SEGMENT THREE; LECTURE FOUR: EXTINCTION/ADAPTIVE RADIATION

Mass extinctions are repeated events evident from the fossil record (Fig. 25.14), during which half or more of all marine species become extinct (recall why marine species are more likely to be fossilized than terrestrial species). Mass extinctions define eras and periods in the Geological Time Scale (Table 25.1). People may be starting another mass extinction by altering/destroying natural habitats. Two examples:

1) Permian extinction (~251 million years ago [mya]) - 96% of marine animals and many terrestrial species were extinguished. Possible causes:

At this time Pangaea formed with the loss of coastal habitats (Fig. 25.13);
Massive outgassing of Siberian volcanoes caused global climate changes including reducing dissolve oxygen in the ocean.

2) Cretaceous extinction (~65.5 mya) - extinction of more than half of all marine species and terrestrial dinosaurs occurred. Evidence for the Impact hypothesis:

Walter (geologist) and Luis (physicist) Alvarez identified an iridium-rich layer of clay. Iridium, an element common in asteroids but rare in the earth's crust, is 30 times more common in clay sediments of 65.5 mya.
Gravity anomaly maps indicate that there is a buried multi-ring crater on the Yucatán coast of Mexico near the village of Chicxulub where an asteroid struck 65 mya;
Crystalline glasses were deposited because of heating at the time of impact.

Consequences:
Firestorms;
Tsunamis, saturating the soil of coastal areas with saltwater;
Dust clouds (Fig. 25.15).

Mass extinctions may create new opportunities for adaptive radiations. New adaptive radiations may also occur when new adaptations evolve, as may have caused the Cambrian explosion.

adaptive radiation = period of evolutionary change in which many new species evolve.

1) After a founding event (Hawaiian Drosophila (Fig. 25.18), Silverswords, in which 28 spp. (vines, trees, cushion plants etc. found in swamps, deserts, etc.) evolved from one ancestral California tarweed in the Aster family in 6 my);

2) After a mass extinction reduces competition and opens new opportunities for surviving species (mammals radiated after extinction of the dinosaurs, Fig. 25.17);

3) After a new adaptive capability arises (shells or eyes in molluscs (Fig. 25.24). In this case, many variants of the basic adaptation increase fitness.

Heterochrony is evolutionary change in the rate of timing of developmental events, as in the skulls of primates (Fig. 25.19).

Homeotic (=***Hox***) **Genes** encode transcription factors, proteins that form the transcription initiation complex. Hox gene products control body plans by specifying the way that cells will divide or differentiate (Fig. 21.17). *Hox* gene products activate other genes that specify the development of specific anatomical structures (Fig. 21.18).

Fig. 25.23. Marine populations of the three-spine stickleback fish have a set of protective spines on their lower surface. Lake populations of this fish lack the spines. Two hypotheses were tested about the underlying genetic cause of this difference. Hypothesis A is that there is a change in a developmental gene *Pitx1*. Hypothesis B is that there is a change in the regulation of the expression of *Pitx1*.