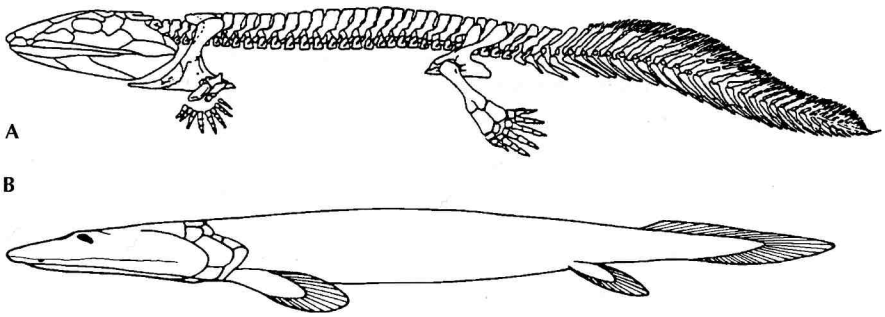

Figure 10.9. **A,** Preliminary reconstruction of the Late Devonian amphibian *Acanthostega*. This is the most primitive tetrapod in which both the fore and hind limbs can be reconstructed. The ribs have been omitted (from Coates and Clack 1995). **B,** The early Upper Devonian osteolepiform fish *Panderichthyes*. The general body form most closely resembles that of tetrapods in the loss of the dorsal and anal fins, but the paired fins retain an external form that is typical of aquatic vertebrates (from Vorobyeva and Schultze 1991).

provides an informative model as to how these two sources of information can be combined to explain how major morphological transitions have occurred.

The closest comparison between the paired fins of obligatorily aquatic fish and animals that were at least facultatively terrestrial is provided by the osteolepiform sarcopterygians *Eusthenopteron* and *Panderichthys* and the stem tetrapods *Acanthostega* and *Ichthyostega* (Figs. 10.9, 10.10). Superficially, the paired fins of the fish appear typical of strictly aquatic vertebrates. They are small relative to the body; they narrow at the base that articulated with the pectoral and pelvic girdles, but broaden distally to form an effective surface for locomotion or directional control in the water. The fin is sheathed with a continuous covering of scales. The proximal scales resemble those on the trunk, but more distally they are narrowed to form jointed dermal fin rays termed **lepidotrichia**.

In contrast, the internal, endochondral bones of the fin are closely comparable to those of terrestrial vertebrates. There is a single proximal humerus and more distal ulna and radius in the forelimb, and the femur, tibia and fibula in the hind limb. They are succeeded distally by bones that are homologous with proximal elements of the wrist (intermedium, ulnare, and centralia) and ankle (fibulare, intermedium, and possibly distal tarsals) of land vertebrates, but they could not have functioned in the manner of these joints in terrestrial vertebrates because they are extensively overlapped by the radius and the tibia. The entire endochondral skeleton is within a functionally continuous fin structure, as seen from its scaly covering. There is no trace of endochondral skeletal elements comparable with the distal carpals or digits of terrestrial vertebrates.

The limbs of *Acanthostega* and *Ichthyostega* have all the major features of later tetrapods. They bear no trace of dermal scales. Much more extensive areas of articulation have evolved between the pectoral and pelvic girdles and the proximal limb bones. The humerus, radius, and ulna, and femur, tibia, and fibula are massive, potentially supporting elements, and the areas of the carpus and tarsus comprise shorter bones that could have served as zones of hinging and/or rotation. The exact patterns of the carpus and tarsus have not yet been determined and are dif-