

University of South Bohemia  
Faculty of Science



Morphological and ecophysiological traits shaping  
altitudinal distribution of three *Polylepis* treeline species  
in the dry tropical Andes

RNDr. Thesis

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### **Annotation**

Numerous species of the genus *Polylepis* form the highest treeline in the world, with striking dissimilarities in their upper altitudinal limits. The commonly accepted hypothesis is: growth at a treeline is temperature-limited. The aim of this work was to identify other factors influencing altitudinal distribution of *P. tarapacana*, *P. tomentella* and *P. rugulosa* in dry tropical Andes by means of using records of morphological and ecophysiological traits.

I hereby declare that this RNDr. Thesis has been fully worked out by myself and the named co-authors, and with the use of the cited references.

I declare that in accordance with the Czech legal code § 47b low No. 111/1998 in its valid version, I consent to the publication of my RNDr. Thesis (in an edition made by removing marked parts archived by the Faculty of Science) in an electronic way in the public access to the STAG database run by the University of South Bohemia in České Budějovice on its web pages.

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Jana Macková

České Budějovice, 6<sup>th</sup> January 2010

Hereby I confirm, that Jana Macková significantly contributed to measuring and collecting data in the field, laboratory analyses and manuscript preparation in the following research paper:

Macek P., Macková J., de Bello F., 2009. Morphological and ecophysiological traits shaping altitudinal distribution of three *Polylepis* treeline species in the dry tropical Andes. *Acta Oecologica*, 35: 778–785.



RNDr. Petr Macek, PhD.



Francesco de Bello, Ph.D.

The text of RNDr. Thesis is formed by the following paper:

Macek P., Macková J., de Bello F., 2009. Morphological and ecophysiological traits shaping altitudinal distribution of three *Polylepis* treeline species in the dry tropical Andes. *Acta Oecologica*, 35: 778–785.

#### Abstract

Numerous species of the genus *Polylepis* form the highest treeline in the world, with striking dissimilarities in their upper altitudinal limits. The commonly accepted hypothesis is that growth at a treeline is limited by temperature. Here, using *in situ* records of various morphological and ecophysiological traits, we aimed to identify other factors influencing altitudinal distribution of three congeneric species from the dry tropical Andes: *Polylepis rugulosa*, *Polylepis tarapacana* and *Polylepis tomentella*. While *P. tarapacana* and *P. tomentella* reach their altitudinal limit at around 5000 m asl, *P. rugulosa* does not thrive above 4300 m, but precipitation is markedly lower in its distribution area. The three species responded to altitude by a change of morphological (e.g. decreased tree height and leaf size) and ecophysiological (e.g. decrease of transpiration rate, nutrient concentration or enrichment in the  $^{13}\text{C}$  isotope) traits, and this response was generally more pronounced in *P. rugulosa*. In comparison with *P. tarapacana* and *P. tomentella*, *P. rugulosa* displayed higher transpiration rates. Waxes from the abaxial (stomatous) leaf side of *P. rugulosa* were most strongly enriched in  $^{13}\text{C}$ . Furthermore, leaves of all species studied here had exceptionally low N and P concentrations. Trade-offs linked to changes in leaf area (e.g. bigger leaves, higher photosynthetic capacity but elevated transpiration) seem to drive differentiation and adaptations to altitude among these three congeneric species. We hypothesize that, while the upper distribution limit of *P. tarapacana* and *P. tomentella* is largely driven by low temperature, water is an important additional factor controlling the altitudinal distribution of *P. rugulosa*. Our results suggest that water stress needs to be taken into account among the factors shaping the altitudinal distribution of tropical treeline species.

#### Shrnutí

Srovnáním ekofyziologických a morfologických vlastností tří příbuzných druhů rodu *Polylepis* tvořících hranici lesa jsme se pokusili vysvětlit jejich různé výškové rozšíření (horní limit od 4300 do >5000 m.n.m.). Hranice lesa je obecně ovlivněna teplotou. Pomocí gazometrických charakteristik a izotopového složení kutikulárních vosků jsme se pokusili identifikovat alternativní faktory. Zatímco výškový limit u *P. tarapacana* a *P. tomentella* je ovlivněn především teplotou, dostupnost vody hraje klíčovou roli ve výškové distribuci *P. rugulosa*. Stress nedostatkem vody by měl být brán v potaz jako faktor ovlivňující hranici lesa v tropických horách.

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