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Cover image & p. 19: Single-celled freshwater green alga, genus Micrasterias (order Desmidiales), showing typical bilateral symmetry, with two mirror image semicells (J.P. Pickett-Heaps and T. Spurk).

Botany Foundation

The University of Melbourne Botany Foundation supports the discipline of Botany – the study of plants and plant processes.

The Foundation supports excellence in education and research in the School of BioSciences through: student awards and scholarships, early career postdoctoral awards and fellowships, a Professorial Chair, seed grants, and a partnership with the Royal Botanic Gardens Victoria. Plant science contributes to Australia's National science and research priorities and capacity building in the areas of biosecurity, agriculture and food production, the environment, biodiversity classification and conservation, and health.





— BOTANY FOUNDATION

Board Members 2021

Dr Tony Gregson AM FTSE, External Chairman

Professor Pauline Ladiges AO FAA, Deputy Chairman

Ms Sally Browne AM, External Member

Professor Adrienne Clarke AC FAA FTSE, External Member

Associate Professor John King AM, External Member

Professor Moira O'Bryan, Dean Faculty of Science

Associate Professor Alex Johnson, School of BioSciences

Ms Kia Matley,
Postgraduate Student

Associate Professor Ed Newbigin, School of BioSciences

Professor Ute Roessner, Head School of BioSciences

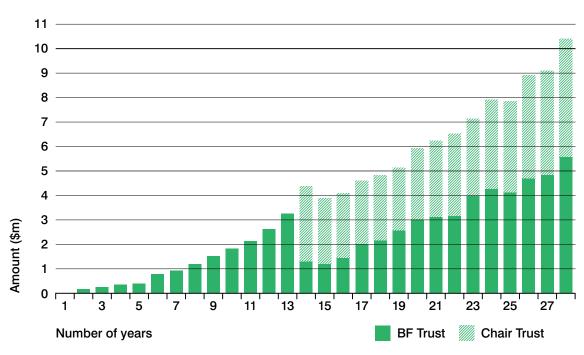
Supported by Ms Penny Fairbank, Advancement, Faculty of Science

- INTRODUCTION

Report from the Botany Foundation's Board Chairman

2021 was another challenging year for university students, teaching staff and researchers. However, study and research progressed, and the Foundation was able to continue its support through our named scholarships and prizes, fellowships and grants.







Growth and impact of the Foundation

The Board recently summarised its history and achievements over the last 27 years. The Botany Foundation was established in 1995 with a starting value of \$32,920 and has steadily grown to an impressive current total of \$10.4 million.

In 2007 the Foundation transferred funds to establish a separate Trust, the Adrienne Clarke Chair of Botany, which has grown to \$4.8 million. The Board has set an ambitious target to increase this Chair fund by a further \$1-2 million to be able to provide significant support for leadership in plant science. Current holder of the Chair, Professor Michelle Watt (see 2020 Annual Report), is a distinguished expert in crop root physiology who is focused on understanding plant root functions and their function in water uptake and soil carbon sequestration. Plant roots are the foundation of carbon storage in soils, a significant part of the global carbon cycle, and relevant to agriculture and managing climate change. Michelle sees an opportunity to enhance plant roots and fill the large gap in scientific knowledge of biological functions below ground.

Our first student scholarship, the Sophie Ducker Postgraduate Scholarship, was awarded in 1996 (see p. 8) and since then the Foundation has been able to support nearly 400 students through an increased number of endowed awards (now 10) as well as travel scholarships for postgraduate students to attend national and international conferences and research laboratories. Many of our students have gone on to have successful careers in scientific research, administration, teaching and industry.

Our goal is also to grow our 'untied' funds that allow the Foundation the flexibility to respond to new initiatives and retain key researchers in partnership with the Faculty of Science, School of BioSciences and other external institutions. This year we contributed funds for a 'Botany Foundation Fellow', plant cell biologist Dr Berit Ebert (profiled in our 2020 Annual report) with the aim to support, retain and recognise excellence in plant science.

We sincerely thank all of our donors for enabling us to be in a position to help our young graduate students and research scientists, enabling continued excellence in plant science in the University.

Yours sincerely,

Dr Tony Gregson AM FTSE

Chairman, Botany Foundation

— SUPPORTING STUDENTS

2021 Student Scholarships and Awards

The Botany Foundation scholarships and awards provide financial support to plant science students in the School of BioSciences each year.

The value of the eleven awards listed here totalled \$33,200 this year.

Botany Prize – Top 3rd year botany student

Braden Callaway

David H Ashton Scholarship

Allison Mertin PhD: "Understanding the diversity and ecology of native grass seed microbiomes for improving restoration practices"

David Ashton Travel Scholarship

Tessa Doherty Honours: "Shrub reproductive output and growth over time since fire at Black Mountain, Canberra"

Sophie Ducker Postgaduate Scholarship

Amelia-Grace Boxshall PhD: "Phylogenetic investigation of field-mushroom genus *Agaricus* (Agaricales) biodiversity across eastern Australasia"

Megan Klemm Postgraduate Research Award (shared)

Huizhen Xu PhD: "How plants make woody tissue"

Nicholas Chong PhD: "Role of transposable elements in the blackleg fungus in its ability to overcome canola cultivar resistance and to develop fungicide resistance"

Bruce Knox Prize – Top 4th Year (Honours) Botany Student

Oscar Fung

Ethel McLennan Award (shared)

Cheka Kehelpannala PhD: "The profile of lipids in specific tissues of the model plant *Arabidopsis*"

Uthpala Lekamlage Don PhD: "Characterization of algal-bacterial interactions through metagenomic and culture analysis"

Gretna Weste Plant Pathology and Mycology Scholarship

Tianxiao Hao PhD: "Unravelling the biogeography of Australian fungi"

Kingsley Rowan Marine Botany Prize – Top 3rd Year Marine Botany Student

Matthias Haslauer

G.A.M. Scott Research Award

Qiwei Li PhD: "Investigating the function of a gene regulation complex (called LEUNIG) in a basal plant lineage, the liverwort *Marchantia polymorpha*, for understanding adaptation and early colonisation of land"

John S. Turner Postgraduate Scholarship (shared)

Chris Buckley PhD: "The circadian control of leaf senescence and nutrient mobilisation in wheat and *Arabidopsis*"

Patrick Hannah PhD: "The role of the small protein Ubiquitin (found in all eukaryote cells) in the regulation of plasma membrane-bound proteins in plants, including during grain-filling in rice and wheat"

Student awards named in memory of past botanists and staff of the University

The John S Turner Postgraduate Scholarship honours the scientific contribution and leadership of John Stewart Turner OBE FAA (1908-1991), graduate of Cambridge University and second Professor of Botany and Plant Physiology from 1938 to 1973. He made important advances in plant physiology, strongly supported ecological research and became an influential voice for conservation.

The Gretna Weste Plant Pathology and Mycology Scholarship honours the late Dr Gretna Weste (d. 2006) who was a member of the School of Botany from 1961-1982. She was the foremost authority in Australia on the biology and impact of the soil borne oomycete *Phytophthora cinnamoni*, which has caused dieback disease in forests of Victoria, Tasmania and Western Australia.



1996 – The first Foundation student award

The first postgraduate student to receive a
Botany Foundation scholarship was Andrew
Doust. He was awarded the **Sophie Ducker Postgraduate Scholarship** for research
on Australian flora. For his PhD, Andrew
investigated floral morphology and development
of plants in the 'primitive' family Winteraceae,
and made field collections in Australia and
New Caledonia. He was the first student
representative on the Board of the Foundation.

Andrew is now Professor and Associate Dean of Academic Programs in the College of Arts and Sciences, Oklahoma State University, USA. He also leads a successful research team investigating plant architecture, developmental genetics, and domestication events in grasses and grain crops.

Prof. Andrew Doust, Red Rock Canyon, Oklahoma

— STUDENT RESEARCH

Understanding the diversity and ecology of native grass seed microbiomes for improving restoration practices

By PhD student, Allison Mertin who was awarded the David H Ashton Scholarship

My research is aimed at using seed microbiome knowledge to improve restoration and conservation outcomes of degraded grassy woodland, grassland, and swampland ecosystems. I am investigating the diversity, ecology and biology of the endophytic bacteria and fungi within seeds of Themeda triandra (kangaroo grass), Microlaena stipoides (weeping grass) and Melaleuca quinquenervia (paperbark tree). Microbes can exist asymptomatically within the seed of their host plants and play an important role in forming the initial beneficial plant microbiome through promoting seedling growth and establishment. They can also occur as latent pathogens and decomposers, causing seed disease and decay. Understanding what microbes are present and their roles will inform how seed is stored in seed banks for restoration, provide benchmarks for what endophyte diversity is present within seed of natural ecosystems and provide opportunities to utilise these microbes in field-based restoration of degraded ecosystems.

My project involves collecting seed from these three species along the eastern coast of New South Wales and within the Monaro and Western Tablelands regions, which contain endangered ecological communities such as Cumberland Plain Woodlands and *Themeda* grasslands. The collection sites include those that have been restored and also those that are within conservation areas.

In a collaboration with the Royal Botanic Gardens of New South Wales, I am isolating to pure culture and characterising the seed bacteria and fungi. Novel isolation techniques, conserved gene sequencing, and determination of the presence of plant growth promoting traits of the microbes are being used. At the University

Allison in the lab processing the collected seed



of Melbourne, I am determining the microbiome makeup by high throughput DNA sequencing (meta-barcoding) and I will use microfluidics (using fabricated micro-scale devices to observe and model the dynamics of swimming cells under a high-powered microscope) to investigate the role that seed exudates play in attracting these microbes to the germinating seed.

Allison's research is supervised by Professor Linda Blackall and Dr Douglas Brumley (University of Melbourne) with external supervisors Dr Edward Liew and Marlien van Der Merwe (RBG, Sydney)

How plants make woody tissue

By Huizhen Xu, who shared the Megan Klemm Postgraduate Research Award

The tallest flowering plant in the world is *Eucalyptus regnans*, Mountain Ash, a tree endemic to wet forest of Victoria and Tasmania. It can reach heights of over 100m. To grow to this height a critical adaptation is the highly specialized vascular tissue that provides efficient water transport from the roots to the shoots and sufficient mechanical strength to support the massive upright stature of the tree.

This vascular tissue is largely made up of cell walls, which in turn are composed of multiple polysaccharides, proteins, and phenolic compounds; but the most abundant, and arguably the most important, component is cellulose. Cellulose is a major loadbearing component of the cell wall and is responsible for providing strength and rigidity to the walls. It is also economically important because it is a critical component of the food we consume and many of the everyday materials we use including paper, textiles and wood.

The synthesis of cellulose is a highly complex, and a highly regulated cellular process mediated by large CELLULOSE SYNTHASE A (CESA) protein complexes at the membrane that surrounds all plant cells. Although intense



efforts have been invested in unravelling cellulose synthesis, relatively little is known about the mechanisms that regulate the synthesis of cellulose biosynthesis at a post-translational level.

My research explores how post-translational modifications, especially phosphorylation, mediates cellulose biosynthesis. Phosphorylation is one of the most common reversible post-translational modifications and plays an important role in regulating protein activities, protein-protein interactions, subcellular localization, and signal transduction. My research will reveal which phosphorylation sites in CESA proteins are critical for the rate and pattern of cellulose deposition in plant cell walls and how this might affect the form and function of vascular tissues in plants.

The Megan Klemm Postgraduate Award provided support to Huizhen Xu to extend her PhD research time when her laboratory experimental program was delayed due to Covid restrictions. She is supervised by Dr Edwin Lampugnani and Professor Staffan Persson.

— STUDENT RESEARCH

Discovering the biodiversity of *Agaricus* mushrooms across eastern Australia

 By Amelia-Grace Boxshall, who was awarded the Sophie Ducker Postgraduate Scholarship

The mushroom genus *Agaricus* (Basidiomycota) is estimated to contain more than 500 species globally, many of which are commercially and culturally significant fungi, including the edible button mushroom *A. bisporus* and the toxic species *A. xanthodermus*. In Australia, *Agaricus* species (native, cosmopolitan or introduced) can be found in sclerophyll woodlands, semi-arid rangelands, and urban parks. As a saprophytic genus, *Agaricus* plays a major role in nutrient recycling of forest litter and is a food source for native animals that are mushroom foragers. Australian *Agaricus* are poorly known, with only two recent studies of truffle-like forms published and only 13 species described from Australian types. Another 26 species are named based on northern hemisphere species concepts or represent informally recognised morphotypes for which 'tag' names, but no descriptions, are available.

The aims of my research are to assess the diversity of species in eastern Australasia (including representatives from New Zealand), and determine their phylogenetic relationships within a global framework of *Agaricus*. I am sampling mushrooms in the field but also I have access to herbarium specimens and collections obtained from collaborators. In recent years molecular analyses have revolutionised the study of fungi, and thus I am sequencing nuclear DNA from my samples to build a comprehensive multi-gene data set for analysis. So far I have nearly 300 DNA sequences in my data set.

My results should identify species and taxonomic groups that have evolved in the Australasian biogeographic region, some of which have been misidentified as northern hemisphere taxa; this will lead to more accurate taxonomic treatments. Furthermore, by sequencing mushroom DNA and comparing taxonomic patterns based on traditional characters such as the colour and structure of the mushroom fruiting body and spore shape and size, I will be able to determine the utility of morphological and ecological characters for taxonomy and field identification.





Top: Unidentified species of Agaricus.

Bottom: Amelia-Grace in the field

Grace is supervised by Dr Jo Birch (The University of Melbourne Herbarium) and Dr Teresa Lebel (State Herbarium of South Australia)

— FOUNDATION RESEARCH FUNDS

WISE Fellowship – enabling Coral reef conservation

"Spatial metabolomics – visualising biomolecule interactions between corals and their symbiotic microalgae *in situ* at a micrometre scale"

 By Dr Wing Yan Chan, Research Fellow awarded the 2021 Women in Science for the Environment (WISE) Fellowship

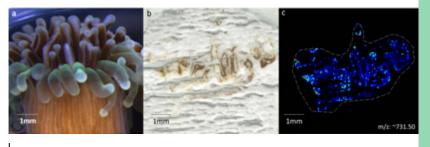
In the face of global coral reef decline, research that informs reef and biodiversity conservation is essential.

Although coral reefs occupy less than 0.1% of the ocean surface they support almost one third of presently known marine biodiversity. However, ocean warming has caused worldwide reef decline, and coral resilience to ocean warming is strongly affected by the taxonomic identity of their microalgal symbionts. Much of our understanding of biomolecule interactions between corals and their symbiotic microalgae is established using tissue homogenates, where spatial information is lost. My research aims to pioneer a method novel for coral - to visualize the spatial distribution of biomolecules (e.g., metabolites, lipids, peptides) in situ at a micrometre scale. and to reveal the change in types and distribution of these biomolecules during a simulated heat shock event.

I have successfully developed mass spectrometry imaging (MSI) in corals with a Matrix-Assisted Laser Desorption-Ionization method, and generated density maps of biomolecules at $50\mu m$ resolution for each of the thousands of biomolecules. I am also using Fluorescence *in Situ* Hybridization (FISH) probes that have taxon-specific binding to microalgal ribosomal RNA, which allows me to map different microalgal taxa within a coral section. By using these two methods I can thus co-locate algal taxa and the biomolecules they produce as symbionts of coral.

The method being developed in this project will allow me and other researchers to visualize metabolic interactions between corals and their symbiotic microalgae at a resolution that is not currently available. This will allow inferences on how these interactions will change under global warming, providing guidance to microbiome manipulation in reef restoration practices.

The WISE fellowship is an excellent opportunity for me to conduct novel research and develop an area of expertise.



- a) A polyp of the coral Galaxea fascicularis;
- b) 12 μm thin section of the polyp with microalgal symbionts in brown colour;
- c) density map of a betaine lipid at 50 µm resolution in situ.

— FOUNDATION RESEARCH FUNDS

V Sarafis Fund – supporting bryophyte research

— By Dr Edwin Lampugnani and Ms Fiona King

The late Vassilios Sarafis was a biologist, microscopist and physicist and a regular donor to the Foundation. He left a lasting bequest for an endowment to support work on bryophytes, ferns, gymnosperms and algae.

Plant cell walls give form and function to individual cells and have significant implications for the food we consume and many of the everyday materials we use including paper, textiles and wood. However, precisely how these celluloserich walls are made is not well understood as we do not know the identities of all components needed to make them.

We have been developing the bryophyte (liverwort) Marchantia polymorpha as a simple model system to study cell wall biosynthesis. During the several COVID-related lockdown periods of 2020 and 2021, one of the biggest challenges our research encountered was the difficulty of keeping plant lines alive and healthy. Unlike flowering plants, bryophytes do not set seed suitable for long-term storage. Instead, plant lines must be actively maintained through asexual propagation,



Fiona King and Edwin Lampugnani with their new storage unit for growing bryophytes

usually by collecting fragments of tissue from the parent and transferring the material to new growth media. Throughout the entire lockdown period, plant lines had to be transferred to new growth media every 4-6 weeks, which is a time-consuming process. It is, however, possible to slow the growth rate of *M. polymorpha* in order to extend their life cycle by many months, by storing plants at a constant low temperature (between 4 and 10 degrees) with supplemental light.

With financial support from the Foundation's V Sarafis Research Fund, we were able to purchase a large, refrigerated unit to house our bryophyte samples for long-term storage. The unit has a glass door and internal lighting that ensures that the plants receive sufficient natural and supplemented light for healthy growth. We expect that samples will be able to be keep growing for up to 12 months to increase our capacity to run more experiments.

Fern Research Fund – Curating the Herbarium Fern Collection



The Fern Research Fund was established by a gift in 2014 from the Victorian Fern Society. The Fern Society had been formed many years before to promote knowledge and interest in ferns and fern allied plants, and the conservation of ferns and their habitats, but with declining membership it was disestablished and funds given to both the Botany Foundation and Royal Botanic Gardens Victoria.

The University's Herbarium curator Dr Jo Birch is using the modest annual investment income to employ a casual student assistant each semester to continue curation of the MELU herbarium's Pteridophyte (fern) collection for research.

Curation includes remounting of specimens whose treatment didn't meet current standards, updating fern scientific names accepted in the Australian Plant Census, and digitisation for online data record and access. Digitizing the collection provides valuable reference information for taxonomists, ecologists and anyone interested in ferns.

Professor Jeremy Pickett-Heaps award for plant and algal cell biology research

With the support of family, colleagues and friends, the Botany Foundation has raised funds for an award in honour of the late Professor Jeremy Pickett-Heaps. Through generous donations, the fund has reached \$50,000 and will be able to provide support to an early career researcher working in the area of plant and algal cell biology in

recognition of Jeremy's discoveries of cell dynamics.

Jeremy was devoted to filming the complex and extraordinary life of microscopic cells and microorganisms, producing a range of exceptional teaching and research videos that have thrilled and inspired generations of undergraduate and postgraduate students.

Jeremy Pickett-Heaps, BA PhD Cambridge FRS FAA, died on 11th April 2021. He was Professor of Botany at the University of Melbourne from 1988 until his retirement in 2002, when he became an active Professorial Fellow. He was elected to the Australian Academy of Science in 1992 and the Royal Society in 1995 for his research excellence.



Foundation Gifts Received In 2021

Adrienne Clarke Chair of Botany

Clarke AC, Adrienne Delmer, Deborah

Botany Foundation

— Unrestricted/Research

Anderson, John &
Anderson OAM, Patricia
Harrison, John
Huynh, Luan
King, John &
King, Heather
Watt, Michelle

— Pollen CountAnonymous x 8

Carter, Paul
Connell, Mark
Cosgrove, Bradley
Cybula, Thomas
Hine, Margaret
Quach, William
Rogers, Rebecca
Sharp, Simon
Luo, Jun

— Jeremy Pickett-Heaps Award

The Family of Jeremy Pickett-Heaps The Musser Family Fund Anonymous x 4 Beech, Peter Bennet, Dana Berry, Rebecca &

Berry, David

Boyle, Judith
Francis, Ross
Helper, Peter
Kowalski, Susan
Ladiges AO, Pauline &
Nelson, Gareth
McIntosh, Richard
Perasso, Laura
Rezendes, Beau
Smyth, Rick
Watts, Cassie
Wills, Anuysua

Gretna Weste Plant Pathology & Mycology Scholarship

Anonymous Guest AM, David Idnurm, Alexander Ladiges AO, Pauline

David H Ashton Scholarship

Hooley, Doug

Sophie Ducker Postgraduate Scholarship

Flesch, Juliet

Megan Klemm Research Award

Anonymous Hallam, Neil

Ethel McLennan Award

Gaff. Donald

Pauline Ladiges Plant Systematics Research Fellowship

Costermans, Leon Moors AO, Philip Nelson, Gareth

Plant Systematics Research Fund

Chambers AM, Carrick Chambers, Margaret Ladiges AO, Pauline Playford, Mary

Protist Systematics Research Fund

Cowan, Roberta Kershaw, Helen

John S Turner Postgraduate Scholarship

Anonymous Gaff, Donald Regan, Margaret Tarrant, Valerie Turner, Peter

The Herbarium Fund

Anonymous x 2
Gregson AM, Tony
Ladiges AO, Pauline
Morgan OAM, Susan
Watts, Cassie

WISE Fellowship

Carrucan, Anna

- FINANCIALS

Foundation Financial Summary in 2021

	Balance at 01.01.2021 (\$)	Income¹ (\$)	Awards & Expenses ² (\$)	Revaluation ³ (\$)	Balance at 31.12.2021 (\$)
Adrienne Clarke Chair of Botany Trust	4,252,859.00	182,943	(130,200)	536,047	4,841,649
Botany Foundation Trust					
Unrestricted Funds ⁴	1,363,114	117,249	(58,447)	165,650	1,587,566
David Ashton Travel Award	51,841	1,974	(3,549)	5,956	56,222
David H Ashton Scholarship	139,027	6,734	(5,243)	17,521	158,039
Sophie Ducker Postgraduate Scholarship	83,651	3,487	(3,186)	10,518	94,470
Megan Klemm Research Award	117,184	9,986	(4,520)	14,514	137,164
Bruce Knox Prize	45,322	1,822	(1,746)	5,527	50,925
Pauline Ladiges Plant Systematics Research Fellowship	1,388,681	65,140	(64,110)	173,168	1,562,879
Ethel McLennan Award	64,034	2,721	(2,464)	7,796	72,087
Plant Systematics Research Fund	301,619	13,897	(10,311)	37,962	343,167
Protist Systematic Research Fund	77,457	13,388	(2,952)	9,631	97,524
Kingsley Rowan Marine Botany Prize	26,536	1,074	(927)	3,266	29,949
G.A.M. Scott Research Fund	143,642	5,819	(5,645)	17,724	161,540
John S. Turner Postgraduate Scholarship	93,945	5,392	(3,497)	11,880	107,719
Gretna Weste Plant Pathology and Mycology Scholarship	41,537	3,849	(1,642)	5,162	48,906
The Fern Research Fund	37,258	1,485	(1,274)	4,515	41,984
V Sarafis Research Fund	72,745	2,935	(1,618)	8,974	83,035
The University of Melbourne Herbarium Fund	693,417	38,251	(7,031)	88,326	812,962
Women in Science of the Environment (WISE) Fellowship	123,096	4,919	(6,958)	14,985	136,043
Botany Foundation Trust – Total	4,864,106	300,122	(185,120)	603,074	5,582,182
Total of the Two Trusts	9,116,965	483,065	(315,320)	1,139,122	10,423,831

- 1. Income includes donations and earnings on investments
- 2. Expenses include administration charges
- Revaluation amounts represent the change in unit price of the capital units during 2021 of respective Trusts
 Unrestricted Funds support research initiatives, the Pollen Count and events. The Fund currently includes donations to the Jeremy Pickett-Heaps Award, which will be transferred to a separate project account during 2022.

Visit the Botany Foundation web site for information and how to donate:



science.unimelb.edu.au/engage/ giving-to-science/botany-foundation

