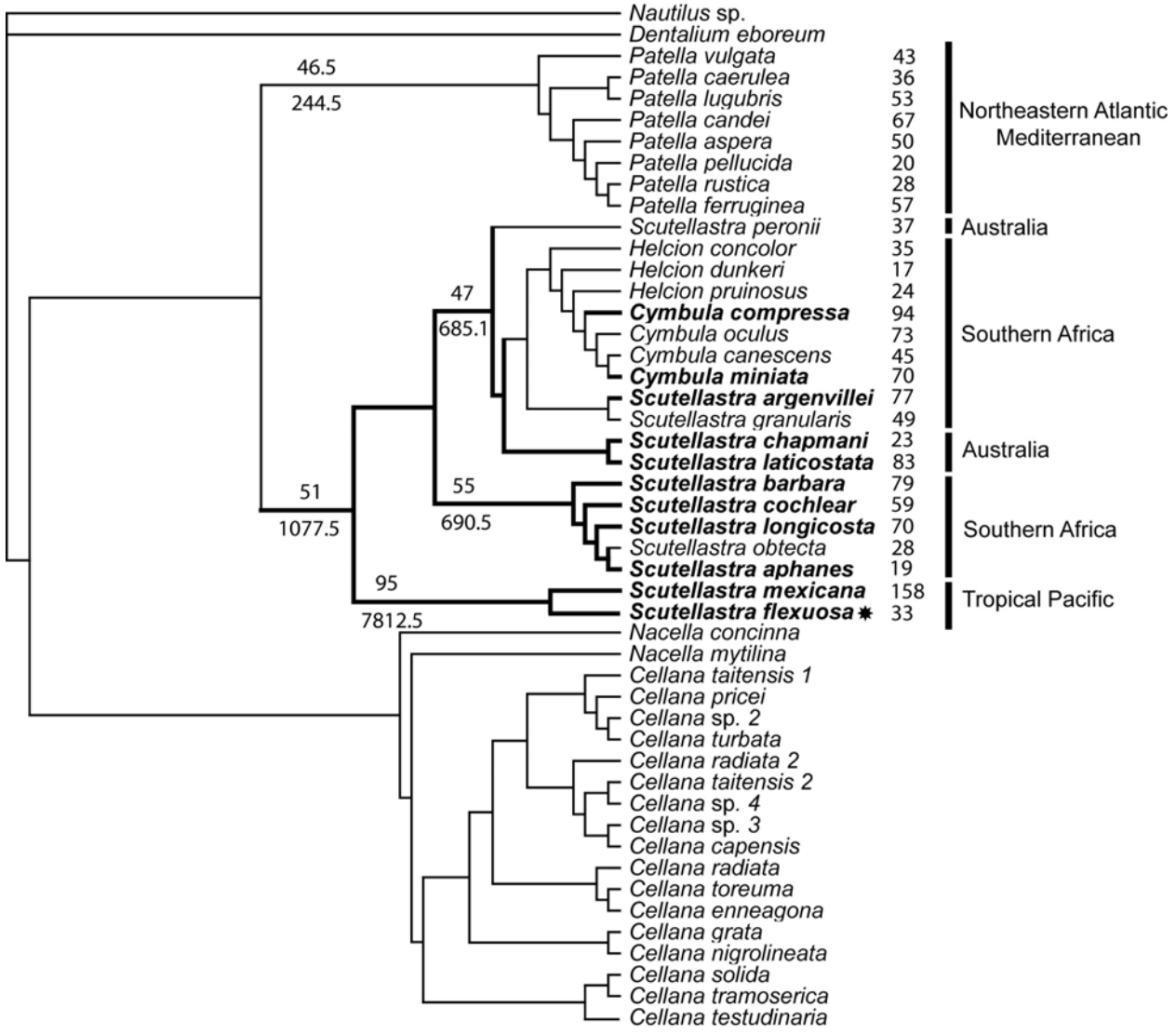


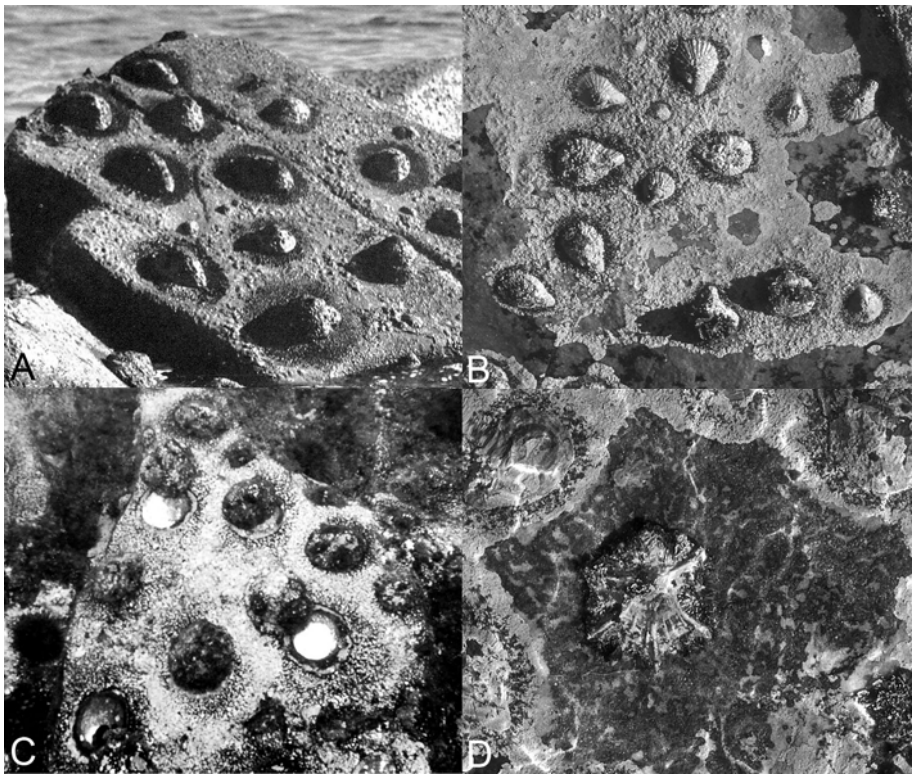

H. varia
H. glabra
H. dohrniana
H. ovina
H. diversicolor
H. australis
H. iris
H. fulgens
H. corrugata
H. cracherodii
H. roberti
H. pourtalesii
H. gigantea
H. discus
H. madaka
H. rufescens
H. walallensis
H. sorenseni
H. kamtschatkama
H. tuberculata
H. asinina
H. pustulata
H. rugosa
H. midae
H. cyclobates
H. rubra
H. conicopora
H. roei
H. scalaris
H. laevigata

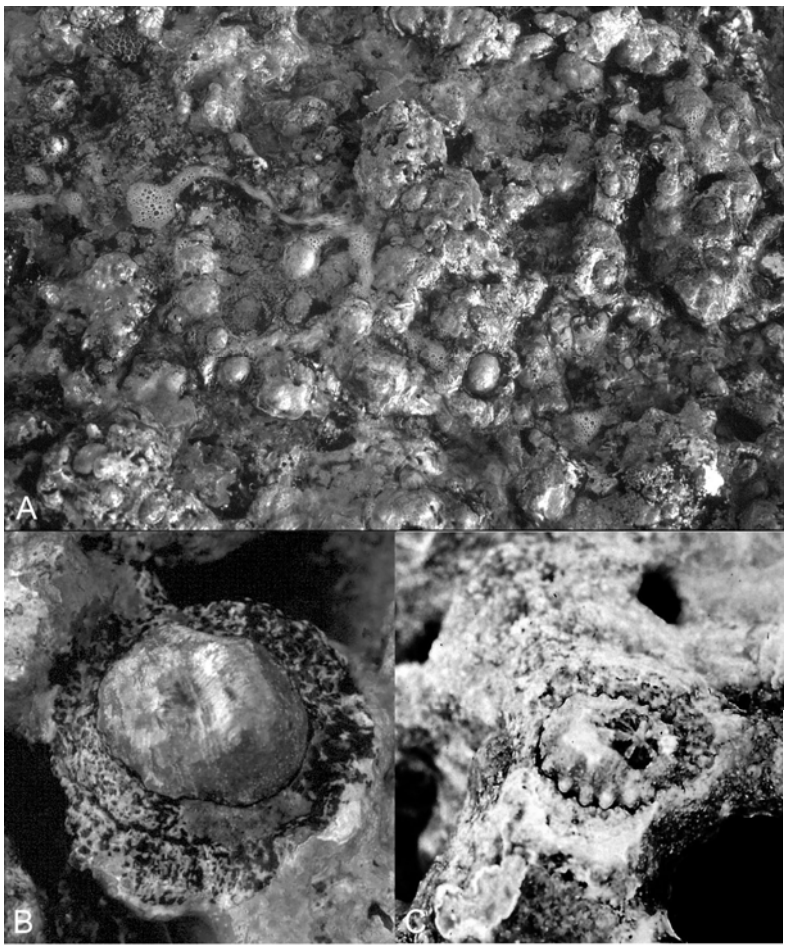

Pal
Eo
Ol
Mio
Pli
E
Polar Ocean Equivalent ΔT (°C)
PETM
Eocene Optimum
Antarctic Glaciation
Antarctic Thawing
Antarctic Reglaciation
Rapid Glacial Cycles
Benthic δ 18O (‰)
Equivalent Vostok ΔT (°C)
65 Million Years of Climate Change
60
50
40
30
20
10
0
Millions of Years Ago

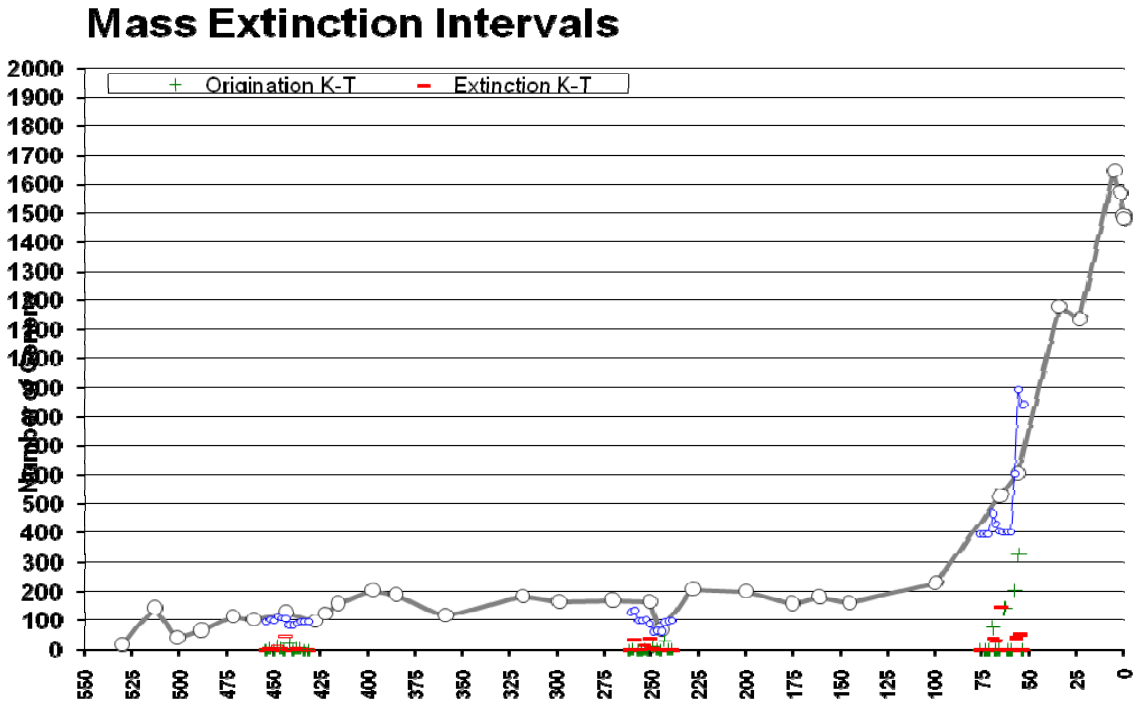
Ecology


'Specialists'
Branch's Ranking
1.0
0.5
0.0
-0.5
-1.0
S. granularis
C. granatina
H. concolor
C. oculus
S. barbara
S. argenvillei
S. flexuosa
C. compressa
C. miniata
S. tabularis
S. longicosta
S. cochlear
'Generalists'


Nautilus sp.
Dentalium eboreum
Patella vulgata 43
Patella caerulea 36
Patella lugubris 53
Patella candei 67
Patella aspera 50
Patella pellucida 20
Patella rustica 28
Patella ferruginea 57
Scutellastra peronii 37
Helcion concolor 35
Helcion dunkeri 17
Helcion pruinosus 24
Cymbula compressa 94
Cymbula oculus 73
Cymbula canescens 45
Cymbula miniata 70
Scutellastra argenvillei 77
Scutellastra granularis 49
Scutellastra chapmani 23
Scutellastra laticostata 83
Scutellastra barbara 79
Scutellastra cochlear 59
Scutellastra longicosta 70
Scutellastra obtecta 28
Scutellastra aphanes 19
Scutellastra mexicana 158
Scutellastra flexuosa ✱ 33
Nacella concinna
Nacella mytilina
Cellana taitensis 1
Cellana pricei
Cellana sp. 2
Cellana turbata
Cellana radiata 2
Cellana taitensis 2
Cellana sp. 4
Cellana sp. 3
Cellana capensis
Cellana radiata
Cellana toreuma
Cellana enneagona
Cellana grata
Cellana nigrolineata
Cellana solida
Cellana tramoserica
Cellana testudinaria
46.5
244.5
47
685.1
51
1077.5
55
690.5
95
7812.5
Northeastern Atlantic Mediterranean
Australia
Southern Africa
Australia
Southern Africa
Tropical Pacific


A
B
C
D


A
B
C



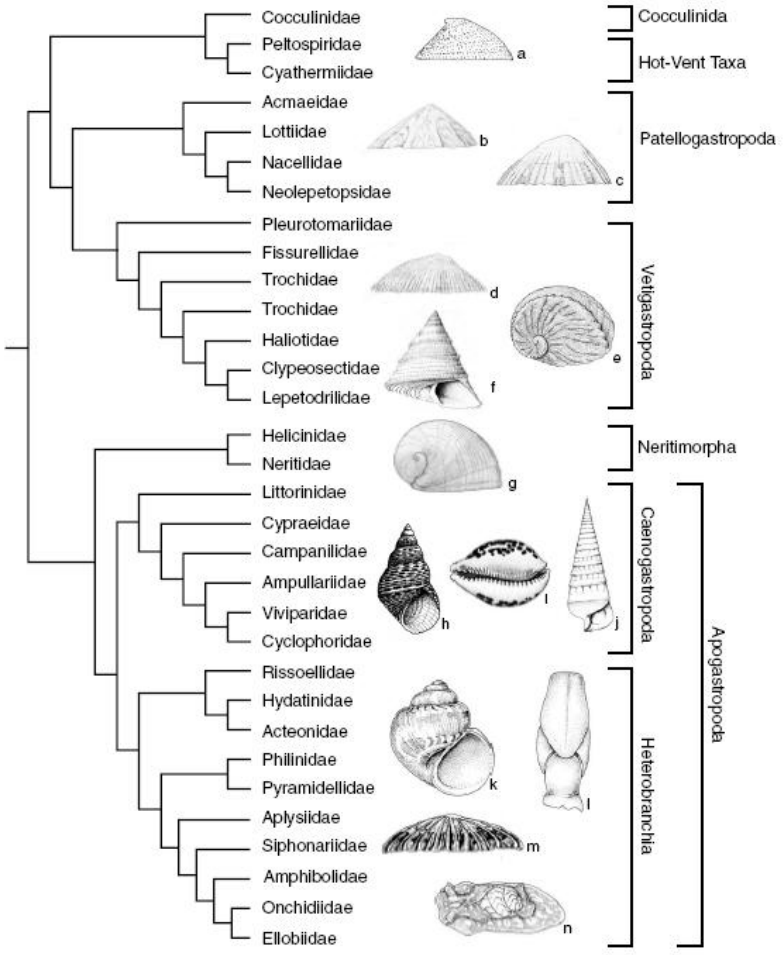


FIGURE 9.7. Schematic representation of gastropod relationships based on the optimal parameter set (121) for the combined analysis of morphological and molecular data. See text for further details. Taxa represented in the figure are (a) *Coccopigya hispida* (Cocculinidae); (b) *Patelloida saccharina* (Lottiidae); (c) *Cellana tramoserica* (Nacellidae); (d) *Diodora lineata* (Fissurellidae); (e) *Haliotis ruber* (Haliotidae); (f) *Calliostoma* sp. (Trochidae); (g) *Nerita atramentosa* (Neritidae); (h) *Littoraria luteola* (Littorinidae); (i) *Cypraea tigris* (Cypraeidae); (j) *Campanile symbolicum* (Campanilidae); (k) *Phallomedusa solida* (Amphibolidae); (l) *Philine columnaria* (Philinidae); (m) *Siphonaria aira* (Siphonariidae); (n) *Micromelo undatus* (Hydatinidae). All images from Beesley *et al*. (1998).