

Functional Diversity of Plant Physiology on Extreme Sites

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How diverse can function and physiology be on extreme sites? How diverse can the species, and their physiological responses and adaptations be if the hydric conditions vary from extremely dry to extremely flood along the annual course? How specialized do species need to be, which physiological amplitudes can or must species possess on extreme sites? The term, 'extreme site' is frequently used in current publications, but its delimitation and definition are not clear. The above mentioned questions have been a challenge in the past decades for ecologists and physiologists. I propose a definition of the term, 'extreme site' basing on the biological stress concept, Larcher [1] which states that, resulting from cumbering climatic conditions, limited nutrient availability, biological competition and damage, plants are subjected to a variety of strains, for which the term stress is used. Extreme sites are therefore "environments in which one or more factors are over- or underrepresented in a manner that the organisms can live there only if they possess special adaptations". These environments normally are represented by polar deserts in the Antarctic region [2] arid deserts [3-5] alpine environments with debris [6], or inselbergs [7,8]. Ecosystems with extreme conditions where non-coniferous trees dominate, for example, gallery forests in deserts and savannas or mangrove forests along tropical coasts, normally represent forests with low diversity of species and a low diversity of physiological responses [9,10]. On the other hand, there are extreme sites which show a very high diversity despite unfavourable growth conditions—a good example are Amazonian floodplain forests [11]. These show all the characteristics typical for a stressful extreme site: uninterrupted flood duration with high amplitudes, rapid changes of water levels, anoxic conditions in the rhizosphere, high sedimentation in várzea, nutrient scarcity in sediment-poor igapó, high mechanical stress, sometimes even drought contribute to make growth and establishment difficult for most organisms [12,13].

Despite the strongly restricting environmental conditions, Amazonian floodplain forests are characterized by an extremely high diversity of species and physiological responses [14-17]. This diversity results from the fact that the stressors in this extreme site possess only a low level of restriction for tree life, and disturbances may even represent an enhancing factor for resistance and adaptive evolution. The high complexity of the system and the short, but regular presence of factors favourable for high physiological performance allowed the evolution of highly diverse survival strategies. The species living there partly are highly specialized, but most of them have rather high physiological amplitudes. One may say the physiological specialization of the trees is low enough to be able to respond flexibly to changing environmental conditions and guarantee survival. On the other hand, specialization is high enough to allow a high diversity and establish different species along hydric and edaphic gradients.

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