**The Evolutionary Origin of Plants**

**植物的进化起源**

The evolutionary history of plants has been marked by a series of adaptations. The ancestors of plants were photosynthetic single-celled organisms that gave rise to plants presumably lacked true roots, stems, leaves, and complex reproductive structures such as flowers. All of these features appeared later in the evolutionary history of plants. Of today’s different groups of algae, green algae are probably the most similar to ancestral plants. This supposition stems from the close phylogenetic (natural evolutionary) relationship between the two groups. DNA comparisons have shown that green algae are plants’ closest living relatives. In addition, other lines of evidence support the hypothesis that land plants evolved from ancestral green algae used the same type of chlorophyll and accessory pigments in photosynthesis as do land plants. This would not be true of red and brown algae. Green algae store food as starch, as do land plants and have cell walls made of cellulose, similar in composition to those of land plants. Again, the good storage and cell wall molecules of red and brown algae are different.

植物的进化史是以一系列对周遭环境的适应为标记的。植物的“祖先”是能够进行光合作用的单细胞生物，并由它们进化出那些可能缺少真正的根、茎、叶以及复杂生殖结构——如花朵——的植物。上述提到的这些特征出现于植物进化史的后期。在今天的众多藻类中，绿藻可能与植物的祖先最为相似。这个假说根植于两种物种很近的系统发育(自然进化论)的关系。通过对比两者的DNA，得知绿藻是目前还存活的与植物亲缘关系最近的“近亲”。此外，其他一系列证据支持了这种假说，即陆生植物由原始绿藻进化而成，两者在进行光合作用时使用了相同类型的叶绿素和辅助色素。而红藻和褐藻则并非如此。绿藻以淀粉的形式贮藏能量，这与陆生植物相同;绿藻具有由纤维素构成的细胞壁，这与那些陆生植物的组织结构相同。同样的，红藻和褐藻在能量贮藏形式和细胞壁分子构成方面与之不同。

Today green algae live mainly in freshwater, suggesting that their early evolutionary history may have occurred in freshwater habitats. If so, the green algae would have been subjected to environmental pressures that resulted in adaptations that enhanced their potential to give rise to land-dwelling or organisms.

如今的绿藻大多生活在淡水水域中，这一点说明它们的早期进化史起源于淡水生境。如果事实如此的话，绿藻可能曾经受到环境的压力，产生了适应机制，即提高进化出陆生植物或其他有机体的可能性。

The environmental conditions of freshwater habitats, unlike those of ocean habitats, are highly variable. Water temperature can fluctuate seasonally or even daily and changing level of rainfall can lead to fluctuations in the concentration of chemical in the water or even to period in which the aquatic habitat dries up. Ancient fresh water green algae must have evolved features that enable them to withstand extremes of temperature and periods of dryness. These adaptations served their descendant well as they invaded land.

与海洋生境不同的是，淡水生境的环境条件非常多样。水温会随季节变化，甚至在一天当中也不尽相同;降雨情况的变化也会导致水中所含的化学元素的变化，或因水域生境干涸而成周期性变化。古老的淡水绿藻必须进化出一些特征以保证它们能够对抗极端温度和干旱。这些适应机制在它们的后代进化成陆生生物时起了很好的协助作用。

The terrestrial world is green now, but it did not start out that way. When plants first made the transition ashore more than 400 million years ago, the land was barren and desolate, inhospitable to life. From a plant’s evolutionary viewpoint, however, it was also a land of opportunity, free of competitors and predators and full of carbon dioxide and sunlight (the raw materials for photosynthesis, which are present in far higher concentrations in air than in water). So once natural selection had shaped the adaptations that helped plants overcome the obstacles to terrestrial living, plants prospered and diversified.

陆地世界现在充满绿色，但开始时并非如此。当植物在4千万年前第一次向岸上过渡时，陆地是贫瘠且荒芜的，并不适合生物生存。然而，从植物进化的角度来看，这同时是一片充满机会的土地，没有竞争者和捕食者，并且具有充足的二氧化碳和阳光(这些是光合作用的原材料，它们在空气中的含量要远远高于在水中的含量)。所以，一旦自然选择塑造了植物的适应机制，使之克服在陆地生活的障碍，植物物种就生机勃勃且丰富多样了。

When plants pioneered the land, they faced a range of challenges posed by terrestrial environments. On land, the supportive buoyancy of water is missing, the plant is no longer bathed in a nutrient solution, and air tends to dry things out. These conditions favored the evolution of the structures that support the body, vessels that transport water and nutrients to all parts of plant, and structures that conserve water. The resulting adaptations to dry land include some structural features that arose early in plant evolution; now these features are common to virtually all land plant. They include roots or root-like structures, a waxy cuticle that covers the surfaces of leaves and stems and limits the evaporation of water, and pores called stomata in leaves and stems that allow gas exchange but close when water is scarce, thus reducing water loss. Other adaptations occurred later in the transition to terrestrial life and now widespread but not universal among plants. These include conducting vessels that transport water and minerals upward from the roots and that move the photosynthetic products from the leaves to the rest of the plant body and the stiffening substance lignin, which support the plant body, helping it expose maximum surface area to sunlight.

当植物开拓陆地的时候，它们要面对一系列陆地环境带来的挑战。在陆地上，水中支撑植物的浮力消失，植物不能再漂浮在营养液里，空气会风干水分。这些条件有助于进化出那些用于支撑枝干的结构、运输水分和养分到植物各部分的导管以及储存水分的结构。对干旱陆地的适应结果包括一些在早期植物进化中所体现出的结构特征; 现在，这些特征几乎在所有的陆生植物上都有所体现。其中包括根或者类似根的结构、覆盖茎叶表面能阻止水分蒸发的蜡质角质层以及茎叶上被称为气孔的小孔——气孔的存在可以保证气体的交换，并在水分缺失时关闭气孔从而防止水分的进一步流失。其他的适应机制在向陆地过渡过程中出现得较晚，现在体现在很多植物上，但并不是所有的植物。其中包括从根部向上运输水分和矿物质的导管，从叶片向植物其他部分输送光合作用产物的筛管以及用来支撑植物体、使得它以最大表面积接触阳光的硬化木质。

These adaptations allowed an increasing diversity of plant forms to exploit dry land. Life on land, however, also required new methods of transporting sperm to eggs. Unlike aquatic and marine forms, land plants cannot always rely on water currents to carry their sex cells and disperse their fertilized eggs. So the most successful groups of land plants are those that evolved methods of fertilized sex cell dispersal that are independent of water and structures that protect developing embryos from drying out. Protected embryos and waterless dispersal of sex cells were achieved with the origin of seed plants and the key evolutionary innovations that they introduced: pollen, seeds, and later, flowers and fruits.

这些适应机制保证了不断增加的植物形态的多样性，以便于它们去开拓干旱的陆地。然而，陆地上的生物也需要新的方法来受精。与水中和海洋中的形式不同，陆生植物无法总是依赖水流来携带生殖细胞或传播受精卵。因此，陆生植物中最成功的那几组植物都进化出了不依靠水也可以传播受精生殖细胞的方式和防止发育中的胚胎变干的结构。进化到种子植物时，保护胚胎以及在无水环境下传播生殖细胞的方式才得以实现，它们带来的关键进化创新的产物是：花粉、种子以及后来的花朵和果实。