Mit dem **Preis der Mathematisch-Naturwissenschaftlichen Klasse für Biologie 2021** wurde LAURA RAGNI, Tübingen für ihre herausragenden entwicklungsbiologischen Arbeiten im Bereich der pflanzlichen Wurzel- und Stammzellentwicklung ausgezeichnet.

Laura Ragni

Reinforcing plant armors to improve plant resilience in a changing environment

Laura Ragni, Trägerin des Nachwuchspreises für Biologie 2021

I am a European plant molecular biologist, I studied Plant biotechnology (BSc+MSc) in Milano; during this period I visited the UK as an Erasmus student. After my studies, I moved to France (INRA-Versailles) for my PhD on flower and plant architecture. As an EMBO post-doc fellow I studied root secondary growth in Switzerland, and since 2013 I am group leader at the University of Tübingen with my own line of research on the periderm.

Plants are sessile organisms that have to face many different environmental conditions, and due to climate change they will soon face even harsher conditions. Plants respond and adapt to stress with a plethora of molecular and physiological responses. Plant-pathogen interactions have been extensively studied and characterized at molecular level during the last years, but these are not the only plant defense mechanisms, as plants have evolved mechanical barriers that protect them from the environment. Depending on the plant family and on the plant developmental stage we can find different root barriers. For example in rice the key root barrier are the endodermis and the exodermis, while in the model plant Arabidopsis we find the same barriers as present in trees: the endodermis during primary growth and the periderm during secondary growth (Fig1A) (Campilho *et al.*, 2020; Serra *et al.*, 2022).

You should imagine the periderm as a medieval armor that protects the plant vasculature of stems, branches and roots of many woody and some herbaceous plants. The periderm is formed during secondary growth, the increase of girth of plant organs and it is a complex barrier. It comprises a stem cell niche, the cork cambium that is very similar to the vascular cambium, divides bifacially and forms toward the inside the phelloderm and toward the environment the cork (Fig1B).

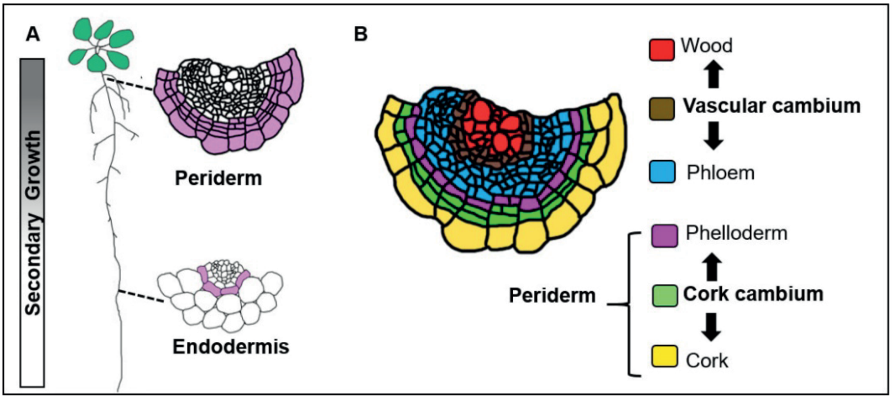

Fig 1. A) Root barriers present in the root of Arabidopsis thaliana. B) Sketch of a root cross-section highlighting the different tissues.

Cork cells are unique as they are impregnated with suberin and lignin. This special cell wall composition confers to the cork the barrier properties (Campilho *et al.*, 2020; Serra *et al.*, 2022). In fact, we could show that plants that lack suberin and lignin in the cork are less resistant to salt stress (Andersen *et al.*, 2021). In potato tubers, the cork protects also against biotic stress, in fact the potato skin is a periderm and varieties that are resistant to common scab disease display more suberin and more cork layers (Thangavel *et al.*, 2016).The cork also has economic value as it is used as insulating material, to make resins and polymers and for wine stopper production (Silva *et al.*, 2005). Despite the fact that the cork has economic and agricultural relevance, and cork cells were the first cells ever observed under a microscope in 1665 (Hooke and Lessing, 1665), the molecular mechanisms of cork formation are largely unknown. Thus, we established a framework and tools to study periderm development in the root of the model plant Arabidopsis. The root represents a developmental gradient, and in a single root we can study all steps of periderm formation. The periderm arises from the pericycle, an inner tissue which is surrounded by the endodermis, the cortex and the epidermis. The pericycle after the vascular cambium is initiated reacquires pluripotency and starts to divide forming the cork cambium (Wunderling *et al.*, 2018; Xiao *et al.*, 2020). During this process the endodermis undergoes programmed cell death and the cortex and epidermis break to accommodate radial growth (Wunderling *et al.*, 2018).

Using the Arabidopsis root model, we aim to investigate how the cork cambium is established and how cork cells differentiate into unique specialized cork cells. When I started my group, we only knew that the cork cambium arises from the pericycle, now we know that the plant hormone auxin plays a critical role during cork cambium formation. Briefly, using biosensors, which report the concentration or the activity of a hormone *in vivo*, we showed that auxin accumulates in the cork cambium, while using genetic tools that block auxin signaling specifically in the periderm, we demonstrated that auxin is required for cork cambium initiation and maintenance (Xiao *et al.*, 2020). Moreover, we identified two transcription factors that act downstream of auxin during periderm development, elucidating the first cork cambium regulatory network (Fig2) (Xiao *et al.*, 2020).

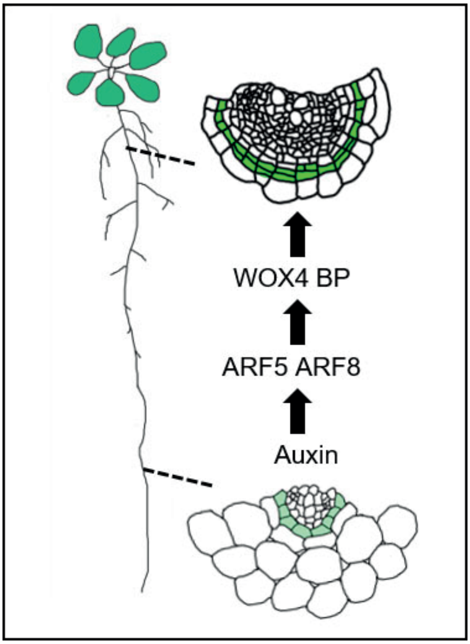

Fig 2. Regulatory network underlying cork cambium initiation based on Xiao et al 2020.

We also showed that vascular cambium initiation is a prerequisite for cork cambium formation and that lateral root formation inhibits both vascular cambium and cork establishment. Future studies addressing how the cork and the vascular cambium activity is coordinated and how the environment influences the cork cambium will pave the way for breeding programs aiming to increase wood production and plant resilience.

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