Growth forms of plants – optimized to mechanical stresses

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A particular plant growth form is an adaptation to life in the three-dimensional space, under influence of gravity and other abiotic and biotic factors. Different growth forms have different mechanical constraints and have adapted various ways of producing stiffness, flexibility and resistance to failure. The family Aristolochiaceae contains a huge variety of growth forms, ranging from small herbaceous plants to large woody climbers and even shrub-like species. This diversity makes this group highly interesting for studying growth forms and their shifts between each other. In general, self-supporting plants need sufficient rigidity to remain upright whereas non self-supporting growth forms use other plants as mechanical support and usually include a high degree of flexibility in the main stem. Aim of this study is to analyze the mechanical properties and underlying internal organization of different growth forms within the order Piperales and the family Aristolochiaceae, as well as the evolutionary shifts leading to them. Besides the functional and structural analyses this study includes molecular phylogenetic investigations to detect the occurrence of different growth forms within the respective clades. This study aims thus at analyzing underlying biological and evolutionary principles of different plant constructions by using a wide range of methods and delivers therefore a base for bionic inspirations. One special focus is on the climbing habit of plants and the related mechanical and anatomical traits. Climbers show many fascinating strategies to cope with biotic and abiotic challenges such as water conductivity or connection to the support plant as well as mechanical stresses. They combine soft and hard tissues in a kind of compound material, which is obviously characterized by a low risk of failing. To study this kind of growth form with respect to their tissue and interface properties is of high interest for understanding the underlying natural principles and for transferring them into technical tasks.

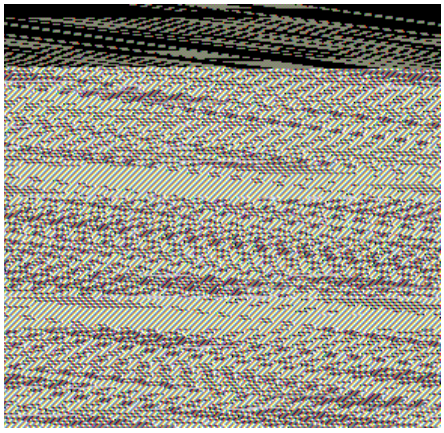

Figure 1: "Rope" of two lianas carrying a collapsed tree.

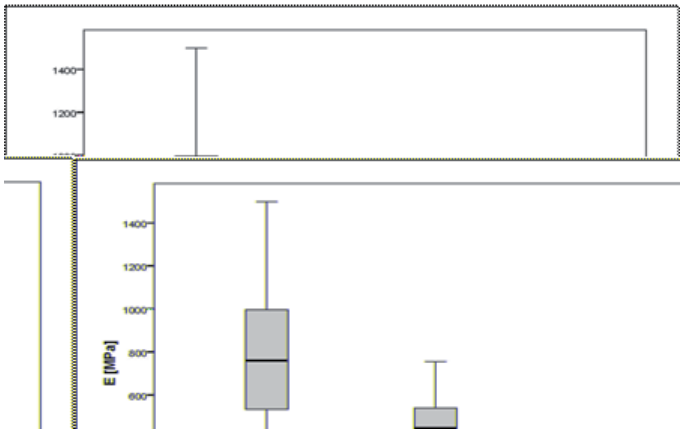

Figure 2: Characteristic decreasing pattern of Young's modulus during the development of a climbing plant; y-young axes, m-medium and o-old axes.