Life on land in the Paleozoic

Paleozoic Terrestrial Life: Some highlights

- First life on land probably Ordovician (or maybe even earlier), but not abundant until Silurian
- History of land (i.e., vascular) plants.
- Plants, coal, glaciation, and atmosphere
- History of insects
- History of terrestrial vertebrates (tetrapods)
Challenges of living on land (for both plants and animals)

- Dessication
- Feeding
- Locomotion
- Respiration
- Reproduction

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Highlights of vascular plant evolution

- Oldest definite vascular plant: Late Silurian
- Oldest seed: Middle Devonian
- Changing dominance of different groups
- Coal swamps dominated by lycopsids, ferns, and sphenopsids: Carboniferous
- Dominance of conifers and cycads: Triassic-Jurassic
- First flowers: Early Cretaceous
The Rhynie Chert
(Scotland)

Rhynia

*Cooksonia* fossil specimen (L) and reconstruction (R).

Both Images from [http://www.ucmp.berkeley.edu](http://www.ucmp.berkeley.edu).


Early Devonian landscape, painting by Zdenek Burian
The Gilboa Forest, Gilboa, Schoharie Co., NY
-- *Eospermatopteris*, a seedfern and one of the earliest trees
The origin of seeds

From Ovule to Seed

Key to Labels
Haploid (n)
Diploid (2n)
Archeopteris, an early seed fern (progymnosperm)
LYCOPOD

SPHENOPSID

TREE FERNS

Lycopods

Lepidodendron

Stigmaria

Living lycopods
Sphenopsids

Calamites

Modern horsetails

Figure 1. Generalized phylogenetic relationships of major vascular plant groups as understood in 1983. Compare with Fig. 2, which shows relationships as understood in 2009. See Fig. 3 for further explanation of the figure.
Early Carboniferous  356 Ma

PANHALASSIC OCEAN

PALEOTETHYS OCEAN

RHEIC OCEAN

GONDWANA

Ancient Landmass
Modern Landmass
Subduction Zone (Triangles point in the direction of subduction)
Sea Floor Spreading Ridge
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Figure 1. The long term or geochemical carbon cycle.
(Berner 1991, 1984). Arrows indicate fluxes between reservoirs. v = volatilization; m = metamorphism; d = diageneric
burial = burial in sediments.

Table 1. Masses of carbon in various reservoirs

<table>
<thead>
<tr>
<th>location</th>
<th>mass (10^{18} \text{ g of C})</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbonate in rocks</td>
<td>60 000</td>
</tr>
<tr>
<td>organic C in rocks</td>
<td>15 000</td>
</tr>
<tr>
<td>ocean (\text{HCO}_3^- + \text{CO}_3^{2-})</td>
<td>42</td>
</tr>
<tr>
<td>soil carbon</td>
<td>4</td>
</tr>
<tr>
<td>atmospheric (\text{CO}_2)</td>
<td>0.7</td>
</tr>
<tr>
<td>biosphere</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Fig. 4. Plot of CO₂ versus time for variable and constant values according to the standard reference simulation and for constant land area and elevation where CO₂ = 1.

Fig. 5. Atmosphere oxygen versus time for constant and variable worldwide total sedimentation rates. Variable sedimentation rates taken from unpublished calculations all with data from the data of Kasten (1975). Results for 200% increase in carbon cycle input and a lower residence time of the young reservoir, relative to an average total reservoir of 1.06 Rs.
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The oldest known insect

*Rhyniognatha hirsti*
Rhynie Chert
Early Devonian, Scotland

Carboniferous Insects

*Cockroach*

*Meganeura*
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A. Acanthostega; - Late Devonian
B. Ichthyostega; - Late Devonian
C. Tulerpeton; - Late Devonian
D. Loxommatidae; - Carboniferous
E. Crassigyrinus; - Carboniferous
F. Anthracosauridae; - Carboniferous to Triassic
G. Amniota (including Seymouriamorpha); - Carb-Recent
H. Amniota; - Carboniferous
I. Nectridea; - Carboniferous to Permian
J. Colosteidae; - Carboniferous
K. Capitosauridae; - Carboniferous to ?Cretaceous
L. Lissamphibia. - Triassic to Recent

Nested taxa and selected synapomorphs (unique characteristics):
1. Tetrapoda (limbs with digits, sacrum, fenestra ovalis, hyomandibula modified into a stapes); 2. reduced gill apparatus; 3. cleithrum free from scapulocoracoid, five digits in hind limbs; 4. Neotetrapoda (five digits or less in both fore and hind limbs); 5. Reptiliomorpha (retractor pit for eye muscles); 6. loss of post-temporal fenestra; 7. incipient pterygoid flange, phalangeal (finger/toe) formula of pes in 2, 3, 4, 5, diplodispondylous vertebrae, stapes sound-conducting; 8. Amphibia (four-digit manus); 9. large interpterygoidian vacuities; 10. temnospondyls.'
Two reconstructions of *Acanthostega*

**Primitive Amniotes (Reptiles)**

*Seymouria*, Late Permian

*Hylonomus*, Early Pennsylvanian

(the earliest known reptile)
The amniotic egg

Terrestrial Tetrapod Diversity
(after Benton, 1985)