Plastome Evolution in Hemiparasitic Mistletoes

Santalales is an order of plants consisting almost entirely of parasites. Some, such as Osyris, are facultative root parasites whereas others, such as Viscum, are obligate stem parasitic mistletoes. Here, we report the complete plastome sequences of one species of Osyris and three species of Viscum, and we investigate the evolutionary aspects of structural changes and changes in gene content in relation to parasitism. Compared with typical angiosperms plastomes, the four Santalales plastomes are all reduced in size (10-22% compared with Vitis), and they have experienced rearrangements, mostly but not exclusively in the border areas of the inverted repeats. Additionally, a number of protein-coding genes (matK, infA, ccsA, rpl33, and all 11 ndh genes) as well as two transfer RNA genes (trnG-UCC and trnV-UAC) have been pseudogenized or completely lost. Most of the remaining plastid genes have a significantly changed selection pattern compared with other dicots, and the relaxed selection of photosynthesis genes is noteworthy. Although gene loss obviously reduces plastome size, intergenic regions were also shortened. As plastome modifications are generally most prominent in Viscum, they are most likely correlated with the increased nutritional dependence on the host compared with Osyris.