Biomechanical, anatomical and morphological analysis of different growth habits in the Genus *Lonicera*

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The genus *Lonicera* (Caprifoliaceae) is characterised by the occurrence of different growth habits among its various species [1,2]. The eight tested species are currently placed in different systematic subdivisions of the genus *Lonicera* [1,3]. The plants have been chosen to cover the entire range of growth habits found in the genus *Lonicera*. According to our functional analysis the eight tested species show ontogenetic variations in bending mechanical properties and the underlying stem anatomy typical of self-supporting shrubs (*L. nigra, L. alpigena*), semi-self-supporting woody plants (*L. xylosteum, L. myrtillus, L. sempervirens*) and non-self-supporting twining lianas (*L. periclymenum, L. alseuosmoides, L. reticulata*) [4,5].
In biomechanical experiments the ontogenetic variations of flexural stiffness and of the structural Young's modulus were tested by 4-point bending [4,6,7]. In the anatomical studies the relative contribution of different stem tissues to the cross-section area and to the axial second moment of area was determined.
In addition to these investigations morphometrical studies were made in a few species (*L. xylosteum, L. myrtillus*) by using stereophotogrammetric analysis of the growth habits [8]. For these analyses three-dimensional digital models of the shrubs were produced in CAD-program by digitising stereophotographies of the plants. From this three-dimensional models it becomes possible to quantitatively analyse the branch architecture and the curvature of single branches. This procedure allows to combine biomechanical and anatomical results with morphometrical analyses [9].
The results are presented exemplarily for three species with typical growth habits: *L. nigra* (self-supporting shrub), *L. xylosteum* (semi-self-supporter) and *L. periclymenum* (non-self-supporting, twining liana).
The shrub *L. nigra* shows an increase of the structural Young's modulus during ontogeny by a factor of 2.7 which is typical of self-supporting woody plants. The semi-self-supporting species *L. xylosteum* is characterised by a relative constant structural Young's modulus in all ontogenetic stages. The structural Young's modulus of the liananescent twiner L. periclymenum decreases during ontogeny to about 41% of the value found in the youngest, one year old axes.
A typical feature of most studied *Lonicera*-species is a high 'plasticity' in their mechanical stem properties according to environmental conditions. Some of the tested species seemed to be able to shift from one growth habit into another during ontogeny.
Examples are creeping basal branches often found in old plants of the self-supporter *L. nigra*. These horizontally creeping branches can produce roots and reiterative twigs, and therefore help vegetative dispersal by forming clones.

The structural Young's modulus of these horizontally growing big axes is much smaller than the values found in typical upright branches of the same diameter and age (up to 13 years). It equals the value found in the youngest, relatively bending flexible one year old axes.
Another example are the oldest most basal upright stem parts found in some specimens of the liana *L. periclymenum*. These most basal, up to 20 years old stem parts show a slight increase in structural Young's modulus compared to the low value found in 8-15 year old stems of the same specimen.
These results can be interpreted as an 'opportunistic' mode of growth, that allows plants to produce axes with different mechanical properties according to the environmental constraints [10]. Our results indicate that in the genus *Lonicera* not only a great variety of growth habits exists, but that the 'basic growth habit' which is typical of a certain species shows - at least in some species - a high plasticity.

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