BOKU UNIVERSITY

2023 Annual Report

Institute of Biophysics

Department of Bionanosciences
University of Natural Resources and Life Sciences
Vienna, Austria

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University of Natural Resources and Life Sciences Vienna
(BOKU), Austria

Foreword

2023 was full of surprises, not at the institute level, but at the university level. In social and quantitative terms, it was a very good year for us. Some of our staff and students finished their work with us and left. As a result, we have recruited a new generation of staff who will stay with us for a few years and help us develop new topics, bringing ideas (and good humour).

In quantitative terms, we have published 14 articles and had 20 contributions to conferences (workshops, seminars, outreach media). We also have new projects (big and small) that allow us to finance young people.

Following our tradition, our institute has hosted external national and international researchers (from professor to master student). We should continue in this way. It is good for us on the research level and we support the international strategy of BOKU with our small contribution. Also in this last year of the Department of Bionanosciences we did a good job.

The future will be new. BiMat (which will be called Colloids and Biointerfaces) and Biophysics will be integrated into a new department (with other 10 institutes) called Department of Natural Sciences and Renewable Materials (or something similar). We do not yet know how independent the institute will be and how the global budget and investment money will be allocated. We have to assume that the equipment we are using is at least ten years old and may need to be repaired or replaced soon. 2024 will be another year of transition (with a lot of university politics in the air). I think we should explore new ways (and not just collaborate more with other institutes). One issue that could be important is science communication. How can we (properly) reach the general public outside the walls of BOKU? How can we show that science has a good social value in itself? I am not worried about our science, but it is better to plan our future than to leave it to others... although every new situation offers new opportunities. We may have to join forces if we want to stay together. Finally, I would like to thank all the people who have been with us during 2023 for their work and dedication. Thank you (and good night).

Jose L. Toca-Herrera

Institute members and visitors

- Univ. Prof. Dr. José L. Toca-Herrera (director)
- Dr. Wisnu Sudjarwo (Univ. Assistant, deputy director)
- Assoc. Prof. Dr. Notburga Gierlinger (group leader)
- Assoc. Prof. Rafael Benitez Suarez (University of Valencia)
- Assoc. Prof. Luis Millan Gonzalez (University of Valencia)
- Assoc. Prof. Maria Teresa Pellicer (University of Valencia)
- Dr. Sebastian Antreich (post-doctoral research assistant)
- Dr. Jessica Huss (post-doctoral research assistant)
- Dr. Med. Michael Handler (PhD student, collaboration with Sports Univ. Innsbruck, Austria)
- Dr. Lukas Schrangl (Univ. Assistant)
- Dr. Israel Villarrasa Sapina (postdoc, collboration with University of Valencia)
- Dr. Nannan Xiao (post-doctoral research assistant)
- Mag. Amsatou Andorfer-Sarr (technical assistant)
- Mag. Jacqueline Friedmann (technical assistant)
- Mag. Valerie Wagner (technical assistant)
- MSc. Laura Anton Gonzalez (PhD student, collaboration with University of Valencia)
- MSc. Alexander Einschütz Lopez (PhD student)
- MSc. Isabel Gris Cardenas (PhD student, Collaboration with BioGUNE)
- MSc. Mahder Mekonnen (PhD student, OeAD grant)
- MSc. Giuseppe Tiloca (PhD student)
- MSc Barbara Zbiral
- BSc. Victoria Beneder (MSc student)
- BSc. Paraskevi Charalambous (MSc student)
- BSc. Tobias Eder (MSc student)
- BSc. Martin Grömmer (MSc student)
- BSc Marin Milićević (MSc CEEPUS student, Univ. of Mostar)
- BSc Lidija Pejak (MSc-CEEPUS student, Univ. of Mostar)
- BSc. Elisabeth Schögl (MSc student, collaboration with University of Vienna)
- Wintana Reichenvater (BSc Student)
- Daniel Tyrakowski (Bsc student, collaboration with FH Tulln)
- Hannah Blaschka (apprentice)
- Konstantinos Kounetas Jasmina (apprentice)

Research projects

Kalmia procumbens: Cuticle, trichomes, and stomata chemistry revealed by Confocal Raman Microscopy

Giuseppe Tiloca[1] , Paraskevi Charalambous[1] , Peter Bock[1] , Othmar Buchner[2] , Gilbert Neuner[2] , Notburga Gierlinger[1]

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[2] Department of Botany, University of Innsbruck, 6020, Innsbruck, Austria

Elucidating plant leaf cuticle composition, along with its properties and thermal tolerance, is essential to predict species adaptation to environmental changes, especially those that grow in endangered ecosystems. Together with the cuticle, trichomes and stomata usually co-exist forming a protective layer against living organisms and environmental threats. *Kalmia procumbens* is a prostrate alpine shrub growing above tree lines. Owing to its growth form, periodic overheating risk is regular. Its leaves can withstand high-temperature stress; however, it is not known how extreme events impact the cuticle. In the present work, we reveal the chemical composition of *K. procumbens* leaf cuticle, trichomes, and stomata by using Confocal Raman Microscopy. Thin (12-14 µm) leaf sections were prepared using a cryomicrotome. Sections were placed on microscopy glass slides with a drop of distilled water, covered with microscopy coverslips, and sealed with nail polish (Fig. 1). Linear polarized (0°) 785 nm and 532 nm lasers, were used for Raman imaging experiments. Along selected regions of interest, including the cuticle region, the epidermal layer, and trichomes, spectra were recorded every 300 nm. Based on the Raman spectra, chemical images were generated (Fig. 2), and components, such as aromatics and lipids visualized within the anatomical structures with micro resolution. Compared to other leaf cuticles (e.g., *P. abies*, *Arabidopsis*), chemistry of *K. procumbens* revealed mainly lipids, tri-terpenoids, and flavonoids. Distinctions between adaxial and abaxial surfaces are noted: stomata are only located on the abaxial surface, surrounded by trichomes made of tri-terpenoids and lipids; ‘tiny’ trichomes located on the adaxial surface revealed mainly flavonoids. The different chemical compositions reflect environmental adaptations to the ecosystem. Further investigations of different species will give insights into chemical and structural adaptations of the plant cuticle.

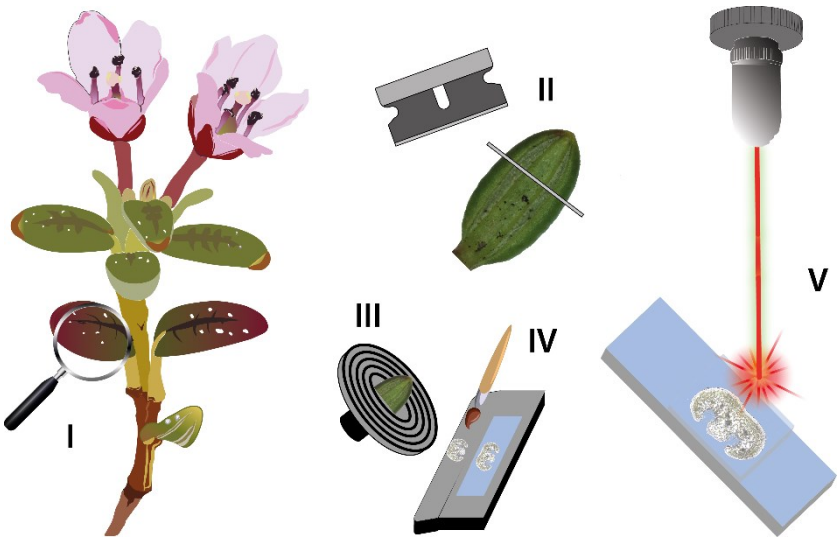

Figure 1 Cuticle sample preparation for Raman microspectroscopy using a microtome. (**I**) The plant is visually inspected; (**II**) a selected leaf is chosen and cut using a razor blade; (**III**) the leaf portion is mounted by freezing it on a sample holder in the Cryomicrotome; (**IV**) frozen cut sections are collected using a fine brush and placed on a microscope slide; (**V**) Raman spectra acquisition by exposing sample to monochromatic laser (Experimental: 785 nm excitation, 100x oil

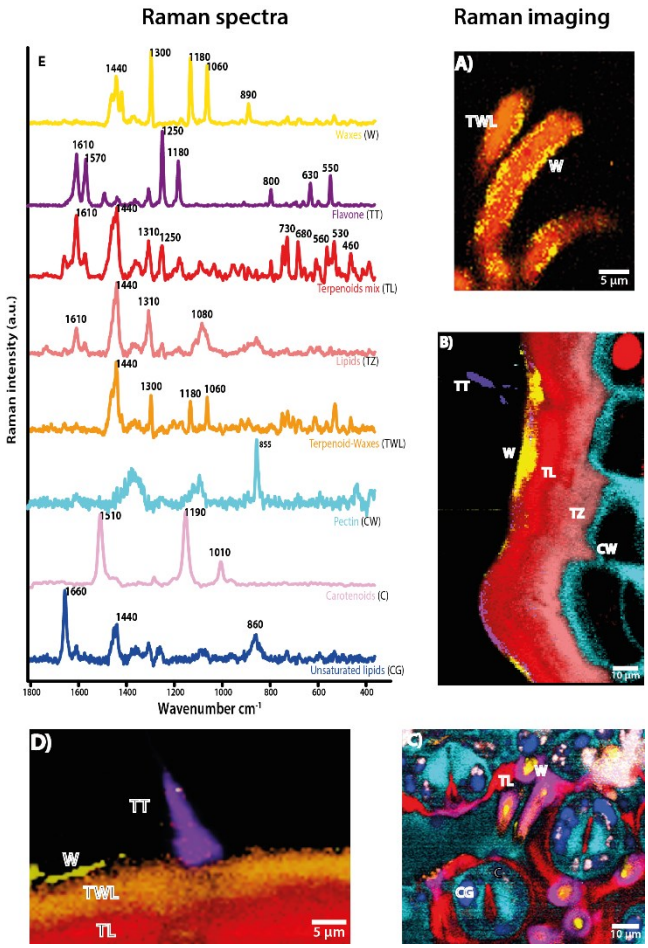

Figure: Raman imaging and spectra acquisition of *K. procumbens* samples. **A**) Trichomes on the abaxial surface; **B**) Cuticle different layers, cell wall and 'tiny' trichome; **C**) Stomata on the abaxial surface surrounded by trichomes; '**D**)Tiny' trichome on the leaf adaxial surface; **E**) Corresponding Raman spectra. Legend: (**TT**) 'tiny' trichome, (**W**) waxes, (**TL**) terpenoid layer, (**TZ**) transition zone, (**CW**) cell wall, (**TWL**) terpenoid-waxes layer, (**C**) carotenoids, (**CG**) cell guard.

Frozen mountain pine needles: a lignified endodermis and parenchyma to accommodate ice

Matthias Stegner[1], Nannan Xiao[2], Gilbert Neuner[1], Notburga Gierlinger[2]

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[2] Institute of Biophysics, Department of Nanobiosciences, University of Natural Resources and Life Science, Vienna, Austria

Objective

During needle freezing, the exceptional leaf anatomy, where an endodermis separates the mesophyll from the vascular tissue, could have consequences for ice management and photosynthesis. Therefore, we aimed to investigate the microchemistry of the needle tissue to explain frost hardiness of pine needles.

Results & Conclusion

The needle anatomy of mountain pine follows the characteristic anatomical pattern of conifer needles with a central vascular tissue, an endodermal cell layer and photosynthetic active arm palisade parenchyma cells (Fig. 1A).

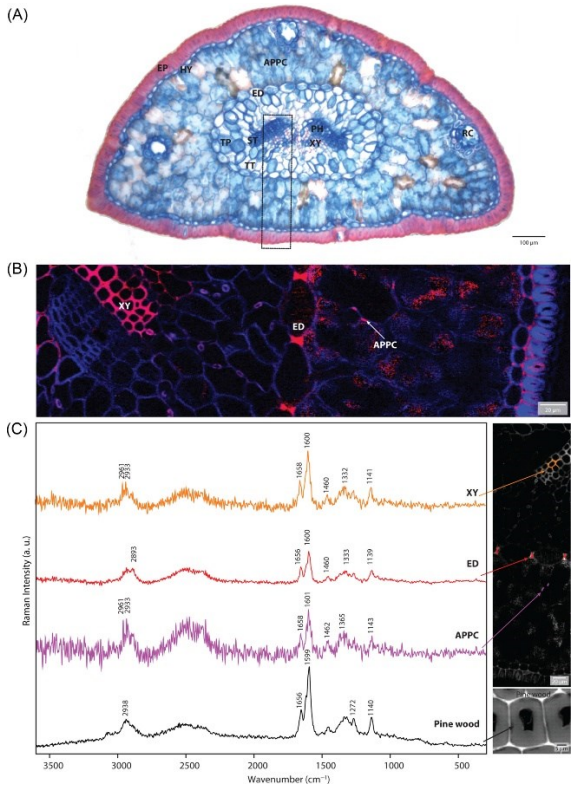

Figure 1 : Light and confocal Raman microscopy images of mountain pine needle cross-sections. (A) Fuchsin–Chrysoidine–Astrablue staining revealed a lignified epidermal layer (EP), the xylem (XY) in the vascular bundles, and the endodermis (ED). (B) Raman imaging (frame inserted in A) based on True Component Analysis of the cell walls (in blue) and lignified xylem, radial walls of the endodermis and partial walls of the arm palisade parenchyma cells (APPC, red), overlay of both images. (C) Extracting average spectra selectively from the xylem cells (orange), radial endodermis walls (red), the walls of the arm palisade parenchyma cells (purple) in the needle and from pine wood (black), confirmed similar lignin structures within the needle cell walls and pine wood.

The outer epidermis had the most reddish-stained cell walls and was therefore considered to have the most lignified cell walls, followed by the xylem in the vascular bundles and the endodermis. This exceptional lignification of the radial endodermis wall was verified by Raman imaging (Fig. 1B, red). Extracting average spectra selectively from the red-coloured xylem cells, radial endodermis walls, the stained walls of the arm palisade parenchyma cells in the needle and pine wood confirmed similar lignin structures within the needle cell walls and pine wood (Fig. 1C). The most prominent lignin bands at 1656, 1660, 1460, 1333, 1272, and 1140 cm^{-1} were found in similar ratios in all extracted average spectra and are typical bands from coniferyl alcohol and coniferyl aldehyde. Spectra of the arm palisade parenchyma cells were very noisy as high fluorescence background overlaid the Raman signal in these tissues and lignin bands were only found at a few places (Figure 1B arrows and Figure 1C).

For a more comprehensive view, longitudinal sections were investigated with histochemical staining (Figure 2A,B) and Raman imaging (Figure 2C–F). Both histochemical stainings confirmed the epidermis and hypodermis to be lignified as well as the endodermis (Figure 2A,B). To get rid of the high fluorescence background and get a better signal-to-noise ratio of the spectra, the micro sections were also scanned after EtOH extraction (Figure 2C–F). By this high signal to noise ratio spectra were obtained and revealed a regular pattern of lignified tangential arm palisade parenchyma cell walls (Figure 2C). Only the tangential walls are lignified; consequently, the arm palisade parenchyma cells are in a strip-like arrangement between the endodermis and the hypodermis (Figure 2A–C). The endodermis, hypodermis and the inner xylem were most lignified (red colour, Figure 2C; red spectrum Figure 2E), while the other cell wall spectra were dominated by carbohydrate bands, for example 1379, 1097 and 379 cm^{-1} (Figure 2E, blue spectrum). Within the needles, the ice masses were strictly confined to the central vascular cylinder. This suggests an important putative function of the endodermis. The revealed particular lignification pattern may block the penetration of ice from the frozen transfusion tissue into the mesophyll. This, together with the structurally rigid mesophyll cell walls, prevented mesophyll freeze-dehydration. As a result, the intercellular gas spaces of the mesophyll remained free of ice, which may allow needle gas exchange during prolonged periods of frost at the alpine treeline.

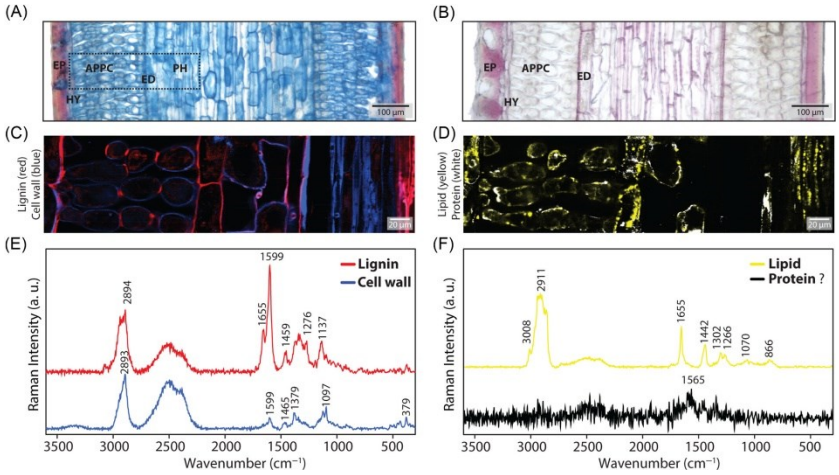

Figure 2: Light and confocal Raman microscopy images of mountain pine needle cross-sections.

Original Reference : Stegner M, Buchner O, Gesslbauer M, Lindner J, Florl A, Xiao NN, Holzinger A, Gierlinger N, Neuner G (2023) Frozen mountain pine needles: The endodermis discriminates between the ice-containing central tissue and the ice-free fully functional mesophyll. Physiologia Plantarum 175 (1): e13865, DOI: 10.1111/ppl.13865

Chemical tissue heterogeneity of young Arabidopsis stems revealed by Raman imaging combined with multivariate data analysis

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Objective

The aim was to unravel details on chemical heterogeneity in the different tissue types of *A.thaliana.* To go beyond common approaches to visualize common component classes, we aimed to fit at every pixel selectively relevant reference spectra.

Results & Conclusion

Structural and chemical tissue heterogeneity in plant stems is essential to fulfil the many different functions for growth and survival. Cutting microsection of young developing stems of the model plant Arabidopsis opened the view on vascular bundles (transport of water, nutrients, food, and other chemicals), interfascicular fibers (mechanical support), parenchyma (production, storage) and the epidermis with cuticle (protection, barrier, exchange,..). Mapping such a cross-section with a Confocal Raman microscope resulted in hyperspectral datasets, which are the basis to image chemical heterogeneity with a spatial resolution of 300 nm in context with the microstructure. We generated the images based on three different multivariate approaches: unmixing to find the most pure components, cluster analysis so segment the dataset into clusters with spectral similarity, and fitting the original spectra at every pixel by a linear combination of plant component reference spectra. The true component analysis was superior to cluster analysis in specificity and added information on lipids and starch distribution. Due to the multicomponent nature of plant tissues no “pure” components were retrieved, wherefore a subsequent mixture analysis (orthogonal matching pursuit) of extracted component spectra with a reference database followed (Figure 1). This led to details on the molecular composition of the spectra and tissues and was essential input for a final reference component fit at every pixel. By the last analysis, different aromatic components and hemicelluloses were discriminated and a similarity of their distribution patterns elucidated. Insights into starch and lipid distribution as well as the aromatic and protein co-location (mixtures) of cell contents were gained. The fit of the latter lumen content was inferior to the other fits due to noisier spectra (higher fluorescence background) and relevant protein and enzyme spectra were missing in our database. The gained comprehensive view on plant stem tissue heterogeneity showed the potential for future studies to unravel plant species characteristics and adaptations, but also to follow plant developmental processes and/or stress responses and/or genetic modifications.

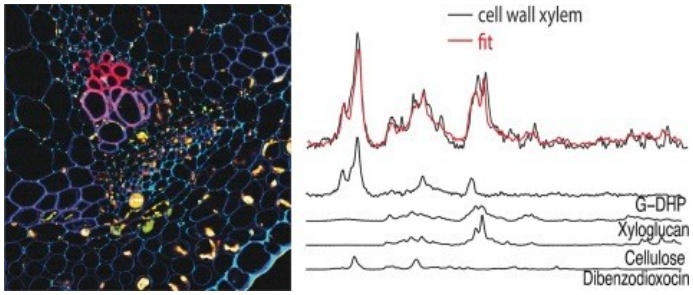

Figure1 : Tissue heterogeneity of Arabidopsis and example of fitting the Xylem spectra by reference spectra (Morel O & Gierlinger N, 2023).

Original Reference : Morel O, Gierlinger N (2023) Chemical tissue heterogeneity of young Arabidopsis stems revealed by Raman imaging combined with multivariate data analysis. Microchemical Journal 191, DOI: 10.1016/j.microc.2023.108900.

Molecules in the Self-Healing Adhesive from Mistletoe Viscin

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Objective

The objective was to unravel details on the molecular structure of viscin, an adhesive from Mistletoe berries, by Raman microscopy.

Results & Conclusion

Berries from the European Mistletoe (Viscum album)(Figure 1A-B) have a unique sticky tissue called viscin, which facilitates adhesion and germination onto host trees. Its adhesive capacity has been shown on a range of natural and synthetic surfaces including wood, skin, metals, and plastic. Therefore this biosourced extract has potential for adhesive applications in industry and biomedicine.

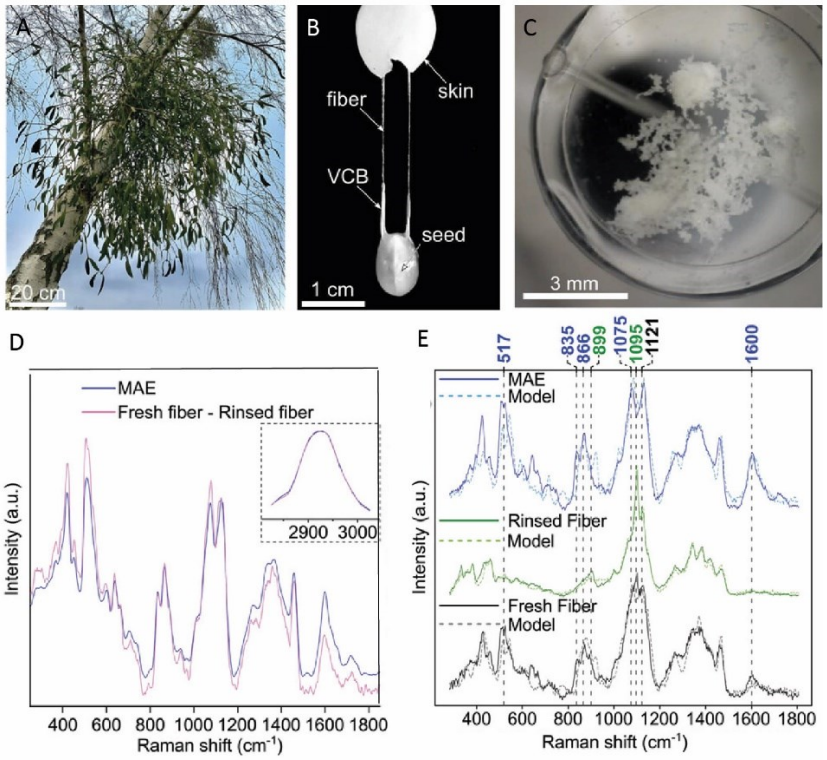

Figure 1 : Mistletoe berries, adhesive extractives and their Raman spectra. A) Mistletoe (*V. album* ssp. *album*) plant with berries growing on a deciduous host. B) Extraction of the seed from a mistletoe berry results in fiber formation C) Freeze-dried Mistletoe adhesive extractive (MAE) powder D) Raman spectrum of the MAE powder is overlaid with a difference spectrum resulting from the subtraction of averaged water-rinsed fiber spectra multiplied by a prefactor of 0.2 from the averaged native fiber spectra E) Raman spectra of a native viscin fiber, a fiber formed from water-rinsed viscin, and MAE powder. Dotted line stands for the fitted model based on a reference database. (from George et al. 2023,

It was identified that the adhesion originates from a water-soluble component that can be extracted (Fig.1C). To get insights into the molecular composition of the viscin fibers and its water extracted components we acquired Raman spectra of native as well as rinsed fibres and the water soluble mistletoe adhesive extractive (MAE) alone (Figure 1B-E).

The MAE spectrum was similar to the fresh fibre spectrum and by extracting partly the spectrum of the rinsed fibre, the same spectral signature was gained (Fig. 1D). A fit with reference spectra revealed Arabinogalactan as one of the main component of the MAE (fig. 2A), whereas the rinsed fibre spectrum was clearly dominated by strong and sharp cellulose bands (Fig. 2B). As the fresh fibre was again dominated by Arabinogalactan (Fig. 2C), it was verified that the MAE surrounds the fibre.

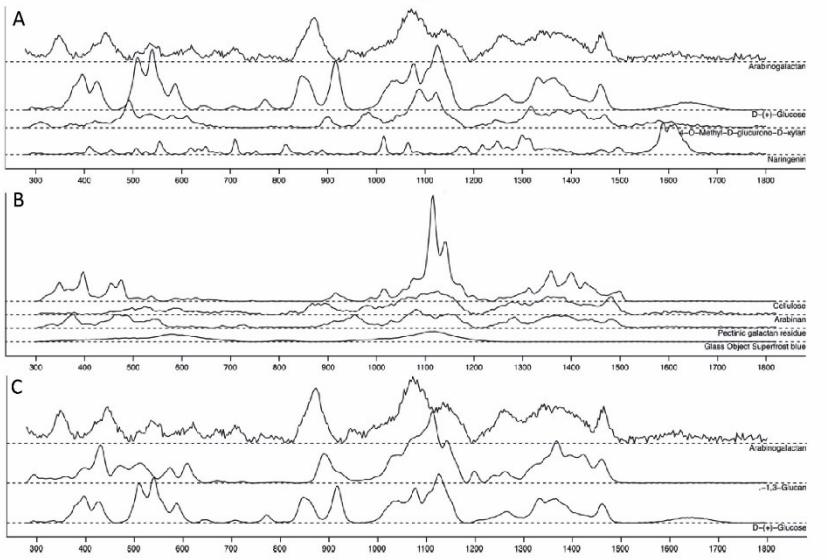

Figure 2 : Component spectra used in the fitted model of the mistletoe spectra. A) Reference component spectra fitted into the MAE spectrum (Fig. 1D), verifying a high arabinogalactan content of the adhesive. B) Fitting of the rinsed fibre revealed strong cellulose contributions, reflecting the core of the viscin fibres adn C) model fitting the fresh fibre was again based on Arabinogalactan (details in George SD et al., 2023)

Mass spectrometry investigations confirmed a composition consisting primarily of an atypical arabinogalactan, with additional sugar alcohols. Indeed, through systematic and thorough characterization of the chemical components in MAE, their structure, and their function, it should be possible to directly link the adhesive function to specific chemical features. But, even without a full mechanistic understanding, MAE is an easily extracted adhesive material that can be directly used for relevant applications. European mistletoe is a highly abundant parasitic plant that colonizes host trees across Europe. A single plant contains thousands of berries each of which can generate ≈10 mg of MAE residue, ripe for the picking for technological approaches (George SD et al. 2023).

Original Reference : George SD, Andraos E, Priemel T, Horbelt N, Keiser G, Kumar A, Heiss C, Gierlinger N, Azadi P, Harrington MJ (2023) Structure, Function, and Application of Self-Healing Adhesives from Mistletoe Viscin. Advanced Functional Materials, DOI10.1002/adfm.202307955 http://dx.doi.org/10.1002/adfm.202307955

Wood Molecule Rearrangement in lignocellulosic Aerogels

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Objective

To come up with a better understanding of wood aerogels we aim to track the rearrangement of molecules by confocal Raman microscopy and structural changes on the nanoscale by Atomic force microscopy

Results & Conclusion

Wood is currently driven beyond its traditional use through creative innovations and transformations. New properties are achieved, whereby the micro- and nanostructure plays a crucial role. Therefore, one key challenge is to control and detect the chemical and physical processes in the confined microstructure and nanopores of the cells and cell walls. With Raman imaging we can track in-situ molecules within lignocellulosic tissues and cell walls and with Atomic force microscopy (AFM) we can add nanostructure and nanomechanics. Due to the non-destructive nature of the methods we can follow in-situ the re-arrangement.

With chemical treatments like ionic liquid mixtures, the wood can be transformed into strong, shape-memory bio-aerogels with high specific surface areas (Garemark et al. 2023). On microsections of native and treated balsa wood Raman hyperspectral datasets were acquired and analysed using multivariate approaches. We first searched for the most distinct Raman spectra to visualize changes in chemistry (Figure 1a–d) and in a second step, the interpretation of the spectra was verified based on a linear combination of reference spectra (Figure 1e–g). In the Aerogel, the multivariate algorithm separated the CC (Figure 1a) from the cell wall (Figure 1b) and the nanofibrillated networks in the lumen (Figure 1c). Fitting with references verified the lignin composition of the CC (Figure 1e) and the spectral fitting with “MWL pine” points to a lignin structure with less methoxy groups than found in the balsa untreated wood. Lignin content gradually decreases toward the lumen, and some particles were found in the lumen networks (Figure 1a). The cell wall and lumen network have the same spectral signature (Figure 1b) and are carbohydrate-rich with a lower amount of lignin (Figure 1f). The fibrillated lumen networks were distinguished (Figure 1c) with typical bands at 492 and 902 cm–1 and fit with the hemicellulose xylan (Figure 1g). Altogether, nanofibrillated networks composed of holocellulose (cellulose and hemicellulose) were visualized, while cell walls showed a gradual lignin increase from the surface toward the cell wall interior (Fig. 1d). The still lignified CC results in good interfiber adhesion, and the “aerogel” filled lumen provides enhanced specific surface area. This dual structure has a positive effect on both strength and fibril surface accessibility, a rather rare combination for porous materials.

On the cut surfaces of the wood AFM measurements were done and visualized the cell corner, cell wall and the nanofibril networks with high resolution (Fig. 1h-l). The network attaches distinctly to the remaining cell wall, which strongly supports the assumption of the dissolution and conformational change of the cell wall.

Correlative Raman imaging and atomic force microscopy advanced our knowledge of the molecular re-organization and nanostructure of the lignocellulosic aerogel (Garemark et al. 2023).

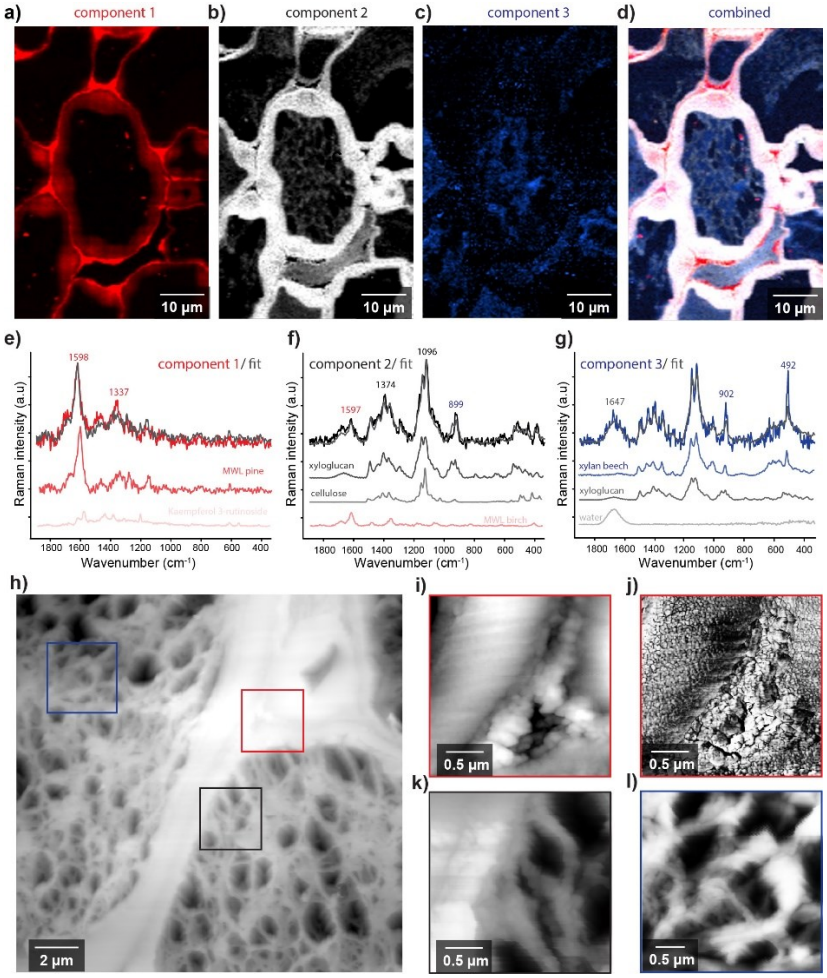

Figure: Raman imaging and Atomic force microscopy of wooden aerogels. The distribution images of the different cell wall components (a-d) and their spectral signature (e-g) show the re-arrangement of molecules and AFM images give details on the nanostructure (h-l).

Original Reference: Garemark J, Perea-Buceta E, Felhofer M, Chen B, Ruiz MFC, Sapouna I, Gierlinger N, Kilpelainen IA, Berglund LA, Li YY (2023) Strong, Shape-Memory Lignocellulosic Aerogel via Wood Cell Wall Nanoscale Reassembly. ACS Nano 17(5): 4775-4789, DOI: 10.1021/acsnano.2c11220

The opening mechanism of walnut shells

Nannan Xiao [1], *Sebastian J. Antreich* [1], *Martin Felhofer* [1,2], *Notburga Gierlinger*[1]

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[2]Holzforschung Austria. Österreichische Gesellschaft für Holzforschung, Vienna, Austria

Objective

In nature, the evolution of hard shells and seed coats served as protective mechanisms for seeds, but they often pose barriers to germination, resulting in mechanical dormancy. This research delves into the strategies employed by walnuts to overcome these protective obstacles and enable their reproduction. Employing a multidisciplinary approach encompassing chemical imaging and microscopic analysis, we explore structural and compositional disparities between walnut shells and suture tissue.

Results & Conclusion

Our findings reveal distinctive cell wall compositions in the two tissues, characterized by non-lignified thin cell walls in the suture and highly lignified thick cell walls in the shell. During drying and rehydration, walnut shells exhibit remarkable hygroscopic movements, primarily driven by the expansion of the suture. The variance in swelling between suture and shell, attributed to these cell wall distinctions, triggers the initiation of cracks in the cell walls within the transition zone. Multiple cycles of drying and rehydration subsequently enlarge these cracks, facilitating the eventual opening of the shell during seed germination.

Ultimately, this study advances our understanding of the intricate mechanisms governing walnut shell opening, shedding light on the pivotal roles played by environmental factors and structural adaptations in ensuring walnut trees' reproductive success.

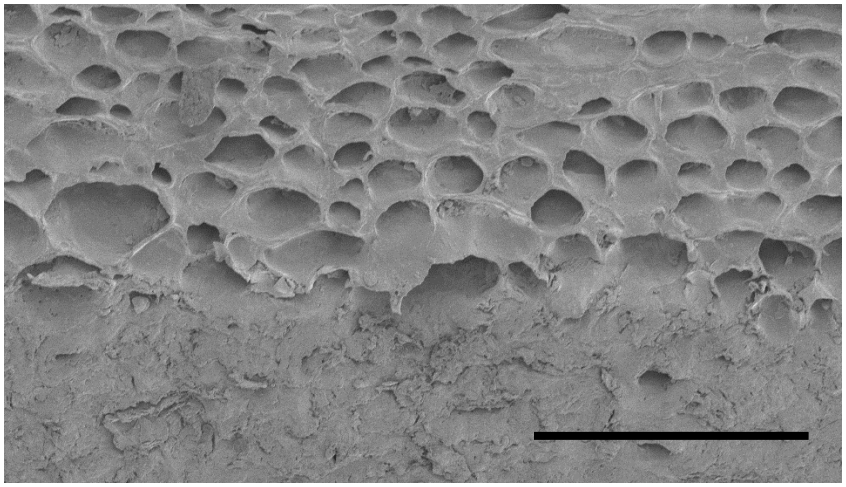

Figure: SEM image of a walnut shell showing the thin-walled suture tissue (top) and the transition to the thick-walled puzzle cells (bottom). (scale bar = 100µm)

Treating nutshell waste with deep eutectic solvents: a promising approach for renewable materials?

Paraskevi Charalambous[1], Sebastian J. Antreich[1], Notburga Gierlinger[1]

[1]Institute of Biophysics, Department of Nanobiosciences, University of Natural Resources and Life Science, Vienna, Austria

Objective

We aim to manufacture functional and sustainable materials based on two cellulosic wastes: walnut shells and kombucha pellicles. The latter ones derive from the kombucha tea fermentation and are based on bacterial cellulose fibrils, known for exceptional high tensile strength. The walnut nutshells, currently mainly incinerated, exhibit high compression within the three dimensional interlocked polylobate sclereid cells. We hypothesize that by combining these two cellulosic wastes, one optimized towards compression and one towards tension, we may introduce new attribute combinations in the resulting material.

Results & Conclusion

With deep eutectic solvents (DES), known for their environmentally friendly and efficient lignin extraction properties, we break down the complex lignocellulosic nutshells into single polylobate sclereid cells dissolved in lignin. After adding cellulose fibers to the dissolved nutshells, we formed films by regenerating the lignin to achieve flexibility and cohesion. To reveal the structure and performance of the films various methods were applied: mechanical tests, contact angle measurements, moisture content analysis, infrared spectroscopy, and scanning electron microscopy. The lignocellulosic films possessed unique properties derived from the waste material combination and DES treatment, making them suitable for applications in various industries, such as packaging, textiles, construction, and more. By repurposing waste materials, minimizing environmental impact, and contributing to the creation of renewable alternatives, treating nutshell waste with DES, and adding cellulose from a fast generative cycle exemplifies a promising path for sustainable material developments. This approach aligns with the global drive toward circular economy principles and eco-friendly practices.

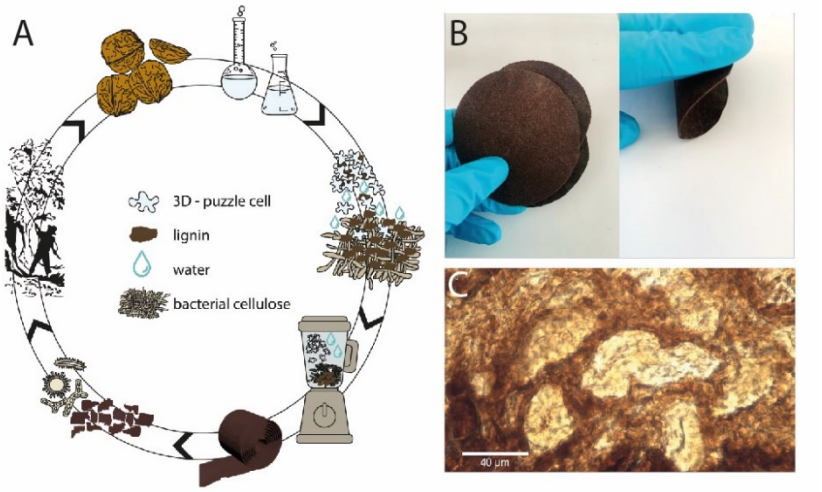

Figure: A) Closed loop cycle and procedure of making sustainable composites out of walnut shells and kombucha pellicles. B) Composite on the macro and C) micro-scale.

Adaptations for fog and dew harvesting in cactus spines

Jessica C. Huss[1], *Martin Grömmer*[1]

[1]Institute of Biophysics, Department of Bionanosciences, University of Natural Resources and Life Science, Vienna, Austria

Objective

Cacti are native to the New World and show distinct adaptations that allow them to survive even in the driest deserts of the world. A characteristic feature of cacti is the formation of spines instead of leaves, which are commonly known as mechanical defence. Interestingly, some species are able to harvest fog and dew with their spines. A basic understanding of the structure and biochemistry of water harvesting cactus spines is still largely lacking. Therefore, this project aims at investigating the anatomy, biochemistry and water interactions of different spines systematically to understand how cactus spines contribute to water collection in arid regions.

Results & Conclusion

Some species utilize spines with porous surfaces that absorb water and transport it within the spine by capillary forces, whereas others show hydrophobic and continuous surfaces. This suggests that at least two fundamentally different types of cactus spines exist for water harvesting: 1) porous spines with internal water transport, and 2) non-porous spines with surface transport.

Pictures/Figures

Figure: Spine of *Copiapoa* after exposure to fog. © Huss/Grömmer, Institute of Biophysics, BOKU Vienna

Characterisation and cytotoxicity investigation of environmental nanoparticles as an approach to health risk assessment the case of Ethiopian Rivers and Reservoirs

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Partner universities: Addis Ababa University

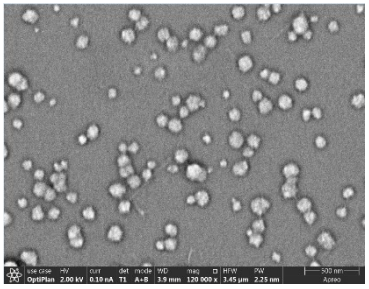
Statement of the problem

The analysis of nanoparticles in environmental samples is a relatively new field of research. Moreover, most of the research reports on spiked nanoparticles in environmental samples are limited to pristine nanoparticle composition and there are few scientific reports dealing with real environmental samples. The lack of attention to emerging pollutants, especially in growing cities such as Addis Ababa, would pose serious health and environmental risks. Although there is a large body of scientific knowledge on aquatic ecosystems on water quality status using physicochemical and biological water quality variables, and although there are many suspected sources of engineered nanoparticles in this growing world, the knowledge on the assessment of emerging pollutants such as nanoparticles is lacking and the impact of pollution is not sufficiently addressed. So far, the different environmental variables that describe the level of pollution have been assessed in the rivers found in Addis Ababa and its surroundings. Thus, high concentrations of trace metals such as chromium, lead and arsenic, as well as high concentrations of nutrients and pathogenic organisms have been reported (Badatu et al., 2019 and Mekonnen and Amsalu, 2018). However, the impact of emerging pollutants such as nanoparticles has never been seen and attention is only given to their advancement and use in daily life. Therefore, the aim of this study is to characterise nanoparticles in rivers and reservoirs found in and around Addis Ababa and investigate their cytotoxic effects as an approach for human and environmental risk assessment.

General objective The main goal of this research will be to investigate the size, quantity and toxicity effects of environmental nanoparticles and assess their risk to environment and human health. The specific objective are: i) Assessing the water quality status of the selected rivers and reservoirs, ii) Nanoparticles shape, size and concentration analysis of the selected rivers and reservoirs, and iii) Cytotoxicity study (on model fish cell lines) and risk assessment.

Results & Conclusion

First analytical measurements (from chemical composition to physical properties) were conducted.



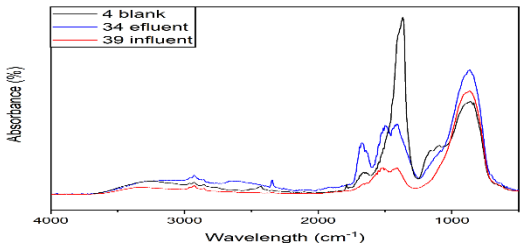


Figure. Left: representative SEM image of nanoparticles of the Aba Samuel reservoir. Right: FTIR spectrum analysis for the influent and effluent (after treatment) samples from Kality wastewater treatment.

Title: National Parks in Twitter: A German speaking perspective

María Teresa Pellicer-Chenoll[1], Karolina Taczanowska[2], Pilar Serra-Añó[3], José Luis Toca-Herrera[4], Luis-Millán González[1]

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[2]Institute of Landscape Development, Recreation and Conservation Planning, University of Natural Resources and Life Sciences Vienna (BOKU), Austria.

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Objective

Mining data from social media platforms is a way to explore aspects of human behaviour towards the natural environment. The main objective was to explore Twitter content on national parks, published be tween 2006 and July 2021, in German language.

Results & Conclusion

The tweets came from German-speaking countries, but also other countries worldwide. The most frequently mentioned national parks were located mainly in mountain areas, yet terms, hashtags, emojis and topics directly relating to mountains were rare in comparison to other subjects. Tweets most frequently included words such as forest (Wald), holiday (Urlaub) and nature (Natur); messages related not only to the natural heritage and environmental protection but also to natural disasters. The Covid-19 pandemic and national parks were also a subject of discussion on Twitter, often accompanied by photographs or videos. As 85% of all the tweets studied were never retweeted, 92% never received a reply, and 74% were never assigned likes, we conclude that there is potential to improve (social media) communications by users interested in protected areas in mountainous regions.

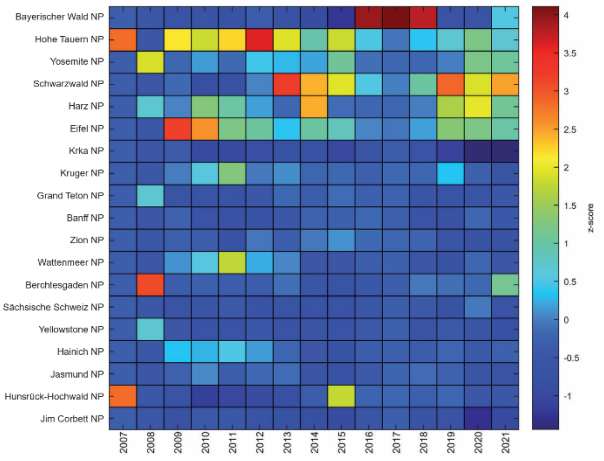

Figure: occurrence of national park (NP) names in tweets, 2007–2021. The z-score is a measure of how many standard deviations you are away from the mean.

Hierarchical polymer niches for enhanced cell attachment

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Objective

Controlling and understanding adhesion of cells (and their mechanical properties) on artificial surfaces remains as a critical topic in materials and life sciences. In this regard, combination of top-down (contact printing) and bottom-up approaches (ATRP polymerization + layer-by-layer adsorption of polyelectrolytes and proteins) as well as hydrogel production appear as a promising tool for the design and fabrication of cell-appealing interfaces. Of particular interest is the production of hydrogels of different Young´s modulus and permeability properties with embedded fluorescent beads for traction force microscopy. This will allow us to measure the shear forces that cells exert on such interfaces. Thus, the combination of substrate-anchored polymer brushes and layer-by-layer deposited polyelectrolyte chains give rise to soft 3D niches for the enhanced adsorption of ECM proteins, which will enhance cell attachment and proliferation of cells, with particular impact on both cell morphology and the number of cell-substrate connections formed. Finally, cell-substrate forces, cell-cell forces and shear forces will quantified.

Results & Conclusion

The first substrates for cell attachment, culture and proliferation have been engineered. In particular, we have prepared hydrogels of polydimethylsiloxane (PDMS) substrates and Polyacrylamide (PAA). The substrates were characterized with atomic force microscopy and contact angle. Preliminary results regarding substrate functionalization with fibronectin and the culture of MCF-7 have been obtained.

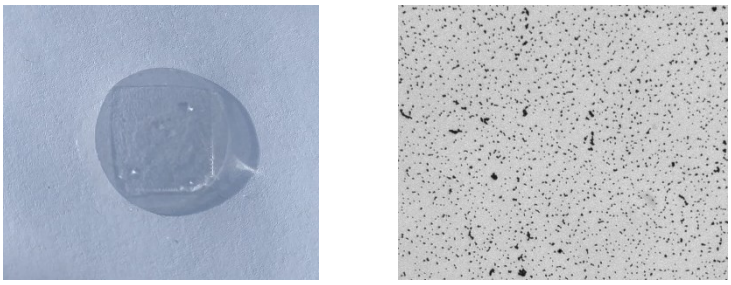

Figure: Polyacrylamide hydrogels on a 24 mm circular glass slide (recht). Brightfield image of a dispersion of 1 um green fluorescent beads on the hydrogel. Note that some particles form aggregates (left).

Effect of Reduced Feedback Frequencies on Motor Learning in a Postural Control Task (Young Adults)

Adrià Marco-Ahulló[1] , Israel Villarrasa-Sapiña[2], Jorge Romero-Martínez[3], Gonzalo Monfort-Torres[3,4], José L. Toca-Herrera[5], XavierGarcía-Masso[3]

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Objective

The objective of the study was to investigate the impact of varying feedback frequencies on motor learning during a postural control task.

Results & Conclusion

The effects of the use of reduced feedback frequencies on motor learning remain controversial in the scientific literature. At present, there is still controversy about the guidance hypothesis, with some works supporting it and others contradicting it. To shed light on this topic, an experiment was conducted with four groups, each with different feedback frequencies (0%, 33%, 67%, and 100%), which were evaluated three times (pre-test, post-test, and retention) during a postural control task. In addition, we tested whether there was a transfer in performance to another similar task involving postural control. As a result, only the 67% feedback group showed an improvement in their task performance in the post-test and retention evaluations. Nevertheless, neither group showed differences in motor transfer performance compared to another postural control task. In conclusion, the findings of this paper corroborate the hypothesis of guidance and suggest that the use of a reduced frequency of 67% is a better option for improving motor learning than options that offer feedback at a lower frequency, at all trials or not at all.

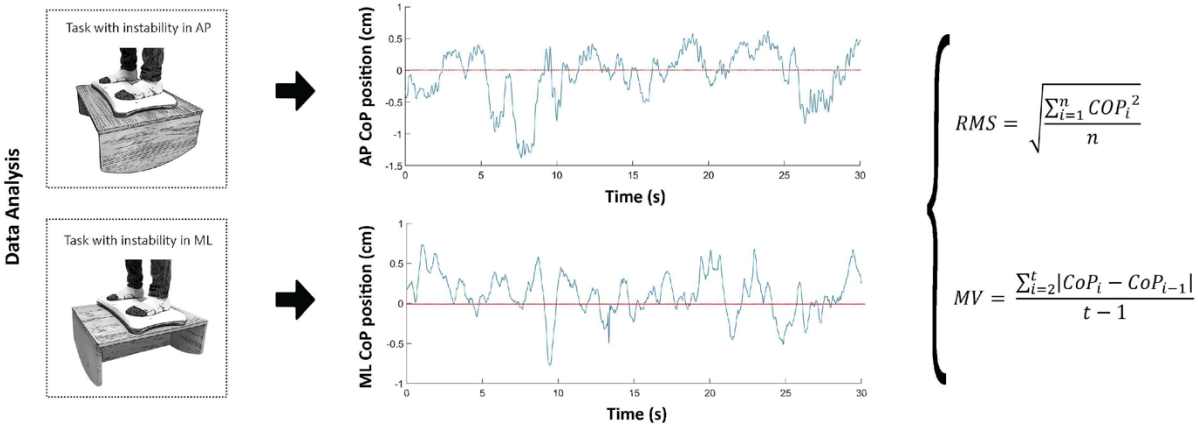

Figure: The tasks involved standing on a seesaw with anterior-posterior (AP) or medio-lateral (ML) instability, which participants had to keep as horizontal as possible for 30 seconds.

The present study suggests that reduced feedback is more effective than full feedback for learning a postural task.

Effects of meteorology on bike-sharing: Cases of 13 cities using non-linear analyses

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Objective

The objective of this research was to explore the impact of meteorological factors on bike-sharing systems (BSS) across 13 different cities. By employing non-linear analyses, the study aimed to uncover how weather conditions influence BSS demand.

Results & Conclusion

Bike-sharing system (BSS) provides bicycle rental services for short-term use. The association of BSS with meteorological factors has not been studied sufficiently using nonlinear analysis. To bridge these gaps, this study explored the impact of meteorological conditions on bike-sharing system (BSS) usage in 13 cities in Europe and North America, using a combination of nonlinear analyses to avoid the limitations of linear analyses used traditionally. Specifically, self-organizing map (SOM) and decision tree analyses were used. The SOM results revealed six meteorological profiles (clusters). Kruskal–Wallis test was applied to determine the main effect of the cluster on the input variables. The decision tree indicated temperature (34.4%), followed by clusters (23.3%), and cities (17.5%) as the most influential factors on BSS usage.

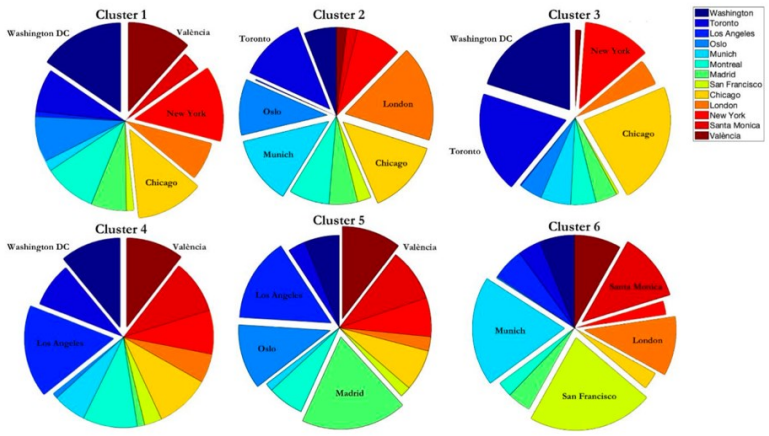

Figure: Distribution of cities in the clusters. The percentage of days of each city in clusters has been shown. Cities with >10% of the days in each cluster are separated.

The results indicate that temperature, clusters, and geographic area **were** sufficient to predict the use of BSS. All meteorological variables, except temperature, were of marginal. These findings demonstrate the need to generate nonlinear analyses to understand the dynamic interaction of meteorological variables and BSS usage, providing insights for developing sustainable urban transportation policies.

Trends in the Discussion of Cycling in Urban Environments: An X-Based Study

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Objective and Summary

Urban transportation addresses issues affecting the population and environment of a city. To handle this problem, scientific literature and policies are oriented towards promoting sustainable means of transport in urban environments, such as cycling. Public opinion is a key factor in shaping these policies for greater effectiveness, and therefore, must be taken into consideration. This study aims to analyse bicycle users' topics and sentiments on X (formerly Twitter) regarding urban cycling since the implementation of the Sustainable Development Goals (SDGs). From 2016 to 11 2022, more than 116, 051 posts were published on this subject and downloaded through the X search API; duplicates, replicas, and reposts were removed. The results showed a total of 9641 (unique) words, with 'good' and 'great' as the most repeated terms (excluding search keywords and accompanying verbs or prepositions). 'Bike Lane', 'New York City', '#mobility' and '' were the most repeated bigram, trigram, hashtag and emoji, respectively. Analysis of the topics resulted in 10 positive themes and 10 negative themes. The most relevant positive topic was the benefits of cycling as a means of transport and the most relevant negative topic was the coexistence with motor vehicles. This study provides a useful overview to guide and support effective policies oriented towards the population to promote cycling as a means of transport, and consequently, to achieve SDGs.

Results & Conclusion

This work identifies the key issues that the population considers relevant to urban cycling. This enables policies to be oriented towards user concerns and address them, eventually increasing the use of cycling as a means of transport in the urban context. Moreover, including emojis in the search equation allowed us to achieve greater precision in discerning the subject matter of the posts.

Figure: Main topics found in positive post.

Oligomer assembly of Bacillus thuringiensis Cyt2Aa2 on lipid membranes reveals a thread-like structure

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[4]Department of Biology, Faculty of Science, Burapha University, Chonburi 20131, Thailand

Objective and Summary

Bacillus thuringiensis, a widely known insecticidal bacterium, produces several insecticidal proteins, including cytolytic (Cyt) proteins. Cyt proteins bind directly to the lipid membrane and form large protein complexes. In addition to the protein size (ladder band), information on the oligomeric structure in lipid membranes is necessary to understand the mechanism of Cyt. In this work, we have investigated the oligomeric Cyt2Aa2 complex with lipid bilayers. When the activated Cyt2Aa2 protein was incubated with lipid membranes, the protein ladder pattern was detected in the acrylamide gel that was relevant for haemolytic activity. In addition, AFM topographic images revealed a fusilli-like structure and a ring-like structure for POPC and POPC/Chol, respectively. Moreover, TEM micrographs provided additional information of the oligomeric structure of Cyt2Aa2 in erythrocytes. Cyt2Aa2 appears to oligomerise/aggregate into mixed structures between the filamentous structure and small protein complexes in erythrocytes. In addition, the nanopore was found to be a substructure of the filamentous structure. These results strengthen the understanding of the mechanism of Cyt2Aa2 and support the possibility of two model mechanisms, pore formation and detergent action, depending on the type of lipid membranes.

Results & Conclusion

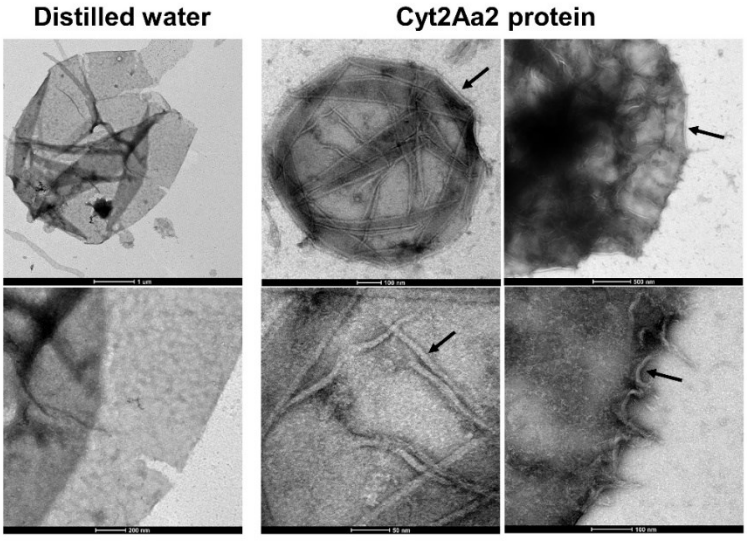

Figure: TEM micrographs of Cyt2Aa2 complex on the erythrocyte membranes.

The highlights of this work are: i) Cyt2Aa2 forms the fusilli-like structure with the POPC lipid membrane, ii) Cyt2Aa2 forms the ring structure with the POPC/Chol lipid membrane, iii) Cyt2Aa2 oligomer on the erythrocyte membrane reveals the filament thread-like structure.

Characterization of Breast Cancer Aggressiveness by Cell Mechanics

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[1]Institute of Biophysics, Department of Bionanosciences, University of Natural Resources and Life Sciences, Muthgasse 11, 1190 Vienna, Austria
[2]Cancer Heterogeneity Lab, Center for Cooperative Research in Biosciences (CIC bioGUNE), Basque Research and Technology Alliance (BRTA), Derio, Spain

Summary

In healthy tissues, cells are in mechanical homeostasis. During cancer progression, this equilibrium is disrupted. Cancer cells alter their mechanical phenotype to a softer and more fluid-like one than that of healthy cells. This is connected to cytoskeletal remodeling, changed adhesion properties, faster cell proliferation and increased cell motility. In this work, we investigated the mechanical properties of breast cancer cells representative of different breast cancer subtypes, using MCF-7, tamoxifen-resistant MCF-7, MCF10A and MDA-MB-231 cells. We derived viscoelastic properties from atomic force microscopy force spectroscopy measurements and showed that the mechanical properties of the cells are associated with cancer cell malignancy. MCF10A are the stiffest and least fluid-like cells, while tamoxifen-resistant MCF-7 cells are the softest ones. MCF-7 and MDA-MB-231 show an intermediate mechanical phenotype. Confocal fluorescence microscopy on cytoskeletal elements shows differences in actin network organization, as well as changes in focal adhesion localization. These findings provide further evidence of distinct changes in the mechanical properties of cancer cells compared to healthy cells and add to the present understanding of the complex alterations involved in tumorigenesis.

Results & Conclusion

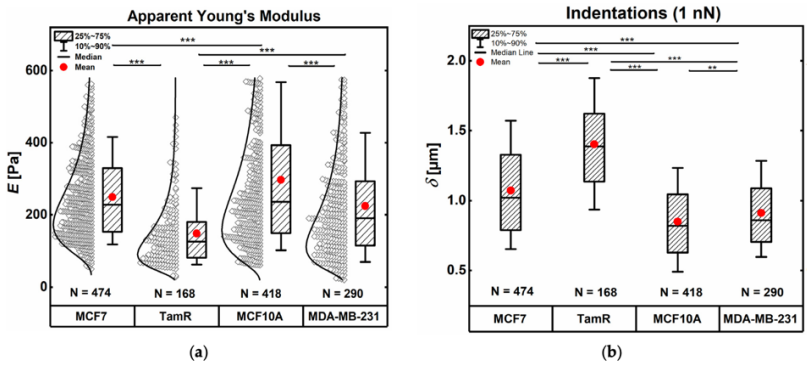

Figure: Cell mechanical data derived from the indentation segments of AFM force spectroscopy curves: (a) elasticity E expressed as the apparent Young's modulus and (b) indentations recorded at curves: (a) elasticity E expressed as the apparent Young's modulus and (b) indentations recorded 1 nN for the examined cell lines.

Out of the examined cell lines, the non-tumorigenic MCF10A cells are the stiffest cell line with well-defined ventral actin stress fibers. MCF-7 cancer cells, which are malignant with low invasive potential, are softer with seemingly fewer and thinner ventral stress fibers, but with more transverse actin arcs forming lamellae. The highly invasive, triple-negative MDA-MB-231 cells are softer than both MCF-7 and MCF10A cells, despite forming well-defined ventral actin stress fibers, with few to no transverse a

Application of self-organizing maps to AFM-based viscoelastic characterization of breast cancer cell mechanics

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[2]Cancer Heterogeneity Lab, Center for Cooperative Research in Biosciences (CIC bioGUNE), Basque Research and Technology Alliance (BRTA), Derio, Spain

Objective

The objective of the study was to utilize self-organizing maps (SOMs), an unsupervised artificial neural network technique, for analyzing mechanical measurements obtained via Atomic Force Microscopy (AFM).

Results & Conclusion

Cell mechanical properties have been proposed as label free markers for diagnostic purposes in diseases such as cancer. Cancer cells show altered mechanical phenotypes compared to their healthy counterparts. Atomic Force Microscopy (AFM) is a widely utilized tool to study cell mechanics. Together with the need to perform many measurements for statistical significance and to probe wide enough areas in tissue structures, the application of machine learning and artificial neural network techniques to automatically classify AFM datasets has received interest recently. We propose the use of self-organizing maps (SOMs) as unsupervised artificial neural network applied to mechanical measurements performed via AFM on epithelial breast cancer cells treated with different substances that affect estrogen receptor signalling. We show that changes in mechanical properties due to treatments, as estrogen softened the cells, while resveratrol led to an increase in cell stiffness and viscosity. Our approach was able to distinguish between estrogen treated, control and resveratrol treated cells in an unsupervised manner. In addition, the maps enabled investigation of the relationship of the input variables.

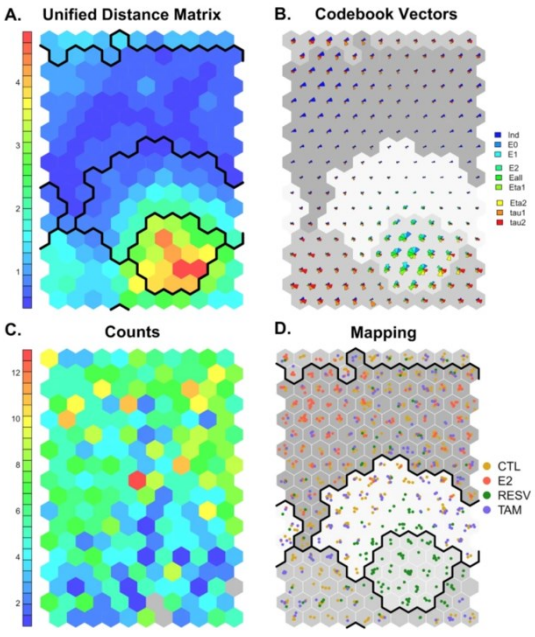

Figure: Results of training the self-organizing map using a batch algorithm. (A) Unified distance matrix plot. The colour scale corresponds to Euclidean distance between nodes. The post hoc clustering was performed using kmeans clustering with 4 centroids. (B) Fan-diagram showing the spatial distribution of the nine different variables on the 2D map. Parameters: indentation, the equilibrium modulus, moduli of the springs in Maxwell arms, instantaneous modulus, relaxation times and viscosities. Counts plot of the number of observations per node. In grey nodes, zero observations are placed. (D) Mapping of the treatment as input factors. Cluster1 includes 227 measurements, Cluster2 69, Cluster3 195 and Cluster4 545. Notation: CTL (control), E2 (estrogen), RESV (resveratrol), TAM (tamoxifen).

The Rust programming language for data analysis

Lukas Schrangl[1], José L. Toca-Herrera[1]

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Objective

Rust is a rather new programming language featuring memory safety and support for parallel computing while offering similar runtime performance as C/C++. Recently, Rust has been adopted in a variety of large software projects including the Linux kernel, web browsers, and cloud computing. We want to explore the use of Rust for analysis of biophysical data, which we believe will yield much faster code than popular programming languages, such as Python, while keeping common problems with compiled languages, like memory management issues, at a minimum. Additionally, Rust allows for easy implementation bindings to other languages, making it possible to integrate into existing projects.

Results & Conclusion

A framework for statistical permutation testing has been implemented for use in the molecular forces project mentioned above. Even though it does not use parallel computing yet, its performance is much superior to a simultaneously developed Python implementation.

Building of a Brewster angle microscope

Lukas Schrangl[1], Wisnu Sudjarwo[1], José L. Toca-Herrera[1]

[1]Institute of Biophysics, Department of Nanobiotechnology, University of Natural Resources and Life Science, Vienna, Austria

Objective

Brewester angle microscopes allow for imaging of lipid monolayers formed at the interface between an aqueous solution and air. Since commercial microscope are expensive, we want to build our own from readily available parts.

Results & Conclusion

Necessary parts have been identified and ordered. BAM is expected to be operational by mid 2024.

Publications
(SCI articles, reports, preprints, etc.)

1. **Structure, Function, and Application of Self-Healing Adhesives from Mistletoe Viscin**
   S. D. George, E. Andraos,T. Priemel, N. Horbelt, G. Keiser, A. Kumar, C. Heiss, N. Gierlinger, P. Azadi, M.J. Harrington
   Advanced Functional Materials 34 (2024), 2307955
   doi: 10.1002/adfm.202307955

2. **Hydrolyzable tannins are incorporated into the endocarp during sclerification of the water caltrop Trapa natans.**
   J.C. Huss, S.J. Antreich,M. Felhofer, K. Mayer, M. Eder, A.C. Vieira Dias Dos Santos, G. Ramer, B. Lendl, N. Gierlinger
   Plant Physiology 194 (2023) 94
   doi: 10.1093/plphys/kiad408

3. **Chemical tissue heterogeneity of young Arabidopsis stems revealed by Raman imaging combined with multivariate data analysis**
   O. Morel, N. Gierlinger
   Microchemical Journal 191 (2023) 108900
   doi: 10.1016/j.microc.2023.108900

4. **Curvature in Biological Systems: Its Quantification, Emergence, and Implications across the Scales**
   B. Schamberger, R. Ziege, K. Anselme,M. Ben Amar, M. Bykowski, A.P.G Castro, A. Cipitria, R. A. Coles, R. Dimova, M. Eder, S. Ehrig, L.M. Escudero, M.E. Evans, P.R. Fernandes, P. Fratzl, L. Geris, N. Gierlinger, E. Hannezo, A. Iglic, J.J.K. Kirkensgaard, P. Kollmannsberger, L. Kowalewska, N.A. Kurniawan, I. Papantoniou, L. Pieuchot, T.H.V. Pires, L.D. Renner, A.O. Sageman-Furnas, G.E. Schroder-Turk, A. Sengupta, V.R. Sharma, A. Tagua, C. Tomba, X. Trepat, S.L. Waters, E.F. Yeo, A. Roschger, C.M. Bidan, J.W.C. Dunlop
   Advanced Materials 35 (2023) 220611
   doi: 10.1002/adma.202206110

5. **Strong, Shape-Memory Lignocellulosic Aerogel via Wood Cell Wall Nanoscale Reassembly**
   J. Garemark, E. Perea-Buceta, M. Felhofer, B. Chen, M.F.C. Ruiz, I. Sapouna, N. Gierlinger, I.A. Kilpelainen, L.A. Berglund, Y.Y. Li
   ACS ACS Nano 17(5) (2023) 4775-4789
   doi: 10.1021/acsnano.2c11220

6. **Frozen mountain pine needles: The endodermis discriminates between the ice-containing central tissue and the ice-free fully functional mesophyll**
   M. Stegner, O. Buchner, M. Gesslbauer, J. Lindner, A. Florl, N.N. Xiao, A. Holzinger, N. Gierlinger, G. Neuner
   Physiologia Plantarum 175 (2023) e13865
   doi: 10.1111/ppl.13865 4775-4789

7. **3D (x-y-t) Raman imaging of tomato fruit cuticle: microchemistry during development**
   A. González Moreno, E. Domínguez, K. Mayer, N. Xiao, P. Bock, A. Heredia, N. Gierlinger
   Plant physiology 191(1) (2023) 219-232
   doi: 10.1093/plphys/kiac369.

8. **Characterisation of breast cancer aggressiveness by cell mechanics**
   B. Zbiral, A. Weber, M. dM Vivanco, J. L. Toca-Herrera
   International Journal of Molecular Sciences 24 (2023) 12208
   doi:10.3390/ijms241512208

9. **Measuring (biological) materials mechanics with atomic force microscopy. 5.**
   Traction force microscopy (cell traction forces)
   J.C. Gil-Redondo, A. Weber, M. dM. Vivanco, J. L. Toca-Herrera
   Microscopy Research and Technique
   doi: 10.1002/jemt.24368

10. **Recombinant peptide production softens Escherichia coli cells and increases their size during C-limited fed-batch cultivation**
    A.Weber, M. Gibisch, D. Tyrakowski, M. Cserjan-Puschmann, J. L. Toca-Herrera, G. Striedner
    International Journal of Molecular Science 24 (2023) 2641
    doi: 10.3390/ijms24032641

11. **Mutation of a Threonine Residue in αD-β4 Loop of Cyt2Aa2 Protein Influences Binding on Fluid Lipid Membranes**
    C. Tangsongcharoen, J. L. Toca-Herrera, B. Promdonkoy, S. Tharad
    Toxins 15 (2023) 167
    doi: 10.3390/toxins15020167

12. **National Parks in Twitter: a German-speaking Perspective**
    M. Pellicer-Chenoll, K. Taczanowska, P. Serra- Añó, J. L. Toca-Herrera, L.-M. González
    eco.mont 2023 (15) 25 (doi:10.1553/eco.mont-15-1s25)

13. **Unraveling Complex Hysteresis Phenomenon in 1,2-Dipalmitoyl-sn-Glicero-3-Phosphocholine Monolayer: Insight into Factors Influencing Surface Dynamics**
    Wisnu Arfian A. Sudjarwo, Jose L. Toca-Herrera.
    Int. J. Mol. Sci 24 (2023) 16252, 2023

14. **Application of self-organizing maps to AFM-based viscoelastic characterization of breast cancer cell mechanics**
    A.Weber, M. dM. Vivanco, J.L. Toca-Herrera
    Scientific Reports 13 (2023) 3087
    doi: 10.1038/s41598-023-30156-3

15. **Expert opinion on "Cholesterol can make surfaces non-stick"**
J. L. Toca-Herrera
Nature 618 (2023) 733
doi: 10.1038/d41586-023-01681-y

Conferences, seminars, schools, and workshops

TITLE: Kalmia procumbens: Cuticle, stomata and trichomes chemistry revealed by Confocal Raman Microscopy
AUTHORS: G. Tiloca, P. Charalambous, P. Bock, O. Buchner, G. Neuner, N. Gierlinger
CONFERENCE: 24th Conference of the Austrian Society of Plant Biology (ATSPB)
PLACE: Salzlager (Austria), 2023

TITLE: Dissolving and reshaping walnut shells: a sustainable material solution?
AUTHORS: P. Charalambous, J. Huss, S.J. Antreich, N. Gierlinger
CONFERENCE: 24th Conference of the Austrian Society of Plant Biology (ATSPB)
PLACE: Salzlager (Austria), 2023

TITLE: Kalmia procumbens: Cuticle, stomata and trichomes chemistry revealed by Confocal Raman Microscopy
AUTHORS: G. Tiloca, P. Charalambous, P. Bock, O. Buchner, G. Neuner, N. Gierlinger
CONFERENCE: MECAREACT: Vibrational and Electronic Spectroscopies applied to the study of reaction mechanisms
PLACE: Paris (FR), 18-23/06/2023

TITLE: Chemical imaging of plant tissues in context with microstructure
AUTHOR: N. Gierlinger
CONFERENCE: EPSO Seminar “The cutting Edge of Cell Imaging in Plants”
PLACE: online 14/12/2023

TITLE: Raman Imaging of Plant Cells: probing distribution and orientation of molecules
AUTHORS: N. Gierlinger
CONFERENCE: 12th International Conference of Advanced Vibrational Spectroscopy (ICAVS12)
PLACE: Krakow (Poland) 2023

TITLE: Raman Imaging of Plant Cells
AUTHOR: N. Gierlinger
CONFERENCE: Seminar of the Vibrational Spectroscopy Section of the Swedish Chemical Society
PLACE: online 18/04/2023

TITLE: Raman Imaging of wood: chemistry in context with anatomy
AUTHOR: N. Gierlinger
CONFERENCE: Q-net mini-symposium on plant cell walls
PLACE: online (Austria) 2023

TITLE: Fog and dew harvesting in cactus spines
AUTHOR: J.C. Huss
CONFERENCE: Seminar in the Desert Botanical Garden
PLACE: Phoenix, AZ, (USA) 2023

TITLE: Structure and growth of cactus spines
AUTHOR: J.C. Huss
CONFERENCE: The Batsheva de Rothschild Seminar on Physics & Biology of Plant Growth
PLACE: Ein Gedi (Israel) 2023

TITLE: Fog and dew harvesting in cactus spines
AUTHOR: J.C. Huss
CONFERENCE: Biological Colloquium, TU - Dresden
PLACE: Dresden (Germany) 2023

TITLE: Crystalline structures in biology
AUTHOR: J.C. Huss
CONFERENCE: Lecture for the Arts & Science Master Programme, University of Applied Arts
PLACE: Vienna (Austria) 2023

TITLE: Molecularly Imprinted Polymers and Their Use in Sensor Applications
AUTHOR: Wisnu Arfian A. Sudjarwo
CONFERENCE: Lecture at Faculty of Industrial Technology, Bandung Institute of Technology
PLACE: Bandung – West Java (Indonesia) 2023

TITLE: Optical imaging of intra- and extracellular micro- and nanoplastic during cell division (poster)
AUTHORS: E. Brynzak-Schreiber, E. Schögl, K. Cseh, V. Kopatz, A. Legin, M. A. Jakupec, A. Weber, J. L. Toca-Herrera, G. del Favero, E. Kiss, W. Wadsak, L. Kenner, V. Pichler
CONFERENCE: 18th European Molecular Imaging Meeting
PLACE: Salzburg (Austria) 2023

TITLE: The Influence of Hypoxia on Breast Cancer Cell Mechanics (poster)
AUTHORS: B. Zbiral, Maria DM Vivanco, Jose L. Toca-Herrera
CONFERENCE: Exner Lectures 2023
PLACE: Vienna (Austria) 2023

TITLE: Predicting cycling in urban environments through non-linear analysis using exposome variables: A pilot study (poster)
AUTHORS: L. Anton Gonzalez, I. Villarrasa-Sapiña, J. Devis-Devis, L.M. Gonzalez, F. Stefan, J.L.Toca-Herrera, K. Taczanowska
CONFERENCE: Exposome
PLACE: Utrecht (Netherlands) 2023

TITLE: Biophysical and Substrate Bioengineering Methods for investigating Cell Adhesion, Cell Spreading and Cell Mechanics (poster)
AUTHORS: A. Einschütz-Lopez,A. Moreno-Cencerrado, R. Ortiz, J.C: Gil-Redondo, V. Saravia, J. Iturri, A. Weber, M. dM. Vivanco, I. Quintana, J.L. Toca-Herrera
CONFERENCE: 12th International Colloids Conference
PLACE: Palma de Mallorca (Spain) 2023

TITLE: Investigating the Influence of Lipid Composition on Lipid Monolayer Behaviour: A Rheological and Hysteresis Study (poster)
AUTHORS: W. Sudjarwo, J.L. Toca-Herrera
CONFERENCE: 15th ÖGMBT Annual Meeting
PLACE: Salzburg (Austria) 2023

TITLE: Erasmus forever
AUTHOR: J.L. Toca-Herrera
CONFERENCE: Researchers and Teachers go international (BOKU IR)
PLACE: Vienna (Austria) 2023

TITLE: Science, where are ou going
AUTHOR: J.L. Toca-Herrera
CONFERENCE: Institute of Pure and Applied Mathematics (Polytechnic University Valencia)
PLACE: Valencia (Spain) 2023

Ongoing projects, national and international collaborations

Projects and research:

https://boku.ac.at/nano/biophysics/forschung

Main collaborations:

- **Assoc. Prof. Rafael Benítez**, Faculty of Economics, University of Valencia, Spain
- **Prof. Ingo Burgert**, Head of Institute for Building Materials ETH Zurich, Switzerland
- **Dr. Michaela Eder**, Max Planck Institute of Colloids and Interfaces, Potsdam, Germany
- **Prof. Wolfgang Gindl**, Institute for Wood technology and Renewable materials, BOKU Vienna, Austria
- **Assoc. Prof. Luis Millán González**, Dept. of Physical Education and Sport, University of Valencia, Spain
- **Prof. Anna de Juan**, Chemometrics group, University of Barcelona, Spain
- **Dr. Chartchai Krittanai**, Mahidol University, Institute of Molecular Biosciences, Thailand
- **A.o. Univ. Prof. Ursula Lütz-Meindl**, University of Salzburg, Cell Biology and Physiology Department, Salzburg, Austria
- **Prof. Shawn D. Mansfield**, University of British Columbia, Forest Sciences Centre, Vancouver, Canada
- **Prof. Gilbert Neuner**, University of Innsbruck, Institute of Botany, Unit Functional Plant Biology, Innsbruck, Austria
- **Prof. Georg Papastavrou**, Faculty of Biology, Chemistry, and Earth Sciences, University of Bayreuth, Germany
- **Prof. Gerald Striedner**, Institute of Bioprocess Science and Engineering, BOKU Vienna, Austria
- **Dr. Maria Vivanco**, CICbioGUNE, Spain